



**INDUSTRY  
COMMISSION**

**RESEARCH  
AND  
DEVELOPMENT**

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(Parts D to G)**

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## **PART D BUSINESS R&D**

This part of the report looks at R&D carried out by the business enterprise sector, defined as covering mining, manufacturing and services. This definition follows the approach of the ABS, whereby enterprises mainly engaged in agriculture, forestry, fishing and hunting are not included in its surveys of business enterprise R&D. This is partly because of collection difficulties and partly because such enterprises are believed to have very low R&D activity — agricultural R&D is generally carried out by specialised research institutes not included in the business enterprise sector. Rural R&D is considered separately in part E.

In chapter D1, some basic characteristics of business R&D activity are presented, and international comparisons made in respect of business expenditure on R&D and levels of government support. In chapter D2, the main government programs supporting business R&D are described, and a detailed assessment of selected programs is undertaken in chapters D3 through to D5. The major program of business R&D support — the 150 per cent R&D tax concession — is discussed in chapter D3. The effectiveness of that scheme, together with the syndication arrangements, is assessed and the views of participants for modifying the schemes are canvassed.

Prior to the May 1994 White Paper, the IR&D Board operated a set of five grant programs which complemented the tax concession. In the White Paper it was announced that the five grant schemes would be combined into one, with a single set of eligibility and merit criteria. The effectiveness of the separate schemes is assessed in chapter D4, in order to provide insights into the likely effectiveness of the combined scheme. Chapter D5 looks at commercialisation issues both in terms of companies commercialising the outcomes of public sector research as well as the results of their own R&D.

Chapter D6 addresses the issue of cost recovery — an addition to the inquiry's terms of reference in February 1995.

Finally, recommendations to enhance the efficiency and effectiveness of existing programs are put forward in chapter D7.

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# D1 CHARACTERISTICS OF BUSINESS R&D

## D1.1 Introduction

This chapter presents a number of ‘stylised facts’ on Australian business R&D activity. Section D1.2 looks at what business R&D is mainly about, while section D1.3 looks at how business R&D activity has changed over the past couple of decades. The amount that business in Australia spends on R&D (relative to GDP) is compared with other countries in section D1.4, while international comparisons of government support for business R&D are presented in section D1.5. The remaining sections look at what sectors or industries mainly carry out business R&D (section D1.6) and what types of company have mainly contributed to the change in business R&D in recent years (section D1.7).

## D1.2 What is business R&D?

As noted in chapter A1, R&D is commonly viewed as encompassing three types of activity:

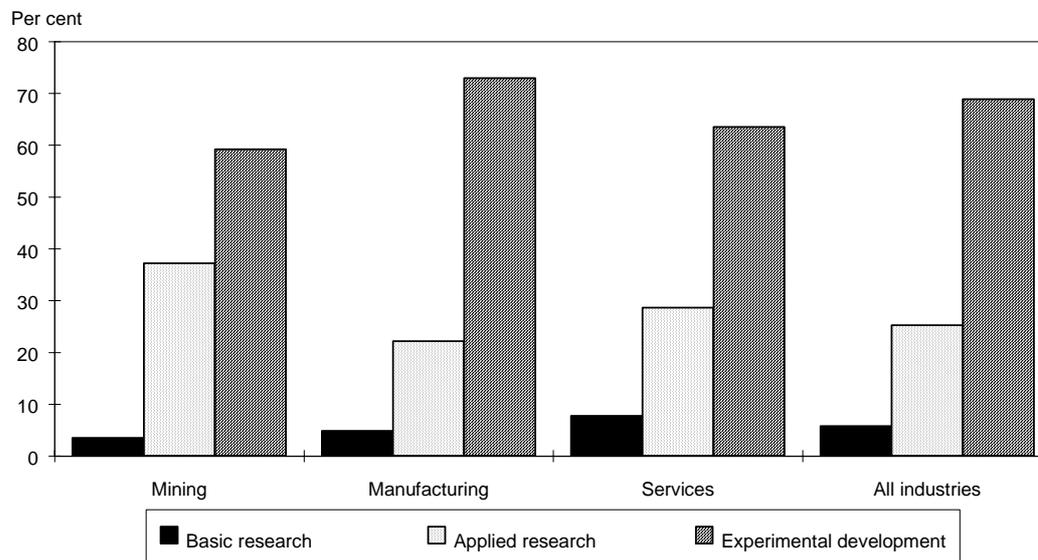
- *Basic research* — experimental and theoretical work undertaken primarily to acquire new knowledge without a specific application in view.
- *Applied research* — original work undertaken in order to acquire new knowledge with a specific application in view.
- *Experimental development* — systematic work, using existing knowledge gained from research or practical experience, for the purpose of creating new or improved products/processes.

Typically, business R&D activity is mainly experimental development. For example, 69 per cent of business R&D expenditure in 1992–93 was on experimental development, whereas 25 per cent was on applied research and only 6 per cent on basic research (figure D1.1). At the broad sector level, manufacturing enterprises devoted a higher proportion of R&D to experimental development (around 73 per cent), while mining and services devoted a higher proportion to applied research than manufacturing.

Therefore, while the term ‘R&D’ is used throughout this chapter, it is important to be mindful that business R&D is more ‘D’ than ‘R’.

While this chapter focuses on R&D, it should be pointed out that R&D is, of course, an input into the innovation process. Some output measures of R&D and innovation are presented in chapter A3.

Figure D1.1: Business R&amp;D by type of activity, 1992–93



Source: ABS, Cat. No. 8104.0, table 4.

### D1.3 How has business R&D activity changed over time?

#### Trends in business R&D activity

The available data on business R&D activity extends back to 1968–69. In considering changes in business R&D activity over time, three useful indicators are business expenditure on R&D (BERD), human resources devoted to R&D, and the number of enterprises performing R&D (table D1.1). The most notable features of the trends over the complete period are the marked contrasts in business R&D activity during the decades of the 1970s and 1980s, and the very recent upturn since 1990–91.

During most of the 1970s, BERD was declining or stationary and the ratio of BERD to GDP fell from 0.42 per cent in 1971–72 to 0.25 per cent in 1981–82. By contrast, the 1980s was marked by substantial increases in R&D effort, with BERD almost trebling in real terms, and more than doubling as a proportion of GDP. Human resources devoted to R&D increased by around 140 per cent over the decade.

Table D1.1: **Business enterprise R&D activity, 1968–69 to 1992–93**

Year	BERD current prices \$m	Ratio of BERD to GDP %	BERD constant 1989-90 prices		Human resources <sup>a</sup> person years	R&D performers No.
			\$m	% change		
1968-69	124	0.43	777		n.a.	n.a.
1971-72	166	0.42	889	4.8	n.a.	n.a.
1973-74	210	0.39	980	5.1	n.a.	n.a.
1976-77	225	0.26	651	-11.2	9 343	n.a.
1978-79	280	0.26	665	1.1	8 626	n.a.
1981-82	397	0.25	698	1.7	8 489	1 278
1984-85	731	0.34	1 023	15.5	12 563	1 986
1985-86	948	0.39	1 229	26.0	14 784	n.a.
1986-87	1 289	0.48	1 544	19.8	17 591	3 029
1987-88	1 456	0.48	1 656	7.3	18 479	n.a.
1988-89	1 798	0.54	1 943	17.3	20 803	3 048
1989-90	1 990	0.54	1 990	2.4	20 301	n.a.
1990-91	2 082	0.54	1 989	-0.1	20 907	2 685
1991-92	2 320	0.59	2 170	9.1	21 066	2 398
1992-93	2 788	0.67	2 541	17.1	22 811	2 766

a Human resources devoted to R&D measures the effort of researchers, technicians and other staff directly involved with R&D activity.

Sources: ABS, Cat. No. 8104.0; DITAC 1994a.

However, the rate of increase in R&D effort during the 1980s was not uniform. Real BERD increased quite rapidly in the period 1981–82 to 1984–85 (by around 15 per cent per year). The largest year-on-year increases in real BERD during the complete decade occurred in 1985–86 and 1986–87. These were the first two years of operation of the 150 per cent R&D tax concession, a much more broadly-based form of government support for business R&D than had operated before — such as AIRDIS (the Australian Industrial Research and Development Incentives Scheme).

In the latter part of the decade, there was a plateauing in R&D activity. Over the three-year period 1988–89 to 1990–91, the ratio of BERD to GDP was stationary at 0.54 per cent, real BERD increased by just 2 per cent, and human resources devoted to R&D was virtually unchanged. However, there was a substantial increase in R&D activity in the two most recent years reported — real BERD increased by 28 per cent.

The pattern of change in R&D activity during the 1980s was even more dramatic in terms of the number of enterprises identified as performing R&D. There was a very substantial increase in the number of R&D performers up to 1984–85 and particularly in the first two years of operation of the tax concession. However, the subsequent levelling off and decline was far more

severe than for either real BERD or human resources devoted to R&D — the number of R&D performers fell by 12 per cent between 1988–89 and 1990–91, and dropped even further during 1991–92 before recovering somewhat in 1992–93.

There are currently around 50 000 manufacturing enterprises and approximately 550 000 (non-agricultural) enterprises in total in the Australian economy. Hence, with around 2 500 to 3 000 companies identified by the ABS as R&D performers, it is clear that only a small proportion of companies carry out formal R&D.

But this needs qualification in several respects. First, the total number of enterprises includes overwhelming numbers of small businesses in services (such as newsagents, plumbers) for whom R&D is less relevant (Sub. 412, p. 5). Second, the proportion of manufacturing enterprises undertaking R&D is higher among larger firms — less than 5 per cent of small enterprises (with fewer than 100 employees), but around 40 per cent of large enterprises conduct formal R&D. Finally, it should be noted that *all* firms learn informally and incrementally from the knowledge they generate in the course of producing goods and services.

### **Explanations for changes in business R&D activity**

As noted above, the upward trend in BERD during the 1980s preceded the introduction of the tax concession in 1985–86. Part of the increase between 1981–82 and 1984–85 might reflect a definitional change — the definition of R&D in 1984–85 was extended to include computer software development. But the historical series compiled by DIST has been adjusted for this definitional change — if this were not so, the growth in BERD over this period would appear even more substantial (Sub. 412, p. 5). It has also been suggested that the relatively high level of BERD in 1984–85 reflected a ‘gearing up’ effect on companies in anticipation of the introduction of the tax concession. Finally, there was a receptive climate in industry towards R&D and innovation at the time, as a result of government initiatives to develop a venture capital market, and an increased awareness of science and technology among business (DITAC 1987).

The increase in BERD in the second half of the 1980s is often attributed solely to the introduction of the 150 per cent tax concession in 1985–86. However, there are other features of trends in BERD which caution against any inference of a simple link with the introduction of the concession.

First, some part of the increase in BERD in 1985–86 and 1986–87 is likely to have reflected a reclassification influence: some activities undertaken before but

not described as R&D were subsequently classified as R&D in order to qualify for the concession.

Second, the tax concession was only one of many factors which influenced the environment in which firms operated during the 1980s. One key influence often stressed is that the abolition of exchange controls, reduction in tariffs and deregulation of selected industries in the early to mid 1980s opened the Australian economy to international competitive pressures, which in turn played a catalytic role in encouraging R&D (Hall 1993; BCA 1993).

In relation to the most recent experience, it appears that expenditure on R&D held up fairly well despite the recession — there is a possibility that the tax concession might have played a role in this respect. Certainly, Australian business enterprises have emerged from the recession displaying the most substantial pickup in R&D expenditure for some years.

#### **D1.4 How does Australia's BERD performance compare with other countries?**

Many participants drew attention to Australia's below-average business R&D performance. For example, the Australian Biotechnology Association noted that:

Despite good percentage gains over recent years, the level of industrial R&D [as a ratio of GDP] in Australia still remains at about one-half of the OECD average and one-quarter of that in the USA or Japan. Even the growth rate of industrial R&D in Australia is still substantially less than that in South Korea, Singapore and Taiwan (Sub. 206, p. 3).

In view of this, the suggestion was put to the Commission that a target growth rate in BERD should be set as a national goal, to close the gap in relative R&D performance.

#### **Comparison of BERD/GDP ratios**

One measure for comparing business expenditure on R&D across countries is the ratio of BERD to GDP. Data for 24 OECD and Asian countries are reported in table D1.2. Notable features of the comparisons are:

- across the 24 OECD and Asian countries reported, Australia has a relatively low ranking of eighteenth;
- even compared to other similar sized R&D performing countries (like Canada, Belgium and the Netherlands), Australia's BERD/GDP ratio is relatively low; and

- the fastest growth in BERD during the 1980s was displayed by three Asian countries — South Korea, Singapore and Taiwan.

**Table D1.2: International comparisons of BERD/GDP ratios and real BERD growth**

<i>Country<sup>a</sup></i>	<i>BERD/GDP</i> %	<i>Change</i> <i>since 1981</i> <i>percentage point</i>	<i>Average growth rate</i> <i>in real BERD</i> <i>since 1981</i> %
Sweden (1993)	2.14	0.68	5.0
Japan (1992)	2.06	0.65	8.2
United States (1992)	2.04	0.33	3.8
Switzerland (1992)	1.88	0.18	3.5
Germany (1992)	1.70	0.00	4.0
France (1992)	1.51	0.35	4.8
South Korea (1990)	1.38	1.12	31.6
United Kingdom (1992)	1.33	-0.16	2.1
Finland (1992)	1.24	0.59	8.2
Belgium (1991)	1.11	0.06	2.8
Denmark (1991)	1.00	0.45	8.3
Netherlands (1992)	0.97	-0.02	3.2
Norway (1993)	0.89	0.21	5.7
Taiwan (1990)	0.89	0.37	16.5
Canada (1992)	0.82	0.22	5.4
Austria (1989)	0.80	0.15	4.9
Italy (1992)	0.77	0.28	7.1
<b>Australia (1992)</b>	<b>0.69</b>	<b>0.47</b>	<b>13.0</b>
Ireland (1992)	0.67	0.37	11.7
Singapore (1990)	0.49	0.34	23.8
Spain (1992)	0.47	0.27	12.8
New Zealand (1991)	0.28	0.06	4.6
China (1990)	0.19	n.a.	n.a.
India (1990)	0.18	0.02	7.2
Average (24 countries)	1.06	0.30	8.6
Average (OECD only)	1.18	0.27	6.3

n.a. = not available.

a Also shows year for which BERD/GDP ratios are available.

Source: Cook 1995a, p. 4.7.

Despite the fact that Australia exhibited the highest rate of growth in real BERD over the period 1981 to 1992 from among the 19 OECD countries reported in table D1.2, this only enabled Australia essentially to maintain its relative

ranking — other fast growing OECD countries also tended to be those whose growth took place from relatively low levels of BERD.

Also presented in table D1.2 is the absolute change in the BERD/GDP ratio since 1981. While many of the better R&D performing countries have exhibited below average growth in BERD, some have achieved well above-average increases in their BERD/GDP ratio — including Japan, Sweden and France.

### **Explanations for Australia's low BERD/GDP ratio**

A number of empirical studies have examined Australia's comparative BERD performance (see for example Castles 1989, BIE 1990a, BIE 1990c, DITAC 1992, Gregory 1993, and Hall 1993). Several underlying explanations have been identified for the relatively low BERD/GDP ratio, turning mainly on the size of the manufacturing sector, the structure of industries within manufacturing, and the R&D intensity of individual industries (box D1.1).

#### **Box D1.1: Reasons for Australia's low BERD/GDP ratio**

*Small size of the manufacturing sector* — In all countries, manufacturing industries perform a high proportion of business R&D. In Australia, the manufacturing sector accounts for a smaller share of GDP than many other countries.

*Different industry structure within manufacturing* — Within manufacturing, the ratio of R&D expenditure to value added (R&D intensity) varies across industries. Compared to the OECD average, Australian manufacturing has a bias towards low and medium R&D-intensive industries.

*Low R&D intensity within manufacturing industries* — Within most manufacturing industries, Australian companies tend to be less R&D intensive than their overseas counterparts.

#### *Size of manufacturing sector*

The manufacturing sector in Australia accounts for a relatively small share of GDP — around 14 per cent, compared to an OECD average of around 18 per cent. But this argument appears to be only a minor factor explaining Australia's low BERD/GDP ratio. Apart from Germany and Japan, whose manufacturing sectors account for 28 and 26 per cent of GDP respectively, most other countries lie in a band between 12 and 20 per cent. But countries like Denmark and Norway have manufacturing sectors which account for a smaller share of GDP than in Australia and yet their BERD/GDP ratios are nearly twice as large. More important explanations for the low BERD/GDP ratio relate to the structure of manufacturing industry and 'within industry' R&D-intensity.

### *Structure of manufacturing sector*

One frequently used basis for identifying differences in the structure of the manufacturing sector across countries is to distinguish between high, medium and low technology industries. The basis for such a classification turns on the R&D intensity of an industry, as measured (say) by the ratio of R&D expenditure to value added.

Compared to the industry structure of an 'average' OECD country, Australia tends to have below average shares in all 'high technology' (that is, high R&D intensive) industries and in most 'medium technology' industries. However, industries in which Australia has an 'above average' share are Non-ferrous metals and Rubber and plastics (medium technology) and Food and beverages, and Textiles and clothing (low technology) — see DIST (1994a).

### *R&D intensity in manufacturing industries*

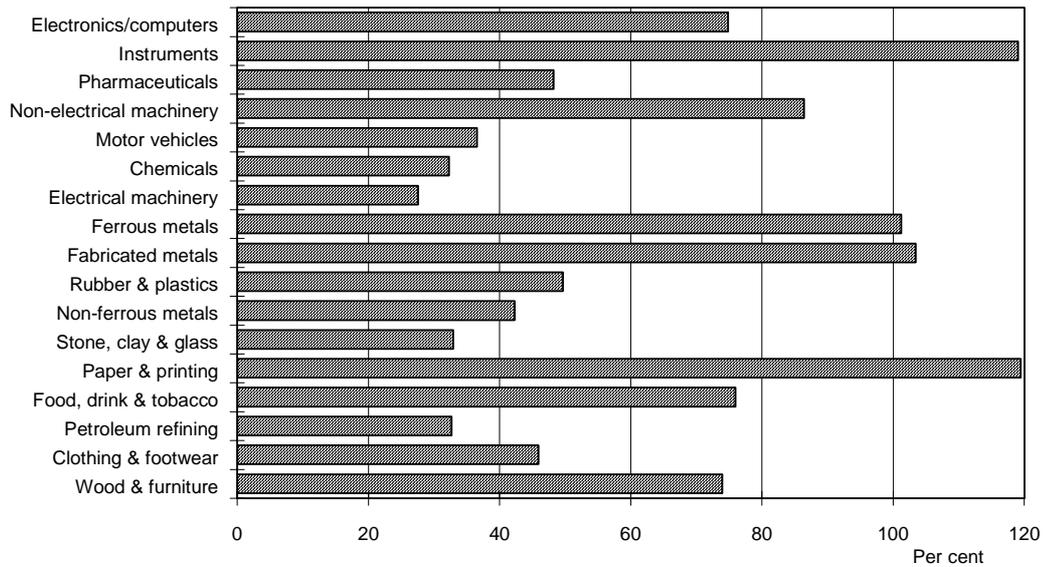
The ranking of industries in Australia in terms of R&D intensities is quite similar to other countries, because R&D intensity reflects underlying determinants of innovation activity within those industries. Nevertheless, a feature of the Australian situation is that R&D intensity in over three-quarters of all individual industries is *lower* than in their overseas counterparts (figure D1.2). In terms of a 17 industry breakdown of manufacturing, Australian R&D intensities were within 20 per cent of the OECD average in only five of the 17 industries distinguished — namely, Instruments, Paper and printing, Fabricated metals, Ferrous metals, and Non-electrical machinery. In two of these industries, the Australian R&D intensity was actually around 20 per cent *higher* than the OECD average.

The relative importance of the 'industry structure' and 'within industry R&D intensity' arguments in explaining Australia's relatively low BERD/GDP ratio appears to have changed somewhat during the 1980s. An analysis by Gregory (1993) which sought to explain the gap in the manufacturing R&D to value added ratio between Australia and the OECD average for 1981 found that R&D intensity within manufacturing industries was a far more important explanation than differences in industry structure — these effects respectively accounted for 60 per cent and 11 per cent of the gap, with the remaining 29 per cent due to the combined influence of these two effects.

A more recent analysis for 1987 (DITAC 1992) suggests that about one-third of the gap between Australian and average OECD manufacturing R&D/GDP ratios is a result of R&D intensity differences within manufacturing industries, and the remaining two-thirds is accounted for by differences in industry structure and the combined influence of these two effects. The finding that the low 'within industry' R&D intensity argument now appears to play a somewhat less

important role in explaining Australia's relatively low BERD/GDP ratio than was the case in the early 1980s is perhaps not surprising, given the substantial increase which has taken place in real BERD during the 1980s.

Figure D1.2: **R&D intensity in Australian manufacturing industries compared to OECD average<sup>a</sup>**



a The data depicted are 1990–91 Australian R&D intensity (ratio of R&D expenditure to value of production) as a percentage of OECD average R&D intensity (1987–89). The Commission has adjusted the Australian R&D intensity for petroleum refining.

Source: DIST 1994a.

### Reasons for relatively low R&D expenditure by Australian companies

The upshot of the previous section is that while R&D intensities have increased across many industries in Australian manufacturing, and while this has helped to close some of the gap between the Australian and OECD-average BERD/GDP ratios, Australian companies still tend to be less R&D intensive than their overseas counterparts in most industries. In this section, some of the possible reasons for this are canvassed.

One explanation frequently suggested is that the high degree of foreign ownership in Australia might contribute to low BERD insofar as local subsidiaries of multinationals can source most of their technology requirements from their parent.

As one participant to the inquiry, Ampol Ltd, commented:

The overseas ownership of a significant proportion of Australian business has reduced the attention given to R&D. With large research and development facilities located overseas, there has been little incentive to create similar operations, or operations of any significance, in Australia (Sub. 88, p. 6).

In respect of its own industry (petroleum), Ampol stated that:

All of our competitors are multinationals. They have no research and development facility of any significance in Australia. Ampol has no overseas parent or affiliate and so all its research and development is done within Australia (transcript, p. 802).

But the argument that the high degree of foreign control in Australia has inhibited local R&D effort is not unambiguously supported by the data. A study by the BIE (1990d) found (on the basis of data for 1986–87) that foreign-controlled firms, overall, exhibited *higher* R&D intensity than Australian-owned firms, but this is likely to reflect the fact that foreign subsidiaries tend to occur in the more R&D-intensive industries. However, across 11 industries within manufacturing, Australian controlled firms had higher R&D intensities in seven (Basic metals, Fabricated metals, Machinery, Appliances, Paper, Chemicals, and Miscellaneous manufacturing) and foreign-controlled firms in four (Transport, Minerals, Textiles, clothing and footwear, and Food). Similarly, for a sample of firms in the Australian telecommunications industry, the Centre for Technology and Social Change (TASC 1990) found that multinational subsidiaries had much lower R&D intensities, but much higher absolute levels of R&D expenditure, than locally-owned firms.

A detailed discussion of other reasons for the below-average R&D intensity of Australian firms is provided in section A4.6. There it is suggested that attitudes to R&D are conditioned by the competitive environment in which firms operate. The incentive to carry out R&D and innovate was weakened by many decades of insulation from international competitive pressures, as a result of geographic isolation and high tariff protection. The lesson from this experience is that because R&D is a cumulative process, any ‘catching up’ in R&D intensity levels in response to changes in the economic environment facing companies — including the opening up of the Australian economy to international competitive pressures and provision of R&D support programs — is likely to take time.

### **A target rate of growth in BERD?**

Because Australia’s BERD/GDP ratio is relatively low by comparison with its trading partners and competitors, some participants suggested that a target growth rate for BERD should be set as a national goal and as a focus for policy. For example, the Australian Electrical and Electronic Manufacturers’ Association (AEEMA) commented that:

While the commitment to R&D expenditure by Australian industry is increasing, we need as a nation to accelerate the culture of innovation and elevate it to the highest position of importance in national life. As a preliminary step to achieving this, AEEMA recommends [that] the Government set a goal for increases in business expenditure on R&D of 15 per cent per annum (Sub. 126, p. 10).

The IR&D Board also suggested that Australia should adopt a target growth rate for BERD:

A national target should be set to achieve a compound average annual growth in business expenditure on R&D of 17 per cent to the year 2001 (Sub. 78, p. 10).

The IR&D Board target is the rate of growth in BERD required for Australia to achieve the expected average BERD/GDP ratio across the 24 countries listed in table D1.2 in the year 2001. The Board estimated the average BERD/GDP ratio to be 2.49 per cent in 2001 (compared to 1.07 per cent in 1991) by extrapolating the 1991 BERD/GDP ratio of each country, assuming that the growth rates in BERD and GDP in these 24 countries during the decade 1981 to 1991 are maintained to the year 2001. Given Australia's BERD/GDP ratio of 0.56 per cent in 1991, an average annual increase in BERD of 17 per cent would be required to achieve a BERD/GDP ratio of 2.49 per cent by the year 2001.

There are obvious limitations in the IR&D Board's approach. These include:

- whether the notion of a 'world average' BERD/GDP ratio is meaningful (for example, should the comparisons include all countries, including the 'Big 5' R&D performers, or only include other similar sized R&D performing countries?);
- whether it is tenable to assume that the likely growth rate in a country's BERD/GDP ratio is independent of its current level (theory and evidence suggest not); and
- whether it is appropriate *not* to control for inter-country differences in manufacturing industry structure (such differences explain a large part of the 'gap').

In the draft report, the Commission tried to assess the feasibility of the suggested target by considering what improvement in Australia's BERD performance would be needed by 2001 to meet it. In 1981, the Australian BERD/GDP ratio was 0.25 per cent, and by 1991 this had increased to 0.56 per cent, implying an absolute percentage point increase over the decade of 0.31 per cent. Given a target ratio of 2.49 per cent by 2001, the required absolute increase in the BERD/GDP ratio is 1.93 percentage points. In other words, the required percentage point increase in the BERD/GDP ratio over the decade to 2001 is *six* times that achieved during the decade 1981 to 1991 — but during that decade, Australia's average annual rate of growth in BERD was already the second fastest of any other OECD country.

The IR&D Board was critical of the Commission's reaction to this target, and stated that:

... the draft is wrong in its analysis of the feasibility of targets for R&D growth rates. It claims with no evidence whatsoever that growth rates of 17 per cent are impossible (Sub. 363, p. 24).

However, no material provided in the Board's submission on the draft report has led the Commission to alter its judgment — despite the fact that real BERD increased by 17 per cent in the year to 1992–93, the magnitude of the task needed to reach the IR&D Board target for the year 2001 casts serious doubts on its feasibility.

But there are other considerations. Given the limited capacity of the economy to respond, such a target might well mean either forcing more R&D than is efficient, diverting resources from other activities, or raising the cost of funds. Indeed, as one writer has observed (in respect of Canada):

Setting an unrealistically high R&D target could result in less than optimal allocation of scarce resources elsewhere in the economy since resources for other sectors would be diverted to the R&D effort (Schulz 1994, p. 46).

The IR&D Board was disappointed with the Commission's conclusion that there seems little to be gained from seeking to identify what an 'appropriate' level of BERD or BERD/GDP ratio might be for Australia.

As the Chairman of the IR&D Board stated:

We cannot understand the lack of desire to benchmark. ... [O]ur training from industry is that you make things happen by defining the gap, saying where you want to go and setting your plans in place to get there (transcript, p. 3354).

What we do is we say where we would like [Australia] to be ... We have benchmarked ourselves to what we think is the moving target of the OECD average [BERD/GDP ratio] at the year 2001 (transcript, p. 3359).

The Commission does not necessarily disagree with the notion that targets can usefully focus attention on issues, but it does not consider it appropriate that it should venture a particular numerical target for the 'optimal' level of BERD or growth rate in the BERD/GDP ratio. What is more important, in the Commission's view, is to create a better environment in which firms and other organisations make their R&D decisions — it is in the context of creating a better environment that 'appropriate' R&D outcomes should emerge.

On the question of benchmarking R&D inputs, the comments of Laver are apt:

The question [can be] asked as to whether Australian business has ... reached the appropriate balance point [in respect of R&D projects carried out]. This is not known — all that can be stated with confidence is that the optimum level will be unique to Australia and cannot be determined by equating it with other countries. The likelihood of present expenditure being too far from the optimum is not great; while Australian business people may not necessarily always lead the world, it is unlikely they are so far behind that they consistently misjudge investment in R&D so badly that many really attractive opportunities are being ignored (1993, p. 26).

Laver continued:

Each country faces a different situation which means inputs [R&D outlays] should not be seen as the problem. Incremental returns on any investment made, the outputs from research, are the matters for attention. Only if these are being radically underestimated and Australia is denying itself major benefits by not increasing research expenditure can a case be made for more outlays (p. 26).

### **D1.5 Government support for BERD: Australia and international context**

As noted in chapter A5, government support for R&D may in general involve strengthening intellectual property rights, direct provision of R&D, and a range of instruments aimed at encouraging firms to undertake R&D themselves. Among the last of these, governments must choose from selective (firm- or project-specific) or non-selective (general) policy instruments; debt or equity involvement; loans which are repayable on concessional terms or not repayable at all (grants); subsidies or tax concessions bestowed in a variety of ways and at different rates; prizes offered for excellence in performance; policies which specially favour firms of given size, or which have particular or technological characteristics, and so on. The list is not exhaustive but provides a basis for describing Australia's current approach, and how that compares with international experience. Earlier reviews reveal that Australia has experimented with a variety of approaches over the years.

#### **Direct and indirect instruments of support**

In considering instruments of support for business R&D, one commonly used distinction is between direct instruments (such as grants, loans, equity) and indirect instruments (fiscal incentives such as tax credits or concessions). Instruments such as grants or loans are normally treated as *direct* measures of support because they provide up-front funding to companies. An instrument such as government procurement contracts is difficult to classify but, as the

OECD notes (1993e, p. 21), is generally treated as a measure of direct support. On the other hand, tax-based instruments such as tax credits (which operate by reducing tax payable) or tax concessions (which operate by reducing taxable income) are generally classified as *indirect* forms of support because the R&D expenditure must normally be carried out before the benefit in the form of a tax saving is derived.

But there is a degree of confusion even among different OECD publications in respect of this distinction. While the conventional breakdown of public support used is between direct and indirect (fiscal) measures (1993e), elsewhere fiscal measures such as tax credits and tax concessions are treated as *direct* financing instruments (OECD 1994d).

A second distinction frequently made is that between general (across-the-board) instruments, and selective (targeted) instruments. Linking this classification to the direct/indirect distinction, most indirect instruments tend to be general or non-specific in their objectives whereas direct instruments tend to be targeted. However, there are exceptions — for example, in the case of Japan a fiscal incentive (tax credit) is available to target a range of basic technologies.

An indication of the range of different instruments of R&D support across selected countries is provided in table D1.3.

Grant and loan schemes are used either to complement broad-based forms of support (in countries which operate tax-based instruments) or as the sole approach to supporting business R&D. Typically, these grants or loans are targeted at specific aspects of R&D, technology use and innovation, including:

- collaboration between industry and public sector research organisations;
- particular types of companies, such as small and medium sized enterprises (SMEs);
- particular areas of technology, such as generic, strategic or enabling technologies (for example, biotechnology, new materials technology);
- the uptake of new technology (that is, technology diffusion rather than development);
- particular activities within the broad innovation process (such as pre-competitive R&D, near-market R&D, product development, commercialisation).

Among the direct instruments used, a distinction can be drawn between those where no repayment is required and those that involve an element of repayment. Loans are normally provided at a concessional rate of interest, and may be conditional, that is, repayable if the R&D project is successfully commercialised (France and Sweden). Similarly, grants can be provided either in the form of an outright grant (requiring no repayment at all — such as in Australia, the United

Kingdom, and New Zealand) or repayable through some sort of royalty arrangement if the project is successfully commercialised (Israel and Singapore).

**Table D1.3: Instruments of business R&D and innovation support, by country**

Country	Indirect (tax-based)	Direct	
		Grants	Loans
Australia	✓✓	✓	✓
Japan	✓	✓	✓✓
United States	✓	✓✓	✓
Germany		✓	✓✓
France	✓✓	✓	✓
United Kingdom		✓✓	
Canada	✓✓	✓	
New Zealand		✓	
Israel		✓✓	
Sweden		✓	✓✓
South Korea	✓✓	✓	✓
Taiwan	✓✓	✓	✓
Singapore	✓✓	✓✓	
Malaysia	✓✓	✓✓	

✓✓ denotes a major program; ✓ denotes a minor program.

Source: IR&D Board, Sub. 243, attachment F, corrected to take account of more recent information; Rubenstein 1994.

### Overall degree of government support for business R&D

As well as Australia's BERD/GDP ratio being relatively low by international standards, it is also commonly believed that Australia has one of the lowest levels of government support for business R&D. For example, the Chairman of the IR&D Board stated that:

... in terms of government funding to promote business expenditure [on R&D], Australia ranks third bottom of the OECD and Asian nations (*Australian R&D Review*, March 1994, p. 4).

Similarly, in its submission to the inquiry, the IR&D Board reported that:

Amongst OECD countries, Australia has one of the lowest levels of direct support for industrial innovation. While we have many of the programs in use overseas, they are less generously funded, and we omit some of the programs which our overseas competitors clearly regard as vital threads in the tapestry of innovation (Sub. 219, pp. 61–2).

However, in making cross-country comparisons of government support for business R&D, it is often not clear which government R&D programs are included. For example, in official ABS statistics of sources of R&D funding, grants and loans are classified as direct funding, while the 150 per cent R&D tax concession is classified as an *indirect* form of support — the revenue forgone under the concession is *not* treated as a government source of business R&D funding. Statistics of international comparisons compiled by the OECD follow the same approach.

Most previous Australian comparisons of rates of government support for BERD have been distorted not only by excluding the major form of government support for business R&D in Australia, but also by expressing this (inappropriate) measure of government support as a ratio of GDP rather than BERD. On this basis, DIST (then DITAC 1992) concluded that:

Together with New Zealand, Australia has the lowest proportionate Government support for business R&D (p. 38).

There are two elements involved in calculating the extent of government support for BERD — the choice of the numerator (such as budgetary costs) and the choice of the denominator. In its *Australian Science and Innovation Resources Brief*, DIST has always expressed government support for BERD as a ratio of GDP, rather than BERD. In the draft report, the Commission indicated that this was inappropriate and that the preferred measure of the level of government support was given by expressing government support as a ratio of BERD — in other words, calculating simply the percentage of BERD funded (directly and indirectly) by government.

The IR&D Board was highly critical of the Commission's approach and claimed that it had:

... selectively chosen benchmarks ... [and used] the only measure where funding of R&D in business could be portrayed as high (Sub. 363, pp. 22-3).

DIST was similarly critical and stated that:

... the draft report is wrong in its conclusions with regard to the generosity of government funding of BERD ... Business R&D is *not* more generously supported in Australia than in almost any other country (Sub. 412, p. 2 and 5, emphasis in original).

The Commission considers that the most relevant indicator to use for making international comparisons depends on the particular purpose of the comparison. For example, the Commission agrees that to compare relative industrial R&D activity levels across countries, the ratio of BERD to GDP — the most widely used and accepted measure — is appropriate. However, that does not mean that GDP is the appropriate denominator to use for other, or all, international comparisons.

The measure that the Commission uses to compare government support for BERD across countries is that used by the OECD — the proportion of business enterprise expenditure on R&D actually financed by government. Such a measure approximates the rate of subsidy provided per dollar of the supported activity. It is the best measure of the government inducement to firms to do R&D, which is what the Commission's international comparisons are about.

Against this background, information on the quantitative importance of direct and indirect (tax-based) government funding of BERD is provided in table D1.4. A lack of data for South Korea, Singapore, Malaysia and Taiwan precludes their inclusion in the comparisons.

Among OECD countries, on average around 10 per cent of business R&D is funded directly by government. Countries with the highest levels of direct government funding of business R&D include the United States, France, Norway, Italy, and the United Kingdom.

In some of these countries, this high degree of government funding reflects the prominent role of defence-related R&D, with such R&D frequently funded as part of procurement contracts with private firms (Mowery 1993). In this respect, it has been observed that:

... it is probably no accident that the larger [direct] governmental funders of industrial R&D are also those nations with large defence programs (Government of Canada, 1994b, p. 24).

The countries with the highest shares of military R&D in total government R&D spending in 1991 were the United States (59 per cent), France (37 per cent), the United Kingdom (44 per cent) and Sweden (27 per cent) (OECD 1993f). In the United States, for example, two defence-related industries (aircraft and missiles, and communication equipment) received 76 per cent of total government direct support to industry in 1993 (NSB 1993). Excluding defence, therefore, direct government funding of business R&D in the United States is probably less than 10 per cent of BERD, not too dissimilar from the majority of countries reported in table D1.4.

While Australia provides a relatively low degree of direct support for business R&D, it provides one of the highest overall degrees of support when account is taken of *both* direct and indirect measures. Indeed, in terms of support for *non-defence* business R&D, it is probable that Australia ranks second only to Canada.

Table D1.4: Government direct and indirect funding of BERD

Country	Year	Percentage of BERD funded by government:		
		Direct <sup>a</sup>	Indirect <sup>b</sup>	Total
United States	1992	28	2	30
France	1991	22	4	26
Canada	1992	9	13	22
<b>Australia</b>	<b>1992</b>	<b>5</b>	<b>15</b>	<b>20</b>
Norway	1991	19	-	19
Italy	1992	17	-	17
United Kingdom	1991	15	-	15
Sweden	1991	12	-	12
Spain	1990	12	-	12
Germany	1992	11	-	11
Netherlands	1991	8	-	8
Denmark	1991	8	n.a.	8
New Zealand	1990	6	-	6
Austria	1989	6	-	6
Finland	1991	6	-	6
Belgium	1990	5	-	5
Ireland	1991	4	-	4
Japan	1991	1	1	2
Switzerland	1989	1	-	1

n.a. = not available.

a Mainly grants, loans, government contracting.

b Tax-based instruments (tax concessions/credits).

Source: OECD 1993a; ABS, Cat. No. 8104.0; IC 1995b, tables D1.5 and D1.8.

The two countries that provide proportionately the largest degree of *indirect* support are Australia and Canada. As noted below, these two countries differ from some other countries that operate tax concessions or tax credits, in that their schemes apply to the *level* of eligible R&D carried out — whereas the tax-based instruments in the United States, France and Japan are incremental schemes (applying only to the *increase* in R&D expenditure above some base).

The unusual feature of the mix of Australian government support for BERD in the context of these international comparisons is the extent to which Australia favours *indirect* support — the 150 per cent R&D tax concession is overwhelmingly the major instrument, funding around 15 per cent of BERD and accounting for 75 per cent or more of total government funding of BERD.

The estimate for Australia on direct government support for business R&D provided in table D1.4 is based on the budgetary costs of Commonwealth

programs listed in table D1.5 (taking account of State government programs would increase the importance of direct support only marginally).

**Table D1.5: Commonwealth government funding of BERD, Australia, 1992–93**

<i>Program</i>	<i>Cost (\$m)</i>
<b>Direct funding:</b>	
Industry Innovation Grant Programs	43.5
Cooperative Research Centres Program	45.3
Computer Bounty	30.0
Factor f	8.3
National Space Program	5.4
Total direct funding	132.5
<b>Indirect funding:</b>	
150 per cent R&D tax concession (inc. syndicated R&D)	415.0

While the computer bounty and Factor f programs are broader than just R&D support, the cost estimates quoted refer to the assistance paid only in respect of R&D activity.

*Source:* Cook 1995a; IC 1995b, table F1.

**In summary, the proportion of BERD funded by government in Australia is among the highest of all OECD countries. From the viewpoint of support for non-defence industrial R&D, it is likely that Australia ranks second only to Canada. Compared to most other countries, an unusual feature is the extent to which Australia favours *indirect* support — the 150 per cent R&D tax concession funds around 15 per cent of BERD and accounts for around 75 per cent of overall government funding of BERD.**

### **Tax credits/concessions for R&D**

As noted above, the 150 per cent tax concession is by far the main instrument of support for R&D in Australia. Other countries that provide support for R&D through tax-based schemes are reported in table D1.6.

A small number of countries operate R&D tax *concessions*, which operate by allowing firms to deduct more from their taxable income than they actually spend on R&D — ranging from 125 per cent in Denmark to 200 per cent in Singapore and Malaysia. The tax concessions are typically based on the *level* of eligible R&D expenditure. In the Singaporean scheme, capital expenditure on plant, machinery, land or buildings is excluded from qualifying expenditure, while in the Australian scheme, depreciation allowances on R&D equipment are among the items eligible for the concession. In Denmark, the concession is available only to companies participating in international collaborative research

projects such as a European Community program, EUREKA (a non-EC program), or one sponsored by the Nordic Industry Fund.

**Table D1.6: Tax-related incentives for business R&D, by country**

<i>Country</i>	<i>Nature of R&amp;D tax incentive</i>
Australia	150% tax concession
Malaysia	200% tax concession
Singapore	200% tax concession
Denmark	125% tax concession
United States	20% (federal) incremental tax credit; some states also have incremental tax credits
Canada	Large companies — 20% tax credit; small companies — 35% tax credit Some provinces also have tax credits
France	50% incremental tax credit
Japan	Large companies — 20% incremental tax credit <i>plus</i> 7% tax credit (basic technology) Small companies — 6% tax credit <i>plus</i> 7% tax credit (basic technology)
Spain	15% tax credit on intangible expenses incurred; 30% tax credit on acquisition value of fixed assets
Sth Korea	Large companies — 5% tax credit; small companies — 10% tax credit <i>plus</i> 25% incremental tax credit
Taiwan	5 - 20% tax credit

*Source:* Warda 1994; Liyanage and Hill 1994; KPMG 1990.

A more common instrument used to encourage business R&D is a tax *credit*, which reduces income tax payable. Countries using a tax credit include the United States, Canada, France, Japan, South Korea and Taiwan. Tax credits are normally non-taxable — Canada and the United States are exceptions — and are based on either:

- the total *level* of R&D undertaken (Canada and Taiwan); or
- the *increase* in R&D above some base level (United States and France); or
- both the level and increase in R&D (Japan, South Korea).

The tax credits in some countries differ according to size of firm — small firms are eligible for a larger tax credit than large companies (South Korea), while in Japan large companies have an incremental tax credit and small firms a level-based tax credit. Japan is also unique in that it has introduced a special tax credit for machinery and equipment used in connection with R&D in basic technologies. In the Canadian scheme, there is a general tax credit rate of 20 per

cent, and an enhanced rate of 35 per cent for Canadian-controlled private corporations (CCPCs) whose taxable income for the preceding year was \$CAN 200 000 or less.

Where the tax credit is based on incremental R&D, the base for calculating the increase also differs among countries. In France, the marginal tax credit is applied to the difference between the current year R&D expenditure and the average of the two preceding years, after adjusting for inflation. By contrast, the tax credit in the United States is more complex. The base in that scheme is the product of a fixed-base percentage and the average of the company's gross sales in the preceding four years — the fixed-base percentage is the ratio of R&D expenses to gross sales for the period 1984–88.

In the United States, only current R&D expenses qualify for the tax credit, whereas in most other countries with a tax credit, expenditures on machinery and equipment (depreciation allowances on machinery and equipment in the case of Japan) also qualify.

In Taiwan, a Statute for Upgrading Industries promulgated in 1990 allows companies to claim a 5-20 per cent tax credit in three areas: funds invested in equipment for automation of production or production technology; funds invested in purchasing pollution control equipment or technology; and expenditure incurred for R&D, professional personnel training and creation of internationally acceptable brands and products (Liyanage and Hill 1994).

Some countries have limits on the maximum value of the tax credit that can be claimed in any year. For example, in Japan, the maximum tax credit allowed is 10 per cent of the company's tax liability (15 per cent for SMEs); while under the French scheme the maximum tax credit is FF<sub>r</sub> 5 million per year. Under the Canadian scheme, an annual limit of 75 per cent of tax payable operated from 1987, but that limit was removed in 1993.

Because some companies might not have sufficient tax liability to take full and immediate advantage of the tax credit, carry forward provisions normally operate. But in Canada, CCPCs with a taxable income of not more than \$200 000 can claim *refunds* for unused tax credits, on the basis of 100 per cent of the tax credit attributed to current R&D expenditure and 40 per cent of capital expenditure (Feely et al. 1995).

### **Cross-country comparisons of tax-related R&D incentives**

The incentive for companies to undertake R&D is influenced not only by the existence of special schemes such as tax credits or tax concessions, but also by other features of the tax system such as the time period over which current and

capital R&D expenditures can be written off against taxable income, and the company tax rate. These elements have been used by Warda (1990, 1994) to construct a measure of the relative incentive provided by different countries' tax systems for firms to undertake R&D.

### *The Warda B-index*

Warda measures the relative attractiveness of R&D tax systems across countries by reference to a so-called 'B-index'.

The B-index is a critical minimum benefit-cost ratio: when the benefit-cost ratio for an R&D project falls below the level of the B-index in a country, it will not be undertaken. The B-index is constructed to reflect the impact of the tax treatment of R&D in such a way that fiscal systems more favourable to R&D lower the level of the index. Thus, other things equal, the more favourable the tax treatment of R&D, the lower the B-index and the more R&D firms will undertake in a country.

From the cross-country comparisons (table D1.7), Australia emerges as providing relatively generous tax incentives for companies to engage in R&D. While the measured B-index is currently not quite so favourable as when the 150 per cent R&D tax concession was first introduced in 1985–86 (due to the fall in the company tax rate), Australia's current ranking is behind only Malaysia, Canada and Singapore.

Canada's high ranking reflects the outcome of a favourable federal tax incentive package (including a 35 per cent tax credit for R&D expenditure by small firms, and 20 per cent tax credit for large firms), coupled with additional R&D tax incentives offered by some of the provinces. While Malaysia and Singapore both have 200 per cent tax concessions, Malaysia's more favourable B-index reflects the fact that it has a higher company tax rate — 35 per cent compared to 27 per cent in Singapore.

Most countries with lower B-index rankings provide no special tax credits or concessions for R&D — including Germany, Italy, Sweden, and the United Kingdom. However, the United Kingdom tax system provides for immediate expensing of both current *and* capital R&D expenditures, which (given other features of its tax system) results in a similar inducement to invest in R&D as in Japan, where special tax credits operate.

Table D1.7: **Relative incentive provided by R&D tax mechanisms**

<i>Country</i>	<i>B-index<sup>a</sup></i>
Malaysia	.536
Canada (small company) <sup>b</sup>	.571
<b>Australia (1985–86)<sup>c</sup></b>	<b>.632</b>
Singapore	.678
Canada (large company) <sup>b</sup>	.733
<b>Australia (1995–96)<sup>d</sup></b>	<b>.757</b>
<b>Australia (1994–95)<sup>e</sup></b>	<b>.787</b>
South Korea (small company)	.814
South Korea (large company)	.893
France	.910
United States <sup>f</sup>	.915
Japan (small company)	.926
Japan (large company)	1.000
United Kingdom	1.000
Sweden	1.017
Mexico	1.031
Italy	1.034
Germany	1.057

a See text for definition. The calculations assume a common structure of R&D expenditure across countries, comprising: current expenses (90 per cent), machinery and equipment (5 per cent), and buildings and structures (5 per cent). Deductions which apply to future periods are discounted at a 10 per cent nominal interest rate.

b The figure for Canada is an average across the five provinces of Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia.

c A company tax rate of 46 per cent applied in that year.

d Estimated for a company tax rate of 36 per cent.

e A company tax rate of 33 per cent applied in that year. It should be noted that B-index estimate differs from that reported by Warda due to the use of incorrect deductibility assumptions for building expenditures in that study.

f The figure for the United States is an average across the four states of California, Illinois, Michigan and North Carolina.

Source: Warda 1994; IC estimates.

### *Limitations of the B-index approach*

#### *Differences between 'level' and 'incremental' schemes*

A limitation of the B-index approach is that it does not take account of any special conditions that a scheme may have — such as whether the tax credit or concession applies to the *level* of R&D undertaken or only to the *increment* above some base level. Hence, while the B-indexes presented in table 5 indicate that, at the margin, the Australian incentive (a 150 per cent tax concession applying to *all* eligible R&D) is somewhat more favourable than the United States system (an *incremental* 20 per cent taxable tax credit), this fundamental

difference in the nature of the schemes is not adequately captured. To compare level and incremental schemes, the budgetary impact of the Australian, Canadian, United States and French tax instruments for R&D is compared in table D1.8.

**Table D1.8: Budgetary impact of R&D tax instruments, by country**

Year	Australia	Canada	USA	France
	Ratio of tax expenditures <sup>a</sup> to BERD (%)			
1990–91 (1990)	14.4	12.2	1.6	3.5
1991–92 (1991)	17.5	12.8	1.5	4.1
1992–93 (1992)	14.9	n.a.	n.a.	n.a.

a Tax expenditures are calculated as the difference between revenues that would be collected with and without the tax credit/concession. Data for Australia relate to financial years; data for Canada, the United States and France refer to fiscal years.

Source: ABS, Cat. No. 8410.0; Cook 1995a; NSB 1991, appendix tables 4-3, 4-21; Government of Canada 1994a; OECD 1993a; Birch and Shaw 1993.

The cost to government (tax expenditures) as a ratio of BERD for the two level-based schemes — Australia and Canada — is much higher than the incremental schemes. Indeed, the ratio for the Australian scheme is around ten times that of the United States scheme, and around four times that of the French scheme, indicating that the Australian scheme provides a very much higher degree of support for business R&D. As a qualification though, in Australia's case the effect of dividend imputation is not taken into account in the cost to revenue figures presented in table D1.8 — insofar as there is some clawback of the tax concession (see section D3.5), the tax expenditure figures for Australia will be somewhat overstated.

#### *Qualitative differences in nature of schemes*

Another limitation of the B-index in providing an indication of the incentive that special tax allowances in a country provide to R&D is that it cannot capture administrative features of the schemes. One recent commentary comparing the Australian and selected Asian schemes concluded that the latter schemes generally tend to be rather more directed than is the case for Australia (Liyanage and Hill 1994, p. vii).

Under the Malaysian scheme, the 200 per deduction is approved on a project-by-project basis — applications are processed by the Malaysian Industrial Development Authority and approved by the Minister of Finance. Similarly,

under the Singaporean scheme, projects must be approved prior to commencement, and approval is provided on a case-by-case basis. In determining the eligibility of companies, consideration is given to the level of sophistication of R&D projects; the level of expertise and qualifications of the researchers; and the level of R&D activities as measured in terms of R&D expenses (Liyanage and Hill 1994).

In the Australian case, companies registering for the concession are required to identify R&D expenditure on a project basis (IR&D Board 1994a, pp. 230-231), but companies themselves are initially responsible (under self-assessment) for determining eligible R&D activities and associated R&D expenditure. Subsequently, the Commissioner of Taxation can request the IR&D Board to determine whether particular activities claimed by a company are R&D activities under the various provisions of the legislation.

In respect of the extent to which the schemes are actually used by companies, it has been observed that their use in Singapore and Malaysia appears to be limited, due largely to administrative formalities and the overall low level of R&D (Liyanage and Hill 1994, p. viii). The Malaysian scheme is used by 30 to 40 companies annually, and the amount of R&D claimed appears to be less than 20 per cent of their current expenditure on R&D (Liyanage and Hill 1994). By contrast, around 2000 companies register annually for the Australian tax concession, and the amount claimed is around 70 per cent of overall business expenditure on R&D (BIE 1993c).

#### *Other limitations*

The B-index is calculated on the assumption that firms have sufficient taxable income to benefit fully and immediately from the tax incentives — certain dynamic aspects such as carryback/carryforward provisions for firms unable to benefit in the current year cannot readily be taken into account. Finally, of course, the B-index only focuses on *tax-related* measures of support for R&D.

**In summary, international comparisons of the incentive provided by tax-based instruments indicate that Australia provides one of the most generous R&D tax incentives in the world. While the concession rate provided in Malaysia and Singapore at 200 per cent is higher than in Australia, and the measured B-indexes are also more favourable, other comparisons with the Malaysian and Singaporean schemes reveal that the Australian tax concession is more easily accessible and more widely used.**

## D1.6 In what sectors and product fields is BERD mainly carried out?

In classifying the R&D expenditure of organisations to sectors or industries, two approaches can be followed. On the one hand, the R&D expenditure can be classified on the basis of:

- industry of *enterprise* — the whole of the R&D expenditure of an enterprise is allocated to the industry in which it mainly operates.

Alternatively, the R&D expenditure can be classified in terms of:

- *product field* of R&D — the R&D expenditure of an enterprise is apportioned across the product fields to which the R&D is directed.

On an ‘industry of enterprise’ basis, 60 per cent of BERD in 1992–93 was undertaken by enterprises whose major activity was in manufacturing, 35 per cent by enterprises classified to services, and 5 per cent to mining companies (table D1.9). However, a slightly different picture emerges from a ‘product field of R&D’ viewpoint — 66 per cent of BERD was directed at product fields classified to manufacturing, only 29 per cent to services, and 5 per cent to mining.

Table D1.9: **Comparison of BERD by industry of enterprise and product field of R&D, 1992–93**

<i>Sector</i>	<i>Industry of enterprise</i>		<i>Product field of R&amp;D</i>	
	<i>R&amp;D expenditure \$m</i>	<i>Share of BERD %</i>	<i>R&amp;D expenditure \$m</i>	<i>Share of BERD %</i>
Mining	150	5	134	5
Manufacturing	1667	60	1836	66
Services & other	971	35	818	29
<b>Total</b>	<b>2788</b>	<b>100</b>	<b>2788</b>	<b>100</b>

Source: ABS, Cat. No. 8104.0.

Any sectoral breakdown depends, of course, on how particular activities are classified. In previous ABS statistics on BERD, computer software (which is now the largest individual R&D activity) was treated as a manufacturing product field. That contributed to a very substantial discrepancy in the relative importance of manufacturing between the industry of enterprise and product field of R&D classifications.

At a more disaggregated level, R&D expenditure tends to be concentrated in a relatively small number of product fields (table D1.10). In 1992–93, six product fields accounted for slightly more than half of BERD — Computer software, Electronic equipment, Motor vehicles and parts, Basic iron and steel, Pharmaceutical and veterinary products, and Mining. Further, the top ten accounted for around 70 per cent, and the top 15 around 80 per cent. The most important product field of R&D — Computer software — accounts for 23 per cent of overall BERD.

**Table D1.10: Main product fields of R&D expenditure, 1992–93**

<i>Rank</i>	<i>Product field</i>	<i>R&amp;D \$m</i>	<i>Share %</i>	<i>Cumulative %</i>
1	Computer software	634.7	22.8	22.8
2	Electronic equipment	239.8	8.6	31.4
3	Motor vehicles & parts	166.3	6.0	37.3
4	Basic iron & steel	145.4	5.2	42.5
5	Pharmaceutical & veterinary products	135.7	4.9	47.4
6	Mining	133.5	4.8	52.2
7	Ships & boats	115.8	4.2	56.4
8	Food, beverages & tobacco	115.7	4.2	60.5
9	Other industrial chemical products	107.6	3.9	64.4
10	Fabricated metal products	102.5	3.7	68.0
11	Basic non-ferrous metals	97.2	3.5	71.5
12	Industrial machinery & equipment	92.7	3.3	74.9
13	Rubber & plastic products	70.6	2.5	77.4
14	Other electrical appliances	69.0	2.5	79.9
15	Other manufacturing	65.4	2.3	82.2

*Source:* ABS, Cat. No. 8104.0.

### **D1.7 What types of company have mainly contributed to the change in BERD in recent years?**

Previous analysis of the contribution of firms of different sizes to the observed increase in BERD over the period 1984–85 to 1990–91 (BIE 1993c) found that three quarters of this growth was accounted for by small and medium sized firms (with less than 100, and between 100 and 499 employees respectively).

Another notable trend during the six-year period to 1990–91 was the decline in the share of R&D contributed by very large enterprises (with 1000 or more employees) — across all industries, their share declined from 54 per cent of BERD in 1984–85 to 37 per cent in 1990–91.

Given that the two-year period to 1992–93 exhibited a substantial increase in BERD (table D1.1), it is of interest to determine what size of company has mainly been responsible for this most recent increase. Some relevant information is presented in table D1.11.

The declining contribution of very large companies to BERD appears to have been reversed — across all industries, and within manufacturing, very large enterprises accounted for a larger share of BERD in 1992–93 than in 1990–91. Furthermore, enterprises in all size categories larger than 100 or more employees accounted for a disproportionate share of the increase in BERD over this period. Perhaps not surprisingly, large companies have emerged from the recession displaying much stronger R&D expenditure growth than smaller sized companies.

**Table D1.11: Change in R&D expenditure, by employment size of firm**

<i>Size of enterprise (persons)</i>	<i>Share of R&amp;D 1990-91 %</i>	<i>Share of R&amp;D 1992-93 %</i>	<i>Change in R&amp;D 1990-91 to 1992-93 \$m.</i>	<i>Share of change in R&amp;D %</i>
<b>All industries</b>				
Very small (less than 20)	10.2	7.5	-4.4	-0.6
Small (20 to 99)	16.7	16.0	99.6	14.1
Medium (100 to 499)	28.4	25.8	127.1	18.0
Large (500 to 999)	8.0	12.2	172.7	24.5
Very large (1000 or more)	36.7	38.5	310.5	44.0
	100.0	100.0	705.5	100.0
<b>Manufacturing</b>				
Very small (less than 20)	10.7	5.7	-26.4	-5.0
Small (20 to 99)	17.9	12.9	10.1	1.9
Medium (100 to 499)	25.3	28.3	183.0	34.8
Large (500 to 999)	12.0	15.8	126.1	24.0
Very large (1000 or more)	34.2	37.3	232.6	44.3
	100.0	100.0	525.4	100.0

Source: ABS, Cat. No. 8104.0.

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## D2 SUPPORT FOR BUSINESS R&D

### D2.1 Introduction

In recent years, Commonwealth Government support for business R&D has been provided mainly by a set of schemes administered by the IR&D Board under the Industry Innovation Program (IIP). Prior to the May 1994 *Working Nation* White Paper, the IIP comprised the 150 per cent R&D tax concession (the most important scheme), and a set of five grant schemes — the Discretionary Grants Scheme (DGS), Generic Technology Grants Scheme (GTGS), National Procurement Development Program (NPDP), Advanced Manufacturing Technology Development Program (AMTDP), and National Teaching Company Scheme (NTCS). However, the White Paper contained the announcement that the five grant schemes would be replaced by a single scheme, and a new program would be introduced that supported early commercialisation activities by small and medium sized enterprises. Hence, the Industry Innovation Program now comprises a suite of three programs:

- the 150 per cent Tax Concession for Research and Development;
- Competitive Grants for Research and Development; and
- Concessional Loans for Commercialisation of Technological Innovation.

Other main Commonwealth Government programs of support for business R&D are two industry development programs which have an R&D element and are operated by the Department of Industry, Science and Technology (DIST):

- Partnerships for Development (PfD)/Fixed Term Arrangements (FTA); and
- Pharmaceutical Industry Development Program (Factor f).

Some DIST programs have among their aims the encouragement of linkages between industry and public sector research institutions. Of importance in this respect is the Cooperative Research Centres (CRC) Program, responsibility for which was transferred from the Department of Prime Minister and Cabinet to DIST in the May 1994 White Paper. The former Generic Technology Grants Scheme and National Teaching Company Scheme also had the encouragement of linkages as one of their aims. There are also several programs administered by the Department of Employment, Education and Training (DEET) which encourage linkages — Collaborative Research Grants Scheme, and Australian Postgraduate Awards (Industry). These are discussed in part F of the report.

The budgetary costs associated with all these and other programs supporting business R&D are detailed in appendix QD of this report.

In section D2.2, the main IR&D Board programs of support for business R&D are described, including the activities (elements of the innovation process) covered. In section D2.3, selected support schemes for business R&D are outlined, including State government programs and recent new initiatives. Finally, in section D2.4, some private sector initiatives for encouraging collaborative R&D are examined.

The discussion of programs in this chapter is purely descriptive. The Commission's assessment of the R&D tax concession, and IR&D Board grant programs, is provided in chapters D3 and D4. Programs broadly supporting innovation (and commercialisation activities in particular) are discussed in chapter D5.

## **D2.2 Industry Innovation Program**

### **150 per cent R&D tax concession**

The 150 per cent R&D tax concession was introduced on 1 July 1985. Since that time, it has changed from being a temporary measure (originally scheduled to terminate at 30 June 1991) to a 'permanent' measure (announced in March 1991). Also, the level of the concession was scheduled to fall to 125 per cent from 1 July 1993; but in the 1992–93 Budget it was announced that the concession would be retained indefinitely at the original rate of 150 per cent.

The R&D tax concession is a broad-based form of support, which does not target any particular industry or technology. There are, however, a number of eligibility requirements in respect of type of entity, minimum threshold level of expenditure, and type of R&D.

Because the program operates through the tax system, an eligible taxpayer must be either a company incorporated in Australia, a public trading trust, or a partner in a partnership of eligible companies. To be able to benefit from the tax concession, the taxpayer must have sufficient taxable profits.

Prior to the May 1994 White Paper, only annual R&D expenditure above \$50 000 attracted the full 150 per cent concession, while expenditure below \$20 000 was ineligible except where contracted to an eligible external organisation (Registered Research Agency). A sliding scale rate of concession applied between the minimum threshold and the \$50 000 level of expenditure. It was announced in the White Paper that the sliding scale would be eliminated,

and that the full 150 per cent deduction would be allowable where research and development expenditure is more than \$20 000. Other changes announced in the May 1994 *Working Nation* White Paper and 1995–96 Budget are set out in box D2.1.

### Box D2.1: Recent changes to R&D tax concessions

#### General 150 per cent R&D tax concession:

- the expenditure threshold for qualification for the full 150 per cent tax deduction reduced from \$50 000 to \$20 000.
- on a discretionary basis, specific R&D activities carried on outside Australia allowed to be eligible for the tax concession, up to a limit of 10 per cent of total project cost.

#### Syndication provisions:

- the expenditure threshold for syndicated R&D lowered from \$1 million to \$500 000.
- a generic syndicate structure to facilitate access by small and medium sized companies to be developed.
- eligibility for syndicates investing in private tax exempt bodies to be limited to exclude investors who are not fully at risk.

#### Company tax rate:

- the rate of company income tax to be increased from 33 to 36 per cent for the 1995–96 and subsequent income years.

For an R&D project to be eligible for the concession, it must be based on a 'core' activity that involves either:

- innovation — that is, having an appreciable degree of novelty; or
- technical risk — that is, there is reasonable uncertainty over what the results of the activities will be, or reasonable uncertainty over which of several alternatives is technically feasible, meets a desired technical specification, or meets a desired cost target (IR&D Board 1994a).

There are also other requirements as to the nature of the R&D undertaken: first, it must be carried out in Australia; second, it must have adequate Australian content; and third, the results of the R&D must be exploited for the benefit of the Australian economy. A second change announced in the May 1994 White Paper was that the concession would be extended to expenditure incurred on certain research and development activities undertaken outside Australia (box D2.1).

The tax concession also has syndication provisions, originally intended to cater for large and risky projects that were beyond the resources of a single company to carry out. In practice, syndication is a mechanism of tax benefit transfer

which enables tax loss companies to exchange those losses for R&D funds. Eligibility for syndication was originally restricted to projects involving R&D expenditure of more than \$1 million, but that has since been reduced to \$500 000 (box D2.1). In the 1995–96 Budget it was announced that syndicates investing in private tax exempt bodies would be limited to exclude investors who are not fully at risk.

### **Competitive Grants for Research and Development**

As noted earlier, another initiative contained in the May 1994 White Paper was the replacement of the five R&D grant programs operating at that time by a single grants scheme with a single set of eligibility and merit criteria. One difference between the tax concession and the grants scheme is that the concession operates as an ‘entitlement’ for undertaking eligible R&D, whereas the grants program operates on the basis of a competitive merit-based selection process.

The objectives of the competitive grants scheme are (IR&D Board 1994b):

- to encourage companies, particularly small to medium sized enterprises, to develop internationally competitive goods, services and systems;
- to encourage companies to adopt new products, materials and methods to improve manufacturing capability, productivity and quality;
- to strengthen linkages between technology developers and technology users;
- to encourage the development of technologies, including emerging and enabling technologies, that are likely to have wide application in Australian industry; and
- to foster collaboration between companies and research institutions.

The eligibility criteria for the single scheme are set out in box D2.2. The first of the alternate eligibility criteria (number 7) is directed to companies unable to benefit adequately from the tax concession — previously supported under the Discretionary Grants Scheme, introduced in July 1986 as a complement to the 150 per cent R&D tax concession.

Eligibility criterion 8 mainly caters for companies that were previously supported under two grant programs:

- the National Procurement Development Program (NPDP), which supported joint projects between firms and government partners to develop and trial new products, systems or services; and

### Box D2.2: Competitive Grants for Research and Development

Committees of the IR&D Board will only consider projects that meet all of the eligibility criteria listed from 1 to 6 below and either 7 or 8 or 9.

- 1 The project involves research and development, or product development (including the development of prototypes) or trial or demonstration or related market research; and
  - 2 The project is directed to the development of internationally competitive goods, systems or services; and
  - 3 The results of the project will be exploited for the benefit of Australia; and
  - 4 The project will not proceed satisfactorily without grant support; and
  - 5 The grant will not exceed 50 per cent of eligible project expenditure; and
  - 6 The project will be completed within three years;
- and either**
- 7 The applicant, or a company that controls the applicant, is unable to obtain full financial benefit under the 150 per cent Tax Concession for Research and Development to undertake the project while in receipt of a Competitive Grant for Research and Development;
- or**
- 8 The project involves a significant proportion of activities (trials, demonstration and marketing) that are outside the scope of eligible activities under the 150 per cent Tax Concession for Research and Development;
- or**
- 9 The project involves a graduate working on a specific company based research and development project which results in the formation of new and appropriate linkages between a company and a tertiary/research institution.

*Source:* IR&D Board 1994b.

- the Advanced Manufacturing Technology Development Program (AMTDP), which supported enterprises involved in the research, development, trialing and demonstration of advanced manufacturing technology, working jointly with potential users.

Eligibility criterion 9 caters for companies previously supported under the National Teaching Company Scheme (NTCS), which was targeted at encouraging links between industry and research organisations, by providing support to enterprises to employ a graduate to work on a business-related problem.

The other grant program which operated prior to the 1994 White Paper was the Generic Technology Grants Scheme (GTGS). That scheme provided support for enterprises undertaking collaborative work with research organisations on

projects in particular ‘generic’ or ‘enabling’ technologies. A characteristic of these technologies was that they were able to be applied in a wide range of industries, and were considered to be important for Australia’s competitiveness. Originally, three areas were designated as generic technologies under the GTGS — Biotechnology; New materials technology; and Information technology. Communications technology and Environmental technology were subsequently declared generic technologies, while New materials was subsumed from the beginning of 1991–92 under a broader area of Manufacturing and materials technology.

While the fostering of collaboration between companies and research institutions is one of the broad objectives of the new scheme, there appears to be no explicit eligibility criterion in relation to collaborative R&D.

However, the Board has advised that:

Collaborative projects with universities are clearly eligible under the first of the alternate criteria (Sub. 441, p. 2).

There is no practical change in the ability of companies or universities to take advantage of incentives for collaborative R&D ... Applicants must not be able to fully benefit from the R&D tax concession. Thus, tax loss firms can apply, as can research bodies such as universities. In the case of a collaboration between two eligible bodies, say a tax loss firm and a university, the application can be from either or both partners. Tax loss firms, universities and similar R&D organisations can apply for grants for projects where they will collaborate with companies able to fully utilise the 150 per cent R&D tax concession (Sub. 461, p. 1).

Further details on the operation of the new scheme are provided in section D4.9 below.

### **Concessional loans for commercialisation of technological innovation**

In the *Working Nation* White Paper, the Government allocated \$48 million over four years to provide concessional loans to technology-oriented small firms seeking to commercialise their technological innovations. The new loans scheme is discussed in detail in section D5.5.

### **Activities supported**

The suite of three programs under the Industry Innovation Program support a broader range of activities than just R&D. In table D2.1, the activities (or elements of the innovation process) are identified, and an indication provided of whether they are eligible for support under the various programs. As well as indicating the types of activities that are supported under the new single

Competitive Grants scheme, the activities that were eligible under the main four earlier grant programs are also identified.

**Table D2.1: Activities supported under Industry Innovation Program**

Activity	Tax concession	Former grant schemes				1994 White Paper Initiatives	
		DGS	GTGS	NPDP	AMTDP	CGRD	CLCTI
Pre-R&D market research		✓			✓	✓	
Pre-competitive (generic) research	✓		✓			✓	
Commercial R&D (research & experimental development)	✓	✓	✓	✓	✓	✓	
Product development (design, development of prototypes)	?			✓	✓	✓	
Trial or demonstration				✓	✓	✓	✓
Other early commercialisation							✓

CGRD = Competitive Grants for Research and Development scheme.

CLCTI = Concessional Loans for Commercialisation of Technological Innovation scheme.

✓ = eligible activity under the scheme.

? = may be an eligible 'supporting' activity under the scheme, ie only if it supports the core R&D activity.

In chapter D1, in addressing the question of what business 'R&D' (research and *experimental* development) is mainly about, it was noted that it tends to involve much more 'D' than 'R'. Of the research that is undertaken by business, it is generally of an applied nature and product/process specific. By contrast, very little pre-competitive, generic type research is carried out individually by companies. This is because the private incentive to carry out such research is weakened through those carrying it out not being able to appropriate enough of the benefits for it to be privately profitable. The closer the innovation activities are to the market, the greater is the likelihood that the benefits arising from those activities can be captured by the firm concerned.

All projects that qualify as research and development are eligible for support under the tax concession. In table D2.1, *product development* is defined as work undertaken to improve the performance or reduce the cost of a product, process

or service which does not require systematic investigation or experimentation. Such activities may include the development of prototypes. While this activity is not regarded as ‘core R&D’ under the tax concession, it may qualify as a supporting activity (and eligible) if it is integral to and directly related to the core R&D. Industrial design is another example of an activity that may qualify as a supporting activity for the purpose of the tax concession (see section D3.7).

R&D activity was supported under all the former grant schemes. But whereas it was typically of the commercial (close-to-market) type, the projects supported under the GTGS were mainly pre-competitive — characterised by strong and visible industrial relevance but rarely product-specific. However, consistent with the trend to increase the commercial focus of projects across all the former grant schemes, support was allowed under the GTGS for both *early-stage* and *nearer-market* projects (IR&D Board 1991).

Some of the programs supported other activities as well as R&D. For example, the NPDP and AMTDP also provided support for industry to undertake trials and demonstrations — elements of commercialisation. The DGS and AMTDP provided support for project related market research, that is, market research undertaken directly in support of an R&D project and carried out prior to the application for a grant.

The Competitive Grants for R&D scheme which has replaced the individual schemes has retained all of these activities as eligible for support — R&D, product development, trial or demonstration, and related market research.

The activities that are eligible for the Concessional Loans scheme comprise early commercialisation activities, including: product/process design; trial production runs including tooling up costs; regulations and standards compliance; protection of core intellectual property; trial and demonstration activities; and product documentation.

While trial or demonstration activities are eligible for both Competitive Grants and Concessional Loans, only projects which involve *collaboration* between technology developers and potential customers are eligible for grant support.

## **D2.3 Other programs directly supporting private R&D**

### **Factor f (Pharmaceutical Industry Development Program)**

The Pharmaceutical Industry Development Program, commonly known as Factor f, was introduced by the Commonwealth Government in 1988 to enable pharmaceutical companies which agree to undertake additional activity — in

respect of value added on exports, value added on domestic sales, and expenditure on R&D — to achieve higher prices for some of their products listed under the Pharmaceutical Benefits Scheme.

The scheme uses the following definition of R&D:

R&D is generally R&D as defined by the IR&D Board for the purposes of applying the Industry Research and Development tax concession. To be approved for price increases, R&D will need to have the potential for use in the development of pharmaceutical products and processes or in the application of pharmaceuticals (Factor f Guidelines 1992).

But as the IR&D Board has noted (1994a, p. 135), it is possible that companies approved for the Factor f scheme may not satisfy all the eligibility requirements for the 150 per cent tax concession in two respects:

- the ‘on own behalf’ provisions — the R&D activity must be undertaken on the claimant’s own behalf; and
- the ‘exploitation’ provisions — the R&D activity must be exploited on normal commercial terms and in a manner which is to the benefit of the Australian economy.

The Factor f entitlements that accrue to the additional R&D activity carried out under the scheme are defined as follows:

... the maximum payment rate which a company can receive is 25 per cent of the increase in total R&D expenditure, or 50 per cent of the increase in after-tax expenditure, whichever is the lesser (Factor f Guidelines 1992).

The Commission is shortly to commence a separate inquiry into the pharmaceutical industry.

### **Computer bounty**

The computer bounty scheme commenced in 1984, and is scheduled to expire in December 1995. The bounty is available to domestic producers of eligible hardware and some software. The rate of bounty has been reducing in tandem with general reductions in industry assistance, and is currently paid at the rate of 8 per cent of factory cost. Approximately 40 per cent of the bounty is paid to companies for R&D costs. On that basis, estimated government support provided to R&D through the bounty in 1992–93 was around \$30 million. The scheme is currently under review by the Commission in a separate inquiry.

## **Selected State Government initiatives supporting business R&D**

### *Strategic Industry Research Foundation (SIRF)*

The SIRF (formerly the Strategic Research Foundation) was established by the Victorian Government in 1988. Following a review of the organisation in 1993, it was decided to restructure its role and strengthen the links between industry and research. A commitment was made to provide \$16.5 million over three years to the new SIRF, with a view to using public funds as a catalyst for encouraging industry-led collaborative R&D projects identified and mainly funded by industry (Victorian Government, Sub. 241). The key objectives of the SIRF are set out in box D2.3.

#### **Box D2.3: Strategic Industry Research Foundation**

The SIRF's prime role is as a facilitator and lever for private sector investment in R&D. Its key activities are:

- facilitating the identification of strategic industrial research opportunities by drawing together senior representatives of industry, research organisations and tertiary institutions;
- establishing the foundations for co-operative research projects by promoting projects identified by industry to suitable industrial and research partners;
- using its own funds to leverage private sector investors into co-operative research ventures and
- providing administrative, legal and financial expertise to the co-operative venture.

*Source:* Sub. 241, p. 46.

The R&D projects funded so far have averaged around \$1 dollar of SIRF funds for every \$3 contributed by industry, CSIRO and/or universities, with the SIRF aiming to limit their contribution to \$1 in \$10 by 1995–96. The SIRF adopts an 'investment in R&D' approach, and expects to get a return from the projects that it funds (through taking a share of property rights). The priority industry areas in which the SIRF focuses are those in which Victoria has competitive strengths — aerospace, food processing, marine engineering, advanced materials, energy and minerals, automotive engineering, biotechnology, pharmaceuticals, and waste and environmental management.

### *Minerals and Energy Research Institute of WA (MERIWA)*

MERIWA is a statutory authority which receives funding from the WA government (of around \$750 000 in recent years) to fund applied research. Government funding is supplemented by support from industry where available, and another \$1 million is raised in this way.

Some MERIWA projects involve 'public good' research and are funded entirely from government funds; most projects involve pre-competitive strategic research for which multiple industry sponsors are obtained; and a few projects are pre-commercialisation research in which a single sponsor bears most of the cost and MERIWA expects to recoup its expenditure from future sales.

Most of the projects funded are researcher initiated.

MERIWA receives research proposals from the research laboratories [of universities, CSIRO and some State government agencies] and these are assessed by the Minerals or Energy Research Advisory Committee, according to their merit, cost and potential benefits, before a recommendation is made to the Board for funding. At the same time, interested companies are canvassed for their sponsorships, and meetings are arranged between company representatives and the research team to allow the program to be refined and accepted. Good quality projects which are definitive and have worthwhile benefits are generally accepted by industry for sponsorship and joint funding with MERIWA (Sub. 22, p. 7).

And again:

Government funds are supplemented by sponsorship from industry sponsors to support research projects initiated by universities and CSIRO and some State government agencies. The level of industry sponsorship in a MERIWA project is a clear measure of the relevance of a proposal to the industry sector to which it relates (Sub. 22, p. 24).

### *Queensland Grants for Industrial Research and Development Scheme*

The Queensland Department of Business, Industry and Regional Development administers a competitive grants scheme (QGRAD) which aims to assist business R&D in Queensland's manufacturing and traded services sectors. Applications are evaluated on the basis of merit against criteria established by an independent Advisory Panel. Grants are provided for up to 50 per cent of total project R&D expenditure, for projects exceeding \$50 000. Since the start of the scheme in 1990, 36 grants have been awarded involving a funding commitment of over \$5.3 million (Queensland Government, Subs. 253, 257).

### **New schemes announced in May 1994 White Paper**

As well as announcing several changes to existing schemes, the *Working Nation* White Paper also contained a number of new initiatives. These are set out in table D2.2. The Concessional Loans for Commercialisation of Technological Innovation Scheme is discussed in detail in chapter D5.

A further initiative was the creation of AusIndustry, to bring together under a single umbrella the full array of programs of business support operated by DIST and other portfolios, but excluding the IR&D Board. The aim of such an umbrella organisation is to improve the coordination and delivery of business

assistance programs and to provide a better, more focused, service to Australian business.

**Table D2.2: Initiatives announced in May 1994 White Paper**

<i>Scheme</i>	<i>Description/objectives</i>
Commercialisation of Technological Innovation Scheme	\$48 million to be provided over four years through concessional loans to support small firms in the early stages of commercialisation of their innovations.
Development and Application of Technology in Industry	\$63 million to be provided over four years to assist the development and diffusion of key technologies through Australian industry. Includes the establishment of technology access and diffusion networks to strengthen the links between users, science agencies, research centres and technology centres.
Innovate Australia campaign	To publicise the benefits of innovation to Australian businesses.
Funding to improve access by SMEs to CSIRO	CSIRO to spend \$10 million over the next three years to improve access of small and medium enterprises to CSIRO technology and expertise.
Funding for nanotechnology facility	\$3 million to be provided to support a National Nanotechnology Facility to be used by Australian industry.
Program to encourage formation of networks	Up to \$32 million to be provided over the next four years to encourage enterprises to form networks.

*Source:* Keating 1994.

## **D2.4 Private sector initiatives**

There are a number of private sector organisations that facilitate collaborative R&D projects, frequently with public sector research institutions, which do not receive any direct government funding.

### *Mining*

The mineral industry supports collaborative research efforts through organisations such as the Australian Mineral Industries Research Association Ltd (AMIRA) and Australian Coal Research Ltd, with funding via contributions from participating companies.

AMIRA is a private, non-profit organisation established by the mineral industry in 1959 to manage jointly sponsored R&D on behalf of member companies. AMIRA has no research facilities of its own, but contracts out the R&D to publicly funded institutions such as the universities and CSIRO, as well as to private companies. A small levy is imposed on members for administration of the organisation. Individual projects are funded by companies which agree to sponsor them, and the results are confidential to the companies that fund them. Unlike the rural R&D corporations and councils, there is no matching government funding provided to AMIRA, though companies' contributions to project funding are eligible for the tax concession.

As AMIRA noted:

Individual enterprises will determine their R&D priorities based on their strategic business plans. Much of the R&D will be carried out in-house. But where appropriate skills or facilities are not available, companies will seek these in the publicly funded infrastructure in Australia and overseas. In some cases companies can benefit from sharing inputs and outcomes of research and tackle problems collaboratively. The industry set up AMIRA specifically to manage this collaborative work and much of it is contracted to the publicly funded R&D infrastructure such as universities and CSIRO (Sub. 32, p. 1).

Australian Coal Research Limited (ACRL) runs the Australian Coal Association Research Program (ACARP), which is an industry-wide research program supporting black coal producers in New South Wales, Queensland and Western Australia. ACRL was established by the Australian Coal Association (ACA) when the Government announced a major package of reforms for the black coal industry in December 1991. Referring to the origins of ACARP, the ACA stated:

Major problems with National Energy Research and Development and Demonstration Program, from the industry's point of view, centred around the lack of relevance of many of the research projects to industry's needs, lack of effective monitoring of the projects and lack of any effective means of disseminating research results throughout the industry. It had become a scheme driven largely by researchers, owned by the Government and funded, increasingly reluctantly in the light of these concerns, by the coal companies. [Such] industry concerns ... remain valid criticisms of any research program that is removed from the funders and potential beneficiaries (Sub. 164, p. 2).

The Australian coal industry opposed the establishment of a Coal R&D Corporation, along the lines of the various Primary Industries and Energy R&D Corporations, and sought to take over administration of industry research itself.

ACA did not believe that the Corporation structure would bring the research sufficiently close to industry such that it would be 'owned' by the industry, rather than the Corporation or Government (Sub. 164, p. 2).

Under the ACARP, which commenced in January 1993, coal producers pay a levy of 5 cents per tonne to ACRL (which amounts to around \$8 million per annum) for the purpose of 'collective and integrated research on coal'. ACARP accounts for between 10 and 15 per cent of the total coal-related research undertaken in Australia each year. ACARP projects mainly involve problem-solving research, and are planned and structured on the basis of prioritised needs rather than initiated by researchers. The research program is, therefore, essentially industry driven and aimed at achieving commercial applications (Sub. 164, pp. 3-5). Unlike the rural industry RDCs, there is no government contribution to ACARP. But projects are generally required to be eligible for the 150 per cent R&D tax concession (Sub. 181, p. 6).

### *Manufacturing*

Australia has had a long history of government (matching) support for voluntary research associations in the manufacturing sector. A Research Associations Program operated for a period of some forty years (from 1947 to 1988) which had the objective of encouraging cooperative R&D and technology transfer by Australian industries. But only eight such associations participated in the program: the Sugar Research Institute, the Bread Research Institute, the Australian Welding Research Association, the Brick Development Research Institute, the Medical Engineering Research Association, the Australian Timber Research Institute, the Radiata Pine Research Institute, and the Australian Particleboard Research Institute. A review of the program recommended ending the matching support, given the (recently introduced) tax concession and other forms of business R&D support (BIE 1986) — support was terminated from 30 June 1988.

Most of these organisations still operate, and some have the status of a Registered Research Agency (RRA) under the *Industry Research and Development Act 1986* — that is, they are approved by the IR&D Board to undertake contract R&D for multiple clients.

However, for those former participants in the Research Associations Program, there has been a trend away from funding on the basis of voluntary levies and carrying out of generic research (of benefit to the industry as a whole), to an approach of conducting research on a fee-for-service basis for individual companies.

For example, membership of the Sugar Research Institute determined in December 1991 that it should change from a cooperative research association, dependent on voluntary levies, to a commercially orientated research and development organisation, funded mainly on a fee-for-service basis from sugar millers (Sub. 121, p. 13; Sub. 291).

More recently, the Bread Research Institute (BRI) has also been restructured:

The restructure of the BRI brought an end to whole-of-industry participation and an end to funding through a levy collected on flour sales. Much of the BRI's focus is now directed to contract research for large bread manufacturers and the Australian Wheat Board (Sub. 452, p. 7).

### *Services*

One recent private sector initiative in the services sector is the establishment of the Construction Industry Institute (CII) for the purpose of collaborative research.

The collaborative model operated by the CII enables members to benefit from combined funds and intellectual strength. Improved R&D performance in engineering and construction will bring better infrastructure, better production facilities and improved systems, all enhancing Australian industry's capacity to be more competitive at home and overseas (Sidwell 1994, p. 53).

The question of whether it would be useful for the government to enact enabling legislation for the creation of research associations with the power to levy members in manufacturing and service areas is taken up in chapter D7.



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## D3 THE 150 PER CENT R&D TAX CONCESSION

### D3.1 Introduction

This chapter looks in detail at the effectiveness — and more broadly at the benefits and costs — of the main government program of support for private sector R&D, namely the 150 per cent tax concession. The tax arrangements have been the subject of two recent reports conducted by the Bureau of Industry Economics (BIE): an evaluation of the general scheme (1993c), and an assessment of the syndication arrangements (1994a). The Australian National Audit Office examined administrative and other operational aspects of the concession (ANAO 1993b). Changes to the tax concession were announced in the May 1994 White Paper (section D2.2 above). The 1995–96 Budget announced changes in the company tax rate from 33 per cent to 36 per cent (influencing the value of the R&D tax concession) and in the syndication arrangements.

The analysis in this chapter begins with a consideration of the value of the tax concession in section D3.2. The main findings of the BIE evaluation of the general tax concession are then presented and assessed in section D3.3. Many participants suggested ways in which the scheme should, in their view, be changed. Most commentary focused on the *level* of the concession and, in particular, the need for it to be increased in order to offset the erosion in the value of the concession resulting from reductions in the company tax rate in the period since the concession was introduced. That and other reasons suggested for increasing the concession are presented in section D3.4. The question of unevenness in the rate of assistance provided by the concession is discussed in section D3.5, and syndication is addressed in section D3.6. Other modifications to the scheme suggested by participants are canvassed in section D3.7, while the policy implications of the findings are taken up again in chapter D7.

### D3.2 How valuable to companies is the 150 per cent R&D tax deduction?

In broad terms the tax arrangements for R&D expenditure by companies have the following features:

- current expenditure may be deducted at a rate of 150 per cent of costs in the year in which it is incurred;

- plant and equipment used for R&D may be depreciated over 3 years and deducted at a rate equal to 150 per cent of the deduction that would otherwise apply; and
- buildings used for R&D may be depreciated over the standard period of 40 years at a rate equal to 150 per cent of the deduction that would otherwise apply.

The concessional element of the tax concession is thus conventionally thought to be equal to the additional 50 per cent of expenditure that may be deducted.

In fact, however, arrangements for deducting expenditure are somewhat more generous than this when compared with taxation treatment that would apply to true economic income generated by investment in R&D. Taxation of true economic income would not permit immediate deduction of 100 per cent of R&D costs.

R&D is an activity that broadly corresponds to investment in an asset — in this case a discovery — which adds to income generating potential. Like any asset (such as a machine), the generation of economic value may be thought of in two stages — the process of asset creation (manufacture) which provides income for the asset manufacturer, and the use of the asset in a productive activity. Each stage should be subject to taxation under income taxation principles.

In practice these stages are combined, because R&D tends to be performed by the firms that use it. But at the time that firms have created an asset by performing R&D they have deducted all the expenditure, rather than, as would be appropriate if they had bought the asset, beginning on a process of depreciation. Perhaps the most important deviation from true economic income taxation therefore is that the expenditure in creating the asset is not congealed into a single asset value and then depreciated over the life of use of the discovery.

The broad implication of all this is that the deduction of even 100 per cent of expenses in the way currently allowed for 150 per cent, is itself quite concessional relative to income taxation. 100 per cent deduction of costs, or expensing, favours R&D relative to income tax treatment. If income is subject to a tax rate of 50 per cent, expensing can double the after-tax return relative to true income taxation.

In practice, expensing may not be quite so valuable as to double after-tax returns when all the complexities of imputation and the capital gains tax are worked through. Moreover, it is true that investment in some other assets (although not the major building, and plant and equipment assets) is treated in a similar way.

**Nevertheless, 100 per cent deductibility for R&D is a significant tax inducement to perform R&D, compared to other investments, in addition to any further concessional deductions.**

Having made these observations, it is nonetheless helpful to examine the way in which moving from a deduction of 100 per cent of costs to 150 per cent lowers the cost of undertaking R&D.

At the time of the introduction of the R&D tax concession on 1 July 1985, the company tax rate was 46 per cent, and the after-tax cost of any (non-concessionary) tax deductible expenditure was therefore 54 cents in the dollar. The 150 per cent tax concession reduced the after-tax cost of R&D to 31 cents in the dollar. The (nominal) subsidy provided by the tax concession was therefore 23 cents in the dollar (see section D3.4).

In the period since 1985, the company tax rate has fluctuated. In the 1995–96 Budget the company tax rate was set at 36 per cent, having been increased from the 33 per cent which previously applied. Under this regime, the after-tax cost of R&D is reduced by the tax concession from 64 cents in the dollar to 46 cents — a nominal subsidy of 18 cents in the dollar.

For some companies, however, the benefit derived from the concession can differ from this nominal rate. In particular, the value to a company and to shareholders of a dollar obtained from a tax concession differs according to: the tax paying status of the company; dividend payment policies of the company; marginal tax rates of individual shareholders; and whether the shareholder is domestic or foreign.

A first major source of unevenness in the benefit provided by the concession is that shareholders of companies in tax loss get no immediate benefit from the tax concession — it adds to a company's tax loss and is of no benefit until realised. Because tax loss companies suffer a delay in realising the tax saving, the benefit of the concession is eroded through inflation and real interest losses.

A second source of unevenness is dividend imputation. Under the imputation system, the benefit to shareholders in taxpaying companies can vary significantly depending on their marginal tax rates.

These issues are considered further in section D3.5.

### **D3.3 Effectiveness of the R&D tax concession**

In its evaluation of the R&D tax concession, the BIE looked at the extent to which the scheme had been effective in meeting its stated objectives. In considering whether the tax concession should be continued, the BIE sought to

answer the question of whether it conferred a net social benefit for Australia. Those two main concerns are discussed in turn.

### **To what extent has the tax concession achieved its objectives?**

The R&D tax concession has multiple objectives (box D3.1). Increasing companies' investment in R&D is the main sub-objective of the scheme, but the ultimate objective is to make companies more innovative and internationally competitive.

#### **Box D3.1: Objectives of the 150 per cent R&D tax concession**

To make Australian companies more internationally competitive through improving innovative skills in Australian industry by:

- increasing investment in R&D;
- encouraging better use of Australia's existing research infrastructure;
- improving conditions for the commercialisation of new process and product technologies developed by Australian companies; and
- developing a greater capacity for the adoption of foreign technology.

*Source:* IR&D Board 1994a, p. 12.

The BIE assessed the extent to which the scheme had *increased companies' investment in R&D* by looking at two questions:

- did the scheme encourage *more companies* to do R&D? The BIE found that around 200 new consistent performers emerged in each of the first three years of the scheme. But a similar number of registrants dropped out each year so that the overall number of registrants was relatively stable at around 2000 per year.
- did the scheme encourage *existing performers* to do more R&D? The BIE found that the concession had encouraged only *some* companies (23 per cent overall) to carry out more R&D than they would have done otherwise. The amount of additional R&D induced was estimated to lie in the range of 10 to 17 per cent of eligible R&D; or alternatively, the concession might have generated between \$0.60 and \$1.00 of additional R&D per dollar of tax revenue forgone — the 'bang for a buck'.

The BIE noted that while the role of the tax concession in *encouraging better use of Australia's existing research infrastructure* was difficult to isolate, the decision to contract out R&D appeared largely to be driven by factors unrelated

to the tax concession — mainly the specialist skills and abilities of the external research organisations.

Because the R&D tax concession does not directly subsidise non-R&D costs, its impact on *commercialisation of new process and product technologies developed by Australian companies* can only be indirect — it tended to assist the innovation process more so for those projects where R&D represented the major part of overall innovation costs.

The BIE found that the R&D tax concession appeared to have little influence on firms' *acquisition of foreign technology*. However, this is not all that surprising insofar as the concession provides only indirect support for the use of overseas technology — by reducing the cost of complementary Australian R&D.

To assess the effectiveness of the scheme in meeting its overall objective of *increasing companies' innovation and competitiveness*, the BIE sought to identify empirical links between R&D and innovativeness, and between innovation and competitiveness. Innovativeness was proxied by the share of company sales accounted for by totally new, significantly improved and incrementally improved products or processes. Indicators of competitiveness used included market share, sales growth and profitability. Stronger links were found between the effect of companies' R&D performance on innovativeness than between the impact of innovation on competitiveness. On that basis, the BIE concluded that from the viewpoint of tax concession recipients:

... the concession clearly contributes to increased innovativeness and is likely to contribute to increased international competitiveness (1993c, p. 158).

As a qualification, however, it should be noted that this is a partial viewpoint. Since the R&D tax concession is financed by taxing the wealth produced by others, the improved international competitiveness of tax concession recipients will to some extent be at the expense of other companies' competitiveness.

### **BIE assessment**

The BIE approached the question of whether or not the tax concession was worth having by assessing whether the scheme generated a net social benefit for Australia. But because any assessment of social benefits and costs is an extremely complex task, the BIE was cautious in its assessment of whether the scheme was worth having:

For a wide range of scenarios, the analysis indicates that the scheme generates a net social benefit. For a significant, but smaller, range of equally possible scenarios, there is a net social loss. At the mid-range values of the key parameters, the net social return [the ratio of net social benefit to program cost] was estimated to be around 10 per cent.

On this basis, the BIE considers that the 150 per cent R&D tax concession is more likely to have generated a net social benefit for Australia than not to have done so (1993c, p. 184).

The BIE pointed to two key features of the scheme which detract from its effectiveness. First, a substantial share of program costs accrues to R&D that would have taken place anyway (the transfer component). The large transfer element is not surprising for two reasons:

- the tax concession accrues on *all* eligible R&D undertaken, and the BIE estimated that between 83 and 90 per cent of eligible R&D would probably have taken place without the concession; and
- the tax concession is just one of many influences on the R&D performance of companies — R&D is mainly market and/or technology driven, while factors influencing the ‘price’ of R&D (such as the tax concession) are generally perceived to play a secondary role.

A second feature was that while the tax concession appears to return positive net social benefits for R&D in Australian-owned companies, negative net social returns tend to apply to foreign-owned companies, mainly because their share of the transfer component flows to foreign shareholders and hence is an economic loss to Australia.

Of the options canvassed by the BIE to reduce transfer payments, perhaps the most promising appeared to be that of a carefully designed incremental scheme (with support provided only to the change in R&D over and above some base level, rather than the level of R&D undertaken). However, the BIE was unable to recommend this redesign of the concession because the absence of company tax consolidation in Australia would provide considerable scope for abuse of an incremental scheme.

One of the major shortcomings in the current tax concession arrangements identified by the ANAO (1993b) was that despite the eligibility requirement that the results of the R&D should be exploited for the benefit of Australia, there had been little monitoring of the effectiveness of the R&D carried out under the scheme.

The monitoring of exploitation undertaken by the ATO and DIST has been insufficient to provide a real understanding of the concession’s value to the Australian economy (1993, p. xi).

Arising from this concern, the ANAO reported that the ATO, DIST and the IR&D Board have agreed to work more closely in monitoring exploitation (ANAO 1993b, p. xvi).

*Some comments on the BIE evaluation*

Because the parameters needed to calculate the net social benefit of the tax concession cannot be estimated with certainty, the BIE study used sensitivity analysis. The BIE estimates of the inducement ratio were based on survey information provided by tax concession registrants. While the possibility of an upward bias from this methodology was raised by the BIE, they assessed the results as likely to provide a 'reasonably balanced view'. But allowing for at least some strategic response would imply a lower degree of responsiveness.

Yet there is likely to be one compensating influence. One aspect of the tax concession that might have reduced its effectiveness is the uncertainty that has surrounded its continuity and level. The 1992–93 announcement that the scheme would be a permanent measure might increase the extent to which it is factored into companies' R&D decisions. But in this respect, participants' views differed. For example, Leeds & Northrup Australia Pty Ltd thought that the tax concession was mainly the preserve of accountants rather than production managers:

One problem is that a corporation is judged on the pre-tax operating income. Taxation concessions are often only seen by the accountants or tax experts (Sub. 167, p. 4).

On the other hand, CRA reported that:

[The] scheme is influencing the research priority process, as the incentive has a direct impact on the industrial enterprise manager who determines priorities (Sub. 44, p. 39).

One element omitted from the BIE framework was the compliance cost associated with actually claiming the concession. The BIE estimated the average on-going compliance costs of recipients to be around 3 per cent of eligible expenditure on R&D. But even a cost of this order of magnitude would be sufficient to change the mid-range value scenario assessment from a positive to a negative net social benefit, illustrating just how borderline is the question of whether the scheme is welfare enhancing under the BIE methodology.

In addition, the BIE evaluated the concession as though the concessionary element was limited to the additional 50 per cent deduction contained within the 150 per cent deduction. As was discussed in an earlier section, however, the 150 per cent tax deduction actually provides a considerably larger subsidy to undertake R&D.

This has consequences for the estimates of the social benefit-cost outcome, through the assumptions made in estimating the spillover return to the induced R&D. Because the BIE methodology probably understates the size of the

subsidy inherent in the concession, the private return *net* of the subsidy on projects that would not have proceeded without the tax concession is therefore likely to be somewhat lower than that estimated by the BIE. Because the spillover return is assumed to be a constant ratio of the private return, the BIE estimates of the spillover return to the induced R&D might be too high.

On the other hand, there is a questionmark over the assumption in the BIE analysis that spillover returns are of the same order of magnitude as the private returns to the R&D performer — the assumption of a spillover to private return ratio of unity — and that spillovers decline as private returns decline. As discussed in part A, there is an issue about whether spillovers do follow this pattern and about their precise magnitude.

### *Commission's modelling*

The Commission itself sought to investigate empirically the role of the tax concession (appendix QC) by estimating the long-term economy-wide impact of removing the concessionary component (that is, allowing R&D expenses to be deductible at 100 per cent rather than 150 per cent). Using the measure of the inducement rate estimated in the BIE study (an additional 15 per cent of eligible R&D induced by the concession), the model simulations suggest that the tax concession yields a small net gain to the economy.

The study also found that the cost of eliminating the concession would be higher if the inducement rate were higher, and therefore that there could be significant gains to the extent that the tax concession could be successfully targeted at R&D that would not have been undertaken otherwise.

## **D3.4 Suggestions to increase the value of the concession**

Many participants' comments on the R&D tax concession related to its *level*, suggesting that the concession should be increased from 150 per cent to 200 per cent or higher, in order to:

- offset the erosion in its incentive value arising from reductions in the company tax rate since the scheme was introduced; and
- match R&D support schemes in neighbouring countries, such as Singapore and Malaysia.

These suggestions are evaluated as a background to examining whether increasing the concession would be likely to improve the net social benefit of the scheme.

## Offset erosion in the incentive value of the concession

### *Measures of the incentive value of the concession*

Claims about the value of the tax concession being eroded and a need to restore its value (see box D3.2) presuppose some concept of the ‘incentive value’ of the concession. Here two measures are discussed and the effect of the fall in the company tax rate on each is described. The measures are calculated in ‘nominal’ terms — that is, for companies in tax profit with sufficient franking credits to enable them to benefit fully and immediately. Consideration of unevenness in the value of the incentive is taken up in section D3.5.

#### **Box D3.2: Erosion in the incentive value of the concession**

Participants had a variety of comments on the changing incentive provided by the concession.

With lower company taxation rates the value of the incentive has been significantly reduced and should be restored (Australian Academy of Technological Sciences and Engineering, Sub. 40, p. 2).

The cut in company tax rate has reduced the R&D incentive. There is a need to increase the incentive to the level available when the 150 per cent concession was first introduced. To do this [for a company tax rate of 33 per cent] a concession of 209 per cent is required (Mt Isa Mines Ltd, Sub. 49, p. 2).

The reduction in the company tax rate means that the benefit of the tax concession is nowhere near as significant as it once was in after-tax terms. As a result, the Government is urged to increase the concession from 150 per cent to 200 per cent (Victorian Employers’ Chamber of Commerce and Industry, Sub. 60, pp. 6 and 9).

The R&D tax concession [should] be increased from 150 per cent to 200 per cent reflecting, in part, the need to compensate for the reduction in the value of the incentive due to the reduction in the company tax rate (MTIA, Sub. 133, p. 3).

Some participants discussed the incentive provided by the concession in terms of the after-tax cost of R&D (for example, Mt Isa Mines Ltd, Sub. 49; IR&D Board, Sub. 219). As noted in section D3.2, when the R&D tax concession was first introduced on 1 July 1985, the company tax rate was 46 per cent. The after-tax cost of any (non-concessionary) tax deductible expenditure was therefore 54 cents in the dollar — that is,  $\$(1.00 - 0.46)$ . The 150 per cent tax concession reduced the after-tax cost of R&D from 54 to 31 cents in the dollar — or, in other words, increased the incentive from 46 to 69 cents in the dollar. With a company tax rate now of 36 per cent, the tax concession reduces the after-tax cost of R&D from 64 to 46 cents in the dollar.

What a measure such as the after-tax cost of R&D fails to account for is the fact that variations in the company tax rate affect the after-tax cost of *all* tax deductible expenditures, not just R&D. In this respect, what the R&D

concession does is to reduce the after-tax cost of R&D *relative* to other deductible expenditures. When introduced in 1985–86, the 150 per cent tax concession provided a subsidy of 23 cents in the dollar. With a company tax rate now of 36 per cent, the tax concession provides a subsidy of 18 cents in the dollar. This second measure of the incentive value of the concession — the after-tax subsidy — was discussed by several participants (for example, AIRG, Sub. 184; John Simmons and Partners, Sub. 217).

These different concepts of the ‘value of the concession’ imply different increases in the concession rate to restore the value as in 1985–86. That is, for a company tax rate of 36 per cent:

- to restore the after-tax cost to its 1985–86 level, a tax concession of 192 per cent would be required; but
- to restore the original subsidy of 23 cents in the dollar, a concession rate of 164 per cent would be required.

In the Commission’s view, the most appropriate indicator of the incentive value of the tax concession is the subsidy it provides per dollar of R&D expenditure. This accords with the notion that the concession is aimed at providing a subsidy for the external benefit that is presumed to arise from the induced investment in R&D.

On that basis, a concession rate of 164 per cent would be required to restore the subsidy to the level that applied when the scheme was introduced. However, in evaluating whether an increase in the concession is justified, other considerations need to be taken into account.

### *Is the current incentive too low?*

Calls to restore the value of the concession contain an implicit judgment that the original incentive was in some sense more appropriate.

As the Taxation Institute of Australia noted:

The conduct of R&D in Australia is not simply based on tax incentives. There are many other reasons why corporations undertake R&D in Australia. The tax concession simply makes conducting R&D in Australia a little more attractive. The important question becomes at what tax level does the incentive lose its effectiveness (Sub. 106, p. 2).

One participant who doubted the effectiveness of the incentive at the current level was Harry Sebel (of The Harry Sebel Consultancy):

Most of those companies who do understand the long term value of R&D would continue to undertake and go ahead with such R&D projects, even without this 16.5 per cent future tax deduction. Conversely, these tax benefits are nowhere enough of an incentive to convert the ‘waverers’, let alone the large mass of living-in-the-past manufacturers who represent 90 per cent of Australia’s total (Sub. 75, p. 3).

And again:

I am sure that for [a 16.5 cents in the dollar tax deduction] many smaller companies do not want to bother with all of the inevitable extra paperwork in making the quite detailed claims. This would involve considerable cost and time, and would for some require specialised and not inexpensive professional advice to organise and prepare (*The Australian*, 15 September 1993, p. 41).

Some evidence of the incentive value provided by the concession (at least to large companies) is available from a study undertaken by the AIRG shortly after the Government announced in March 1991 that the concession rate would be lowered to 125 per cent from 1 July 1993. The study sought to estimate a break-even level of tax benefit for R&D expenditure below which companies would not find the incentive attractive. Based on information drawn from a survey of member companies, the break-even level was estimated to be around 9.8 cents in the dollar, virtually identical to the R&D subsidy of 9.75 cents in the dollar that would have applied with a 39 per cent company tax rate and a 125 per cent tax concession (figures cited in Taxation Institute of Australia, Sub. 215, p. 7).

Therefore, while the subsidy currently provided to R&D through the tax concession of 18 cents in the dollar is somewhat below the 23 cents which applied when the scheme was introduced, it is still well above the AIRG's estimate of the break-even tax benefit.

Other participants expressed the view that the concession should *not* be increased. In their view, leaving the concession at 150 per cent would provide a more stable and certain long-term environment than varying the concession rate upwards or downwards with movements in the company tax rate. To change the concession rate would add one further element of uncertainty to a scheme which has already had a history of uncertainty about continuity and level. For example, the tax concession has changed from being a temporary measure (originally scheduled to terminate at 30 June 1991) to a 'permanent' measure (announced in March 1991); and the level of the concession was announced to fall to 125 per cent from 1 July 1993 but then retained indefinitely at the original rate of 150 per cent in the 1992–93 Budget. Even since that time, however, there has been periodic speculation (generally at budget time) about the future of the concession. As one participant commented:

Australia is generally regarded as having the world's most generous incentive for private sector spending on R&D but the program has always been seen as ephemeral. The lack of time frame and certainty has robbed the incentive of its strategic possibilities (Michael Johnson & Associates, Sub. 195, p. 6).

## Match the tax concessions of other countries

Some participants suggested that the tax concession should be increased to 200 per cent to match the R&D support schemes in neighbouring countries, such as Singapore and Malaysia (box D3.3).

### Box D3.3: Level of tax concessions in other countries

An increase to 200 per cent would bring the R&D deduction available for Australian registered companies closer in line to the R&D tax incentives offered in other countries. In particular, the deduction in Singapore is 200 per cent (John Simmons and Partners, Sub. 217, p. 14).

Australia is in danger of having its R&D activities taken offshore through the widening of the gap between the support that it provides for its R&D and the support which is offered by our South East Asian competitors. Both Singapore and Malaysia offer concessions of 200 per cent deductibility. Taiwan offers a rebate of tax of 20 per cent of the eligible expenditure, which equates to total deductibility of 180 per cent (Graham Carew, Sub. 65, p. 18).

The tax concession rate [should] be increased to 200 per cent to compensate for the reduction in company tax rates. It would also assist in aligning incentives in Australia more closely with its international competitors. Singapore, for example, has a tax concession rate of 200 per cent (Australian Electrical and Electronic Manufacturers' Association Ltd, Sub. 126, p. 11).

The IR&D Board suggested that providing more favourable support for R&D along the lines of matching that provided in Singapore and Malaysia was important for influencing location decisions of multinationals in respect of attracting and retaining regional headquarters:

Australia faces strong competition from its regional partners in its efforts to attract high technology industry. Raising the concession rate will enhance Australia's attractiveness as a destination for high technology companies and match similar actions taken by governments in other countries, such as Singapore and Malaysia (Sub. 219, p. 16).

And again:

Australia also needs to be aware that firms are increasingly mobile and yet still tend to locate a disproportionately high amount of their R&D near their corporate headquarters. In Australia's region the Singapore government is offering a much higher R&D tax concession and incentives to relocate regional headquarters. Korea offers firms the ability to retain pretax profits for spending on R&D, an arrangement which is attractive to successful firms in the region (Sub. 219, pp. 59–60).

There are several points to note about such claims.

First, because a tax concession reduces taxable income, the value of the incentive depends on both the rate of concessional deduction and the company tax rate. Therefore, to suggest a crude matching of the 200 per cent tax concessions of Singapore and Malaysia without reference to the company tax rates in those countries might be misleading. Currently, the company tax rate in

Singapore is 27 per cent, while that in Malaysia is 35 per cent. Hence, if the Australian tax concession were to be increased to 200 per cent, the incentive value would be appreciably *higher* than in Singapore — a subsidy of 36 cents in the dollar compared to 27 cents.

Second, in practice, how much more favourable are these overseas schemes? A consultancy prepared for this inquiry by the Centre for Research Policy (University of Wollongong) examined the R&D tax support instruments used in a number of Asian countries, including Malaysia and Singapore, and concluded that:

... a common condition across Asian countries is that firms seeking tax concessions are required to apply for approval in advance of embarking on an R&D project rather than, as in Australia, obtain a tax concession after the expenditure according to its fit with the scheme's rules. In general then, the schemes tend to be rather more directed than is the case for Australia (Liyanage and Hill 1994, p. vii).

In Australia, use of the 150 per cent tax concession is widespread. Around 60 per cent of R&D performing firms appear to be tax concession recipients, and the proportion of private sector BERD claimed under the concession averages around 70 per cent per year (BIE 1993c). Further, the proportion of R&D performing firms which are registrants varies directly with size of firm — for example, around half of very small R&D performers (less than 20 employees) are registrants, compared to 86 per cent of firms with 500 or more employees (BIE 1993c, appendix 4).

By contrast, the use of the tax concession schemes in Singapore and Malaysia appears to be more limited:

Use of the schemes [in Singapore and Malaysia] is difficult to assess, but appears to be limited. This is largely due to administrative formalities involved and the overall low level of R&D (Liyanage and Hill 1994, p. viii).

Third, other submissions cast doubts on whether government R&D support can play so crucial a role in the decision of companies to carry out strategic research — that is, research which will ultimately lead to a major impact on the profitability of an enterprise.

For example, according to Dr Duncan Seddon:

Although tax and grant policies have an influence on how medium sized companies conduct their research, for the industrial majors the present policies have only a secondary influence on where strategic research is conducted. Other factors, such as the strength of the local scientific community and relationships with major production plant or markets are of more importance (Sub. 7, p. 1).

In respect of the pharmaceutical industry, the APMA stated that:

... it [is] important to recognise the significance of the 150 per cent tax concession and the commitment by the Government ... under the Factor (f) program in the creation of an environment which not only encourages greater levels of R&D and innovation in Australia, but also which is conducive to the retention of a research based industry in this country (Sub. 306, p.1).

But the APMA also noted that for a global industry such as pharmaceuticals, the attractiveness of Australia as a location (for R&D and manufacturing) depends on a range of 'environment' influences such as: the research environment, the broader economic environment, the pricing environment, the regulatory environment, and the intellectual property environment (Sub. 131, pp. 25–6).

### **Likely social benefit-cost impact of increasing the concession**

A fundamental question which needs to be considered in determining whether it would be appropriate to increase the level of the tax concession is whether it would be likely to induce a large enough increase in R&D to enhance the net social benefit of the scheme.

The very cautious and qualified conclusion of the BIE evaluation of the tax concession — 'more likely than not' to be welfare enhancing — was based on a nominal level of support of 19.5 cents in the dollar. With a company tax rate now of 36 per cent, the value of the tax concession is still of the same order of magnitude, 18 cents in the dollar.

As was noted in an earlier section, there are some reasons to think that the benefits arising from the additional R&D induced by the tax concession may be lower than those calculated by the BIE.

Even in the absence of these qualifications, there would be doubts about the welfare implications of increasing the concession rate. On the cost side, any increase in the concession would increase the social cost of the transfers associated with the scheme (for R&D that would have been carried out anyway) — an increase in the tax concession from 150 to 200 per cent would at least *double* program costs. On the benefit side, while some additional R&D might well be induced by the higher concession rate, the spillover return to the extra R&D may decline because more marginal projects (with lower expected private returns) would be encouraged. On balance, therefore, the social benefit-cost outcome is likely to be less favourable.

On the question of the likely benefit-cost outcome of the concession, the view was put to the Commission that the conventional treatment of the R&D tax concession as a cost to revenue ignores the effect of revenue flowing back to the government via taxes paid on profits generated by the R&D activity.

Representative of this view was Mt Isa Mines Ltd, who stated that:

If the government can get more tax back from R&D inspired industrial development than it provides in tax incentives, there is every reason to increase R&D incentives. To do this, each incentive dollar in the form of a tax concession (plus approximately one dollar spent by business) must increase business profits by \$3 (at a 33 per cent tax rate) over the life of a new development/process (Sub. 49, p. 2).

Similarly, the AIRG stated that:

... a primary measure of the 'cost' of the scheme should not be 'revenue forgone', but should include the effects of the revenue stream from profits resulting from the outcome of the [R&D] work (Sub. 184, p.78).

And again:

... although Treasury has generally considered the R&D concession as a cost to revenue, the tax flow derived from profits generated as a result of increased R&D expenditure more than counters any perceived losses in revenues associated with the concession scheme (AIRG 1993).

To support their view, the AIRG provided some model simulations of tax revenue generated from profits arising from R&D activity (Sub. 184, appendices 2 and 3; AIRG 1994). However, a problem with their approach is that it attributes benefits to government revenue to the *whole* of the R&D undertaken by tax concession recipients. But any consideration of benefits in the form of increased tax revenues should only take account of those which arise from the *additional* R&D generated by the tax concession — any benefits arising from the R&D that would have been carried out anyway are not relevant for assessing the impact of the concession.

The fundamental limitation of these approaches is that they are only partial, and overlook the *net* tax outcome. Because the resources attracted into R&D would pay tax in their alternative uses, there might not be any net increase in tax revenue flowing back to the government as a result of successful R&D activity. An associated point is that raising taxes is not costless.

The fact that tax flows might be generated by successfully commercialised R&D is not a strong basis for increased assistance to R&D — indeed, it could be used to justify support for *any* kind of activity. As discussed in chapter A5, the conventional basis for government support of R&D turns on instances of likely market failure.

**The Commission does not support increasing the tax concession, either to restore the effective value that applied in earlier years, or to match rates that apply in other countries.**

### **D3.5 Unevenness in rate of assistance provided**

As noted in section D3.2, the benefit provided by the R&D tax concession is not uniform across all companies, but rather depends on their taxable income status and whether the dividend imputation system serves to cancel or ‘wash out’ some or all of the benefit. Participants to the inquiry commented on both of these aspects of the operation of the concession.

#### **Tax loss companies and the value of the concession**

Tax loss companies face a reduced incentive because they suffer a delay in gaining the tax saving — until they earn sufficient taxable income against which the deduction can be claimed. The incentive is further weakened the longer is the delay in moving out of tax loss because the value of tax losses carried forward are reduced by real interest costs.

Several participants commented on the unevenness of support provided by the concession. For example, Pacific Power stated that:

It is questioned why the tax relief is in the form of a [concession] which can only be claimed if the organisation is profitable. This discriminates against those organisations, especially those innovative companies starting up, which do not make sufficient profit to take advantage of the concession (Sub. 227, p. 2).

Edwin Codd and Partners stated that:

To derive any benefit [from the concession] a company must be profitable. This is a major disadvantage because newly set up or emerging companies which are developing products are unlikely to be profitable for a period of time (Sub. 108, p. 5).

This latter comment needs to be qualified, however, in that tax loss companies receive a lesser benefit rather than no benefit from the concession because they experience a delay in realising the tax saving.

To provide some idea of how long those delays typically can be, the survey of tax concession registrants undertaken by the BIE (1993c) for its evaluation of the concession, distinguished two categories of tax loss companies: those newly in tax loss at the time of the survey and those with accumulated tax losses. Most companies in the former category expected to trade out of tax loss within a year or two, while most firms in the latter category were unlikely to realise the tax saving for at least four years. Hence, the benefit provided by the concession differs among tax loss companies — the longer the delay in realising the tax saving the lower the rate of subsidy.

Because companies need to be profitable to be able to benefit immediately from the tax concession, the Discretionary Grants Scheme was introduced on 1 July 1986 specifically to support companies unable to receive adequate benefit

because of insufficient taxation liability. The effectiveness of that scheme (now absorbed into the Competitive Grants for R&D scheme) is assessed in chapter D4, and policy implications considered in chapter D7.

In addition, the R&D syndication arrangements can provide a mechanism by which companies in tax loss may receive additional incentives to undertake R&D. Syndication arrangements are considered in the following section and in chapter D7.

### **Dividend imputation and the value of the concession**

Under imputation, the value of the concession to companies and shareholders differs depending on the dividend payment policies of companies, the marginal tax rates of individual shareholders and the domestic/foreign status of shareholders. For example, because the concession reduces a company's tax liability and hence its franking account balance, this reduces a company's ability to pay all of its post-tax income as franked dividends. Where unfranked dividends are paid, the benefit of the concession is 'washed out' by taxation of these dividends in the hands of shareholders. Even where companies reinvest the funds sheltered from company tax, the value of the concession can be reduced by taxation of capital gains.

Several participants to the inquiry referred to the potential conflict between the 150 per cent tax deduction and dividend imputation. Nucleus was particularly concerned about the potential for the concession to be washed out through the payment of unfranked dividends:

... dividend imputation has caused some of the tax savings realised by concession recipients to be clawed back to the detriment of their shareholders. The so called 'washout' or 'clawback' effect is that a public company such as Pacific Dunlop can only provide a 55 per cent franked dividend partly because of the extent of research activities by subsidiaries such as Nucleus, which take advantage of the tax concession, and in so doing reduce the franking benefit of the dividend (Sub. 93, p. 18).

In view of the potential impact of imputation on the value of the concession, the IR&D Board commissioned a study by Ernst & Young (1990) to examine the effect of imputation on company R&D investment decisions and attitudes to the concession. Ernst & Young considered that real benefits could still be derived from the concession even in an environment of imputation.

In general, the concession provides a company with a lower tax liability and a greater after-tax profit. This enables a greater amount of dividend to be paid to shareholders, albeit not fully franked. In addition, a company which retains its unfranked profits for reinvestment will benefit through increased capital resources, will defer shareholder tax on dividends, and provide for greater long term capital gains (IR&D Board 1991, p. 100).

Survey results obtained by Ernst & Young from 70 tax concession registrants revealed that the great majority considered that the value of the concession remained unaffected by imputation: only 7 per cent perceived that the value of the concession to the *company* had been affected by imputation, while 10 per cent thought the value of the concession to *shareholders* had been affected.

Additional evidence on the empirical significance of washout was assembled by the BIE (1993c). Surveys of tax concession registrants yielded three key findings: first, only a very small proportion of registrants (around 5 per cent) actually paid at least some unfranked dividends; second, a roughly similar proportion of registrants modified their dividend behaviour in order to avoid washout (such as by paying no dividends or limiting their dividend payments); and third, the prospect of washout appeared to reduce the incentive for firms to carry out R&D in only a very small proportion of companies — perhaps as few as 2 per cent of registrants. The BIE concluded:

... washout of the benefit of the concession as a consequence of dividend imputation currently does not appear to be a major issue. Nevertheless, it is clear that *some* firms *are* disadvantaged and face a reduced incentive (1993c, p. 85, emphasis in original).

Companies most likely to face the potential for washout (because of franking account deficits) are those with a large foreign income source (AIRG 1992) or with a relatively high ratio of eligible R&D expenditure to taxable income (see BIE 1993a).

More generally, the effect of imputation on the value of company tax concessions is highly dependent on the marginal tax rates of shareholders (see box D3.4). The benefit to shareholders in taxpaying companies of a deduction of 50 per cent of expenditure could vary between 25 cents and zero cents per dollar of R&D expenditure.

The maximum benefit of 25 cents in the dollar applies when the concessional tax deduction of 50 per cent allows a shareholder paying the top marginal tax rate to shelter income on which a personal rate of 50 per cent (approximately the top personal rate) would have been paid. This is achieved when the income sheltered by the tax deduction (concessionary income) is reinvested by the company rather than paid out as a franked dividend. To achieve the maximum gain it is also necessary for the shareholder to suffer no capital gains tax liability, which can be done if realisation of shares is deferred indefinitely.

For example, a saving in the company of 18 cents of tax (50 per cent deduction times a 36 percent tax rate) allows 50 cents of dividends that would have been paid franked (and so attracted tax in the hands of high rate taxpayer of a total of 50 per cent) to be retained and, at best, avoid tax altogether. In that case the saving to the shareholder is the full 25 cents that would have been paid.

**Box D3.4: Value of tax deductions under imputation**

Imputation is intended to make company source income subject effectively to personal taxation of shareholders. Under imputation the payment of company tax is akin to a prepayment of personal tax. This means that the value of tax concessions given in the company are affected by the marginal tax rate of the shareholder.

Shareholders with low marginal rates (such as superannuation funds) get relatively little benefit from a tax deduction in the company in which they have a share because they effectively pay little tax on the income the company earns. For example, a tax saving induced by a concessional tax deduction of 36 dollars against company taxation would eventually save them only the 15 dollars that would otherwise be paid on 100 dollars of fully franked dividend. This saving would then be further reduced as a result of any capital gains tax or taxation on unfranked dividends to which the shareholder then became liable.

Shareholders with high marginal tax rates receive much larger benefits. A tax saving induced by a concessional tax deduction of 36 dollars would enable taxpayers on a marginal tax rate of 50 per cent to save 50 dollars that would otherwise be paid on 100 dollars of fully franked dividend. Again, however, this saving would be reduced as a result of any capital gains tax or taxation on unfranked dividends to which the shareholder then became liable. Nevertheless the saving to high tax rate shareholders would still greatly exceed the benefit to low tax rate shareholders.

Rates of benefit are reduced where companies pay out concessionary income to shareholders as unfranked dividends. The degree of clawback depends on the nature of shareholders — such as whether they are Australian individuals (subject to personal income tax), superannuation funds (subject to income tax at a rate of 15 per cent), or foreigners (for whom 15 per cent of the value of unfranked dividends is subject to withholding tax) — see BIE (1993c, appendix 7). Alternatively, where the income is reinvested, some of the benefit of the concession can be clawed back from shareholders through capital gains tax on the sale of shares.

Zero benefit — or so-called complete ‘washout’ of the concession — results when all of the concessionary income is paid out as unfranked dividends to shareholders with a personal tax rate equal to or above the company tax rate, or when shares are realised immediately after the benefit is obtained.

Clearly, determining the effective rate of subsidy provided to particular owners of companies (shareholders) by the tax concession is a complex exercise. In aggregate, account must be taken of the combined effect of realisation lags (for companies in tax loss) and clawback through dividend imputation.

**Companies are occasionally obliged to pay unfranked dividends which ‘wash out’ the value of the tax concession. Generally, however, companies are able to make use of the concession to reduce the taxation liabilities ultimately faced by shareholders. The extent of this reduction will depend on the marginal tax rate of shareholders.**

### **D3.6 Syndication provisions of the tax concession**

The Joint Registration (Syndicated R&D) provisions of the R&D tax concession were introduced in November 1987 following a mid-term review of the tax concession program. The intention of syndication was to cater for large and risky projects that were beyond the resources of a single company to carry out:

Syndicated R&D provides the opportunity for projects, which are too big or too risky for any one company, to be undertaken by a group of companies. Syndication also provides a mechanism to attract funds for R&D investment (IR&D Board 1990, p. 48).

In practice, it is the latter feature of syndication which has figured most prominently. As the IR&D Board noted:

... syndication is fundamentally different in intention from the general [150 per cent R&D] concession since it is a financing instrument rather than a tool for lowering the costs of performing R&D (Sub. 219, p. 21).

Currently, syndication is mainly used by tax loss companies as a vehicle for exchanging those losses for R&D funds.

Syndication is effected through two main vehicles:

- fully at risk syndicates in which syndicate participants share in gains and losses from the R&D which is performed;
- guaranteed syndicates in which the supplier of financial capital receives a guaranteed minimum return irrespective of the outcome of the R&D project.

Guaranteed syndicates may be further subdivided into fully guaranteed syndicates, which provide virtual certainty of return of capital for the investor, and partly guaranteed syndicates, in which the investor assumes slightly greater risk in exchange for the syndicate being permitted to take somewhat larger tax deductions (BIE 1994a, p. 41).

### **Operation of the scheme**

#### *Guaranteed syndicates*

Guaranteed syndicates are estimated by the BIE to account for 85 per cent of the R&D conducted under the program.

The practical arrangements for guaranteed syndicates are extremely complex. In a recent evaluation of the scheme the BIE said:

... syndicated R&D is fundamentally a mechanism for the transfer of tax losses from R&D researchers who cannot take advantage of them to financial investors who can.

This trade in tax losses is, however, conducted in a very complex way and it loses all transparency in the process (1994a, p. 43).

The essence of the arrangement is the sale of ‘core technology’ by a research company with tax losses to a syndicate in which a company with tax profits (the financier) has a very substantial interest. The sale of technology creates:

- a tax deduction of 100 per cent of the value of the core technology which serves to reduce the profits of the company with tax profits; and
- a tax liability of the same amount (generally not sufficient to extinguish tax losses in total) in the research company with tax losses.

The nominal tax deduction which is initially in the hands of the company with tax losses has its real value increased by the transfer because it can be used immediately by the financier rather than having to be deferred until the company in tax loss starts earning profits.

The tax loss company suffers no immediate change in tax position as a result of the transaction, although it does give up a *future* tax deduction at the time of the sale. The financier gains a very substantial advantage through obtaining a large tax deduction in virtue of a capital sum which would presumably otherwise be invested without full deduction. The arrangements are such that the capital and interest are protected, so that the financier has a guaranteed return.

The asymmetry in the transaction — an immediate tax deduction on one side but no immediate increase in taxable income on the other — creates a net gain which, under the scheme, must be applied to an R&D project. In effect, the tax loss research company sells its tax losses for a sum which finances an investment in R&D.

### *Fully at risk syndicates*

In fully at risk syndicates investors take a direct interest in the research results. They reap rewards according to their share of the investment and the degree of success it achieves. Investors are entitled to a deduction of 150 per cent of the costs of the R&D performed.

These syndicates are analytically similar to a situation in which a group of investors come together to sponsor an R&D project as equity partners. In such a situation they would be automatically entitled to the normal tax deduction of 150 per cent. The attraction of syndication over other types of joint venture may be to do with the ability of the syndicate to deduct contract (advance) payments for R&D immediately. This allows, for example, pilot plant expenditure to be expensed rather than apportioned over three years. However, the BIE (1994a, p.32) considers that ‘it is not clear cut whether the treatment of FAR [fully at risk] syndicates is truly concessional relative to the general scheme.’

### *Some other aspects of the operation of syndication*

The value of R&D expenditure undertaken in syndicates has grown from \$105 million in 1989–90 (the first year of registrations) to \$293 million in 1992–93 (IR&D Board, Sub. 219, p. 22) — or more than doubling as a proportion of BERD from around 4 per cent to more than 10 per cent. Syndication is a major program for R&D support.

Up to November 1993, 91 syndicates had been officially registered, of which 68 involved taxable entities and 23 involved tax exempt organisations (mainly public sector). The future involvement of tax exempt public sector institutions has been affected by a legislative change introduced in August 1992, which barred them from eligibility in syndicates characterised by guaranteed returns.

According to the IR&D Board, the rationale for this decision was that:

... the tax exempt nature of these organisations was inappropriate in a scheme that depended for its operation on tax benefit transfer. Because such bodies were perceived as effectively having Government financial backing it would be inappropriate for them to be able to participate in syndication. It was considered that their further participation could attract scarce funding away from private companies because such organisations could offer perceived Government security thereby increasing their attractiveness to potential investors (Sub. 219, p. 32).

Furthermore, according to the BIE (1994a), there was a widespread perception that tax exempt bodies may have been conducting less commercialisable research and that they inflated core technology values so as to solicit investors, thus crowding out syndicate investment in private sector taxable firms.

Financial institutions have provided around 80 per cent of the finance for syndicates, with the remainder provided by smaller non-finance based firms. Because eligibility for syndication was originally restricted to projects involving R&D expenditure in excess of \$1 million, small companies have typically *not* participated in the scheme.

The feature of the scheme as a mechanism for tax benefit transfer is illustrated by the fact that of the 42 (out of 68) syndicates involving taxable research firms that were surveyed by the BIE, all but one involved companies with accumulated losses.

### **BIE evaluation of the scheme**

Two features of syndication are that it typically provides a relatively high rate of subsidy, and has a higher inducement rate (of R&D that would not otherwise take place). On the first point, the BIE stated that:

Compared to the general 150 per cent tax concession, all configurations of syndicates (bar those fully at risk) receive high rates of effective subsidy (1994a, p. 101).

In respect of fully guaranteed syndicates, the BIE commented that:

Notwithstanding the absence of explicit concessionary treatment [a rate of deduction of 100 per cent applies], these syndicates have been by far the most prevalent form because they afford considerable tax benefits to both financial investors and research firms alike (1994a, p. 85).

The Redevelop Australia Consortium noted that:

... the artificial debt leveraging currently in vogue [in fully guaranteed syndicates] results in a grossly excessive subsidy from the public purse (Sub. 338, p. 2).

The subsidy rates provided by the various syndication arrangements are reported in table D3.1.

**Table D3.1: Average effective subsidy rate, by syndicate type**

<i>Type of syndicate</i>	<i>Subsidy rate</i> %
At risk	15
Partly guaranteed	50
Fully guaranteed	45
Tax exempt	138
All syndicates	60

The effective subsidy is defined as the ratio of net revenue forgone to R&D conducted.

*Source:* BIE 1994a, p. 102.

One example of the lack of transparency of syndication is that effective rates of subsidy appear to bear little relation to rates of tax deductibility across different syndication arrangements. Comparing the effective subsidy provided to fully and partly guaranteed syndicates, the BIE noted that while a deduction rate of 100 per cent applies to fully guaranteed syndicates and some concessionary treatment is allowed for partly guaranteed syndicates (the deduction has averaged 130 per cent) :

Collectively, the overall impact on tax benefit is very similar between the two configurations of syndication. *Quite paradoxically, the government ends up contributing almost the same per dollar of investment in R&D, irrespective of rates of deduction applicable to the R&D on its own* (1994a, p. 89, emphasis in original).

Research companies which typically seek syndication funding have substantial accumulated tax losses, but do not generate sufficient trading profits to gain any (immediate) benefit from the 150 per cent tax concession. This financial

position makes securing traditional forms of debt or equity finance virtually impossible (address by Senator Peter Cook to *Syndicated R&D Conference*, Feb 16–17, p. 11).

The syndicate investors (usually financial institutions) provide the research company with de facto venture capital, in return for relinquishing the company's accrued tax losses back to the investors. The BIE has suggested that:

Syndication generally works by facilitating finance for firms who otherwise face an effectively infinite cost of finance: that is, capital is unavailable to them (1994a, p. 58).

Because of this 'last resort' nature of syndication finance, most of the R&D carried out under the scheme probably would not have gone ahead otherwise. Survey evidence reported by the BIE (1994a) suggests that around 70 per cent of R&D conducted under syndication would *not* have proceeded in its absence. This figure is much higher than the amount of additional R&D apparently induced by the general tax concession scheme — estimated to be between 10 and 17 per cent of eligible R&D (BIE 1993c).

The BIE study also pointed out the complexity and lack of transparency of syndication as a mechanism for financing R&D through tax loss transfer. This applies in particular to the core technology payment, which has a crucial role as the means by which tax loss benefits are transferred under syndication. As the BIE noted:

Many firms perceived syndication to be sanctioned tax benefit transfer, but concealed in a confusing parcel involving an artificial core technology valuation which obscured this function (1994a, p. 47).

On balance the BIE considered that syndication generates net social benefits and should be retained. It noted that revenue costs were frequently overstated (because they involved a bringing forward of deductions rather than the creation of new deductions). As the scheme as a whole has operated so far, the 'bang for a buck' (new R&D generated per dollar of revenue forgone) is estimated at around \$1 — which compares favourably with the general tax concession (in the range of \$0.60 to around \$1). Overall then, the higher inducement rate associated with syndication has only served to just offset the higher subsidy rate. But the 'bang for a buck' for fully guaranteed syndicates — the now dominant form — was somewhat higher at around \$1.50 of new R&D for every dollar of revenue forgone.

### **Views of participants**

The IR&D Board made several recommendations in respect of syndication (Sub. 219, pp. 29ff):

- an increase in the rate of deduction for new R&D expenditure to 150 per cent where investors' funds are not at risk;
- develop a new program for (public and private) tax exempt research organisations to provide both venture capital as well as funding and expertise for commercialisation of R&D; and
- modify the existing provisions and administrative procedures to enhance access to syndication by SMEs through: reducing the minimum R&D expenditure threshold from \$1 million to \$500 000; developing a generic syndicate structure; broadening categories of eligible investors; introducing easier exit arrangements; requiring SME syndicates to demonstrate arrangements for commercialisation; and where investors agree to remain in the syndicate beyond the R&D phase, to allow certain specified commercialisation activities to be eligible.

The May 1994 White Paper endorsed two of these recommendations, namely reducing the threshold, and introducing a generic syndicate structure.

Other submissions revealed contrasting views on the value of syndication. A very favourable experience was reported by the Nucleus Group, which has participated in seven separate syndicated projects. Nucleus reported that:

The main benefit of [syndication] is that it enables R&D companies in net tax loss situations to access 150 per cent tax concession benefits in the current tax period and thereby gain additional up front cash flow to fund research and product development.

[Syndication] particularly assists high technology R&D companies which need to deal with the commercial difficulties of funding long product development cycles where costs need to be absorbed by the company over many tax periods before offset by returns from product sales (Sub. 93, p. 16).

Some of the tax exempt government agencies that had participated in syndicates prior to their exclusion (from fully guaranteed syndicates) made a strong plea for this decision to be rescinded. For example, Professor Barry Luther-Davies stated that:

... the decision to exclude non-profit organisations from further involvement in the syndicated R&D scheme should be reversed. This scheme has provided very valuable funding of projects of a somewhat speculative but applied nature. The projects would be unlikely to find funding within Australia from other sources. It can be argued that the scheme is partially funded by taxation, however it is important to recognise that, at least in the case of the ANUTECH project, the funding is underwritten by accessing private funds that would otherwise be completely unavailable to support research. Access to the scheme should be returned to Universities and the other bodies recently excluded from it (Sub. 112, p. 17).

Several other participants had serious reservations about syndication. For example, Gradipore Ltd stated that:

Syndication is probably the worst example of that type of arrangement [for using tax losses], where they bring a whole party of unrelated people whose only interest basically is to get the tax deduction out of that structure.

We have looked at using our tax losses to fund R&D, but because of the various constraints that are in place there, you tend to get the wrong type of investors, interested purely in the tax break. That's all they're there for. They don't care about whether there is going to be any research results or anything else (transcript, p. 904).

Dr Steven Gumley of Critec Pty Ltd stated:

I am sick of merchant bankers and other money men working from mail-lists provided them by Government and touting for R&D tax losses and selling financial schemes based around them. Frankly, this activity, best described as financial telemarketing or spruiking, discredits the whole concept and should be abolished at the earliest possible opportunity (Sub. 180, pp. 8–9).

According to Memtec Ltd:

Syndicates as originally configured were rorts. They were stupid contrivances with funds going around in circles until they became giddy, to get a fairly small outcome. It is a valiant attempt by those that are constrained as to capitalisation to get money, but [from the government's viewpoint] it's giving away massive tax deductions to intermediaries for very little outcome (transcript, p. 890).

Memtec argued strongly in favour of allowing transfer of tax deductibility, though *not* in the form of syndication. The particular characteristics of Memtec's local operations mean that it was unable to benefit from the tax concession and therefore had to seek support through the former Discretionary Grants Scheme (DGS). However, in Memtec's view, other means of assistance would be more appropriate than grant support:

... research grants ... are clumsy mechanisms for providing benefits to companies which cannot otherwise obtain a tax deduction for R&D (Sub. 91, p. 2).

According to Memtec, a mechanism which would enable companies like it to benefit from the tax concession and not have to resort to grant schemes is one where they would be able to transfer their tax deductibility for eligible R&D to suppliers or financiers who have a capacity to absorb that deduction. In Memtec's view:

The IR&D Board already must approve research expenditure for a 150 per cent deduction to be allowed. It would be possible for the IR&D Board to licence recipient financiers such as the major banks or insurance companies so that they can offset these tax benefits against funding costs for developing Australian research based exporters (Sub. 91, p. 2).

However, not all participants were in favour of tax loss transfer. Critec Pty Ltd recommended a tightening of the rules relating to transfer of tax deductions to reduce the capacity for rorting:

I reject the argument that just because Australian firms have relocated the bulk of their operations overseas that those companies should be able to transfer their tax deductibility to other companies. This is not a good use of taxpayers' funds and merely encourages the 'moneymen' to play games with tax losses (Sub. 180, p. 6).

Finally, some other participants, while not critical of the principle of syndication, thought that in practice it was too complex a process. For example, SIEG (the technology industries exporters group) thought that the leap from IR&D grants to syndication was often too complex for smaller companies to accomplish successfully (Sub. 204, p. 4). The Fallon Group said:

A further pressure on packagers has been the steady growth in compliance costs and increasing scope, complexity and uncertainty of the Departmental/approval process.

At present the decision/approval process is protracted, disjointed and highly subjective. ... An increase in the transparency of the decision/approval process would be a significant improvement and an essential first step (Sub. 312, pp. 5, 6)

### **Rationale for syndication**

The rationale for syndication arrangements involving tax loss companies (guaranteed syndicates) may arise in a number of ways:

- the need to encourage R&D performance by tax loss firms to allow them to obtain the appropriate level of external benefits;
- the desirability of firms being allowed to make use of tax losses generally;
- poor access to the finance market by tax loss firms; and
- the need to provide assistance for further development of R&D in public or private tax exempt entities.

#### *Need to compensate for external benefits of R&D in tax loss companies*

One argument in favour of syndication is that the additional R&D is valuable because it is undertaken by tax loss firms which do not receive full benefits from the 150 per cent tax deduction. Given that the incentive implicit in the 150 per cent deduction is thought necessary to produce socially desirable levels of R&D (see section D3.3) in companies in tax profit, it would seem desirable to encourage similar levels in companies in tax loss.

Put another way, there is little reason to think that loss-making firms are likely to produce less valuable R&D (less valuable spillovers) than firms in tax profit. Yet under a tax deduction arrangement for providing a concession to encourage R&D, they receive less incentive because of the delay in obtaining value from their tax deductions.

Thus syndication allows such firms to undertake additional R&D in a situation in which there is *prima facie* evidence that they do not receive sufficient incentive. Even so, in this context there are a number of issues that arise about the desirability of syndication.

One set of questions relates to the amount of R&D that is encouraged by syndication. For while it can be established that the tax concession does not itself provide sufficient incentive for tax loss companies, it does not necessarily follow that syndication effectively corrects that fault. One problem could be that it could overcompensate for the ineffectiveness of the 150 per cent tax deduction. This could come about if the incentives implicit in syndication were too valuable, or if there are other mechanisms already operating to improve the position of tax loss firms.

To consider this question, it helps to abstract from the complexity of syndicate arrangements. One characterisation of syndication as it currently operates is as a tap on a large reservoir of tax losses. When the tap is opened, and companies are allowed to obtain immediate value for their stored up losses, a subsidy is generated. Under current arrangements this subsidy is applied to R&D.

The reservoir of losses is very large because it contains unused tax deductions from all sources in the economy: business reversals, expenses incurred in earning certain foreign source income, deductions incurred in respect of projects with deferred revenue streams, highly geared early-stage projects and so on. If all the tax losses were to be used in support of R&D through syndication arrangements, it is likely that some very ineffective R&D would be undertaken. That is to say the subsidy would be applied to more projects of less and less commercial attractiveness, many with less valuable spillovers associated with them. In the extreme, companies with stored up tax losses which have little prospect of ever being valuable to them could find it attractive to apply them to R&D which has only the remotest chance of success.

This outcome in its most extreme form has been avoided under syndication, as it now operates, by a number of features:

- all syndication projects must be approved by the IR&D Board, a vetting procedure which excludes projects thought to provide very little value;
- syndication has very high transactions costs, limiting its application;
- there has been a nexus between the generation of tax losses and the performance of research — firms have applied their own tax losses to syndicated R&D, limiting the population of potential participants.

Another possible constraint on its extension is the core technology valuation, which potentially limits the tax losses transferred to those incurred in the performance of R&D. This is most obviously so where core technology is

valued according to the historical cost of the R&D. If this were universally used it could prove difficult to transfer losses greater than incurred in previously undertaking R&D.

However, core technology valuations are notoriously difficult and are currently permitted to be made on a number of bases. The BIE said that the core technology valuation was often determined on a more pragmatic basis:

Many firms argued that the point estimate of the core technology valuation was determined by the need to undertake a certain amount of R&D and to set a core-technology value that was consistent with investors' required rate of return (BIE 1994a, p. 48).

Evidence that syndication is not currently providing excessive R&D incentives was provided in the BIE's evaluation. This confirmed that projects being undertaken, although highly subsidised, were not so highly subsidised as to make the program cost-ineffective.

It is, however, relevant that there is no inherent budget limitation on tax expenditure of this form. Moreover there is some evidence that the nexus between the company in which losses are accrued and the company which undertakes the R&D is becoming attenuated. Recent press reports have suggested that syndicates are being mooted which amalgamate losses of a number of firms to undertake research which is unrelated to the activities of the firms supplying the losses. Mr E W Saunders indicated that interposed companies may also be being used to achieve this result:

... the IR&D Board guidelines allow interposed companies to be used for syndication provided the Research work meets these guidelines and meets the Taxation Commissioner's rules for the use of tax loss companies (Sub. 268, p. 2).

There could thus be a legitimate concern that in time, as the better projects become exhausted, there will be increasing pressure on the IR&D Board to approve projects which have lower social values.

As well as the danger that syndication may release inappropriately high incentives for R&D in some companies, it may also suffer the deficiency that there may be other deserving companies which it fails to assist. Many companies, for example, find the transactions costs of syndication militate against harnessing their tax losses in this way.

**Syndication encourages R&D in companies in tax loss. These companies receive lower incentives to perform R&D because of their inability to make full use of available tax deductions. However, it has a number of features which suggest a tendency may arise to exploit the scheme to a greater extent than would be justified by the spillovers generated:**

- **companies may access tax losses from all sources to generate a subsidy for R&D;**
- **companies may be able to exploit the losses of others to support R&D.**

*Need to make use of tax losses incurred in general economic activity*

Syndication in one sense appears to allow firms no more than they deserve, because it permits them to obtain benefits for tax deductions which they have legitimately incurred. Syndication may be used in respect of tax losses arising from all sources, including companies in risky activities, those earning large amounts of foreign source income, and those undertaking investments with deferred income streams.

The tax deductions underlying these losses are available to companies in tax profit, so there would thus seem to be case for companies in tax loss also receiving benefit from them. Syndication provides one avenue for this to occur.

However, not all tax losses arise from deductions that would be allowed with a tax system that effectively taxed true economic income. A practical tax system must make compromises, sometimes erring on the side of generosity to the taxpayer (perhaps because of administration and compliance costs associated with 'correct' taxation treatment). Delays in claiming the resulting tax deductions provide some offset to this concessional treatment. In general terms it is difficult to sustain an argument that tax losses from all sources should be given immediate value to tax loss firms.

Whether or not losses from all sources should be immediately given full value to firms, however, it is clear that there is no reason in general for the benefits to firms of such a policy to be made contingent on performance of R&D. Given a free hand, firms would have many other uses for the funds generated by tax loss transfer. In that sense syndication biases investment decisions.

**The Commission does not consider that syndication should be justified as a mechanism for providing general tax benefit transfer. Such transfers are not always justified, and where they are justified, are not necessarily best channelled into R&D.**

*Need to provide access to the finance market*

Syndication provides access to large amounts of finance for R&D. Most firms in tax loss are unable to obtain such finance through conventional debt and equity channels. Many participants considered this to be a prime justification for the scheme.

There is little doubt that the financial institutions which make funds available to tax loss companies under syndication would not do so otherwise. Most such companies are relatively high-risk, partly because of their loss-making status. Syndication in effect allows them to create an asset out of their tax losses which they exchange for a contribution towards R&D.

However, although the firm is in one sense borrowing against future deductions, in the normal commercial finance market these future deductions are likely to be given a very small weight—they have a low value as an asset of the firm, given uncertainties about future profitability. Thus this is not financing in the conventional sense, where borrowings are made on the expectation of repayment. The funds transferred under syndication are likely to have a large subsidy element.

It is even less like a commercial loan arrangement because the financier is usually not at risk. The investor is the vehicle for delivering the finance, but the capital really comes from the revenue forgone by the government in the favourable tax arrangements.

The need for such a subsidy is often seen to arise from failures in the capital market to cater to these companies in tax loss. Yet it is difficult to see how tax loss companies might be especially affected by finance market failure. Suppliers of finance have profit-making incentives to consider worthwhile propositions from all sources, including tax loss companies. The fact that many such companies find financing difficult is more likely to reflect a rational assessment of risk than any particular bias against them (see chapter D5).

Syndication also provides certain disciplines on firms and investors. Firms are required to justify their R&D proposals to the IR&D Board, and in doing so they are required to prepare business plans and have them vetted by the Board. Both aspects are valuable to the firms themselves. Investors too are required to make contact with the firms in which they have an interest and this can lead to future associations.

While these are benefits that arise out of syndication, they are also benefits that can be the subject of normal market transactions. Firms that require advice on business plans may purchase this from consultants and receive assistance for it through schemes offered by AusIndustry. Similarly, financial institutions are always on the lookout for opportunities to establish links with good lending propositions.

**Syndication is therefore better seen primarily as a subsidy for the performance of R&D rather than as a surrogate for the capital market.**

*Need to encourage R&D in tax exempt entities*

When tax exempt entities engage in syndication they transfer a tax deduction to the investor on the basis of the valuation of the core technology. Unlike firms in tax loss, however, they do not give up any tax deductions of their own (because they do not pay tax).

Thus tax exempt entities lack one of the disciplines on the extent of syndication which is placed on taxable firms.

Subsidies for tax exempt entities through syndication also lack the fundamental justification for syndication applying in the case of taxable firms, in that it compensates for a disadvantage which they would otherwise suffer under the tax system. Taxable companies which are in loss receive tax deductions in the knowledge that profits made by them will eventually be taxed. Because they are in loss they are unable to claim their tax deductions in respect of R&D and are thus disadvantaged relative to companies in profit.

But tax exempt entities are not subject to the tax system. It cannot therefore be argued that syndication is necessary to offset a disadvantage created by it.

In more general terms it seems more appropriate for any subsidy given to tax exempt entities to be given in a transparent fashion. There is no need to act through a tax system which does not apply to them. In practice, of course, the very exemption from taxation is a valuable inducement to undertake investments such as R&D.

**The Commission therefore endorses both:**

- **the removal from eligibility of fully guaranteed syndicates involving public tax exempt entities; and**
- **the more recent announcement in the 1995–96 Budget of the removal from eligibility of fully guaranteed syndicates involving private tax exempt entities.**

**How could syndication be made more effective?***Syndicate R&D deductions only*

Under current arrangements, syndication can provide benefits to firms which have acquired losses in any type of activity.

This has two important consequences:

- it provides an additional incentive to undertake the activity generating the tax losses; and

- it provides a large pool of potential incentive to undertake R&D projects.

The first effect is undesirable because not all loss-making activities should be encouraged. Some are the result of a (perhaps necessarily) ineffective tax system.

The second effect is undesirable because it can potentially encourage very low value R&D when firms themselves place a low value on their tax losses.

The Commission therefore proposes that these impacts be reduced by limiting losses that can be syndicated to those that have been incurred in respect of R&D. In calculating losses eligible for syndication arising in a given tax year, firms would have access to either their total unclaimed tax losses for that year or to the total deduction in respect of R&D, whichever was the smaller.

Under such an arrangement, firms likely to be in tax loss could still invest in projects which attract the 150 per cent deduction in the knowledge that the deduction could be available to them through a future syndication project. Syndication could still allow firms to anticipate the use of their tax deductions incurred in respect of R&D and thus partially restore their position relative to tax profit companies.

For many companies this change will make little difference since the core technology valuation on which the tax loss transfer is based is, in effect, equal to accumulated R&D expenditure.

**The Commission recommends that losses transferred under syndication be limited to those incurred in undertaking R&D. In calculating losses eligible for syndication arising in a given tax year, firms would have access either to their total unclaimed tax losses for that year or to the total deduction in respect of R&D, whichever was the smaller.**

### *Transaction costs*

Currently, syndication is a very costly method of delivering a subsidy, both in terms of the administrative costs and management burden. The BIE estimated that the average cost of establishing a syndicate was around \$190 000. This is high relative to the new syndication threshold of \$500 000, although the proposed generic syndicate structure should serve to reduce these costs.

Even so, if the program were to remain in a form that is recognisably syndication, there are some unavoidable costs associated with setting up new legal entities. The Fallon Group said:

The cost of syndication has fallen significantly in recent times and currently rests in the vicinity of 4 per cent of the investment sum. This cost is itself made up of legal, accountancy and packagers' fees. Legal and accountancy [costs] will always be a

significant cost of any arrangement of this type, if only for purely commercial reasons. Whilst legal and accountancy fees have changed little, the packagers fees have fallen as a result of intense competition and the growing familiarity and confidence of investor groups in syndicated R&D (Sub. 312, p. 5).

The Commission considered various methods of reducing transaction costs, including allowing the sale of tax losses and refund of tax losses by the tax office. The BIE made a similar proposal, arguing that ‘a simpler system based on explicit tax loss transfer would be more transparent, easier to administer and potentially less costly to revenue’ (BIE 1994a, p. 123).

However, providing money value for tax losses on a systematic basis has potential dangers. Cash subsidies equal to the value of tax deductions can be more valuable to some shareholders than the underlying deductions (see chapters D4 and D7). Moreover, providing a cash subsidy across-the-board, as such a scheme would in effect be, could open up undesirable opportunities for evasion and fraud.

Some of these dangers could be reduced by requiring, as now, that the cash value realised from tax losses be applied to R&D. However, for this to be an attractive alternative, there would need to be greater confidence that ways would not be found to divert cash payments from companies.

### **D3.7 Other modifications suggested by participants**

Apart from focusing on the level of the tax concession, participants also commented on changing the form of the concession, reducing or removing the threshold level of eligible expenditure, broadening the categories of eligible expenditure, and technical aspects relating to the operation of the scheme. In respect of eligible expenditure, many participants suggested that the scheme should be extended to include costs associated with commercialising the R&D. That discussion is postponed to chapter D5, where commercialisation issues are considered in detail.

#### **Convert tax concession to an incremental scheme**

The Australian tax concession applies to the *level* of eligible R&D expenditure. But in many overseas countries (such as the United States, France and Japan), the tax incentive applies only to the *increase* in R&D above some base level. In this respect, the MTIA made the suggestion that:

Perhaps the Commission could look at some of these schemes that are operating overseas, particularly ... the 20 per cent tax credit scheme in America which encourages

all allowable R&D over and above the expenditure in the previous three years (transcript p. 1488).

In designing an incremental scheme, the ideal base above which expenditure would attract the concession is the level of R&D that would have been undertaken in the absence of the concession. The introduction of an incremental scheme along these lines would have a significant advantage over current arrangements in that it would discriminate against providing support to projects that would have proceeded anyway.

There are clearly many difficulties both in principle and in practice in respect of defining a base which best approximates this ideal — there are many different bases for incremental schemes currently in use in overseas countries. But aside from these difficulties, an incremental scheme is essentially precluded in Australia by the potential for abuse due to the lack of compulsory tax consolidation. Under Australian tax law, it would be possible for firms to claim a subsidy intended only for incremental R&D on all of their R&D spending, by setting up special purpose R&D affiliates. Assuming a relatively high subsidy rate for incremental spending, firms doing this would receive more subsidy than before for doing the same amount of R&D.

### **A two-tier form of tax concession**

While the IR&D Board made a general recommendation to increase the tax concession to 200 per cent (Sub. 219, p. 16), it also suggested that consideration be given to a two tiered structure for the tax concession, with a 200 per cent rate applying for ‘strategic’ R&D (involving innovation, novelty or ‘newness’), and 150 per cent for the rest (involving ongoing improvements to existing products and processes characterised by relatively low levels of technical risk). The Board put forward this proposal as a way of addressing the substantial transfer payments associated with the current scheme highlighted in the BIE evaluation (1993c).

A form of ‘two-tier’ tax concession scheme was canvassed in the BIE report (1993c, pp. 247–48). It was noted that to address the issue of transfer payments by such an approach, it is necessary to reduce the concession on R&D that is more likely to be carried out anyway (and which therefore has the larger transfer component), and provide a higher incentive to the more responsive type of R&D.

The IR&D Board suggestion for a two-tier structure *maintains* the current rate of 150 per cent for all R&D other than strategic, for which a higher concession of 200 per cent would be provided. While such an approach would result in lower transfers than increasing the concession to 200 per cent for all R&D, such

a scheme would *not* reduce transfer payments relative to the current arrangements. To achieve this, the rate of concession on the non-strategic type of R&D has to be reduced (significantly) because there are likely to still be some transfers associated with the strategic R&D which would attract a higher concession rate.

A slightly different approach was suggested by the Institution of Engineers. While arguing that the tax concession should be increased to maintain its former value, they also considered there was a case for *targeting* the higher tax concession at particular types of R&D and/or companies. In their view, the targeting should apply to R&D which is undertaken:

either in association with, and based upon significant financial contributions from, public sector research organisations, tertiary education institutions, or certain recognised industry-based research associations; or by a company which is at least 85 per cent Australian owned and operated; and which can demonstrate a high export potential (Sub. 198, p. 8).

From these criteria, the Institution of Engineers appears to hold the view that R&D is 'more valuable' in some sense if it involves linkages with research infrastructure, or is undertaken by predominantly Australian owned and export oriented companies.

However, the Australian Biotechnology Association made the point that it is the level of *industrial* R&D in Australia that is below average, and suggested another variant of a two-tier concession:

... industry should be encouraged to stop abdicating its R&D responsibility to publicly-supported laboratories, for example by maintaining the tax concession rate at 150 per cent for R&D carried out *for* industry in public sector research organisations while raising it to 200 per cent for R&D carried out *in* industry (Sub. 206, p. 4, emphasis in original).

Overall though, the main problem with two-tier approaches is their operational feasibility: there are severe logical difficulties in separating the two tiers. Even to the extent that it is possible, administrative costs would be higher because of the need to discriminate between the different types of projects, and provision of differential rates of support sets up incentives for strategic behaviour (for applicants to redefine their projects to qualify for the higher concession).

### **Reducing/removing the threshold level of expenditure**

Prior to the May 1994 White Paper, the concessional deduction available for in-house R&D operated on a sliding scale which ranged from 100 per cent deductibility for R&D expenditure of \$20 000 per year, up to the full concessional deduction of 150 per cent for R&D expenditure of \$50 000 or

more. According to the IR&D Board, the thresholds had been put in place because some minimum expenditure was considered necessary for ‘significant’ R&D programs, and to help minimise opportunities for tax avoidance.

A number of participants suggested that the thresholds should be reduced or removed. For example, the IR&D Board recommended complete removal as a means of extending the availability of the concession to a greater number of small and medium sized enterprises undertaking continuous incremental development (but whose annual expenditure might fall below the \$20 000 threshold):

... all expenditure restrictions [should be eliminated] from the concession such that all eligible expenditure will attract the full concession (Sub. 219, p. 20).

Elimination of the threshold was also recommended by the Victorian Employers’ Chamber of Commerce and Industry (Sub. 60). On the other hand, lowering of the threshold to \$20 000 was recommended by Trendcrest Pty Ltd:

... companies with R&D of between \$20 000 and \$50 000 do not bother to claim [the concession] because the small benefit is outweighed by the cost and nuisance of the paperwork. If the 150 per cent rate applied from \$20 000 more companies would apply and gain the management benefits of the discipline of complying with the R&D tax provisions (Sub. 62, pp. 2–4).

The Australian Electrical and Electronic Manufacturers’ Association Ltd (AEEMA) argued for an even lower threshold:

... the expenditure threshold for eligibility under the tax concession scheme should be lowered to \$10 000 without a sliding scale of benefits to permit better participation by small and medium size firms (Sub. 126, p. 1).

The change to the R&D tax concession announced in the May 1994 White Paper that the minimum threshold level of eligible R&D expenditure at which the full concession rate of 150 per cent would apply would be lowered from \$50 000 to \$20 000 therefore goes some way to meeting the concerns of these participants.

## **Broadening items of eligible expenditure**

### *Design costs*

Several participants claimed that design expenditures are not eligible for the R&D tax concession and that eligibility should be broadened to include them. For example, the Australian Academy of Design claimed that:

While many manufacturing companies recognise the need for industrial design and wish to utilise it during new product development programs they find that it is not readily funded by the existing taxation relief or innovation programs (Sub. 166, p. 1).

Similarly, in relation to the tax concession, Edwin Codd and Partners stated that:

Excluding design seems to be counter-productive. It infers a separation between the design process and research and development which should not exist in a properly managed program. [But] design is an integral part of the research and development process. It is the mechanism by which thoughts and processes are converted to reality. Design is essentially an innovative activity (Sub. 108, p. 2 and 5).

However, in relation to these claims, it should be pointed out that while design activities are not treated as ‘core’ R&D under the tax concession, they may be eligible as ‘supporting activities’ if they are integral to and undertaken in direct support of the eligible core R&D activity (box D3.5).

#### **Box D3.5: Supporting activities under the R&D tax concession**

Selected examples of activities that may qualify as supporting activities:

- **Industrial design** — that is, a creative activity the aim of which is to determine the formal qualities of objects to be ultimately produced by industrial processes. These formal qualities are not only the external features but principally those structural, functional and ergonomic relationships which convert a system to a coherent unity both from the point of view of the producer and the user.
- **Engineering design** — that is, aspects included in industrial design requiring engineering expertise in consideration of structure, function and materials.
- **Production engineering** — that is, consideration of aspects including design related to the means and structure of production processes or technology for which the outcome was not predictable.

*Source:* IR&D Board 1994a, p. 46.

#### *Other items of expenditure*

The Australian Coal Association (ACA) suggested that training requirements associated with the introduction of new technology should be eligible for the concession.

... it would be more enlightening to look at the whole process of developing a technology *and* applying it in industry, as qualifying research. If firms which took up a device or system developed from a bona fide Australian research project within, say, two years of [the completion of the research phase], could have all or part of the training and installation costs of the device or system declared as qualifying for the 150 per cent benefit, it would be an excellent stimulus for the rapid uptake of new technology (Sub. 164, p. 8).

Currently, technology which is acquired to support an R&D activity *is* eligible for the concession. However, technology that is acquired which is capable of generating income in its own right or close to being functional is *not* eligible.

**The Commission considers that if the training and installation costs associated with introducing a new technology developed from a *bona fide* Australian research project were deemed eligible for the concession, this would entail only a small relaxation of the current rules and could assist the diffusion of new technology.**

The ACA also questioned the limited eligibility for the concession of research conducted overseas.

This restriction brings into question the philosophical underpinnings of the 150 per cent deductibility: is it designed to encourage the growth of a ‘research industry’ in Australia or is it designed to encourage, through the application of the results of effective R&D, the growth of successful industries in Australia. At the very least it would seem sensible if the costs of monitoring overseas research and participating in international consortia undertaking more expensive research were also deductible (Sub. 164, p. 10).

The *Working Nation* White Paper announced some relaxation of the provisions of the legislation that required R&D activities to be carried out in Australia. Eligibility is to be extended to expenditure incurred on certain R&D activities undertaken outside Australia. However, expenditure on such offshore R&D activities must be given prior approval by the IR&D Board. The *Industry Research and Development Act 1986* will be amended to give the Board power to develop public guidelines specifying the criteria that companies must satisfy for their activities to be approved by the Board (Assistant Treasurer, *Press Release*, 13 October 1994).

#### *Eligibility of clinical trials*

Nucleus (Sub. 93) suggested that the definition of R&D should be extended to cover the clinical trialing necessary to obtain regulatory approvals. Currently, early stage clinical trials up to and including so-called ‘phase III’ are generally eligible, but clinical trials needed to obtain regulatory approvals are ineligible (because there is no core activity involving innovation or technical risk).

While Nucleus regards such clinical trials as the “end of the R&D cycle”, it might otherwise be argued that they represent the first stage of the marketing process, since clinical trials to obtain regulatory approvals are just part of the procedures that companies in their field must comply with in the normal course of marketing a new product. The Commission does not recommend extending eligibility because it may set a precedent for a host of comparable expenditures — similarly removed from R&D as normally defined — that other types of firms need to incur in the normal course of marketing new products.

*Exclusion of unincorporated businesses*

The Victorian Employers' Chamber of Commerce and Industry (VECCI) suggested that because the tax concession only applies to incorporated businesses, many small businesses with corporate structures such as partnerships and trusts are currently ineligible (Sub. 60).

According to the IR&D Board, the Attorney-General's Department is proposing to simplify the requirements for becoming a proprietary company, which will make it easier for sole traders to become companies (Sub. 248, p. 3).

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## D4 COMPETITIVE GRANTS SCHEMES

### D4.1 Introduction

Prior to the May 1994 White Paper, the IR&D Board operated five grant schemes under the Industry Innovation Program (IIP) (box D4.1). In the White Paper it was announced that the individual schemes would be replaced by a single grant scheme — Competitive Grants for Research and Development — with a single set of eligibility and merit criteria. While the individual grant schemes no longer exist as such, the new scheme broadly seeks to support the types of projects and companies that received support under the former schemes. To provide insights into the likely effectiveness of the combined scheme, an assessment is made of the former grant schemes.

#### **Box D4.1: IR&D Board Grant Schemes**

##### **Schemes operating prior to May 1994:**

- Discretionary Grants Scheme
- Generic Technology Grants Scheme
- National Procurement Development Program
- Advanced Manufacturing Technology Development Program
- National Teaching Company Scheme

##### **Following the White Paper, the five schemes were replaced by the:**

- Competitive Grants for Research and Development Scheme

The 1994 White Paper announcement was the second major reorganisation of the IR&D Board grant programs in recent years. The first major change was the bringing together of the Discretionary Grants Scheme (DGS), Generic Technology Grants Scheme (GTGS), National Procurement Development Program (NPDP) and Advanced Manufacturing Technology Development Program (AMTDP) under the umbrella of the Industry Innovation Program in February 1993. At that time the Board also took responsibility for administering the National Teaching Company Scheme (NTCS), which had been established in 1984 and operated by DIST.

Before that reorganisation, applicants could seek support under one (or more) of the individual grant schemes. Applications were assessed by separate scheme-

based committees, and grants were awarded to applications which met scheme-specific eligibility criteria and which ranked highly in terms of merit criteria.

With the change in arrangements in 1993, the grant awarding committees of the individual schemes were replaced by five industry-based committees which awarded grants to R&D projects falling mainly within a particular industry area. In recent years, the IR&D Board received a single line appropriation of around \$40 million per annum for the grant schemes, and around \$7 million was notionally allocated to each committee. The committees covered the following industry groupings:

- Information, communication and electronic industries
- Health, food and bio-industries
- Manufactured products
- Engineering, infrastructure and environment industries, and
- Service and consumer products.

The IIP also saw the introduction of a two-stage application procedure for all programs except the NTCS, designed to reduce the burden on applicants. In the first stage, applicants were required to register an Expression of Interest (EOI) with the IR&D Board, which involved providing minimal information to gauge the eligibility and overall merit of the R&D project. Only those applications that met the eligibility criteria and had some likelihood of receiving a grant were advised to develop a full application, for consideration by the relevant industry committee — with grant approval being at the discretion of the committee, based on their assessment of relative merit against competing projects.

Some basic statistics on the five grant programs are reported in table D4.1, in order to put their relative size in perspective. The dominance of the DGS and GTGS is clear from the fact that they accounted for around 90 per cent of the grant payments in 1993–94.

The chapter is structured as follows. In section D4.2, the objectives of the schemes are outlined and the selection criteria (eligibility and merit) used for assessing grant applications are described. Section D4.3 looks at basic data on the operation of the various grant programs, including the value of grants awarded, and number of applicants and recipients. Some objectives of the programs are scheme specific while others are common to more than one scheme. The discussion of the role of the schemes in meeting their objectives is organised on that basis — the scheme-specific objectives in section D4.4 and the broader objectives in sections D4.5 through to D4.8. The new combined scheme is discussed in section D4.9. The implications of many of the findings are postponed to chapter D7. Further details of the operation and effectiveness of

the two schemes specifically mentioned in the terms of reference — the DGS and the GTGS — are provided in appendix E.

**Table D4.1: Basic statistics on former IIP grant schemes**

	<i>DGS</i>	<i>GTGS</i>	<i>NPDP</i>	<i>AMTDP</i>	<i>NTCS</i>
Commencement date	June 1986	June 1986	Mar 1988	June 1991	Aug 1984
Grant payments (\$m) <sup>a</sup>	115.762	113.547	25.355	1.281	8.788
Number of grants <sup>a</sup>	532	230	113	7	287
1993-94 payments (\$m)	16.366	17.712	1.177	0.565	1.069

a The data reported relate to the period from time of introduction up to end of 1993–94.  
*Source:* IR&D Board, *Annual Report* (various issues).

## D4.2 Objectives and selection criteria

### Objectives and eligibility

The IR&D Board had as part of its mission statement at the time of its establishment:

... to increase the efficiency and international competitiveness of Australian industry by maximising the contribution from industry research and development (IR&D Board 1987, p. viii).

In 1991–92, the Board stated its mission in the following terms:

... to facilitate wealth creation by the development of internationally competitive Australian industries through the encouragement of successful innovation and improving Australian firms' awareness of the role of innovation in business growth (IR&D Board 1992, p. ix).

The provision of support for R&D was therefore seen as only a means to an end, with the ultimate aim being to encourage the growth of internationally competitive companies. But the individual grant programs also had specific objectives. These were set out in the Ministerial Directions that accompanied the establishment of the schemes. The Directions also stipulated the eligibility criteria and considerations to be taken into account for assessing the merit of grant applications. Some of the eligibility criteria were specific to individual schemes while others were common to more than one scheme.

The distinctive feature of the Discretionary Grants Scheme was its role as a complement to the 150 per cent R&D tax concession, in that it was intended to

assist companies unable to take adequate advantage of the concession because of insufficient taxation liability.

The Generic Technology Grants Scheme had two distinctive features — the targeting of selected ‘generic’ or ‘enabling’ technologies, and the collaborative nature of supported projects. A recent statement of the objectives of the scheme (IR&D Board 1993) listed a third objective, namely to encourage the commercialisation of R&D in the designated generic technologies.

The distinctive feature of the NPDP was the focus on assisting firms to link into the forward procurement requirements of government departments and agencies. At the time of the Industry Commission review of the scheme in 1992, the terms of reference for that inquiry described the objectives of the program as being to improve the efficiency and international competitiveness of Australian industry by:

- providing financial support for research and development, trialing and demonstration within government departments and agencies of new internationally competitive Australian goods, services and systems (including prototypes) which meet government purchasing requirements, for the purpose of evaluation and endorsement;
- influencing the attitudes of government purchasing agencies towards positive consideration of Australian products and services for forward procurement requirements; and
- raising the credibility of Australian products and services in the eyes of potential users.

The AMTDP was similar to the NPDP, but differed insofar as it required collaboration between Australian suppliers of advanced manufacturing technology and potential users. The objective of the scheme was to be achieved by providing grant assistance to an applicant company and a commercial partner in the private sector to undertake activities which met the requirements of local users and improved the adoption of advanced technology and techniques (IR&D Board 1992, p. 79).

Finally, the National Teaching Company Scheme (NTCS) shared one of the objectives of the GTGS in that it aimed to increase linkages between public sector research institutions and companies. By so doing, it aimed to provide graduates with experience in industry, provide institution staff with the opportunity to collaborate with industry, and improve company performance.

As well as there being eligibility criteria that were specific to individual schemes, there were two that were common to more than one scheme, namely:

- grant support should be necessary for projects to proceed satisfactorily; and
- projects should be completed within three years of grant approval.

The requirement to demonstrate that grant support was necessary for projects to proceed satisfactorily is taken up in detail in section D4.5 below.

### **Selection criteria**

The Ministerial Directions for most schemes (other than the NTCS) specified a range of economic, technical and commercial considerations that committees were required to take into account in assessing the relative merit of applications. With the reorganisation of schemes under the IIP, the criteria were assembled into a common set. The merit criteria used for these schemes are described in broad terms in box D4.2.

#### **Box D4.2: Merit criteria for assessing grant applications**

**Preference was given to projects which:**

- met the objectives of the particular grant scheme and were consistent with the Government's industry strategies;
- demonstrated an ability to commercialise the results of the R&D; and
- generated national benefits for the Australian economy.

*Source:* IR&D Board 1993.

The IR&D Board has increasingly emphasised commercialisation as the mechanism by which R&D funding provides an eventual economic benefit for Australia. Accordingly, the merit criteria have been applied to increase the likelihood of selecting projects that would result in commercial success. To that end, particular emphasis was given to a range of factors considered to be most indicative of successful commercialisation, such as: management capabilities of companies, market need (size and growth prospects), market competitiveness and dynamism, along with factors like company market knowledge and technical and production strengths (IR&D Board 1993, pp. 28–30).

However, there can be drawbacks in having commercial success as a dominant objective for a scheme of R&D support. As Fölster has noted:

The likelihood of a project succeeding commercially depends on two things. First, the administrator's skill in choosing 'winners' and ... second, the inherent riskiness of the project. The less risky a project is, however, the greater the chance that the firm would have conducted it anyway and the less effective the government subsidy is in stimulating innovation. The administrator therefore has an incentive to pick non-risky projects that the firm would have researched anyway in order to show off his acumen for picking winners (1991, p. 36).

The question of what is the most appropriate bottom line for economically purposive taxpayer-funded research was posed by a participant to the inquiry, Professor Jevons, in the following terms:

Is it the successful completion of the research, or its successful commercialisation, or its commercialisation in such a way that benefits accrue to Australia? For taxpayers, it is the third that counts (Sub. 5, p. 1).

The question of what factors should be taken into account in assessing 'benefit to Australia' is, of course, a difficult one. Among the economic factors suggested in the Ministerial Directions for the grant awarding committees to consider were:

- the pervasiveness of the technology relevant to the project, including the likely benefits to accrue to other businesses and industries;
- the magnitude of the potential impact of the project in terms of knowledge gained, employment generated or cost reductions; and
- the magnitude of the potential impact of the project and the resultant product, process or system on industry's ability to compete effectively in international markets.

Some guidelines for assessing national benefits were provided by the IR&D Board as follows:

Committees must take into account those benefits which will be gained by Australia other than those directly gained by the applicant or the collaborating partner. For example, if innovations can be freely, or cheaply, copied the value of the know-how is not wholly captured by its developers. However, the wider diffusion of this know-how may result in direct economic benefit to other producers, or consumers, or both. The difference between the benefit (received by those undertaking the R&D) and the benefits the wider community receives is the national benefit (1993b, p. 30).

The issues of the appropriateness of the concept of 'benefit for Australia' in the wider context of the extent to which the schemes addressed market failure, as well as the focus on commercial success of projects, are taken up later in the chapter.

### D4.3 Program costs and coverage

#### Value of grants awarded

In 1993–94, grant payments of around \$37 million were awarded under the five IIP grant schemes (table D4.2). The value of payments under the DGS tended to decline each year from the peak of \$18.4 million in 1988–89 to a low of \$13.4 million in 1992–93. By contrast, the annual value of grant payments under the GTGS increased fairly systematically from the inception of the scheme and peaked in 1992–93 at \$20.9 million.

Table D4.2: Value of grant payments (\$m)

<i>Scheme</i>	<i>86-87</i>	<i>87-88</i>	<i>88-89</i>	<i>89-90</i>	<i>90-91</i>	<i>91-92</i>	<i>92-93</i>	<i>93-94</i>
DGS	6.4	17.4	18.4	15.7	14.0	14.0	13.4	16.4
GTGS	4.8	8.2	12.9	16.0	15.2	17.7	20.9	17.7
NPDP	n.a.	0.7	3.9	5.6	4.2	4.4	5.4	1.2
AMTDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.1	0.6	0.6
NTCS	0.7	0.8	1.1	0.7	0.3	1.8	1.3	1.1
<b>Total</b>	<b>11.9</b>	<b>27.1</b>	<b>36.4</b>	<b>38.0</b>	<b>33.8</b>	<b>38.0</b>	<b>41.6</b>	<b>36.9</b>

Source: IR&D Board, *Annual Report* (various issues); BIE 1991a.

Annual payments under the NPDP have been variable, but dropped sharply in 1993–94. Funding commitments were low in the preceding year because the scheme was not operational for a substantial part of that year, following the review of the program by the Industry Commission.

At the time of the establishment of the AMTDP, an amount of \$20 million was committed to the program over a four-year period beginning in 1991–92. However, in the three-year period to 1993–94, grants totalling only \$1.3 million were paid.

The IR&D Board provided limited information on the administrative costs associated with running the grant programs (Sub. 219, pp. 91–2). Expenditure on Central Office support staff was estimated by the Board to be \$2 million in 1992–93, and State Office support was also estimated at \$2 million. However, data on other administrative costs were not available — including the costs of the Board itself in relation to the grant programs and the costs associated with the grant committees.

## Number of applications processed and grants awarded

Over the eight-year period 1986–87 to 1993–94, 1331 applications for DGS grants were processed. There has been a downward trend in the number of applications processed per year from the peak of 244 in 1987–88. However, the sharp drop in 1993–94 partly reflected the introduction of the two-stage application procedure noted above. Overall, 40 per cent of DGS applications were approved for grant support.

**Table D4.3: Applications processed and grants awarded**

	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	Totals
<b><i>Discretionary Grants Scheme</i></b>									
Processed <sup>a</sup>	194	244	187	199	152	130	147	78	1331
Approved <sup>b</sup>	92	69	63	79	67	43	58	61	532
Success rate <sup>c</sup> %	47	28	34	40	44	33	40	78	40
<b><i>Generic Technology Grants Scheme</i></b>									
Processed <sup>a</sup>	106	219	154	114	132	115	74	21	935
Approved <sup>b</sup>	23	27	30	35	39	39	27	10	230
Success rate <sup>c</sup> %	22	12	20	31	30	33	37	48	25
<b><i>National Procurement Development Program</i></b>									
Processed <sup>a</sup>	n.a.	32	64	46	41	50	15	19	267
Approved <sup>b</sup>	n.a.	12	30	16	23	22	1	9	113
Success rate <sup>c</sup> %	n.a.	38	47	35	56	44	7	47	42
<b><i>Advanced Manufacturing Technology Development Program</i></b>									
Processed <sup>a</sup>	n.a.	n.a.	n.a.	n.a.	n.a.	3	9	4	16
Approved <sup>b</sup>	n.a.	n.a.	n.a.	n.a.	n.a.	1	4	2	7
Success rate <sup>c</sup> %	n.a.	n.a.	n.a.	n.a.	n.a.	33	44	50	44
<b><i>National Teaching Company Scheme</i></b>									
Received	114	114	135	166	113	73	32	48	942 <sup>d</sup>
Approved	23	24	42	42	42	29	15	38	287 <sup>e</sup>
Success rate %	20	21	31	25	37	40	47	79	31

a Applications processed is the sum of those outstanding at the start of the year plus those received during the year, minus those carried forward to the following year.

b Applications approved includes agreements signed or offered during the reported year.

c Ratio of approvals to processed.

d Includes 60 NTCS applications in 1984–85 and 87 in 1985–86.

e Includes 12 NTCS grants awarded in 1984–85 and 20 in 1985–86.

Source: IR&D Board, *Annual Report* (various issues); BIE 1991a.

Up to 1993–94, 935 applications for GTGS grants were processed by the various committees, and 230 were approved for grant support. The implied success rate of around 25 per cent was substantially lower than for the DGS, but it has increased in recent years. The decline in applications for the GTGS was even more dramatic than the experience of the DGS.

Applications and approvals in relation to the NPDP were somewhat erratic in recent years, due mainly to the program being non-operational during most of 1992–93. In the three-year period of operation of the AMTDP, only seven grants were awarded. The success rate in both these schemes was quite similar to the DGS.

### **Support provided**

#### *Competitive Grants for Research and Development Scheme*

Under the new grants scheme, the maximum grant available is 50 per cent of total eligible project cost, and there is no minimum level of project expenditure. This is in contrast to the individual grant schemes which the combined scheme replaced. While a maximum rate of grant support of 50 per cent of project cost applied to the former DGS, NPDP and AMTDP, the rate of support provided under the GTGS was variable (project specific). Furthermore, there were minimum project expenditure thresholds of \$50 000 for the former DGS and NPDP, and \$500 000 for the AMTDP.

Yet even under the new scheme, the provision of a uniform grant of 50 per cent of project cost does not necessarily mean that the subsidy provided is the same for all firms.

#### *Projects carried out by tax loss companies*

The maximum grant provided under the DGS was 50 per cent of total R&D project expenditure, and all grants awarded were at this maximum rate. All grants provided by the IR&D Board are treated as assessable income, and hence taxable.

But the calculation of the after-tax cost of R&D resulting from the grant is complex, because the extent to which the receipt of a taxable grant for R&D expenditure affects a company's claim under the 150 per cent tax concession is defined by the so-called 'contamination provisions'. These provisions do not eliminate a future claim to tax deductions whenever an eligible project receives a grant or recoupment — they only reduce the rate of concessional deduction, usually from 150 per cent to 100 per cent (IR&D Board 1994a, p. 70).

For example, a company carrying out a \$100 000 project funded by a 50 per cent taxable grant can deduct the \$100 000 expenditure at 100 per cent once it is paying tax (it is also liable for tax on the grant at that time). The real value of the tax concession entitlement is reduced the longer the time taken to achieve taxable profits, but similarly, the real value of the tax payable on the grant is also reduced.

A comparison of the after-tax cost of R&D for a company claiming the tax concession, and for a grant recipient who subsequently claims the concession, is presented in table D4.4. In the first year of operation (1986–87) of the Discretionary Grants Scheme, the company tax rate which applied was 49 per cent. The after-tax cost of R&D to firms using the concession was only 26.5 cents in the dollar, whereas the after-tax cost of R&D under the grant was typically *above* that level (around 30 cents in the dollar if the company moved into tax profit two years after the grant period, and around 36 cents if the delay was six years).

However, during the more recent periods of lower company tax rates (of 33 and now 36 per cent), the after-tax cost of R&D for grant recipients is somewhat *below* that of firms using the tax concession. Compared to an after-tax cost of 46 cents under the concession (for a 36 per cent company tax rate), the after-tax cost for grant recipients is around 35 cents in the dollar if it moves into tax profit two years after the grant period, and around 40 cents if the delay is six years.

In considering the subsidy provided by the tax concession elsewhere in this report, the measure used is the extent to which the ‘concessional’ 50 per cent component of the tax deduction reduces the after-tax cost — on the assumption that if there were no tax concession, the expenditure would be deductible at 100 per cent. Similarly, the subsidy provided by the grant is defined here as the reduction in the after-tax cost of R&D — compared to the after tax cost implied by 100 per cent deductibility.

It can be shown that in the case of a 50 per cent taxable grant, the level of the after-tax cost of R&D resulting from the grant is equal to the subsidy. The calculations of the after-tax cost provided by the 50 per cent taxable grant shown in table D4.4 can therefore also be interpreted as the subsidy provided.

Table D4.4: **After-tax cost per dollar of R&D<sup>a</sup>**

Company	150 per cent tax concession (¢/\$)	During grant period <sup>d</sup> (¢/\$)	Taxable grant of 50 per cent of project costs <sup>b</sup>			
			Delay before taxable profits <sup>c</sup>			
			0 years (¢/\$)	2 years (¢/\$)	4 years (¢/\$)	6 years (¢/\$)
49	26.5	50.0	25.5	29.8	33.3	36.2
36	46.0	50.0	32.0	35.1	37.7	39.8
33	50.5	50.0	33.5	36.4	38.7	40.7

a The after-tax cost of R&D under a taxable grant can be expressed as:

$$ATC = 1 - \{g [1 - (t / (1 + i)^r)] + [B / (1 + i)^r]\},$$

where  $g$  = grant share of project expenditure,  $t$  = company tax rate,  $i$  = nominal discount rate,  $r$  = number of years before profitability, and  $B$  = entitlement under the tax concession ('contamination provisions').

b These calculations apply the contamination provisions of the tax concession. Those provisions define the extent to which companies claiming the tax concession who received a grant in respect of R&D expenditure, have the benefit of the grant clawed back or offset. For a taxable grant, the amount of expenditure to which clawback applies (ie which is eligible for deduction at 100 per cent rather than 150 per cent) is equal to twice the amount of the grant. Hence, for a grant rate of 50 per cent of project costs, this means that the whole of the project expenditure is deductible at 100 per cent and *none* is deductible at 150 per cent.

c This refers to the delay *after* the grant period. A zero delay implies that the concession is claimed in the year following the grant period. Where grant recipients experience a delay in claiming the concession for the R&D expenditure incurred with the grant project, the value of claims by grant recipients under the tax concession and payment of tax on the grant are discounted at a 10 per cent nominal interest rate per year.

d Applicants for the DGS were required to demonstrate that they had, and would continue to have for the duration of the project, insufficient taxation liability to obtain adequate benefit from the tax concession.

Source: IC estimates.

### *Collaborative projects*

Under the GTGS, grant funds were normally provided to the *research institution* partner, *not* the commercial partner. Because the grant was seen as funding the research institution's contribution to the project, commercial partners could claim their contribution under the 150 per cent tax concession. Commercial partners therefore received twin benefits: the government funding of the research carried out by the research partner from which they stood to gain; and eligibility of their own contribution to the project for the 150 per cent tax concession.

Support provided was project specific, and varied both within and across the five generic technology areas. Further, the rate of grant support provided was typically very high — nearly one-third of the value of grant funds supported

projects where the grant accounted for more than 75 per cent of project costs, and around 70 per cent of grant funds supported projects where the grant accounted for more than 50 per cent of project costs (see appendix E).

In respect of the new scheme, the Board has noted:

Prior to the simplification of the grants scheme, the Generic grants could be provided to either the university or the company. With the simplification, the Government has decided that funds will not be provided to a company if it can take advantage of the tax concession (Sub. 252, p. 16).

But if the funds are provided to the research partner in cases where a company can benefit from the tax concession, which is still possible under the new scheme (section D2.2), there is an opportunity for such companies to receive a higher rate of support.

#### *Projects involving trialing and demonstration*

Assuming that recipients have adequate taxable profits, the nominal subsidy provided by a taxable grant of 50 per cent of project costs for these activities (formerly supported under the NPDP and AMTDP) is 32 cents in the dollar (with a 36 per cent company tax rate, 18 of the 50 cents is clawed back because the grant is taxable).

#### *Projects involving a graduate working on company-based R&D*

The former National Teaching Company Scheme operated differently from the other grant programs in that it provided a maximum support of \$50 000 over a maximum of two years. Because the scheme sought to foster relationships between public sector research institutions and industry, \$40 000 of this amount was paid to the company and \$10 000 to the supporting institution.

## **D4.4 Role of schemes in meeting specific objectives**

### **Role of the DGS as a complement to the tax concession**

In assessing how effectively the DGS performed as a complement to the 150 per cent R&D tax concession, a first consideration is the extent to which the scheme assisted the companies at which it was targeted — namely, those unable to benefit adequately from the R&D tax concession.

The reason why companies typically are unable to benefit adequately from the tax concession is that they have insufficient taxable profits. Such companies in

turn are generally small and new. An analysis of the companies that had received DGS grants up to November 1993 revealed that:

- around 45 per cent were companies with fewer than 10 employees and around 90 per cent were companies with less than 100 employees (a conventional benchmark for small firms in manufacturing and mining); and
- around 43 per cent were companies aged three years or less at the time of their application, and nearly two-thirds were six years old or less.

These data confirm that the DGS mainly supported small, new companies. However, there are concerns over the extent to which it met the objective of supporting companies unable to benefit adequately from the tax concession.

First, only relatively few companies that were unable to benefit from the tax concession actually applied for DGS assistance. The best available estimate of the number of R&D performing companies in tax loss is around 600 per year (refer appendix E), while the number of applications per year for DGS grants dropped from around 250 in 1987–88 to 113 in 1992–93 (before the two-stage application procedure was introduced). There are several reasons why only a small proportion of R&D performing companies that might not have benefited adequately from the tax concession apparently sought DGS support.

- Some might have been unwilling to apply because of the compliance costs — applicants were required to define the project, prepare a business plan, demonstrate that commercialisation finance was available, and document likely benefits arising from the project. The two-stage application process introduced with the IIP attempted to reduce the initial compliance burden on applicants.
- Some companies might have thought that they could not meet all of the eligibility criteria, in particular being able to demonstrate that the R&D would not proceed satisfactorily in the absence of the grant, and other requirements such as an ability to commercialise the R&D.
- The fact that not all applicants in a competitive selection process could be successful might have acted as a disincentive to apply even if a firm satisfied the eligibility criteria.
- Some companies might not have applied simply because they were unaware of the program.
- Any companies seeking to undertake large-scale projects involving R&D expenditure of more than \$1 million could have sought support under the joint registration (syndication) provisions of the tax concession (section D3.6).

Second, only a minority of companies which applied for DGS grants were successful. Over the period June 1986 to November 1993, the success rate was around 38 per cent.

Finally, the DGS funds awarded were concentrated in a relatively small number of firms. Over the seven-year period to 1993:

- only 73 companies (6 per cent of those which applied for support) between them received around half the funds awarded, and some companies received several grants.

At the other extreme:

- 334 companies shared the other half of funds awarded, while
- 670 applicants received nothing.

These features suggest that the DGS has operated in only a very limited way as a complement to the tax concession. But because of its discretionary nature and limited funding, the scheme could never have operated as a full complement to the tax concession.

There is also a range of other ways in which the DGS has differed from the tax concession. As noted in the previous section, the nominal rate of subsidy (per dollar of R&D expenditure) provided by the DGS was more favourable than that provided under the tax concession. There were, of course, differences in the nature of support between the tax concession and the DGS. Whereas only individual projects were supported under the DGS, the whole of a company's R&D might have been eligible for the tax concession. Hence, the importance to a company of the higher rate of support under the DGS depended on how large the supported projects were relative to the company's overall R&D expenditure.

It appears that for around two-thirds of DGS grants awarded, the projects supported represented all the R&D undertaken by the recipient companies. Indeed, in only 15 per cent of cases did the projects represent less than 50 per cent of companies' overall R&D effort. Not surprisingly, the relative importance of these projects decreased with size of firm — in 80 per cent of very small companies (with fewer than five employees) the projects represented the whole of their R&D effort compared to 41 per cent for companies with 50 or more employees.

The requirements that firms needed to satisfy to receive DGS support were more stringent than those needed to claim the 150 per cent tax concession. Under the tax concession, companies are able to obtain the tax saving provided that the R&D is eligible and the company has sufficient taxation liability. By contrast, because the DGS was a competitive (merit-based) scheme, applicants needed to demonstrate not only that they were unable to take adequate advantage of the

tax concession, but also that they were able to commercialise the R&D, and that the project would generate benefits for Australia.

There were also differences between the DGS and the tax concession in respect of certain eligibility criteria. For example, the DGS was confined to projects ‘directed at the development of internationally traded goods, systems or services’. Unlike the tax concession, companies in the non-traded sector were therefore not eligible for support under the DGS. On the other hand, the DGS covered a wider range of legal entities — unincorporated (as well as incorporated) companies were eligible, along with trusts, charitable organisations (non-profit) and non-taxable organisations. Finally, there were differences in respect of types of eligible R&D expenditures — purchase of core technology was eligible for the tax concession but not covered under the DGS, whereas expenditure on market research was eligible for the DGS (but not for the tax concession), provided that it was undertaken directly in support of an R&D project.

### **Role of the GTGS in fostering collaborative R&D**

The background to the goals of fostering collaboration between industry and research institutions was set out in the Second Reading Speech on the Industry Research and Development Act:

Australia’s very good record of scientific research is not reflected in the application of science and technology in industry. Support for these ‘Generic’ areas of technology could be a mechanism for bridging the gap between researchers and commercial interests, for promoting a research and development culture in which both industry and research institutions participate. The benefit of such interaction is two-way. Industry becomes aware of the opportunities R&D presents to provide new products and new/improved processes. Research institutions become aware of opportunities to extend their fields of study and to orient their work towards industry (Senate Hansard, 8 May 1986, p. 2582).

#### *Types and number of collaborative links*

In considering what collaborative links were generated between research institutions and industry as a result of generic grants, it is useful to distinguish projects on the basis of whether they involved one of the following three types of *research* partner arrangements: one or more universities only, other research institutions only, and universities *and* at least one other research institution.

Typically, grants involved collaboration with only *one* type of research partner (refer appendix E, table E18) — 37 per cent of projects involved a university as the only research partner, while 44 per cent involved other research institutions only. By far the most important among the latter was CSIRO, though some

projects involved collaboration with non-profit medical research institutes, the Defence Science and Technology Organisation (DSTO) and private sector research organisations. Around 19 per cent of projects involved collaboration with both university *and* other research institution partners.

The type of collaborative arrangement involved in GTGS grants was typically between only one commercial partner and one research organisation partner (table D4.5). However, this pattern was not so typical in Manufacturing and materials technology, where roughly one-quarter of projects involved three or more commercial partners jointly collaborating with one or more research institutions; or in Environmental technology, where on the industry side 30 per cent of projects involved two or more commercial partners.

**Table D4.5: Proportion of GTGS grants with single or multiple research and commercial partners**

	<i>Number of commercial partners</i>			<i>Number of research partners</i>		
	<i>1</i>	<i>2</i>	<i>3+</i>	<i>1</i>	<i>2</i>	<i>3+</i>
<i>Generic technology</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>
Biotechnology	84	12	4	88	8	4
Manufacturing & materials technology	47	28	25	56	26	18
Information technology	86	7	7	93	7	0
Communications technology	80	8	12	60	24	16
Environmental technology	70	13	17	74	17	9
<b>All generic technologies</b>	<b>70</b>	<b>16</b>	<b>14</b>	<b>73</b>	<b>17</b>	<b>10</b>

*Source:* IR&D Board, *Annual Report* (various issues).

Another aspect of collaborative links is the question of how many *different* companies were involved in GTGS projects. An analysis of the 213 GTGS grants approved and/or signed up to 1992–93 revealed an involvement by 228 *different* commercial partners. Of these, 184 were involved in a single project. The remaining 44 companies were each involved in more than one project, either individually or jointly, and their overall involvement amounted to 148 projects. Therefore, of the total number of 332 company involvements in GTGS projects, 45 per cent were accounted for by companies with more than one involvement. Two companies in particular figured prominently — BHP, with an involvement in 22 grants (either as the sole commercial partner or as one of a group of partners) and ICI Operations Australia, with an involvement in ten.

What might this high proportion of multiple GTGS project participants indicate?

The IR&D Board commented that the involvement of two large companies in generic grants was not surprising:

BHP and ICI are very large conglomerates with a wide range of business and hence research interests. BHP has about 40 separate divisions managing their own research and ICI has around 20. On these grounds alone these large corporations are not disproportionately represented. Similarly they represent a very large component of Australian industrial research, since most business R&D is currently funded by large corporations. Another part of the explanation is that public sector R&D is largely irrelevant to all but the most advanced companies ... A third issue is that the grants were specifically restricted to projects with large spillovers. Clearly such a requirement means that two types of firms will be interested: very high technology companies at the leading edge, and corporations with the larger scale, scope and duration to capture sufficient returns to make the costs of participation worthwhile (Sub. 363, p. 35).

It could also be that these companies were favoured by grant committees because they might have had a better track record in undertaking R&D and commercialising its results. Another possible explanation is that it reflected a lack of depth in the industry structure in these technology areas, such that there was only a relatively small number of key commercial players — or what the IR&D Board has described as ‘receptors for research’ (1992, p. 11).

#### *Impact on attitudes to collaboration*

The Price Waterhouse (1993) study of 15 GTGS projects examined whether the scheme had generated any attitudinal change on the part of companies and research institutions. Broadly, the commercial partners reported that the scheme had resulted in only minimal to moderate impacts on their attitudes. For example, only four of the 15 companies (27 per cent) indicated that the project had significantly changed their attitudes to collaboration or encouraged new or improved links with research institutions, while seven companies reported either no or only a minimal effect. Similarly, six of the 15 companies (40 per cent) reported that the scheme had significantly improved R&D networks with other *companies*, but seven companies reported no impact at all in this respect.

From the viewpoint of the research institution partners, the scheme had had a significant or very significant effect in enabling them to better appreciate the needs of commercial partners in eight out of 12 cases, while in five cases it had improved their attitude to collaboration with industry very significantly.

Participants also reported some benefits from collaborative R&D. For example, Runes Business Services Pty Ltd thought that generic grants yielded benefits to companies by enabling access to a wider range of skills and state of the art equipment. By these means:

... [collaboration] provides a mechanism for companies to upgrade the quality of their R&D to produce an internationally competitive product (Sub. 66, p. 6).

Furthermore, Runes considered that collaboration provided the opportunity for both parties (commercial and research) to gain a better understanding of the other's culture (Sub. 66, p. 8).

### **Roles of the NPDP and AMDTP**

The Report of the Committee of Review of Government High Technology Purchasing Arrangements (the Inglis Report) argued that Australian firms faced barriers in competing for the supply of technology-intensive products to government, arising mainly from attitudes of risk aversion on the part of purchasing authorities, associated with the purchase of unknown or unproven products. One aim of the NPDP, created in response to the Inglis Report, was to address this perceived bias in government purchasing decisions, arising largely for reasons of risk aversion.

A detailed evaluation of the NPDP by the Industry Commission concluded that, in practice, offsetting risk aversion was not an operational objective of the program:

As currently administered, the NPDP does not seek to address risk aversion in government procurement. Instead it subsidises the development of products of some 'interest' to their government sponsors. The possibility of risk aversion on the part of the relevant government agency is of questionable relevance in the case of such projects (1992, p. vii).

Overall, the Commission found that:

- the pattern of grants had not been influenced by any underlying analysis of the incidence of alleged risk aversion;
- the program was not directing grants to firms that were either little known or which had not had the opportunity to establish a track record; and
- the most popular benefit to grant recipients from the NPDP was 'cash injection'.

The IC also commented that:

In practice, the NPDP has operated to subsidise projects where the involvement of a government agency is incidental (and at times contrived) to the progression to market of a new technology. The program targets firms for which the risks of failure in commercialisation are low. ... The criteria [for assessing applications] provide no help towards overcoming any inefficiencies in government procurement arising from purchasing officers being loathe to try products from little-known small Australian firms (1992, pp. 56–7).

On the basis of its assessment of the effectiveness of the NPDP in meeting this and its other objectives, the Commission recommended that the program be terminated.

The Advanced Manufacturing Technology Development Program (AMTDP) was established as an initiative of the Government's March 1991 *Building a Competitive Australia* Industry Statement. The background to the introduction of the program was that:

The use of advanced manufacturing technology and advanced manufacturing techniques can make important contributions to efficiency and productivity, skills enhancement, employee well-being and general competitiveness. As Australian industry moves to compete on world markets, it is essential that it assesses its requirements for advanced and flexible manufacturing capacity. We also need to encourage the local development of key competencies able to assist firms to meet those requirements and use the new technologies and techniques effectively (PM&C 1991b, p. 5.34).

Because of the newness of the scheme, any assessment of effectiveness is difficult. But as noted above, there has been only a very small uptake of the program. While an amount of \$20 million was committed to the program over a four-year period beginning in 1991–92, only seven grants were approved to 1993–94, amounting in total to a funding commitment in the first three years of only around \$2.6 million.

In view of this small uptake, in 1992–93 the Manufactured Products committee, which had special responsibility for the program, sought to promote a more flexible use of the AMTDP funds (IR&D Board 1993, p. 25). Activities under the Innovation Networking Program — which supports projects involving networks of original equipment manufacturers and their suppliers in developing or introducing advanced manufacturing technologies — were funded from the AMTDP.

Prior to the reorganisation of grant programs into a single scheme, the Manufactured Products committee was reviewing a broader range of activities that could usefully be supported from AMTDP funds. This calls into question the need for the scheme and whether there was a market failure to be corrected.

#### **D4.5 Role of schemes in encouraging *additional* R&D**

Government R&D incentives are intended not simply to 'reward' companies for undertaking R&D, but rather to induce them to carry out projects that they would not have done in the absence of the incentive. If R&D grants were provided merely to reward companies for carrying out projects that they would have undertaken anyway, funds in effect are transferred from taxpayers to grant recipients, with no increase achieved in the overall level of R&D.

Hence, a key element in the assessment of the efficiency and effectiveness of any scheme of support is to determine what proportion of the projects which received support were induced by the availability of the grant, and what proportion would probably have been carried out anyway. It should be noted that because eligibility for the various schemes required only that grant support be necessary for a project to proceed *satisfactorily*, this was somewhat weaker than requiring assistance to be provided only to projects that would not proceed in the absence of funding.

A number of recent studies commissioned by the IR&D Board have attempted to assess what proportion of projects that were awarded grants were likely to have been induced by the schemes. In 1993, Price Waterhouse (PW) conducted a small-scale study of selected DGS projects (PW 1993), but the small size of the sample (30 companies) limits the generality of the results. A more comprehensive survey was undertaken subsequently by Invetech (see Sub. 219). In that study, all companies that had received a DGS grant up to 1993 were surveyed. Out of 208 companies that had received a discretionary grant up to 1993, 123 (or 59 per cent) indicated that the R&D project would *not* have proceeded without the grant support.

The Commission considers that survey evidence such as this needs to be adjusted for the likelihood of a respondent bias (strategic response) favouring the scheme. While respondent bias is a commonly accepted problem associated with any survey results, it is more likely to be prevalent for a selective scheme (like the DGS) than a general scheme (such as the tax concession). On this basis, it might be suggested that *at most* around half of the DGS projects that have been awarded grants would not have been undertaken were it not for the availability of the grant support.

Several submissions documented evidence on the importance of DGS grants for the project proceeding. Typically, the DGS grants were seen as important in providing cash flow and enabling companies to sustain their R&D effort. For example, the Nucleus Group reported that:

Federal Government and other grants have been essential for the financing of R&D particularly in the earlier phases of Nucleus' life as a company specialising in medical equipment technology. Without Government support in the form of grants, the sophisticated devices now produced by Nucleus would not have been brought to fruition (Sub. 93, pp. 3–4).

For grant recipients who indicated that their projects *would* have proceeded anyway, the PW study found that DGS support had favourable impacts on the completion date of projects and on the timing of subsequent commercialisation. These outcomes resulted from the fact that the grants enabled the projects to be better resourced and thus completed sooner. Similarly, the Invetech study found

that for projects (across the DGS, GTGS, and NPDP) that would have proceeded in the absence of a grant, in 81 per cent of cases the duration of the project would have been lengthened, for 13 per cent a market opportunity would have been missed, while for 6 per cent the quality of the R&D carried out would have been reduced (Sub. 219, p. 81).

A participant to this inquiry, Gradipore Ltd, commented that:

[The grants] don't influence your decision as to whether you're going to do the R&D or not [but rather] the speed with which we're able to complete the research. In this marketplace, that is the crucial element (transcript, p. 914).

This comment makes clear that speed to market ('first mover advantage') is often an important contributor to the commercial success of an innovation.

In respect of GTGS grants, the Invetech study surveyed the commercial partners in all grants awarded up to that point in time. Of the 54 respondents, 37 (or 69 per cent) indicated that they would *not* have proceeded with the project without the grant support.

This proportion of projects declared to have been induced by the scheme is somewhat higher than for the DGS. This is consistent with differences in the nature of projects undertaken. With the GTGS, more early-stage R&D projects were supported, for which commercial outcomes were more uncertain and there was a greater likelihood of benefits spilling beyond the innovating firm. Both factors reduce the private incentive to undertake such projects. By contrast, DGS support was provided to projects carrying out closer to market R&D.

The Invetech study also provided information on what proportion of NPDP projects supported would not have proceeded without grant assistance. Of the 35 respondents, 16 (or 46 per cent) reported that the project would *not* have proceeded without the grant — or alternatively, around half *would* have been carried out anyway.

This finding is consistent with the results of an earlier survey of NPDP recipients carried out by the Industry Commission for its detailed evaluation of the scheme. The Commission found that:

... about half of all projects assisted by the NPDP would have proceeded without a grant (1992, p. viii).

In its assessment of the NTCS, the BIE (1991a) found that two-thirds of projects would have proceeded in some form without the NTCS funding. Among larger companies (with 100 or more employees), the proportion was as high as 75 per cent, but only around 45 per cent in very small companies (with fewer than 15 employees). The BIE concluded that:

[insofar as] the bulk of projects would have proceeded without the NTCS ... this raises questions as to the extent to which NTCS projects are in fact addressing market failures, especially among larger companies. However, it is quite possible that without the NTCS projects would have been undertaken in-house, rather than in collaboration with a research institution (1991a, p. 60).

Across the individual grant schemes, therefore, perhaps between one-third and even up to two-thirds of projects that were subsidised *would have* proceeded without that support. These proportions appear relatively high, given that the schemes entailed a case-by-case screening of projects. But it should be remembered that the relevant eligibility criterion only required that grant assistance should be necessary for the project to proceed *satisfactorily*. That qualification introduced a significant element of discretion for grant awarding panels.

When the somewhat conflicting evidence presented above was discussed in the draft report, the IR&D Board said that estimates of inducement levels:

... are the critical determinant of social benefits and hence deserve a careful, informed analysis. The draft concedes (D87) that over 90% of projects would either not have proceeded, proceeded more slowly, have missed the opportunity or resulted in lower quality research. Within a page the draft then manages an overall conclusion that between a third and two thirds would have proceeded anyway (Sub. 363, p. 36).

The Board is correct in observing that the evidence about inducement is not always consistent. This is understandable in light of the difficulties of assessing which projects would truly not have gone ahead or been delayed in the absence of a grant. A particular difficulty is associated with projects which might have been undertaken more slowly in the absence of the grant, because once research is commenced, firms themselves will have profit-making incentives to produce research on a cost-effective time scale. They thus forgo a return on their own capital if they proceed too slowly and the impact of a grant in changing their behaviour is unclear. On the other hand, decisions as to whether to proceed or not can be more obviously affected by the presence of additional inducements in the form of a grant.

Fölster notes the difficulty of determining inducement thus:

Agencies distributing subsidies frequently are not in a position to judge whether the project that a firm seeks a subsidy for would have been conducted anyway, or even whether it is socially valuable. Even when these agencies are well endowed with technical know-how they can rarely match the firm's inside information on market potentials. The firms, in turn, have incentives to apply primarily with projects they would have conducted anyway, pocketing the subsidy as a pure gift. In doing so, firms are often forced to exaggerate a project's social value and to present a project as though it would not be conducted without the subsidy (1991, p. 13).

This feature suggests there is a need to canvass whether alternative mechanisms might more effectively induce additional R&D. This consideration is taken up in chapter D6.

#### D4.6 Commercialisation outcomes of supported projects

In considering the merit criteria that were used in assessing applications, it was noted above that the IR&D Board has increasingly placed emphasis on the ability of a company to commercialise the results of its R&D. For most companies undertaking R&D, creating a competitive advantage depends on actually introducing new or improved products, processes or services. As a background to considering the roles of the schemes in improving international competitiveness, it is useful firstly to examine the commercialisation outcomes of supported projects.

In recent years, the IR&D Board has reported information on the outcomes of completed DGS projects. For example, in 1991–92 a survey was undertaken of 213 companies which had received DGS support, representing around 60 per cent of companies that had been supported up to that time. It was found that only 36 per cent of the projects had been successfully commercialised at the time of the survey (table D4.6). However, the eventual commercial success rate is likely to be considerably higher because some proportion of the 40 per cent of projects for which it was too early to assess their outcome might ultimately be commercialised, while projects might also ultimately be successful in cases where the company had been taken over.

Table D4.6: **Outcomes of 213 DGS supported projects, 1991–92**

<i>Outcome</i>	<i>No.</i>	<i>%</i>
Commercial success (sales achieved)	75	36
Company in liquidation	25	12
Company taken over	16	7
Technical failure	11	5
Project terminated	2	1
Too early to assess	84	39
<b>Total</b>	<b>213</b>	<b>100</b>

*Source:* IR&D Board 1992, p. 14.

The Board also noted that the fact that around 12 per cent of grant recipients had gone into liquidation did not necessarily mean that the support was wasted. Often such projects were taken up by other companies and carried through to completion and commercialisation — such technology transfer can enable good technology to survive company failure.

Several studies commissioned by the IR&D Board provide information on the commercialisation record of GTGS supported projects. For example, the Price Waterhouse (1993) review of 15 GTGS projects found ‘limited commercial success to date’ — commercially applicable outcomes had been achieved in only seven of the 15 projects (PW 1993, pp. 81–2). But the apparent lack of commercial outcomes reflected the fact that the majority of the projects reviewed were still in their developmental stage. This in turn reflected both the long-term nature of the commercialisation required in many cases and the relatively short time that had elapsed since R&D commenced.

Information on the time scale of commercialisation envisaged by GTGS grant recipients was obtained from a survey of grant recipients by Deloitte Touche Tohmatsu (1993). The length of time before recipients expected to achieve their first commercial sales at the time the grant commenced is presented in table D4.7.

**Table D4.7: Expected timescale for commercialisation of GTGS projects**

<i>Time period</i>	<i>No. of projects</i>	<i>% of projects</i>
Less than 3 years	14	22
3 to 5 years	37	59
6 to 9 years	11	17
10 years or more	1	2
<b>Total</b>	<b>63</b>	<b>100</b>

*Source:* Deloitte Touche Tohmatsu 1993, table 9.

GTGS grants can be awarded for projects expected to be completed within three years. However, only 22 per cent of grant recipients expected a commercial outcome within that period of time. The time frame to commercialisation was typically up to five years and not uncommonly between six and nine years. It is not surprising, therefore, that there has been only limited commercial success to date for GTGS grants.

Several participants commented on the commercialisation record of GTGS projects. According to Runes Business Services Pty Ltd, two features of the early operation of the scheme contributed to a lack of commercial success.

Firstly, in the initial years, the contribution by the commercial party was very small, 10 per cent, and much of it in kind — there was no hurt money. Secondly, the tertiary institution managed the funds and even though they were not the project manager, unfortunately those that control the money control the research. As well, tertiary personnel had relatively few commercial skills. Further, there was a significant culture difference leading to misunderstandings and lack of commitment to commercialisation (Sub. 66, p. 8).

The need to strengthen the contribution of commercial collaborators to projects in order to improve the market orientation and commercialisation prospects of projects has been an ongoing theme of the IR&D Board (1991, p. 8). In this respect, the Environmental Technology committee sought from its inception in 1990–91 to achieve a greater commercial focus by setting a grant limit of 50 per cent of total project costs, making grant payment through the *commercial* rather than the research collaborator, and requiring the commercial collaborator to manage the overall project (IR&D Board 1991, p. 79). However, no other committee required this degree of commercial commitment — contributions by commercial collaborators of only 10 to 20 per cent of project costs have not been uncommon (appendix E).

The need for a stronger industry commitment was suggested by Australian Photonics Cooperative Research Centre, which is currently associated with five GTGS grants. They thought that the GTGS guidelines could be altered to enhance the effectiveness of GTGS projects conducted in CRCs.

The [GTGS] program is now focused on prototype product development projects. However, the commitment of industry ... is not strong enough, because hands-on involvement is generally through participation in quarterly management meetings ... The [GTGS] guidelines [should] be modified to encourage industry hands-on management ... while recognising that Principal Investigators [from universities] may continue to provide leadership in the research elements of the [project] (Sub. 168, p. 5).

However, there would seem to be some tension between the concern of the IR&D Board with commercialisation and the nature of precompetitive R&D. The Board has described precompetitive research along the following lines:

Precompetitive research is research whose results are not expected of themselves to provide direct competitive advantage to the owner. It is research which is directed into specified broad areas in the expectation of useful discoveries and which provides the broad base of knowledge necessary for the development of new classes of product or the solution of recognised practical problems. In some economies, precompetitive research is performed on a co-operative basis by firms that are in competition with each other (1987, p. 16).

One participant to the Inquiry saw the emphasis on commercialisation in GTGS grants as an unfavourable trend. Professor Barry Luther-Davies stated that:

Unfortunately, schemes like [the GTGS] have drifted in the direction of expecting universities to carry out development on the cheap, with projects dominated by narrowly defined goals, deadlines and performance measured against defined technology outcomes. Such an emphasis is a waste of the talents of the academic cohort. At the same time it is rare that industry pulls its weight in these schemes: personnel are seconded rather than up front cash provided to support the research.

The emphasis of these schemes should focus on the more speculative work handled by the Universities and the development work carried out by industry. This emphasis would make efficient use of the talents of University researchers which should be meshed with different talents and perspectives from the industry sector. Industry should be encouraged to use the strengths of academic institutions rather than try to change them into product incubator laboratories (Sub. 112, p. 18).

Mr Ray Block suggested that to improve commercialisation prospects, the various grant schemes of the IR&D Board could be changed along the lines of the approach followed by the Energy Research and Development Corporation (ERDC).

The ERDC have a number of research managers, who are appointed to look after each investment and they take a close and active interest in each project, which extends to the role of facilitating linkages with people and consortia, together with acting as a sounding board. [If] the IR&D Board were to take a similar proactive role, there would be the probability of greater commercial success (Sub. 45, p. 5).

This relatively 'hands-on' attitude reflects an 'investment in research' approach, whereby the ERDC generally takes an equity position in intellectual property arising from projects. By contrast, the IR&D Board does not seek to own or control any of the intellectual property arising from the projects that it funds.

Mr Block also suggested that:

The need for tough evaluation of grants applications is essential, if commercial success is seen as the major outcome of government funding. A desirable discipline to impose would be to insist that grants made for R&D should be on the basis of at least part repayment by the recipients (Sub. 45, attachment 1, p. 7).

The issue of changing from an outright grant approach to a scheme requiring some repayment is taken up in chapter D6.

#### **D4.7 Role of schemes in improving international competitiveness**

The IR&D Board provided a range of information to the inquiry for the purpose of demonstrating the effectiveness or success of the various grant programs in

meeting the overall aim of ‘increasing the international competitiveness of Australian industry’. That information comprised:

- comparisons of grant recipients with manufacturing firms in dimensions of performance such as R&D expenditure per firm, export propensity, employment per firm, and turnover per firm; and
- estimates of likely commercial returns to projects that had received funding under the various grant schemes.

### *Comparative firm performance*

Data were provided to the inquiry by the IR&D Board showing that grant recipients tended to be more R&D intensive, and exhibited a greater propensity to export, than manufacturing firms on average. From the comparisons the Board concluded that:

While the performance of grant recipients is impressive when considered in isolation, it is only through comparison that the full merit of the grants can be demonstrated. These comparisons indicate that grant recipients consistently out-perform other manufacturers (Sub. 219, p. 84).

It should be noted, however, that the information for the manufacturing sector was on an *establishment* basis while that for grant recipients was on a *firm* basis — it would also have been preferable to compare firms in the comparable industry group rather than overall manufacturing.

In a similar vein, the IR&D Board elsewhere has reported that companies receiving DGS support have performed much better than manufacturing companies as a whole in terms of turnover and employment growth (1992, p. 14).

However, any inference of a simple link between the support provided and the observed performance seems dubious because: the importance of the supported projects to firms’ overall performance is unknown; and given that many projects are still not commercialised, they are not actually contributing to observed firm performance. Such data are only indicative of the types of firms supported, and do not establish the effects of the programs.

Yet there is some survey evidence on how grant recipients perceived they had benefited from the projects undertaken with grant support. Respondents to the Price Waterhouse (1993) survey of 31 completed DGS projects rated the following factors most highly in terms of the extent of the benefit: improved competitiveness; increased sales of associated products; understanding of core technologies; and increased market share. Recipients therefore saw the creation of a competitive advantage for their firms as being among the most important outcomes of the DGS supported projects.

## *Commercial returns to supported projects*

### *Results of studies commissioned by the IR&D Board*

A considerable amount of data on commercial returns was provided to the inquiry, drawn from three studies specially commissioned by the IR&D Board (Sultech 1993; Deloitte Touche Tohmatsu 1993; and Invetech). Most of the information related to the GTGS — information on the other schemes was very patchy. But because only a small proportion of the GTGS projects examined had reached the early marketing stage of commercialisation, the net present value estimates of commercial returns were based on *projected* rather than realised returns.

The Sultech study (1993) estimated the likely commercial returns for all 40 projects supported up to that time in Manufacturing and Materials Technology (one of the generic technology areas), together with 23 projects from other Board grant programs. Private benefit-cost ratios were estimated for the portfolio of projects, calculated as the ratio of the (risk-adjusted) expected net present value to total innovation costs.

Commercial returns were expected for 46 of the 63 projects examined, in that market introduction had been achieved or was still planned. The *expected* net private benefit-cost ratio for these projects receiving grant support was estimated to range from 4.1:1 (85 per cent probability, 10 per cent discount rate) to 8.9:1 (50 per cent probability, 5 per cent discount rate).

A feature of the results was that a small number of 'big winner' projects appeared to dominate the overall outcomes — just six of the 46 projects contributed 50 per cent of the total expected net present returns. But as Sultech noted:

This extent of concentration implies a level of vulnerability of the overall portfolio returns to the fate of the largest projected return projects. However, this vulnerability is not excessive, particularly when it is noted that the projected returns for the high return projects are all based on formal business plans (1993, p. 54).

A second study undertaken by Deloitte Touche Tohmatsu (1993, hereafter DTT) attempted to have a broader scope than Sultech by surveying all recipients of GTGS grants since the inception of the program. Of the 141 companies surveyed, 63 provided sufficient information for net present value and benefit-cost calculations to be made. Across these 63 grants, DTT found a benefit-cost ratio in risk-adjusted terms ranging from 4.3:1 (10 per cent discount rate) to 6.4:1 (5 per cent discount rate). Further, a very small number of 'big winner' projects dominate the overall outcomes even more so than in the Sultech study — just 3 of the 63 projects (comprising two in Biotechnology and one in

Manufacturing and materials technology) accounted for 55 per cent of the projected overall benefits.

The IR&D Board argued that the concentration of projected benefits among a small number of large return projects was not unexpected:

In the Draft Report the Commission argues (D95) that most of the returns have come from three projects. Despite all its own descriptions of risk and uncertainty, as well as the evidence tended by the Board and others, and experiences around the world, there does not seem to be a realisation that this sort of distribution is exactly what is to be expected: a very, very few projects with very, very high returns and many others with more modest but worthwhile returns (Sub. 363, p. 33).

Two points are relevant here. The first is that because of the small number of projects involved in this assessment, it is difficult to distinguish between a chance event and a consistent outcome of the grant program. A second point is the reliance that can be put on results which measure the benefits to project sponsors when the program is intended to generate wider benefits. This question is considered further below.

Much more limited information was available on commercial returns to projects supported under the other grant schemes. Another consultancy commissioned by the IR&D Board (Invetech) reported relatively simple statistics on revenues generated in 1992–93 across surveyed DGS, GTGS and NPDP projects. Some relevant information is reported in table D4.8. Because these data refer to actual commercial returns to projects, the low returns to GTGS projects reflects the limited commercialisation of such projects to date.

On the basis of these results, the IR&D Board concluded that:

The revenue generated by [Discretionary and] NPDP grants is startling. Despite the inclusion of projects that are yet to be commercialised, the average revenue from these projects in one year [1992–93] exceeds the [average] grant value. If revenue [were to be] projected for the life of the projects, returns relative to outlays on grants [would be] far higher (Sub. 219, p. 88).

#### *Relevance of data on commercial returns*

It is commonplace to regard a government program as being effective or successful by reference to the commercial returns to grant recipients generated by the supported projects. However, focusing on private returns to grant recipients ignores other considerations which need to be taken into account in order to assess whether a program of support confers net benefits on the community.

Table D4.8: **Outcomes of IR&D Board supported projects, 1992–93**

	<i>DGS</i>	<i>NPDP</i>	<i>GTGS</i>
No. of companies	121	16	37
Total value of grants (\$)	31 886 270	8 220 091	18 449 185
Average grant (\$)	263 523	513 756	498 627
Total revenue from grant projects in 1992-93 (\$)	35 539 720	8 493 343	2 450 000
Average revenue (\$)	293 717	530 834	66 216

The figures reported relate to projects that would not have proceeded without a grant from the IR&D Board.

Source: Sub. 219, p. 88.

Because the grants are ultimately paid for by taxing other economic activities, an assessment of the *net* (economy-wide) benefit also needs to take into account the competitive advantage or disadvantage imposed on non-assisted firms in attracting resources (capital, labour, technology) and winning markets. In other words, it needs to be recognised that providing assistance to selected firms will be at the expense of other firms and sections of the economy, because taxes have to be increased to finance the subsidies.

Considering just the private benefits, therefore, the effect of a selective program of support may not be to generate a *net* benefit once these adverse effects on others are taken into account. Because of this, demonstrating that private returns accrue to companies that receive grant support is *not* an appropriate indicator of the effectiveness of a program.

In essence, the likelihood of a net benefit depends on whether the provision of selective support results in a more efficient allocation of resources. That depends on whether the support is provided in response to a genuine market failure — a question addressed in section D4.8. There can be a payback for the taxpayer if the entire community benefits in some way from the supported projects, via positive externalities (spillovers) generated beyond the recipient companies. Therefore, economy-wide (external) benefits need to be demonstrated *beyond the private returns to the recipient firms* to justify the government support provided to the R&D projects.

In appendix E, some estimates are made of what spillover returns would be needed for the DGS and GTGS to break even in a welfare sense, that is, for the social benefits generated by the induced R&D to be at least as great as the social costs associated with the programs.

In that framework, key elements on the cost side included: the resource cost associated with the efficiency losses from having to raise a higher level of taxes to finance the schemes; administrative costs; and compliance costs incurred by applicants. On the benefits side, key elements are the extent to which the programs induced additional R&D; and the extent to which the outcomes of the R&D projects were commercialised.

The analysis revealed that under some assumptions, spillover returns of 80 per cent or more would be needed for the schemes to break even, while in more optimistic scenarios, spillover returns of 30 per cent or more would provide social benefits that exceed the social costs.

## **D4.8 Role of schemes in overcoming market failures**

### **Inability to appropriate sufficient benefits?**

As discussed in part A of this report, one reason why a firm might not proceed with an R&D project is because it cannot capture enough of the benefits for it to be privately profitable, even though it might be desirable from a broader society-wide viewpoint for the project to be carried out — because of the benefits that the R&D generates beyond the innovating firm. This inability to appropriate enough of the benefits generated by an R&D project to compensate for the costs involved is perhaps the main ‘market failure’ argument justifying government support for business R&D. And it is the prospect of spillovers to the community from induced R&D that should determine the extent of any publicly-funded assistance.

Because of the selective nature of the various grant schemes, it might be expected that they would target those projects with the largest potential spillovers in relation to R&D. However, there are serious doubts about whether this is typically so in practice.

The notion of ‘benefit to Australia’ has always been one of the merit criteria used to rank competing projects for the various grant schemes and ought, in principle, to approximate the external benefits (spillovers) that the R&D activity might generate beyond the grant recipient. But an approach of discriminating between projects on the basis of the extent to which they generate external benefits is not in itself addressing the question of whether there is a market failure. The mere existence of externalities does not in itself justify government support for any R&D project if prospective returns are sufficient to make the activity viable without government assistance. In such cases, the R&D could be expected to proceed without a subsidy, even though the companies undertaking

the projects might not be able to capture all of the benefits that could ultimately flow from them.

A consideration for establishing the nature of the market failure would be to investigate the reasons why grant applicants seek support. In this respect, companies are not required to demonstrate an inability to appropriate sufficient benefits for the project to be privately profitable. But because likely commercial returns is one of the main merit criteria used to assess applications, there seems little doubt that companies undertaking the supported projects would have been in a position to capture sufficient returns to justify risking their own (rather than public) money. Because large private benefits would have been expected, firms would have had sufficient incentive to undertake the projects without the inducement of the grant.

If the external benefits were correlated with the private returns, it could be that choosing projects on the basis of their likely commercial returns could be a useful proxy. However, if anything, there may even be an inverse correlation — for example, early-stage R&D projects tend to be characterised by relatively large external benefits but only small private returns because most of the benefits cannot be adequately appropriated.

The IR&D Board said that benefits to the nation were closely linked with commercial returns:

No-one realises much private or social benefit, no matter how great the potential is, unless a company can successfully traverse the barriers to commercialisation. When the Board selects projects it selects those which have both a high social benefit and should succeed. Getting spillovers isn't hard, getting those that succeed is (Sub. 363, p. 33).

However, as the Commission notes in chapter A6, it is mistaken to assume that spillover benefits arise only in the case of R&D which is itself commercialised. It is true that spillover benefits are realised when the research is used in a commercial application, but it is in the nature of spillovers that this application may not be directly associated with the original R&D which is supported.

### **Capital market failure?**

In the past, there has been little information available on what criteria are used by grant committees for judging whether a project would not proceed satisfactorily without a grant. Under the new single grants program announced in the 1994 White Paper, applicants are required to demonstrate the necessity of grant support in the following way:

The IR&D Board must be satisfied that [the] project would not be able to proceed satisfactorily without grant support. In making this decision the Board will consider whether project participants have sufficient resources to complete the project and the

need to complete the project in a time that would not be possible without grant support (1994b, p. 10).

In short, applicants are *not* required to demonstrate evidence of market failure (such as a divergence between private and national benefits) as being the reason why they would not proceed with a project without assistance. Rather, the main basis for support in practice appears to be that applicants face a funding problem or wish additional funding to speed up a project.

But this does not necessarily indicate capital market failure. If the schemes had directly addressed capital market failure, applicants would have been required to demonstrate an unwarranted failure of financial institutions to support potentially commercial projects, either in terms of outright refusal or unjustifiably high risk premiums attaching to loans.

The IR&D Board said that the Commission's draft report failed to see the problem from the perspective of the nation as a whole:

For the nation, the portfolio [of investments] is so large that the risks are not much more than that for other investments. However, the nation is still left with individual companies investing far less than is optimal for the economy. Even without the question of spillovers, or the other commercialisation impediments, there is a role for government programs to spread R&D risks. The draft does not adequately account for the risk spreading benefits of the programs (Sub. 363, p. 34).

This is a difficult issue which is considered further in chapter A5. While governments can clearly diversify risk, so can capital markets involving private investors.

The main recipients of DGS grants were small companies. The risk of failure in such companies is often high, because they frequently have neither the financial resources nor the expertise to fully commercialise the results of their R&D. Because of this, the ability to commercialise R&D became a key basis on which applications were assessed — companies were required to have sufficient funds available for successful commercialisation, and/or to have suitable marketing/distribution arrangements in place, before a grant was approved.

But this prompts the question — did such companies really need grant support? It appears that it was often only because of the prospect of grant support that these companies were able to organise such arrangements. For example, of the 310 respondents to a survey of grant recipients by Invetech (1993), 64 per cent reported that it was easier to obtain funding from other (external) sources once a grant had been awarded. According to the IR&D Board:

Before being awarded a grant, firms must pass a rigorous application process which includes the completion of a business and marketing plan. Projects are then subjected to a competitive selection process with the grants being awarded to those projects that have the greatest prospects of success. Financiers recognise the rigour of this process

and are more likely to provide funds to projects once an application for an IR&D Board grant has been successful (Sub. 219, p. 83).

### **Market failure associated with ‘generic’ technologies?**

The particular market failures addressed by the GTGS were described in the Second Reading Speech on the Industry Research and Development Act:

New or emerging technologies with the potential to significantly influence industrial development in the 1990s are unlikely to be fully developed if left to the market alone. The market oriented tax concession would therefore not assist research and development in these areas. Risk is high, the development time frame is often very long and sufficient appropriation of the benefits by the researcher is often not possible. Even with the 150 per cent tax concession it is doubtful whether firms will be able to adequately diversify the risk involved for optimal investment from a community viewpoint. An element of ‘technology push’ is needed to provide the fundamental support (Senate Hansard 8 May 1986, p. 2582).

A characteristic of generic technologies is that they have applications over a range of industries. As the Information Technology committee noted in discussing how it assessed the relative merit of R&D projects, one key criterion was whether the proposed research was ‘generic’:

... in practice this comes down to determining whether the results of the research are likely to provide the building blocks for new advances across a fairly broad spectrum (IR&D Board 1991, p. 10).

A common view is that because generic technologies can have relatively broad applications, benefits tend to spill beyond those companies directly involved in undertaking the R&D projects. But what do the patterns of collaboration identified in section D4.4 reveal about the nature of the generic technology projects that appear to have been supported under the GTGS, and the likely generation of benefits beyond those companies receiving the support?

Virtually all of the generic technology projects supported in Biotechnology, Information technology and Communications technology involved a single commercial partner. On the other hand, in Manufacturing and materials technology, and Environmental technology there was a higher proportion of projects that involved multiple commercial partners, suggesting a greater likelihood that these projects involved ‘pre-competitive’ research.

Given that intellectual property agreements were required before any grant was awarded, these grants may well have supported proprietary rather than generic research. This raises doubts as to whether any flow-on benefits that arose from these projects were greater than those from R&D projects supported under the general 150 per cent R&D tax concession. The GTGS projects, however, were supported at a typically much higher rate (section D4.3).

It is of interest to note that one of the matters specified in the Ministerial Directions for the GTGS that were to be considered in assessing the merit of projects was the degree of proposed dissemination of the results (see IR&D Board 1987, p. 56). However, the question of dissemination appears *not* to have been accorded a priority as the GTGS has actually operated. As the Chairman of the IR&D Board explained:

... when the original generic program was put together, the idea was that we would create diffusion of technology. [However, in reality] we didn't create diffusion because ... [when a] person took out a patent, then that became an exclusive right to operate, and almost a little monopoly. ... But a patent does allow for diffusion of the technology, although it grants exclusion for a period (transcript, p. 846).

### **Barriers to collaboration between industry and research institutions**

Programs aimed at encouraging links between industry and research institutions (such as the GTGS and NTCS) seek to address the problem of an information gap concerning the benefits that each type of organisation can gain from collaborative R&D. One barrier to collaboration often emphasised is a difference in the R&D culture between these types of organisation:

On the one hand, institution research tends to be basic and long term. It emphasises quality of research and public dissemination of results. On the other hand, industry is only concerned with developing innovations that can rapidly be exploited on the market. It emphasises timing and confidentiality (BIE 1991a, pp. 8–9).

However, as noted earlier, aspects of the operation of the GTGS in particular cast doubt on its effectiveness in addressing a market failure in collaboration. The GTGS was characterised by a high proportion of companies with involvement in multiple projects — 45 per cent of all commercial partner involvements in GTGS projects up to 1992–93 were accounted for by companies with multiple involvements. It might be questioned whether experience with as many as that number of projects would be needed to overcome any barriers to collaboration with research institutions that might exist.

### **D4.9 Additional comments on revised arrangements**

The objectives and eligibility criteria for the Competitive Grants for R&D scheme that has absorbed the former grants schemes were provided in section D2.2. The announced reason for combining the individual schemes was 'to address business concerns that the R&D grants system administered by the IR&D Board is too complex' (Senator Peter Cook, *News Release 78/94*, 4 May 1994).

Changes were made to the grants system in early 1993 to simplify and speed up the application process. This involved introducing a two-stage procedure, with applicants required firstly to register an Expression of Interest; and only those applicants with some likelihood of receiving a grant were invited to develop a full application.

On balance, those changes appear to have been successful. The Technology Industries Exporters Group stated that:

The 1993 changes to the IR&D Board application process certainly made it significantly more user-friendly. Most companies would concur that it is straightforward and the initial screening saves a lot of time-wasting on applications that would have failed (Technology Industries Exporters Group, Sub. 204, p. 3).

Similarly, another participant commented that:

The recent improvements in terms of submitting a preliminary EOI (Expression of Interest) ... have been a major gain as at least then the major effort does not have to be put in unless there is a high chance of success. There is still, however, scope for refinement. It is important that the project aims, timetable, and likely progress be carefully thought out and justified at this stage to avoid costly waste (Faculty of Science, University of Technology, Sydney, Sub. 39, p. 8).

But a contrary view was expressed by the New South Wales Government who, on the basis of a small survey of former Discretionary Grants Scheme applicants, reported that:

There have been recent revisions to applicant procedures but the process is still regarded as time consuming and labour intensive, with significant costs attached to it (Sub. 260, p. 15).

The IR&D Board suggested that a single grant scheme would provide a number of advantages (Sub. 219, p. 43):

- easier marketing to clients with a single set of eligibility and merit criteria;
- greater responsiveness to market signals by containing the flexibility to address the individual needs of project proposals; and
- greater responsiveness to new or emerging priority areas of technology for industry development, within the framework of overall program objectives.

However, the Commission has concerns about the new scheme in a number of areas.

In the Commission's view, the attempt to combine the eligibility criteria of the former five schemes into a single set (box D2.2) has resulted in some loss of transparency rather than a gain in simplicity. Most notable in this respect is that while fostering collaboration between companies and research institutions is

one of the objectives of the new scheme, conditions for collaborative R&D no longer appear to be among the stated eligibility criteria.

In response to this claim, the IR&D Board commented that:

We make no apologies that there are not five separate eligibility criteria covering a previous scheme. That would not simplify, only further confuse the clients. The six essential and three alternate eligibility criteria cover all activities available under the previous schemes in a simple straightforward way. Collaborative projects are clearly eligible under the first of the alternate criteria (Sub. 441, p. 2).

However, this does not alter the Commission's view that there are problems of transparency with the new scheme. Indeed applicants could be excused for thinking that the eligibility criterion to which the Board refers, noted below, has very little to do with research in institutions and collaborative projects:

The applicant, or a company that controls the applicant, is unable to obtain full financial benefit under the 150 per cent Tax Concession for Research and Development to undertake the project while in receipt of a Competitive Grant for Research and Development.

A second and related concern arises from the Board's recent announcement that competitive research grants will be awarded to collaborative R&D projects involving pre-competitive or high risk R&D in a targeted industry — namely, the food industry. In its publicity for these new grants, the Board stated that:

As part of the existing [Competitive Grants for R&D] program and in recognition of the food industry's dynamism and potential for growth the Board is seeking to award three grants of up to \$1 million each for R&D projects to be undertaken by the sector (*The Australian*, 4 November 1994).

Under the former GTGS scheme, collaboration was encouraged in 'generic' or 'enabling' technologies that, in principle, had applications over a range of industries. However, as evidenced by the announcement to target support at the food industry, the Board now has a much greater degree of discretion than under the former grant schemes to target particular industries.



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## D5 COMMERCIALISATION ISSUES

### D5.1 Introduction

Commercialisation can be thought of broadly as the process of taking a new product or process beyond the R&D phase and actually introducing it to the marketplace or in production. Commercialisation is a relatively costly and difficult phase of the innovation process. Further, it is essentially the business sector which has the responsibility for commercialising the results not only of its own R&D but also for taking up and commercialising R&D outcomes arising in the public sector.

In section D5.2, the importance of R&D costs in overall innovation is examined as a preliminary to looking at factors that might be impeding Australian companies from commercialising R&D outcomes (section D5.3). Of course, Australian companies are not alone in facing difficulties with commercialisation — it is a challenge faced by all companies worldwide. The rationales for assisting commercialisation are assessed in section D5.4, and the chapter concludes with a discussion of the main programs supporting commercialisation activities, including the recently introduced Concessional Loans for Commercialisation of Technological Innovation scheme (section D5.5).

### D5.2 R&D vs commercialisation costs

There is a widely quoted ‘rule-of-thumb’ that for every dollar spent on research, \$10 is needed for development and \$100 for commercialisation — the so-called 1:10:100 (R to D to C) rule. If these ratios are broadly true, then the magnitude of the costs required to commercialise research outcomes is likely to be a significant factor inhibiting commercialisation in Australia. This section presents available Australian evidence on the relative importance of R&D and non-R&D costs in innovation, drawn from material provided by participants and other recent studies.

The most comprehensive study available to shed light on the generality of the 1:10:100 rule is a BIE survey of tax concession registrants, in which information was obtained on the R&D and non-R&D cost shares of 1155 innovations introduced by 880 companies (BIE 1993c). A key point which this broad-ranging collection of data illustrates is the *variability* in the relative importance of commercialisation costs across innovations.

For example, commercialisation costs comprised 75 per cent or more of overall innovation costs in around 20 per cent of the reported innovations, but less than 25 per cent in around 30 per cent of innovations. The relative importance of commercialisation costs varied widely across product fields of R&D — for example, they tended to be smaller than R&D costs in the majority of computer software innovations but much larger in areas like mining, paper and non-metallic products. Commercialisation costs also tended to be larger than R&D costs where the innovations were relatively costly (involving expenditures in excess of \$1 million). But overall, instances where commercialisation costs were of a magnitude of ten times the R&D costs appeared to be the exception rather than the rule — such cases tended to be very large process-oriented projects, often incorporating pilot plants.

Several participants to the inquiry provided project specific information on the relative importance of R&D and commercialisation costs. For example, in the context of a well-known Australian innovation it was noted that:

As a general rule, for each dollar of research you need at least a dollar for production engineering and two dollars for marketing. In the case of the bionic ear, the numbers were \$3 million in research, \$4 million in production engineering and \$6 million for marketing (Golis 1993, p. 23, quoting Paul Trainor of Nucleus).

CRA Ltd provided details of the proportionate cost breakdown of what it termed a 'typical' recent innovation: laboratory R&D (3 per cent); pilot plant (4 per cent); commercialisation (87 per cent); and post commissioning (6 per cent).

One participant referred to incremental, process technology innovations as typically having the following cost structure:

About 10 per cent research, 40 per cent development, and 50 per cent commercialisation (Critec Pty Ltd, Sub. 194, p. 2).

Another participant noted that the ratio of costs between 'R', 'D' and 'C' differs between incremental improvements or low cost products on the one hand, and high cost products or radical changes in processes on the other. Drawing upon examples of innovations in the shipbuilding and mining equipment sectors, the differences were summarised as:

In most cases the ratio of expenditure on research is one tenth that spent on development. It is the commercialisation costs which differ between the incrementally improved products and those which are high cost or quantum leaps in technology. For incremental developments or low cost products, the ratio of commercialisation costs to development costs is one to one. [For] high cost products or new processes the ratios [are] often ten to one and rarely below eight to one (Australian Shipbuilders Association and Austmine, Sub. 212, p. 34).

The upshot of this evidence is that there is a wide variation in the relative costs associated with research, development, and commercialisation, and the

commonly quoted 1:10:100 rule of thumb is likely to apply to innovations involving high cost new products or radical changes in processes.

### **D5.3 Impediments to commercialisation**

Given the unusually high ratio of ‘R’ to ‘D’ in Australian R&D, some commentators have emphasised that while Australia is relatively strong in research, it is relatively weak in commercialising the results of that research. But insofar as most of the ‘R’ in R&D is undertaken by universities and government research agencies, concern over Australia’s supposed poor record in commercialising R&D outcomes therefore mainly involves addressing problems associated with commercialising the outcomes of public sector research. However, problems associated with commercialising the results of companies’ own R&D also need to be considered.

#### **Possible impediments to commercialisation of public sector research**

In assessing the argument that Australia has a poor record at commercialising public sector R&D, it needs to be recognised that much of the research carried out by universities and government agencies is *not* undertaken for the purpose of realising commercial opportunities — it is basic research ‘undertaken primarily to acquire new knowledge without a specific application in view’. Much of public sector research is of a public good nature and not firm specific, and so would not be expected to produce commercial outcomes.

The Australian Biotechnology Association summed up recent experience in the following terms:

... public sector research is not a major source of novel ideas or opportunities for commercialisation, so that Australian investment in public sector research has led to only a modest level of commercial outcome (Sub. 206, p. 3).

But while much public sector research is in a sense ‘not commercialisable’, it is also argued that there tends to be very little commercialisation of R&D for which commercial outcomes are desired. The obvious question to ask is — why is this so?

#### *Cultural differences in attitudes to research*

Some participants pointed to the role of cultural differences between public sector researchers and industry as impeding commercialisation prospects. Techniche Ltd stated that:

The science community laments industry's failure to commercialise 'ideas' but does not appreciate the differences between scientific curiosity, technology, ideas, prototypes and marketable products. Industry ... regards the science community as focused far more on producing research papers than capable of the professional team discipline necessary to produce commercialisable technology products in viable timescales (Sub. 57, p. 2).

Professor Alan Trounson commented that:

Australian science still suffers from the doctrine that there is a taint about researchers being involved in downstream events, particularly any commercialisation of research developments. This attitude impedes the development and commercialisation of scientific results and feeds the basic knowledge gathering component without realisation of its potential (Sub. 36, p. 2).

### *Lack of market focus and interaction with industry*

Many participants commented on the fact that much public sector research is poorly focused and largely curiosity driven rather than market driven. For example, Dario J. Toncich stated that:

If academic or government research is ever to be commercialised, then it must fit into the long-term business plans of the companies involved. This can only occur with much higher levels of consultation between industry and academic and government researchers than has ever occurred in the past. The major issue that needs to be resolved therefore, is the linkage between research, development, industrial commercialisation and the overall distribution of research funding. Of the \$3000 million spent by the Commonwealth for R&D in 1992–93, only some \$600 million can be identified as directly related to industrial research. The question that we really need to pose, therefore, is not why research hasn't been commercialised in Australia, but rather, why we spend so much money on research that can never be commercialised (Sub. 9, pp. 3–4).

Consistent with this view, some participants viewed the poor record of commercialisation of public sector research as arising from the fact that it is mostly undertaken in an environment isolated from the marketplace. For example, Syrinx Speech Systems Pty Ltd stated that:

One of the most serious problems is that most technology development is undertaken in isolation from commercial and business development activities. Technology development in Australia tends to be heavily biased towards institutionalised development activities, such as those carried out by CSIRO, the Universities and within laboratories such as Telecom's TRL. This leads to development being carried out in a closeted environment highly isolated from the demands and disciplines of the commercial marketplace (Sub. 90, pp. 11–12).

The Task Force Report on commercialisation of research in Australia pointed to impediments to commercialisation arising from the nature of much public sector research and the lack of interaction between the research sector and industry:

... a higher proportion of research undertaken in Australian [compared to most other countries] is performed in the public sector [than] the private sector. This means that a large proportion of research is at least potentially separated from the marketplace. In the view of the Task Force, this can only be remedied by project interactions at an early stage.

The Task Force considers that there is insufficient interaction between government-funded research institutions and industry, which results in a lack of market oriented research. There is also a lack of skills in bringing about transfer of technology from the public sector to the private sector, to enable the rest of the commercialisation process to take place (Block 1991, pp. 2–3).

In the Task Force's view, the question that should be asked in order to achieve commercial returns from public sector research is not 'how to commercialise the research' but rather 'how to bring the market to bear on the research'.

The Centre for Technology and Social Change (TASC) considered that the problem of commercialising public sector research can be solved not so much by pushing that research towards the market as by promoting the *demand* for research from business. In its view, the main focus of government policy needs to switch from research supply and its commercial orientation towards the strong enhancement of demand for research by the market-driven sectors (TASC 1992).

The Commission supports the view that getting the demand side right is a key to correcting the 'commercialisation problem'.

### *Problems of mix and direction of funding*

The high ratio of 'R' to 'D' has been suggested as being the wrong mix for Australian R&D to be commercialised:

One key reason that Australian R&D is not commercialised is that the mix is wrong. In Australia, the public sector policy seems to be to spend \$2.6 billion on research and then hope someone else will come up with the \$10 billion or so needed for commercialisation. This is not clever policy (Golis 1993, p. 23 in Sub. 11, attachment).

Mitec Ltd argued that present policies to get commercial returns from public sector R&D were not working well because funding was mainly being provided to non-commercial entities:

Commercial outcomes ultimately depend on having commercial entities that can translate the R&D into products or services at competitive prices. The most efficient and effective place to locate the R&D effort is in these entities not in R&D institutions. If Australia wants commercial returns from R&D, why is it that we persist in funding non-commercial R&D entities? (Sub. 107, p. 2 and 5).

If it really is the intention of government to make commercial returns from R&D then it would make more sense for public funds to be directed to research institutions via industry. In the short term this would reduce funding but if industry development

is achieved, in the longer term it will result in improved funding to the institutions (Sub. 107, p. 7).

### *Lack of depth in industry structure*

Some participants pointed to there being too few companies with the requisite resources as being an underlying reason for the lack of commercialisation of public sector R&D. As the IR&D Board noted:

The rate limiting step in Australia is the capacity of firms to absorb and commercialise new ideas, not the volume of R&D in the public sector. The accepted wisdom in industry is that 'there are more good ideas than companies to develop them' (Sub. 363, p. 7).

Professor Alan Trounson stated that:

... there are few Australian commercial companies with sufficient resources available to provide the development phase for more than a tiny fraction of the basic medical and rural research presently supported in Australia (Sub. 36, p. 2).

Invetech stressed the problem of a lack of in-house skills in commercialisation among companies:

... difficulties [arise] in getting our public sector research commercialised because local firms do not have the in-house skills to do it. What is needed is the intimate knowledge of the commercialisation process, and the linkage of technology development with corporate strategy, that can only occur within the company, and that needs a company that is active and proficient in R&D (Sub. 142, p. 2).

In relation to medical research, Nucleus stated that:

Australia's medical research industry exhibits world leadership in a number of areas. Product development and commercialisation of strategic research has, however, been limited in Australia, with few companies or commercial enterprises having the skill and resources to manufacture and market sophisticated innovative world competitive medical equipment products. This reflects a lack of commercial orientation in much of Australia's medical research and a lack of sufficient incentives for Australian owned production enterprises or foreign owned enterprises to be engaged in production within Australia (The Nucleus Group, Sub. 93, p. 10).

Some participants stressed the problem of a mismatch between public sector research and the interests and abilities of Australian companies to commercialise the results. The Technology Industries Exporters Group stated that:

It is no use having newspaper articles and television programs berating industry for not picking up the latest 'world beating technology' from CSIRO, when (as is often the case) we have none of the type of industry able to pick up that particular product. Industry gets castigated for missing these 'world beating opportunities' constantly, but if we do not have specific expertise here in Australia, why then is a government funded institution researching in the area? (Sub. 204, p. 7).

As an example of such mismatch problems, one participant cited the case of Gene Shears:

If we are to identify those who might hang their heads in shame, then I would suggest those in charge of the funding of research in this country who continue to pour millions of taxpayers dollars into activities that *if they were successful*, would stand Buckley's chance of being taken up by Australian industry (Dr Duncan Seddon, letter to *The Age*, included in Sub. 7, emphasis in original).

As has been repeatedly emphasised in this report, technological knowledge is highly specific, partly tacit in nature, and takes time and experience to build up. No country in the world can expect to have more than a small proportion of the specific technological competencies which would be required to make effective commercial use of all the potentially good ideas produced by a lively domestic scientific community such as that found in Australia. The challenge is to ensure that the technological competencies which do exist make the best use of new ideas developed anywhere in the world — including Australia.

#### *Commercialising public sector R&D for the benefit of Australia*

One approach designed to enhance the commercialisation prospects of Australia's medical research results was the establishment in 1987 of AMRAD, an Australian-owned pharmaceutical company which is formally affiliated with a number of medical research institutes (box D5.1). To facilitate commercialisation of medical discoveries, AMRAD has first rights to the research projects within the member institutes, from which it chooses a limited number for additional funding in return for marketing rights.

As AMRAD explained:

AMRAD represents a particular model as a linkage between research in the public sector and the commercial development of such research. [It] involves the public sector participating in two ways: they obtain research funding and royalties [and] contribute to the development of an Australian enterprise (Sub. 43, pp. 6–7).

But AMGEN Australia Pty Ltd, a fully owned subsidiary of the United States company AMGEN Inc. (the largest biotechnology company in the world) was critical of this 'tied relationship' between AMRAD and the institutes:

... this arrangement effectively limits the ability of these Research Institutes to collaborate with other organisations who may be able to offer greater expertise and resources and thereby more effectively commercialise an Australian discovered product (Sub. 235, p. 6).

One participant, Professor Jevons, drew the distinction between R&D being commercialised for the benefit of a company compared to commercialising it for the benefit of Australia. This distinction illustrates the concept of 'regional appropriability' — the critical bottom line for government funded R&D should

be the extent to which Australia rather than other nations can appropriate the benefits (Sub. 5).

**Box D5.1: AMRAD Corporation Ltd**

AMRAD's strategic objectives are:

- to build working relationships with Australian biomedical and other research organisations and fund within those research organisations selected patentable projects which present large commercial potential;
- to make arrangements with large overseas pharmaceutical corporations for the development and manufacture of product opportunities derived from the research projects;
- to develop and then to commercialise, on world markets, high value Australian-discovered pharmaceutical products; and
- to become an integrated Australian pharmaceutical group which manufactures products for global marketing and distribution.

*Source:* AMRAD, Sub. 43.

The Australian Biotechnology Association made the point that a key objective should be to achieve *manufacture in Australia* where possible.

In the short to medium term, increasing the proportion of the commercialisation process that takes place in Australia would significantly increase the economic return [to the R&D]. This could be done by fostering the development of pilot plant and production facilities (as in Singapore, for example) and by making it attractive for multinational companies to test-produce and test-market novel high-tech products from an Australian base (Sub. 206, p. 5).

But whether it is feasible to commercialise R&D outcomes in Australia depends on a range of factors, including the knowledge skill base, industrial structure, and availability of complementary assets.

***Improving public sector outcomes***

It is important to be clear that not much public sector research can or should be directed to immediate commercial outcomes. Universities, in particular, have an important role in basic research which has a longer-term payoff through contributions to more applied research and through the training of students.

There have nevertheless been problems when research intended for commercialisation has been undertaken. It makes no sense, for example, for such research to be in areas which Australian firms cannot take up or are not disposed to take up. Nor should worthwhile research opportunities for which institutions have the capability to contribute be passed up simply because business and researchers in the public sector cannot see eye to eye.

Many of the problems pointed to by participants are significantly less substantial today than they were, say, ten years ago. Researchers in institutions are now more conscious of the opportunities to contribute to commercialisable research and firms more inclined to take their problems to them.

The key to successful outcomes, however, is having mechanisms to convey demand signals to researchers in public institutions about the relative value of different types of research, both commercialisable and at the more basic end.

Much of this report is about getting incentives for research better lined up with the demands for it. Reforms of funding of universities and public sector organisations are directed at attempting to identify those who benefit from research and to create mechanisms to transmit their needs to researchers. An important part of that process is explicitly setting up bodies to ‘purchase’ public sector research on behalf of the broader public beneficiaries of research. Especially in the case of public sector bodies such as CSIRO, such demands can at times include that for potentially commercialisable research which might have spillover benefits. The use of a purchasing body for such research should assist in ensuring that research is relevant and well-founded in possible applications.

The question of links between public sector institutions and business is discussed in more detail in part F.

## **Possible impediments to commercialisation of private sector research**

### *Lack of market focus?*

Several participants stressed the imperative of market focus in R&D as a critical precondition for the successful commercialisation of companies’ own R&D. As Strategic Vision Pty Ltd noted:

Too much research and development arrives at a ‘success’ in a technical sense, and *then* the owners look around, scratch their heads and wonder how it is to be commercialised. Without the market focus at the outset, there is a strong element of chance in whether success is achieved (Sub. 102, p. 3).

Similarly, another participant commented that:

Successful commercialisation is the result of driving home competitive advantage. The key input [is] the needs of the marketplace. It is therefore imperative that R&D incorporates into its decision making process some commercial judgements. Indeed, the difference between market pull R&D and technical push is just that: coming at the R&D challenge by posing an acceptable market solution and conducting R&D to achieve it, rather than pushing forward the frontiers of knowledge and then

looking for a market acceptance (Australian Shipbuilders Association and Austmine, Sub. 212, p. 37).

But as Strategic Vision also pointed out, success not only requires developing a product (good or service) that meets a market need. It is also necessary for the commercialiser to have the resources (managerial, financial, production and marketing) to bring the product to market, and for the market environment to be not unduly hostile in terms of competitive pressures, and barriers to entry and trade (Sub. 102, p. 4).

### *Lack of adequate human and financial resources?*

Mr Bill Potter stressed the lack of trained technology managers as being a major impediment to commercialisation:

A further reason for the failure to commercialise is the lack of trained technology managers who are equipped with the specific skills to take research outcomes to market profitably. The skills required, such as project management, technology marketing and intellectual property management have not generally been taught in business schools until the recent introduction of technology management programs. There is no financial sense in increasing the investment in R&D and training of researchers unless there is a far greater investment in the commercialisation process and the training of technology managers. Without the latter, there can be no commercial return on the investment in the former (Sub. 80, pp. 1–2).

The Energy Research and Development Corporation (ERDC) also submitted that the shortage of experienced technology managers in Australia ‘is a major inhibition to successful adoption of innovation and R&D in Australia’ (Sub. 362, p. 3).

Some participants pointed to difficulties in obtaining capital to finance commercialisation of the technologies that they had developed. Syrinx Speech Systems Pty Ltd stated that:

Venture capital in Australia is becoming an increasingly scarce resource and more and more focused on growing established businesses operating in established markets. There are few venture funds which offer risk capital, and even fewer that consider seed capital. Despite having a commitment of cash from a [Discretionary] grant and signed contracts with customers, seed capital necessary to take developed technologies through to commercial products has proved extremely difficult to attract (Sub. 90, p.11).

Mr Ray Block considered there was now less difficulty for small and medium sized innovative companies to obtain new equity capital, but noted that:

... the one remaining area of concern is the continuing lack of capital for start-up businesses (Sub. 45, p. 9).

A number of inquiry participants pressed the issue of access to capital in their submissions on the Commission's draft report. For example, the Australian Academy of Technological Sciences and Engineering, referring to its recent study of technology-based small start-up companies, stated:

The major difficulty for industry development and commercialisation of innovations, especially for start-up firms, is the availability of capital (Sub. 337, p. 8).

Similar comments were offered by Shedden Technology Management:

There's practically no equity capital available for [the blood sweat and tears of starting something new] and very little in the way of loan funds (transcript p. 2949 and Sub. 333).

David Breeze & Associates (Sub. 458) submitted that securities legislation makes it prohibitively expensive to raise money through a prospectus and that government programs to assist small companies such as Pooled Development Funds and the Australian Technology Group 'are just not working'. The ERDC said:

Although the Australian development capital industry is now quite well established, these firms are not prepared, in the main, to provide new enterprises with seed capital (say \$0.5m – \$1.0m). Rather, they concentrate on funding the growth of firms that are already or nearly profitable and providing them with broad level management support (Sub 362, p. 3).

In the consultations Ministers are conducting in the lead-up to the Commonwealth Government's Innovation Statement later this year, the general consensus during the consultation was that there are major market deficiencies — perceived to be the availability of, and access to, seed, venture and development capital (Cook 1995b, p. 10).

### *Lack of government support for commercialisation?*

The extent to which available IR&D Board programs cover research, development and commercialisation is indicated in table D2.1 in chapter D2. Some participants attributed the failure to commercialise R&D outcomes in part to a lack of government support for commercialisation elements of the innovation process. According to Mr Bill Potter:

The prevailing doctrine is that government should only be involved in and support R&D in the pre-commercialisation phase. The R&D grants and concessions are only available for expenditures up to the prototype stage of demonstration. While a gross imbalance in favour of support of R&D to the neglect of encouraging commercialisation continues, we cannot hope to get an appropriate return on our investment in innovation (Sub. 80, pp. 1–2).

The Queensland Government stated that:

... the commercialisation phase is inadequately addressed by current schemes (Sub. 257, p. 2).

Martin Communications thought that:

There is too much focus on the 'R' part of the [innovation] process and not enough focus on the 'D' part. There are no government arrangements ... for small companies to assist in the commercialisation phase of new products. There are some good assistance schemes once exporting has begun but nothing to assist in the start-up phase of commercialisation (Sub. 47, p. 4).

One participant pointed to a gap particularly in respect of demonstration elements of the innovation process. The Australian Shipbuilders Association and Austmine argued that:

Government expenditure on R&D would be more effective if some ... were switched to demonstration funding. Indeed this funding should not necessarily be in grant form but rather in low cost loans which would be repaid on the successful completion of the demonstration phase. The concept is thus one of share the risks and share the benefits. There seems no logical reason why the government should not take some risk in the demonstration phase when it takes a major risk in the two preceding phases [research and development], and then chips in again in respect of international marketing with the provision of grants and risk sharing funding under a number of export enhancement schemes (Sub. 212, p. 38).

Some of these concerns with commercialisation among SMEs have, in part, been addressed by one of the 1994 White Paper initiatives — the introduction of a concessional loans scheme for early commercialisation activities (discussed in section D5.5).

Some participants suggested that direct support should be provided for firms' commercialisation activities, rather than approaches which aim merely to bring public sector research organisations and private sector companies together, as under the CRCs program. While strong industry involvement in such arrangements should provide a greater market focus to the research carried out, Mr Bill Potter thought that:

... [government support is] still expended on R&D, and the private sector partners are expected to achieve the more costly task of commercialisation from their own resources. It is only by channelling resources into the commercialisation process at a far greater rate that the imbalance (between support for R&D compared to commercialisation) can be redressed (Sub. 80, p. 2).

The Australian Biotechnology Association commented that:

The Government should reduce its past emphasis on the funding of R&D in the public sector in favour of increased emphasis on the support of commercialisation. Since the major impetus for successful commercialisation stems from the marketplace rather than the technology base, it is increased support for the commercialisation process that is

likely to lead to an improved economic outcome. A scheme for the funding of large-scale commercial development would be advantageous in this regard (Sub. 206, p. 3).

#### **D5.4 Rationales for assisting commercialisation**

Commercialisation is a difficult and expensive stage of the innovation process. It is critical to the success of innovation but at the same time highly risky.

Nucleus pointed out that the nature of the risks that firms face changes over the different stages of the product innovation cycle.

As a company progresses through the cycle of major technological innovation, the total level of risk and uncertainty remains high, but the nature of the risk changes from technical to predominantly commercially based. Government assistance therefore needs to be tailored to address the different sources of high risk from which market failure is most likely to arise at the different stages of the cycle (Sub. 93, p. 13).

In many ways, however, commercialisation is also similar to other aspects of firms' operations and the key issue is whether it has characteristics which might justify government assistance while other investments which produce private benefits do not.

In principle, there are two aspects of commercialisation of private research that could be used to justify government support:

- if the commercialisation process produced externalities which meant that additional investment in it, above the levels firms would themselves choose, would be justified; and
- if there were failures in the capital market that meant that such investment was not supported to the extent desirable for the economy as a whole.

While the existence of externalities from research and development is not at issue, their extent can vary according to whether it is basic or more applied research (as discussed in chapter A5). In general terms, the key characteristics of non-rivalry and non-excludability (see chapter A5) are less likely to occur as research becomes more applied.

In the case of commercialisation, much of the knowledge produced is both specific to the particular product or process being commercialised (it is rival) and can be undertaken in relative secrecy (it is excludable). While it is not possible to say that spillovers would never occur at the commercialisation stage, their occurrence is less likely than at earlier stages of the innovation process.

Deficiencies in the market for venture capital were examined in the Commission's Inquiry into the Availability of Capital (box D5.2). The Commission found that a number of channels existed for directing funds into

venture capital, including venture capital institutions, private investors (sometimes known as ‘angels’), larger companies and life offices. Some venture capitalists specialised in providing packages of both finance and management to developing ventures. While the Commission heard much evidence from individuals who failed to obtain capital, it was also told by venture capitalists that there was a shortage of good prospects when risks and the capacity of management were taken into account.

**Box D5.2: Some findings on the ‘availability of capital’**

- small and medium sized enterprises (SMEs) claim there is a lack of equity finance, especially for those not having access to the stock exchange, but financial intermediaries are equally adamant that good investment opportunities are lacking
- while SMEs often pay higher interest rates than many large corporations, the administrative costs and risks of lending typically are disproportionately greater
- the difficulties smaller companies can face in attracting the services of an underwriter reflect the risk preferences of investors rather than institutional or market failure
- many smaller businesses are reluctant to dilute control to obtain available equity finance
- deregulation of the banking sector has led to a greater availability of debt finance to SMEs

*Source:* IC 1991b.

The Commission reported on regulatory impediments for government to address, including: easing the restrictions on banks providing equity finance to firms; redressing the adverse impact of the ‘prudent man’ rule on superannuation trustees; and ensuring standards in the Corporations Law such as ‘due diligence’ are not more onerous than is reasonable to facilitate informed decisions by investors. The Commonwealth has since legislated to increase the investment freedom of superannuation trustees.

The Commission found little other evidence of impediments to the supply of capital, except for the inherent riskiness of projects and the reluctance of entrepreneurs to dilute their equity. These factors are normal costs associated with finance transactions that need to be factored into any capital raising that occurs.

Access to capital issues were raised again in this inquiry. They also feature strongly in consultations being held in advance of the Government’s Innovation Statement. There is still a divergence of views on whether there are failures in Australia’s capital market warranting government intervention (box D5.3). The National Investment Council is also currently investigating capital availability

for SMEs so as to provide advice and policy options to the Government. A consultancy has been let on the issue and an interim report received.

**Box D5.3: A summary of current views on the functioning of Australian capital markets**

The outcome of the consultation program held in advance of the Government's Innovation Statement as regards capital markets has been summarised as follows:

***Seed capital***

'The consensus is that there is a shortage of seed capital in Australia, however, it is debatable whether this is really a structural deficiency in the market. Indeed, it has been argued that difficulties in accessing start up finance is a useful discipline and market defence mechanism, ensuring that only the most viable and persistent projects reach fruition.

A major impediment to the financing of smaller firms is the reluctance of many of these firms to surrender equity to secure funds, preferring loan funding even if this inhibits the future development or viability of their business.'

***Venture capital***

'There are differing views as to whether there is a real shortage of venture capital in Australia. Some argue that there are insufficient funds, particularly for small innovative firms where the risks are perceived to be higher. Others, particularly in the finance sector, argue that there is no shortage of funds in Australia or worldwide, especially from overseas, but there is a lack of suitable investment projects. However, the required rate of return of 20% may be an unrealistic expectation with many innovative projects.

It is debatable whether there are any structural barriers to the development of a venture capital market in Australia. However, there seems to be a consensus that access to venture capital funds for smaller firms could be improved and there is an important role for intermediaries and brokers in linking potential investors with suitable projects or firms.'

***Development capital***

'While there are differing views as to the availability of venture capital, there is no perceived shortage of development capital within the finance sector in Australia. However, many innovative small and medium companies with high growth potential feel they are constrained by the conservative nature of the financial institutions and the onerous listing requirements for public flotation on the Stock Exchange.

There is considerable support for the view that a major structural deficiency is the absence of a secondary equity market in Australia and that one should be developed, despite the failure of the Second Boards some years ago. Considering the small scale of the indigenous market, there is some doubt that Australia could sustain an indigenous secondary market, leading some to believe there is greater potential in an initiative in the Asia Pacific Economic Cooperation (APEC) region.'

*Source:* Cook 1995b, pp. 10–11.

Since the Commission reported in 1991, the Government has introduced schemes to increase the availability of funds, particularly for SMEs. Both the Australian Technology Group (ATG) and Pooled Development Funds program, announced in 1992, are described in the next section (D5.5), as well as the recently introduced Concessional Loans for Commercialisation of Technological Innovation scheme.

Participants such as David Breeze & Associates (Sub. 458) were critical of the slowness, so far, with which these two programs have disbursed funds. However, early experience suggests that factors other than availability of funds are constraining the development of small and medium sized enterprises.

For example, the ATG reports that in 1993–94 it received approximately 300 proposals for early stage venture capital, all of which were formally evaluated by its management team (ATG 1994a, p. 4). Of those, ATG invested in only three companies in 1993–94, and subsequently has made a further two investments. Commenting on the quality of the proposals, ATG's Managing Director stated:

The quality from the technical side has been excellent and certainly is world class competitive. Our approach has been market driven in that we ensure that a market exists prior to investing in the technology. I think this is one area where people have stumbled in the past. You have got to be sure that a market is there first. I think there is no question that the technology base is strong, however, we have not seen many good business plans (ATG 1994b, p. 7).

Investment criteria used by the ATG have regard to a number of factors, including: whether a company can demonstrate that the technology it has developed can be differentiated from that of its competitors; an adequate return on investment; and once commercial success is achieved, ATG has a viable exit strategy through trade sale or stock exchange listing.

The ATG has reported:

Without strict investment guidelines that demand commercial returns, ATG could have already invested a major portion of its capital. ATG's methodology is used in most of the world's successful early stage venture capital firms. It recognises that early stage investments are more management than capital intensive (ATG 1994a, p. 5).

This recent experience reinforces the view that capital markets are not operating systematically to deny finance to innovative companies. If the source of the difficulties in attracting finance lie with business management skills and perceptions, these need to be addressed directly. Governments already have assistance programs to develop and improve management skills and business planning techniques. For example, the joint Commonwealth-State National Industry Extension Service (NIES) provides subsidies for a broad range of

business improvement activities including business, strategic, export marketing and financial planning.

If it can be shown that stock exchange listing requirements and the prospectus requirements of corporation law impose unnecessary impediments to firms gaining access to finance, those regulatory barriers ought to be directly addressed. If there are persistent information deficiencies impeding the flow of capital to SMEs, these too should be tackled at their source.

The Commission has not revisited all the issues it addressed in its earlier report on the availability of capital. However, consultations and discussions conducted in the course of this inquiry have not provided grounds for the Commission to change its view that the difficulties high technology SMEs face in attracting capital are explicable in terms of the inherent features of financing such risky ventures rather than a systematic bias by those with funds to lend or invest.

### **D5.5 Programs assisting commercialisation**

In essence, commercialisation costs are associated with developing an innovation beyond the R&D stage. A number of participants suggested that more government support should be provided for non-R&D expenditures associated with innovation, and most of these involved broadening the definition of eligible activity under the tax concession. Those views are presented and assessed.

Details are also provided of two Commonwealth Government initiatives from the February 1992 *One Nation* Statement — the Australian Technology Group, and the Pooled Development Funds Program. Finally, details are given of the Concessional Loans for Commercialisation of Technological Innovation Scheme, announced in the May 1994 White Paper.

#### **R&D tax concession**

Even though one of the sub-objectives of the R&D tax concession is to 'improve conditions for the commercialisation of new process and product technologies developed by Australian companies', its impact on commercialisation can only be indirect because it does not directly subsidise non-R&D costs. The amount of indirect assistance provided will therefore depend on how important R&D costs are in relation to overall innovation costs.

The Report of the Task Force on the commercialisation of research (Block 1991) recommended a broadening of eligible expenditure under the tax concession to account for some commercialisation costs.

Technology oriented firms can build up their experience and competencies in commercialisation by performing R&D in response to market need ...To further strengthen the effectiveness of the concession in aligning R&D activities in response to market needs, the Task Force considers that a component of the costs involved in market analysis and the development of market entry strategies for which the R&D is undertaken should also be eligible for the concession (1991, p. 14–5).

The Task Force also considered that any change along these lines should be implemented at a reasonable cost to the Government. It therefore recommended that market analysis and the development of market entry strategies should be allowed as eligible ‘supporting activities’ under the tax concession, but limited to 10 per cent of total eligible R&D expenditure.

A number of participants endorsed this recommendation, including the MTIA (Sub. 133), the Australian Chamber of Manufactures (Sub. 137), and the IR&D Board (Sub. 219).

One participant, Trendcrest Pty Ltd, went even further and suggested that:

... up to 20 per cent of the total R&D budget [should] be available to be spent on development activities currently excluded from the strict definition of R&D in the Income Tax Assessment Act. ... Many smaller companies use the majority of their resources ... on R&D and thus do not have the necessary funds to commercialise the new technology. ... If the 150 per cent tax concession were available for demonstration models, brochures, marketing, sales trips and so on, the effectiveness of the R&D tax concession would be substantially enhanced (Sub. 62, pp. 1–2).

Other participants suggested that the tax concession should be extended in a variety of ways, including: the initial marketing phase of a development project and the capital for manufacturing of projects emerging from a company’s own R&D (Biotech Australia Pty Ltd, Sub. 81); costs for tooling and die-making (AEEMA, Sub. 126); and expenditure on market visits to gain information to allow local (that is, market by market) export customisation of core R&D conducted under the tax concession (Critec Pty Ltd, Sub. 194).

In its evaluation of the tax concession, the BIE considered the question of whether support should be extended to non-R&D costs. It argued that because a substantial part of the R&D subsidy is paid to firms for R&D that they would have done anyway (the transfer component), the transfer payments are available to fund non-R&D costs. The BIE therefore recommended that eligibility should *not* be extended to non-R&D costs until the R&D tax concession is redesigned to reduce transfer payments (1993c, p. 190).

In his submission to the inquiry, Ray Block was critical of this conclusion.

While acknowledging that the most responsive firms taking advantage of the tax concession tend to be small, young, R&D-intensive, and fast-growing, the BIE seem to have been less conscious of how extremely fragile is their capital base, and how limited

their capital resources. Given the limited capital funding base of small innovative firms, there is a strong case for the 150 per cent tax concession being extended to market analysis and market entry strategies (Sub. 45, p. 8).

In principle, the process of successful commercialisation involves a variety of skills and abilities, including managerial competence, production capability, marketing skills, and distribution networks. It is necessary to draw the line on government involvement at some stage. In the case of the introduction of new products, processes or services, spillovers beyond the innovating firm are most clearly evident at the stage of R&D. As noted, while elements of commercialisation may also be characterised by spillovers to some degree, they are not sufficient to justify across-the-board assistance for the process.

**The Commission does not support extending the provisions of the 150 per cent tax deduction to commercialisation.**

### **Australian Technology Group**

Against the background that a high proportion of research in Australia is carried out in the public sector, and not always directly aligned with the needs and capabilities of industry, the Taskforce on Commercialisation of Research (Block 1991) saw a need for a strong intermediary in the commercialisation process, to bring together researchers with commercially valuable technology or capability, and firms who could benefit from it. Following the Taskforce recommendation that a 'a substantial technology transfer and development company' should be established, the formation of the Australian Technology Group (ATG) was announced in the *One Nation* Statement.

The ATG was initiated in 1992 with a capital injection of \$30 million from the Commonwealth Government. The Government has indicated it wishes to reduce its shareholding, over time, to below 50 per cent through the introduction of new equity capital from the private sector. The ATG was set up as a private corporation and describes itself as:

... a technology commercialisation company investing in the early stages of business development of Australian technology, ultimately for commercial use within Australia and internationally, with an emphasis on Asia (ATG 1994a, p. 1).

The ATG is focusing on taking equity in technology-based enterprises (box D5.4) rather than modelling itself on the British Technology Group, which concentrates on licensing technology. The sources for ATG's technology portfolio include not just public sector research institutions but also technology transfer companies, small to medium sized companies and intermediaries.

**Box D5.4: ATG business strategies**

- to generally invest in stages up to \$1 million as early stage capital in each business — to a maximum of \$2 million where warranted;
- to invest the talents of ATG people to assist managing development of the businesses;
- to create business alliances but to avoid blanket exclusive arrangements;
- to generate long-term revenues from dividends and capital gains;
- to generate short-term income from conservative investment of surplus capital; and;
- to focus in six areas — information technology and telecommunications; health, environmental management, manufacturing, mining, and agriculture.

Source: ATG.

ATG's first investment in May 1994 saw the formation of a subsidiary company, Ilexus Pty Ltd, to commercialise pharmaceutical products under development at the Austin Research Institute. The ATG holds 70 per cent of the equity in Ilexus. The ATG has investments in another four companies.

Several participants commented on the ATG's role. For example, the Australian Biotechnology Association suggested that the remit of the ATG should be changed to ensure that technology is commercialised for the benefit of Australia:

... more emphasis [should be given] to commercialisation of Australian R&D *in Australia*, such that an Australian 'added-value' component can be clearly demonstrated. In this regard, the recent decision of the ATG to focus initially on provision of seed capital to small technology-based and start-up companies in Australia, is to be welcomed (Sub. 206, p. 5, emphasis in original).

However, another participant expressed caution at the announced primary role of the ATG:

... initial impressions [of the ATG] are worrying because the new management has come out saying that intellectual property development is not their key function, but rather the identification of a few 'winners' to help get up and running with seed funding (a very risky strategy indeed). These will be the source of profits for future growth. If that is the case then the crying need for support for intellectual property will remain and many of us will continue to go offshore. The potential overall loss to Australia could be large unless this area is tidied up (Faculty of Science, University of Technology, Sydney, Sub. 39, p. 10).

### **Pooled Development Funds program**

The Pooled Development Funds (PDF) program was another initiative of the *One Nation* statement. The program was set up in 1992 to encourage long-term equity investment and provide patient equity capital for growth oriented, small to medium sized enterprises (SMEs). It provides concessional taxation treatment for investment companies established and registered as PDFs.

The 1994 *Working Nation* White Paper noted that the program had not been very attractive to investors. This view was also voiced by participants to this inquiry. For example, Ray Block said:

The PDF scheme has failed to attract serious new capital as a result of it being too cumbersome and bureaucratic, in the way the scheme has been structured for funding the small company market (Sub. 45, p. 9).

Techniche Ltd said:

This PDF [program] is a complete failure (transcript, p. 1758).

Several changes to the program were announced in the *Working Nation* White Paper, in order to make PDFs more attractive to investors, and to enhance their effectiveness as a vehicle for providing venture and development capital to SMEs:

- the rate of tax on income derived by a Pooled Development Fund from its investments in SMEs was reduced from 25 per cent to 15 per cent, but tax on income derived from other sources continues at 25 per cent; and
- the restrictions under which the PDFs operate were eased.

In the two years to July 1994 a total of \$35 million had been raised by three companies, only one of which had invested all its available capital. During 1993–94 the PDF Registration Board granted registration to six companies, thereby bringing the total number registered under the PDF Act to 11. Eight PDFs were registered after the *Working Nation* changes were effected.

### **Concessional loans for commercialisation of technological innovation**

In the *Working Nation* White Paper, the Government allocated \$48.2 million over four years through the Commonwealth Development Bank for concessional loans to technology-oriented small firms seeking to commercialise their technological innovations. The new loans scheme is operated by AusIndustry. The eligibility criteria for the scheme are set out in box D5.5.

As a background to the introduction of the scheme, the Board noted that:

... firms looking to bring technological innovation into the marketplace often face real difficulties in obtaining access to finance for early commercialisation activities. The intent of this program is to address this commercialisation funding bottleneck. It is hoped that more small technology driven firms will undertake R&D projects when they perceive that some of the difficulties in accessing finance for early commercialisation have been ameliorated (Sub. 252, p. 2).

The Board also referred to a potential longer-term outcome of the scheme:

The concessional loans provided by the Board will provide recipient firms with considerable leverage with financiers. It is hoped that this interaction between loan recipients and financial markets will, in the longer term, assist in educating financial markets in assessing the prospects of firms and improve the credit constriction (Sub. 252, p. 2).

Whereas the R&D tax concession and competitive grants for R&D schemes require no repayment of assistance on the part of recipients, the IR&D Board has adopted a loans scheme to support early commercialisation activities. It is therefore the first Board program to have cost recovery features. Loans are provided on the following terms (IR&D Board 1994c):

- the maximum loan agreement period is 6 years, with repayments commencing after 42 months;
- the interest rate is 40 per cent of the Commonwealth Bank Loan Reference Rate;
- the first 3 years are interest-free; and
- interest and principal is repaid in years 4, 5 and 6.

Information is now available on the experience of this new scheme in its first year of operation. AusIndustry has reported that the rate of enquiry for Concessional Loans has been 'disappointing' (*Australian R&D Review*, March 1995, p. 13). It appears that by the end of June 1995, around \$4 million in concessional loans will be committed to around 40 companies. While \$9 million had been allocated for the first year of the scheme, the unexpended \$5 million will carry over into the new financial year (*Australian R&D Review*, April 1995, p. 9).

As a partial explanation for the low uptake, the Chairman of the IR&D Board reported that negotiations with the Commonwealth Development Bank for the management of the loans had taken a considerable amount of time, and the Board had only recently reached the position where it could undertake a promotional campaign to raise awareness of the scheme amongst smaller technology companies (*Australian R&D Review*, April 1995, p. 9).

### Box D5.5: Concessional loans for commercialisation of technological innovation

Supports small and medium sized enterprises (SMEs) undertaking technically risky projects, through the provision of concessional loans for early commercialisation activities.

To be eligible for support, projects must meet **all** of the following criteria:

- 1 The project involves early commercialisation, limited to the following activities, including related market research:
  - product/process design;
  - trial production runs including tooling up costs;
  - regulations and standards compliance;
  - protection of core intellectual property;
  - trial and demonstration activities; and
  - product documentation.
- 2 The applicant company/group employs less than 100 persons;
- 3 The project is directed at the commercialisation of internationally competitive goods, systems or services;
- 4 The results of the project will be exploited for the benefit of Australia;
- 5 Each loan will not exceed 50 per cent of eligible project costs;
- 6 The project would not proceed satisfactorily without loan support;
- 7 Applicants have been unable to obtain sufficient funding for the project from financial institutions.

*Source:* IR&D Board 1994c.

An earlier IR&D Board program that attracted a low uptake was the Advanced Manufacturing Technology Development Program — now amalgamated into the Competitive Grants scheme. As noted in chapter D4, an amount of \$20 million was committed to that scheme over a four-year period, but in the first three years, grants totalling only \$1.3 million were awarded.

The Commission has already indicated that it believes it unlikely that there are extensive externalities from commercialisation itself or that the capital market is unable to fund venture capital successfully. Given this, it has doubts about the likely benefits from subsidising loans for commercialisation.

However, the program is a recent one, and having been established should be allowed a period of operation to judge its success.

**The Commission would like to see the Concessional Loans Scheme reviewed at the earliest opportunity (within 4 years). The review should pay particular attention to:**

- **indications of likely commercial success of the scheme and whether private financing would have catered for those projects that proved to be commercially successful;**
- **any benefits from the commercialisation that have accrued to others beyond the firm which attracted the loan.**

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## D6 COST RECOVERY

### D6.1 Introduction

The terms of reference for this inquiry were amended on 2 February 1995 with the requirement that the Commission report on 'appropriateness and options for the cost recovery of industry R&D grants'. In this chapter, discussion focuses on mechanisms of support for R&D that could require at least some element of repayment. Options for cost recovery are therefore considered in a broad sense, that is, not just those that would recover the nominal cost of the R&D assistance, or achieve *complete* cost recovery (however defined).

The mechanisms for repayment and views of participants are presented first (section D6.2), as a background to outlining some principles for the efficient design of cost recovery programs (section D6.3). The main benefits that arise from repayable schemes are presented in section D6.4 while problems are considered in section D6.5. The likely gains in cost effectiveness from introducing cost recovery in the Competitive Grants scheme is estimated in section D6.6, while broad considerations of appropriateness are discussed in section D6.7. Recommendations regarding cost recovery options are covered in chapter D7.

### D6.2 Mechanisms requiring repayment

Mechanisms of repayable government funding for R&D exist in many countries, including France, Japan, Germany, Sweden, Korea, Taiwan, Israel, Austria, Denmark, Finland, the Netherlands and Spain. Some examples of instruments which involve an element of repayment of the government funding are listed in table D6.1.

Repayable forms of assistance are not common in Australia. As noted in the previous chapter, an initiative from the 1994 White Paper was the establishment of a new scheme supporting early commercialisation activities — Concessional Loans for Commercialisation of Technological Innovation. This was the first selective program administered by the IR&D Board to take the form of a loan rather than a non-repayable grant.

Another Australian program with repayment features is the International Trade Enhancement Scheme (ITES), a discretionary export marketing assistance scheme operated by Austrade since July 1990. The funding provided is typically

in the form of a loan at a concessional rate of interest, though funding is also available as an ‘advance’, requiring the payment of royalties (Austrade 1994b). The repayment features of the Concessional Loans for Commercialisation Scheme follow closely those of the ITES.

**Table D6.1: Selected instruments involving repayment**

<i>Instrument</i>	<i>Features</i>
<b>Loan</b>	The loan is provided at either a market or concessional rate of interest, and can be either unconditional or repayable only if the project is successful.
<b>Repayable grant</b>	The grant is normally repayable only if the project is successful, and repayment is frequently by way of a royalty based on a percentage of project sales.
<b>Equity investment</b>	The government takes an equity interest in the intellectual property results of the project.
<b>Stock option grant</b>	The government receives an option to company stock in return for a grant.

*Source:* Sub. 316; Fölster 1991.

A final example of programs of support with repayment features is the case of the Energy Research and Development Corporation (ERDC). The ERDC has followed an ‘investment in research’ approach, by seeking to obtain some return on the innovation projects that it funds jointly with contributions from industry partners. As the ERDC commented:

Seeking a return on investment requires public providers of capital for industrial R&D to make a significant change in their attitude and management — a shift from a ‘grant-giving’ to a ‘management of investment’ mentality (Sub. 362, p. 5).

Features of the ERDC’s ‘return on investment’ approach are set out in box D6.1.

Many participants suggested moving from mechanisms of support which require no repayment, to alternatives with at least some element of cost recovery. For example, the Design Institute of Australia considered that a loan scheme would be preferable to the status quo for companies that are in start-up mode, and which have insufficient cash flow and no profits (as yet) to utilise the tax concession. Their suggestion was a self-funding scheme of:

... low interest or no interest loans to fund R&D with repayments linked to earnings (Sub. 63, p. 2).

### Box D6.1: ERDC and return on public investment in innovation

Return on the investment of public capital in innovation is part of ERDC's normal business approach. Any return to ERDC:

- is negotiated into the contract for funding;
- is based on a share of the benefits to the contractor and/or other participants in the project;
- only flows to ERDC if the contractor and/or other participants receive their private benefit;
- is not based on any ownership of intellectual property by ERDC;
- is not an evaluation criterion — the criterion is benefit to Australia; and
- is an indicator that the benefit to Australia is being realised.

*Source:* Sub. 362, pp. 5–6.

Similarly, another participant suggested that:

... the possibility of providing long term loan funds repayable from trading ... should be investigated (Nut Research Company of Australia Pty Ltd, Sub. 141, p. 3).

Mr J B Thomas advocated an approach of providing support at a higher rate (80 per cent of product development costs) than most present grant schemes but making the grants repayable:

[Grant] funds should be re-payable against income from sales. Obviously, the granting authority would be using carefully developed criteria in selecting such investments, on the basis of competitive bidding for such available funds (Sub. 29, p. 10).

Mr Ray Block also suggested that the IR&D Board should move away from an outright grants approach:

... it should be mandatory that each applicant for Commonwealth research funds undertakes to pay back to the Commonwealth a value equal to the funds extended, once a successful technology outcome is achieved (Sub. 45, p. 5).

The NSW Science and Technology Council also suggested that:

... should grants continue to be made available for the support of industry-based R&D then they should be made repayable if a successful outcome is achieved by the recipient of funding (Sub. 446, p. 7).

By contrast, Nucleus pointed out that there would be disadvantages if the current mechanism for providing selective support were changed from an outright grant to a repayable scheme such as a loan, because a loan has quite a different impact on a company in terms of risk and the ability to fund that risk.

If Government assistance is in the form of a loan then it will affect funding and possibly the commercialisation of the product. Balance sheets are affected by the liability or contingent liability of the loan. Unless provided at a concessional rate of interest, [loans] may not provide any real form of assistance (Sub. 93, p. 15).

In Nucleus' view, there are other ways in which the government can get some payback from R&D support, such as through royalties or licensing agreements.

### **D6.3 Principles for designing cost effective support**

One disadvantage of the 150 per cent R&D tax concession noted in chapter D3 was that the major part of the government funding goes to R&D that would have taken place anyway. The estimated social costs associated with these transfer payments are substantial, and this is one aspect which reduces the cost effectiveness of the scheme.

The social costs associated with transfers that have no impact on R&D are less substantial for the Competitive Grants scheme, but even there it appears that at least 40 per cent of projects supported would have been carried out anyway. Because the grants are selective, it might be suggested that one way to improve the inducement ratio would be to have a stronger eligibility requirement, ie that grant support only be available to projects that would not otherwise proceed. However, in practice, grant awarding committees face difficulties in being able to determine whether or not a firm would have conducted a project without the subsidy.

One way of addressing these issues is to design the program of support so that companies are less inclined to apply with projects that they would have carried out anyway. One such feature is to require repayment, rather than provide assistance merely as an outright grant. But for a repayment scheme to deter companies from seeking support for projects that they would have carried out anyway, certain principles should apply:

- repayment should be required in proportion to the profit earned by the recipient from the subsidised project; and
- repayment should not be limited to the size of the subsidy.

The basis for these principles is that low or zero repayment schemes provide no disincentive for firms to apply for funding for projects they would have undertaken anyway. This is explained by Fölster as follows:

If the repayment never exceeds the amount of subsidy, a firm will always expect to gain or break even when applying for a subsidy. There is no incentive for firms not to apply with projects [they] would have conducted anyway. In contrast, if there is a chance that the share of profit to repay is larger than the subsidy, the firm will not apply with many projects that are expected to return a profit. Thus the self-selection of firm applications becomes effective only when there is a chance that the repayment is larger than the subsidy (1991, pp. 65–6).

The principle that the repayment should be greater than the size of the subsidy was supported by the ERDC:

Why limit the return on public capital investment to cost recovery? Why should not the return include a fair share of the private benefit which may flow to the investment recipient[s]? This more business-like approach will encourage industry to 'go it alone' if they can, rather than view public capital as 'easy money' (Sub. 362, p. 5).

Another principle suggested by Fölster for the efficient design of a cost recovery program is that:

- no repayment should be required if the project does not earn a profit.

The importance of this principle is that:

... it induces firms to conduct projects that have positive private expected values but are too risky. ... It [also] contributes to the policy goal of raising the level of R&D and yet it may be on average virtually costless to the public purse, provided that the repayments from those that succeed are sufficiently large to cover the losses from those that fail (1991, p. 66).

Most overseas repayment schemes for R&D are consistent with this principle in that loans or grants are repayable only if the project is successful — a Japanese variant of this approach is that the principal is repayable in all cases, while interest is also payable if the project is successful (see box D6.2).

In the case of the Australian Concessional Loans for Commercialisation of Technological Innovation Scheme, repayment is *unconditional*. This would seem to be appropriate given that closer-to-market activities (early commercialisation activities rather than R&D) are supported by that scheme. By comparison, R&D projects entail two types of risk — the *technical* risk of whether or not the technical objectives of the project will be achieved, and the *market* risk associated with commercialising the results of the R&D project.

## **D6.4 Benefits of mechanisms requiring repayment**

### **Lower cost to government**

One benefit of requiring at least some repayment of government funding is that it reduces the cost to government of providing that support. For example, the Treasury noted that:

A major advantage of schemes that require full or partial repayment for commercially successful R&D projects is that the cost of assistance can be lowered by recycling funds recovered from successful projects (Sub. 236, p. 51).

**Box D6.2: Selected overseas R&D schemes with repayments****France:**

*National Agency for the Exploitation of Research (ANVAR)* — provides support for close-to-market R&D projects in the form of interest-free loans that are repayable only if the innovation is successful. Once a project is commercialised, ANVAR waits between 8 months and two years before requiring repayment of the principal. Repayment can take between 3 and 6 years.

**Sweden:**

*National Board for Industrial and Technical Development (NUTEK)* — provides loans for the development of projects up to the prototype stage. A soft interest rate is charged, with interest repayments commencing only when the project is successfully introduced.

*Industrial Development and Start-up Fund* — provides support to assist product development and marketing activity in SMEs through a soft loan (with repayment conditional on the success of the project) or a repayable grant (with royalty repayments similarly conditional on success).

**Israel:**

The main program of R&D support is a grant scheme, requiring repayment by way of royalties for those projects which result in saleable products. The normal royalty required is 2 to 3 per cent of the sales revenue of the resulting product, up to a total of 100 to 150 per cent of the value of the R&D grant received. Generally, no repayment is required for projects that do not reach commercialisation.

**Japan:**

*Japan Key Technology Centre (Japan Key-TEC)* — administered jointly by the Ministry of International Trade and Industry and Ministry of Posts and Telecommunications, provides loans for applied R&D activities in areas of advanced technology. Features of the loan conditions are: the upper limit to the loan is 70 per cent of eligible project expenditure; no interest is payable while the project is being undertaken (the deferment period, which can be no more than five years); the principal of the loan is repayable in all instances, while all or a fraction of commercial long-term interest is also charged. The size of the fraction depends on the 'degree of success' of the project, and can be zero (if the project is unsuccessful), 25%, 50%, 75% or 100%. 'Success' is defined exclusively in technical terms. The period of repayment of the principal is up to 10 years from the completion of the project.

*Source:* Sub. 316; Rubenstein 1994, Japan Key Technology Centre n.d.

Similarly, in a review of the Export Market Development Grants Scheme it was noted that:

The benefits to the Government of a loan scheme [compared to outright grants] are that, for a given budget outlay, more companies can be assisted because monies can be re-lent to new scheme entrants as loans are repaid (Austrade 1994a, p. 69).

In most countries, loans for R&D are normally repayable only if the project is successful. The extent of cost recovery likely to be achieved in such cases was noted by the Treasury as follows:

In extreme cases, such schemes could be self-funding (ie. costs recovered on successful projects outweigh losses on unsuccessful projects). This is more likely where support is

only provided to projects at the applied or commercial end of the R&D spectrum (Sub. 236, p. 51).

### **Lower transfer element in the subsidy**

Where support is provided in the form of an outright grant:

Firms have incentives to apply primarily with projects they would have conducted anyway, pocketing the subsidy as a pure gift (Fölster 1991, p. 13).

Another potential benefit of schemes which require some degree of repayment is that they reduce the incentive for firms to seek assistance for projects that are viable without government support.

The extent to which this is likely to apply depends on the particular repayment features of the program. For example, consider a program in which repayment is by way of a royalty at a fixed percentage of revenues arising from the successful commercialisation of the R&D project, but capped at say 150 per cent of the amount of the grant. Companies would be less likely to seek support for such projects, if they could have proceeded anyway, because they have to share some of the private returns with government.

However, if the government funding were still the cheapest finance available — for example, a loan at a concessional rate of interest, significantly below the market rate — then the less likely would such a scheme discriminate against projects that would have proceeded anyway.

**In summary, the main benefits from an appropriately designed cost recovery approach are likely to come not just from the repayment of government funding as such, but also from the prospect that such funding is more likely to support projects that would not proceed without it, thus avoiding the social costs associated with the large transfer payments under current arrangements.**

## **D6.5 Problems with mechanisms requiring repayment**

### **Lower incentive**

It has been argued that one disadvantage of cost recovery arrangements is that they provide a much lower incentive, and would therefore induce a smaller increase in the activity which the government support is seeking to encourage (Austrade 1994a, p. 70). The IR&D Board claimed that the effect on inducement rates would be harmful.

It is ... not clear what the [Commission] considers the inducement effect would be when the company is in effect getting no compensation whatsoever for any spillovers. ... A very generous ... assumption would be inducement dropping by half to 30 per cent (Sub. 363, p. 46).

But such arguments overlook the fact that repayable schemes provide less incentive for companies to apply with projects that they would have carried out anyway. In the Commission's view, the current 60:40 split between induced and non-induced projects in the Competitive Grants scheme could be expected to improve under repayable arrangements.

As noted above, repayable schemes of R&D support normally make repayment conditional on the project being a success — in cases where the project fails, the assistance reverts to a pure grant. The IR&D Board was critical of such mechanisms in the following terms:

... a system of repayable grants ... is deliberately favouring losers. Those firms which are doomed to fail because of technologically illiterate projects, poor management, or poor customer focus get subsidised whereas those that succeed get none (Sub. 363, p. 47).

And again:

... a scheme which *in effect* gave grants to bad projects and loans to good ones would only serve to discourage viable projects and increase the ratio of bad to good applications (Sub. 363, p. 47, emphasis in original).

But it is unlikely that a repayable scheme would discourage viable projects because projects that succeed still get the greater *overall* benefit. That is:

- projects that fail get the subsidy but no private return;
- projects that succeed get the private return but must repay the subsidy.

Providing assistance in the form of a repayable grant would *not* be expected to discourage viable projects but rather discourage applications from companies with projects that would be *viable without the assistance*, since repayment of support would only reduce their private return. The suggestion that recipients of a repayable grant receive no benefit because they must repay the subsidy misses the point that, because the assistance *allows the project to proceed*, such firms will gain returns they would have missed had the project not gone ahead. All that is necessary is for the private return to exceed the subsidy repayments.

### **Higher administrative costs**

A scheme requiring some form of repayment would add to administrative costs in several ways (Sub. 316, p. 13). There would be a need to monitor projects well beyond the R&D phase — through to commercialisation and subsequent

sales. Given the long lead times often associated with commercialisation (particularly for early-stage R&D projects), costs associated with project monitoring are likely to be incurred over an extended period of time. While the Treasury noted that these monitoring procedures should be an integral part of *any* type of grant scheme, in order to assess cost-effectiveness (Sub. 236, p. 50), the monitoring required for that assessment might not need to be as comprehensive. Finally, with repayable schemes, monitoring of firms' commercial outcomes might be needed beyond just the particular project, while some monitoring of corporate structures might also be needed to minimise avoidance of repayment.

But it should be noted that any increased administrative costs associated with a cost-recovery scheme need to be balanced against a cost already being incurred (but frequently overlooked) in most other types of schemes, namely the resource costs associated with providing support to projects that would have proceeded anyway.

### **Potential for bad debts**

A potential problem with repayable schemes is that of bad debts if companies cannot meet their repayment commitments. Commenting on the political repercussions that might arise from this, the Chairman of the IR&D Board stated:

I would be very concerned politically to have outstanding amounts for loans to companies appearing on the government's balance sheet. If ... the VEDC [loans] had been grants, a lot of those companies would have survived what was a political disaster (transcript, p. 3377).

In respect of the Concessional Loans scheme, the deputy Chairman of the IR&D Board remarked:

We apply, as best we can, the most serious tests we can of a company's likely ability to repay, because we are really frightened about that public sort of infamy problem that can so easily arise in a very, very unfair way. ... [A] couple of failures ... can undo a scheme that is otherwise successful (transcript, p. 3378).

The potential for such problems may be minimised by designing schemes with features such as concessional interest rates and interest-free periods. Moreover, where repayment is required only where the project is a success, the loan reverts to a pure grant if a project fails.

### **Practical difficulties**

One problem in making operational a program in which repayment of assistance for R&D is conditional on projects being a success is that it is necessary to define what is meant by 'success'.

An R&D project is normally considered to be a 'technical' success if its technical objectives are achieved. However, technical success does not necessarily provide a cash flow from which repayments can be made. That would be the case if the results of the R&D project can be sold immediately (such as through licensing the technology or know-how). More commonly, however, a cash flow arises only after the results of the R&D have been commercialised in the form of a new product, process or service. In that case, success is indicated when a new product or service is introduced to the market, or when a new process is introduced in production.

### *Scope for avoidance*

Where the repayment mechanism involves royalties, for example, there could be an incentive to disguise sales from successful R&D projects. Repayment in the International Trade Enhancement Scheme (ITES) is by way of a royalty. A recent evaluation of that scheme noted that:

On occasion, the ITES-funded project can be less successful than predicted when, at the same time, the company enjoys considerable success in other markets. It is possible that ... companies shift financial resources to other projects which may have been initiated or assisted, indirectly, by ITES funding. In these cases, the ITES cannot share in the 'spin-off' project success and has no recourse to recover funds from that project. ITES management is currently working on ways to improve the coverage of royalty agreements, in terms of which sales to attract royalty, to counter this possibility (Austrade 1994a, p. 72).

Similar concerns might arise, and would need to be addressed, if any repayable scheme in which repayment was conditional on a project being successful were introduced in respect of R&D support.

## **D6.6 Cost to revenue effects of repayable schemes**

In the Australian case, the scope for obtaining cost to revenue savings from repayable schemes has been described by the IR&D Board as follows:

If a company is given a loan of \$50 000 (for a \$100 000 project) which it repays in, say, six years time, it is no longer in receipt of any grant and thus is entitled to claim its full entitlement under the tax concession (\$50 000) [for a 33 per cent company tax rate] once it is paying tax. ... The [government] revenue benefit of loans should only include

the interest payments, not the principal, as it will usually be lost to revenue through the concession (Sub. 461, p. 4).

But in cases where grants are currently provided in respect of activities that are outside the scope of the tax concession, the potential revenue benefit of changing from a non-repayable to a repayable scheme is much more substantial than that suggested by the Board.

Even in the case of an R&D project funded by a non-repayable grant, the current clawback provisions of the tax concession do not eliminate a future claim to tax deductions, they only reduce the rate of concessional deduction — usually from 150 per cent to 100 per cent (IR&D Board 1994a, p. 70). So for a \$100 000 project funded by a 50 per cent taxable grant, a company can claim a deduction for the \$100 000 expenditure at 100 per cent once it is earning taxable profits (it is also liable for tax on the grant at that time). Hence, there is also a potential revenue benefit to government in changing from a non-repayable to a repayable scheme even in these cases.

As noted above, repayable schemes for R&D normally require repayment only if the project is commercialised successfully. According to DIST et al.:

A scheme that involves repayment contingent on success will recover only a portion of program funds because innovation is risky and there will be failures (Sub. 316, p. 12).

But such a conclusion depends on the success rate of projects that are awarded grants, and what value of the grant must be repaid.

To provide some indication of the scope for cost savings that could arise from replacing non-repayable grants with loans, some comparisons are provided in table D6.2 for grants in respect of activities that are outside the scope of the R&D tax concession.

The calculations assume that the repayments are *conditional*. The two loan scenarios differ in the degree of success of projects (70 per cent and 30 per cent) and in the degree of repayment required over and above the value of the loan (50 per cent and 10 per cent more respectively) — in this simple illustration, loan repayments made in future years are not discounted. Because of the much greater monitoring requirements of repayable schemes, administration costs are assumed to be double those of a pure grant scheme.

Where it is assumed that for 70 per cent of loan recipients the project is a success and they repay the loan, the repayments need to be at least 1.5 times the principal of the loan to approach cost recovery (column 2). However, as column 3 illustrates, a critical determinant is also the degree of project success — where this is low (and combined with a lower degree of repayment required), or where firms take strategic action to avoid repayment, the outcome for such a conditional scheme may be little different from the pure grant.

Table D6.2: **Cost to revenue comparison of grant vs loan**

	<i>Taxable grant</i>	<i>Loan</i>	<i>Loan</i>
Activity outside of tax concession (\$m)	100	100	100
Grant / loan per cent of eligible costs (%)	50	50	50
Grant / loan (\$m)	50	50	50
Proportion of grant / loan repayable if project is a success (%)	n.a.	150	110
Proportion of projects successful (%)	n.a.	70	30
Repayments (\$m)	n.a.	(52.5)	(16.5)
Tax payable on grant (\$m) <sup>a</sup>	(18)	n.a.	n.a.
Deductibility of expenses at 100% (\$m) <sup>a</sup>	36	36	36
Administration costs (\$m)	5	10	10
<b>Cost to revenue (\$m)</b>	<b>73</b>	<b>43.5</b>	<b>79.5</b>

n.a. = not applicable.

a A company tax rate of 36 per cent is assumed.

Source: IC estimates.

As noted in the previous section, because suitably designed repayable schemes provide lower incentives for companies to apply with projects that they would have carried out anyway, such schemes are likely to be characterised by higher inducement rates — that is, of those firms which do apply, fewer would have gone ahead anyway. Such an outcome would result in more favourable cost effectiveness than that indicated in table D6.2.

## **D6.7 Appropriateness of introducing cost recovery in competitive grants**

The relative importance of repayable schemes in overall government assistance to business R&D differs across countries. For example, loans or repayable grants are a *major* form of R&D support in Japan, Germany, Sweden and Israel (table D1.3; box D6.2). In many other countries, such schemes supplement more general incentives which require no repayment.

While there is also variation across countries in the type of R&D projects to which repayment schemes apply (such as projects up to the prototype stage in the case of Sweden, or near-to-market projects in the case of France), the contrast with current Australian practice is that all support for R&D under the Industry Innovation Program requires no repayment — it is only early *commercialisation* activities that are supported under the recently introduced Concessional Loans scheme.

As noted in the chapter D4, the Competitive Grants scheme provides support for projects involving:

- market driven R&D in dynamic firms needing assistance but unable to use the 150 per cent tax concession;
- collaborative R&D activities that are high risk but could provide extensive benefit for Australia;
- trial and demonstration activities between technology developers and potential customers; and
- collaborative R&D activity between industry and research institutions (IR&D Board 1994b).

How appropriate would it be to introduce a cost recovery approach to Competitive Grants under the Industry Innovation Program?

### **Complementary role of grants with the tax concession**

One of the three alternate eligibility criteria for Competitive Grants is that:

The applicant, or a company that controls the applicant, is unable to obtain full financial benefit under the 150 per cent Tax Concession for Research and Development to undertake the project while in receipt of a Competitive Grant for Research and Development.

The aim of this criterion is to provide a complementary means of R&D support for firms unable to fully use the tax concession. In view of this objective, concerns have been raised about an inconsistency that would arise if cost recovery features were introduced into Competitive Grants — making the grant funding repayable would create an inequity because the assistance under the tax concession is not repayable (Sub. 316).

But there are already inconsistencies in the current arrangements:

- the 150 per cent R&D tax concession is a non-selective scheme whereas Competitive Grants is a merit-based, discretionary scheme;
- because of its selective nature and limited funding, only a small proportion of tax loss companies receive support under Competitive Grants — in this sense the scheme can never operate as a full complement to the tax concession; and
- the after-tax cost of R&D differs between companies receiving grants (at 50 per cent of project costs) and companies benefiting from the 150 per cent tax concession.

There is some debate on the last point, with DIST arguing that:

The grants are deliberately structured to provide all companies a similar cost of conducting R&D. The after-tax cost of R&D to firms using the concession is 50.5 cents [for a 33 per cent company tax rate]. For those companies who successfully compete for a grant, the cost is 50 cents or more in the dollar for that particular project (Sub. 316, p. 9).

However, the calculation of the after-tax cost for discretionary grants is complex. For companies in tax loss in receipt of a taxable grant at a rate of 50 per cent of project costs, the rate of support can be more favourable than this 'apparent' rate — or the after-tax cost less than 50 cents in the dollar. Project expenditure can also be claimed under the tax concession when companies move into tax profit (they are also liable for tax on the grant at that time).

In chapter D4 (table D4.4), calculations are presented for the after-tax cost per dollar of R&D for a company claiming the tax concession, and for the recipient of a 50 per cent taxable grant — assuming a range of lags before the tax loss grant recipient moves into tax profit, and applying the current clawback ('contamination') provisions of the tax concession.

### **Activities outside the scope of the tax concession**

Another of the three alternate eligibility criteria for Competitive Grants is that:

The project involves a significant proportion of activities (trials, demonstration and marketing) that are outside the scope of eligible activities under the 150 per cent Tax Concession for Research and Development.

The range of activities supported by Competitive Grants is therefore relatively broad. Projects are eligible if they involve one or more of the following activities: R&D (research and experimental development); or product development (including development of prototypes); or trial or demonstration; or related market research.

Trialing and demonstration projects between technology developers and potential customers in either the public or private sectors were formerly supported under the National Procurement Development Program (NPDP) and Advanced Manufacturing Technology Development Program. Trialing and demonstration are early commercialisation activities. As noted earlier in this report, the NPDP was established following the Inglis Committee of Review on Government High Technology Purchasing Arrangements, but the scheme recommended by that Committee included provision for repayment of grants if supported projects were successful — not the outright grant approach that was actually implemented.

In relation to these projects, DIST et al. concluded that:

Trial and demonstration show higher potential for cost recovery than the other elements of [Competitive Grants]. ... It can be argued that once acceptance of the new product by the customer is achieved, a major impediment to sales no longer exists. The supplying firm should have much brighter commercial prospects after successful trial and demonstration, and so be in a position to repay the assistance in the near future (Sub. 316, p. 11).

There would also seem to be an inconsistency with the current Competitive Grants and Concessional Loans schemes. Currently, trial and demonstration activities that involve collaboration between technology developers and potential customers are eligible for outright grant support, while such activities that do not involve collaboration are only eligible for concessional loans.

### **Other projects eligible for Competitive Grants**

The final alternate eligibility criterion for Competitive Grants is that:

The project involves a graduate working on a specific company based research and development project which results in the formation of new and appropriate linkages between a company and a tertiary/research institution.

This criterion mainly caters for companies that were supported under the former National Teaching Company Scheme (NTCS).

Collaborative R&D projects between research institutions and commercial companies (previously supported under the Generic Technology Grants Scheme) are also eligible for Competitive Grants under the first of the alternate criteria. Because these projects typically involve pre-competitive, high risk R&D, they may be characterised by larger spillovers than research which is closer to market, and links back to more basic research imply the need for research procedures which require more consultation and the use of tacit knowledge (see chapter A5).

Collaborative grant payments are made to the *research* institution partner for their share of the costs incurred, while the commercial partner(s) provide their own funds for their contribution to the project. In view of this, according to DIST et al. cost recovery for the taxpayer might be achieved in the following way:

... research agencies should ensure that they receive adequate royalties, or other returns, from grant assisted intellectual property which is commercialised (Sub. 316, p. 11).

## **Assessment**

Schemes which involve at least some element of cost recovery have attractions but there are also uncertainties. The Commission does not favour introducing them in respect of support for companies in tax loss, nor for projects involving collaborative R&D. On the other hand, the Commission does see scope for such schemes in respect of current support for closer-to-market activities outside the scope of the tax concession.

**On balance, the Commission finds that there is scope for introducing cost recovery in *some* of the activities currently supported by Competitive Grants. Recommendations are made in the following chapter.**

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## D7 POLICY IMPLICATIONS AND PROPOSALS

A designer of public innovation policy tends to find himself in the same position as a blindfolded brainsurgeon. After an operation he can rarely surmise what incision, if any, caused the patient's recovery — or demise. The Gordian knot of innovation policies is to know what innovations would have occurred even without a policy (Fölster 1991, p. 9).

### D7.1 Introduction

By international standards, Australian companies are still less R&D intensive than their overseas counterparts in most industries. However, the gap has been closing and was never as large as crude comparisons of BERD to GDP ratios would suggest. Much of that gap is attributable to differences in Australia's industry structure relative to other OECD countries.

The Commission has shown that the residual under-performance of BERD may have a number of causes, but lack of government assistance is unlikely to be one of them. When all forms of R&D support are accounted for (including of course the tax concession) government funds a higher proportion of BERD in Australia than in most other countries.

Indeed in one sense government assistance to industry has been one of the main reasons for less R&D effort. The protectionist policies of the post-war period sheltered Australian companies from international competition and weakened the incentive to innovate. Given that R&D involves a cumulative learning process, any current under-performance can be seen at least in part as a legacy of those earlier policies. The large-scale involvement of CSIRO in industrial research might also have been a disincentive to carry out some types of R&D.

The Commission does not, therefore, consider that government R&D policy should be motivated by any particular catch-up target based on some average international ratio of BERD to GDP. There are inherent constraints (skilled people in particular) on a firm's capacity to respond to government inducements to undertake R&D. Especially in the short term, additional R&D can have decreasing private returns (and negative social returns). The Commission disagrees, therefore, with any suggestion that 'it is impossible to do too much R&D'.

That does not mean that the Commission sees no role for government in ensuring that firms undertake an appropriate amount of R&D over time. The changes in the market environment through microeconomic reform have already

made an important contribution (enhancing product market competition, freeing up financial markets, etc). And, as discussed in the preceding chapters, Government has a range of support measures targeted specifically at business R&D.

The range of measures and their rates of support have varied over time. Indeed in the course of this inquiry, two programs mentioned in the terms of reference — the Discretionary Grants Scheme and the Generic Technology Grants Scheme — were absorbed into one Competitive Grants scheme, along with three other grant schemes that operated under the Industry Innovation Program. The May 1994 White Paper also announced several changes to existing programs, along with the introduction of a new program of concessional loans for early commercialisation activities, and a range of other initiatives. The 1995 Budget announced changes in the company tax rate (influencing the value of the R&D tax concession) and syndication arrangements.

Government support for business R&D includes measures of general application as well as selective assistance to particular firms and technologies. As noted in part A, some diversity in measures of R&D support is desirable where there is uncertainty about their relative performance. However, it is also important to achieve some consistency in support where similar ends are sought.

Ultimately, the objective is to compensate for market failures in a way that maximises the social benefit and minimises the cost of intervention within the realm of what is feasible for administrators, given the information at their disposal.

This chapter builds on the analysis in previous chapters to consider whether current arrangements for business R&D support can be improved. In so doing, it presents some options for consideration.

## **D7.2 The 150 per cent R&D tax concession**

The R&D tax concession is a non-selective (ie general) policy instrument aimed at encouraging firm-level R&D. A general approach to providing R&D support for firms is most appropriate where the external benefits that are generated by the R&D are widely spread and relatively uniform among firms (see chapter A5). As the Treasury noted:

[Tax incentives] are more suitable where it is considered appropriate to support all businesses undertaking R&D (eg because externalities are widespread). Given the large number of firms receiving assistance, it would be difficult to replicate these incentives with grants or loans (Sub. 236, p. 39).

It is also the most appropriate where there is little information available to administrators to distinguish among firms in terms of their need for assistance and capacity to undertake socially beneficial R&D.

The 150 per cent tax concession, as an instrument for assisting R&D, has a number of advantages, but also some disadvantages.

### **Advantages of the tax concession**

#### *Self-selection by companies*

The R&D tax concession is a general mechanism of support that allows firms to decide for themselves what R&D projects to undertake. This is important, as firms are clearly in a better position than any outsiders to evaluate their own technology needs. Ampol Ltd stated that:

The 150 per cent tax concession ... best addresses the business focus component and the financial risk component of R&D. It is broad-banded and therefore the private sector, which has the expertise and takes the risk, can make the choice on innovations of most value to their operations (Sub. 88, p. 9).

#### *Broad-based nature*

The tax concession subsidises R&D activity — the element in the technological innovation process where there are most likely to be market failures. It is also a broad-based, non-selective form of support in that it does not target particular firms or technologies. In this latter respect, Dario J. Toncich thought that an advantage of the tax concession was that:

The concession is applicable to all companies and there is no government attempt to 'pick winners' as there is with other grants (Sub. 9, p. 20).

The scheme thus requires discretion on the part of administrators only to the extent of deciding if eligibility criteria have been met. An R&D project is eligible for the concession if it is based on a 'core' activity that involves either innovation or technical risk. The project must also be carried out in Australia, have adequate Australian content, and the results must be exploited to the benefit of the Australian economy. The Commission considers the definitions in the Act for determining whether an activity is or is not R&D to be satisfactory for this purpose.

#### *Low administrative and compliance costs*

Because there is relatively little need for administrative assessment, the administrative and compliance costs of the tax concession are relatively low. In

this respect, the IR&D Board reported a ratio of administrative costs to revenue forgone of 0.4 per cent for the tax concession in recent years (Sub. 219, p.13).

Social costs associated with attempts by interested parties to gain advantage by modifying or otherwise exploiting the rules (rent seeking) is also likely to be low with the scheme, as the rules for eligibility are reasonably well defined and assistance is generally available (non-selective).

## **Disadvantages of the tax concession**

### *Sensitivity of incentive to changes in company tax rate*

Because the tax concession operates by reducing taxable income, the subsidy provided (reduction in the after-tax cost of R&D) can vary over time with changes in the company tax rate. In recent years, this has varied from 46 per cent, to 49 per cent, then to 39 per cent, 33 per cent, and now 36 per cent in the 1995–96 Budget. This most recent increase in the company tax rate will increase the value of the concession to companies.

### *Unevenness in rate of support provided*

For a given rate of tax concession, the benefit provided can vary among recipients depending on dividend decisions of companies, the tax status and country of origin of shareholders, and according to whether companies have sufficient taxable income to be able to benefit fully and immediately from the concession. In particular, part or all of the benefit of the concession can be subject to clawback or washout through dividend imputation.

A particularly important source of unevenness results from the impact of the concession on companies in tax loss. These companies are unable to benefit from further tax deductions until they achieve taxable profits from other sources. Because the tax system does not refund losses made by companies to shareholders, any benefits from tax deductions are unavailable while the company remains in loss. Companies with tax profits on the other hand are able to reduce their tax payable by using the tax deductions.

In addition, the benefit from the tax concession varies with the marginal tax rate of the shareholder (see box D3.4). This variation among shareholders has important implications for the incentive to invest in R&D relative to other activities. Low tax rate shareholders have their incentives to encourage the company to choose R&D projects over other projects altered very little by the concession. Shareholders who are high tax rate taxpayers, however, have income from all sources taxed at high rates, and gain significantly from the tax concession for R&D.

As a result of this difference, shareholders may have quite different expectations of companies' investment policies with respect to R&D.

*Low inducement effect (high transfer component)*

The R&D tax concession accrues to the *level* of (eligible) R&D undertaken, rather than any increase in R&D during a fiscal year. It is also claimed *after* the R&D expenditure has been carried out. This implies that the concession acts not only as an inducement to increase R&D, but also as a reward for having already made the decision to undertake it.

The BIE estimates that as much as 90 per cent of the R&D expenditure on which the concession is claimed would have been carried out in the absence of the concession. But the 1992–93 announcement that the scheme would be a permanent measure, and subsequent evidence of its durability, could increase the extent to which it is factored into companies' R&D decisions and enhance its effectiveness relative to this estimate.

For many companies, the incentives to do R&D are substantial without government assistance, and companies earning taxable profits are likely to be in a position to finance it. This accords with what the Commission heard from (large) companies overseas and in Australia. But the R&D decisions of smaller companies seem to be more influenced by the availability of government support. However, many of those cannot benefit from the tax concession because they have insufficient taxable profits.

### **Assessment**

One feature of the R&D tax concession which limits its effectiveness is the fact that the great bulk of the cost to revenue is represented by projects that companies would have conducted anyway (the transfer component). Despite these large transfers, the BIE has judged the program as 'more likely than not' to be welfare enhancing. This is not a ringing endorsement. Moreover, if anything, there is a case for the BIE's estimates of net benefits erring on the high rather than the low side, within its methodology (see section D3.3).

Model simulations undertaken by the Commission that investigated the long-term economy-wide impact of the concession found that there would be greater benefits if the concession were more effective at inducing additional R&D and hence that there could be significant gains from better targeting the concession at R&D that would not have been undertaken otherwise.

The transfer problem would be reduced if tax benefits applied only to incremental R&D (*increases* in R&D expenditure above some base level) as

occurs, for example, in Japan and the United States. Transfers would not be eliminated, however, because some companies might have increased their R&D expenditure even in the absence of a tax concession of this form. There are also considerable problems associated with defining the most appropriate base from which the increase should be measured.

In any case, the absence of a requirement for consolidated company accounting would make an incremental scheme vulnerable to abuse, because R&D could be channelled through special-purpose affiliated companies that had never been involved in R&D before. Further, the problem of variability in assistance provided, without any necessary relationship to the benefits from R&D, could continue.

**Empirical evaluations suggest that the 150 per cent tax concession has net social benefits. In broad terms, its advantages are:**

- **self selection of R&D;**
- **broad based;**
- **low cost to administer;**
- **low compliance costs; and**
- **minimal incentives for rent seeking.**

**Its disadvantages are:**

- **assistance is sensitive to changes in the company tax rate;**
- **support is uneven, especially for companies in tax loss;**
- **it provides different incentives to support company R&D among shareholders on different marginal tax rates; and**
- **it has costs associated with supporting projects that would have gone ahead anyway.**

**On balance, the Commission favours continuation of assistance in the form of a tax concession for tax profit companies. In addition to the considerations raised above, it has widespread acceptance among businesses and there could be undesirable impacts on incentives to perform R&D if uncertainty is created by changes in the form of assistance.**

### **D7.3 Syndication**

Syndication was originally introduced to facilitate jointly-owned R&D projects. Through its method of operation, however, it has become a convenient vehicle for transferring the tax losses accumulated by R&D performers to investors. In doing so, it creates a subsidy for the performance of further R&D in companies in tax loss.

#### **Advantages of syndication**

##### *Offsets unequal treatment of tax loss companies*

The benefit that companies with accumulated tax losses obtain from the 150 per cent tax concession is reduced because of the delay experienced before they earn taxable profits and claim the concession. Syndication serves to partly offset this reduced benefit by enabling companies in tax loss to bring forward the realisation of their tax losses.

However, the benefit is less than a company in tax profit receives from the full 150 per cent deduction, because losses cannot be carried forward with interest and are not traded at the full company tax rate. Typically, tax losses are traded for R&D funds at between 25 and 30 cents per dollar (Schultz 1995) — the IR&D Board requires a minimum researcher benefit for their tax losses of 25 cents per dollar.

As syndication becomes entrenched, firms may start to anticipate future syndication of losses on R&D as they start up. Thus a firm may undertake a new R&D project, anticipating that at some early stage it would syndicate the core technology created and use its associated losses. Thus it could claim tax deductions for R&D with a predictable and relatively brief delay. This could put such firms on a similar footing with firms in tax profit undertaking R&D projects.

##### *Large-scale, up-front funding*

Several participants pointed to the advantage of syndication as a mechanism providing up-front funding for the completion of large projects. For example, the Fallon Group stated that:

Researchers seeking to syndicate R&D projects require access to the full R&D budget to complete their projects. Accumulated tax losses over a protracted period have allowed researchers to build an asset of value to the investor which can be traded for the required funds (Sub. 312, p. 3).

Similarly, Aerospace Technologies of Australia stated:

Syndication enables a company with accumulated tax losses to trade its future tax benefits for cash support for R&D. Its great advantage is the provision of cash to finance the complete R&D program (Sub. 349, p. 3).

The large-scale nature of syndicated projects is indicated by the fact that up to June 1994, eligibility was restricted to projects with a minimum R&D expenditure of \$1 million. The *Working Nation* White Paper reduced the threshold R&D expenditure to \$500 000.

### *High inducement rate*

Syndication is generally regarded as a 'last resort' method of funding R&D. The BIE has suggested that:

Syndication generally works by facilitating finance for firms who otherwise face an effectively infinite cost of finance: that is, capital is unavailable to them (1994a, p. 58).

In the BIE's survey of syndicate research firms, three-quarters of respondents chose syndication because they could not obtain the critical mass of finance in any other way, while the remaining firms chose syndication because it was the lowest cost method of financing (1994a, pp. 62–3).

Because of this 'funding of last resort' feature, syndication appears to induce a high proportion of additional R&D. The BIE survey of research firms revealed that around 70 per cent of R&D conducted under syndication would *not* have proceeded in its absence. 'At risk' syndicates, however, displayed an appreciably lower inducement rate — only around 10 per cent of R&D would not have proceeded otherwise.

The Fallon Group summed up the advantages of syndication in the following way:

There are a number of tactical and strategic advantages to syndicated research. A research company with competing demands for limited internal funds can choose to use syndication to attract external investment, thereby freeing-up in-house funding for commercialisation or other purposes. Alternatively, large project funding can be planned using syndicated funds for late stage completion, thereby making local research more attractive and allowing more ambitious research programs (Sub. 312, p. 4).

### *Links between investors and R&D performers are encouraged*

The process of syndication draws financial institutions into close association with firms undertaking R&D. Even though in many cases, investors funds are not at risk, investors often have some financial interest in successfully performed research. This encourages links that might not otherwise occur.

## **Disadvantages of syndication**

### *High and variable rates of subsidy*

All configurations of syndicates (bar those fully at risk) receive high rates of effective subsidy compared to the general 150 per cent tax concessions (BIE 1994a, p. 101). The subsidy rates provided range from around 15 cents per dollar of R&D for 'at risk' syndicates, to 45 cents per dollar of R&D for 'fully guaranteed' syndicates (the most common form), 50 cents per dollar of R&D for 'partly guaranteed' syndicates, and an extremely high \$1.38 per dollar of R&D for tax exempt syndicates (see table D3.1). The very high subsidy for tax exempts arises because they do not forgo tax losses, and they have a very high core technology valuation relative to the R&D.

For the scheme as a whole, the social benefit-cost outcome is still favourable despite the high subsidy rates because of the high inducement rate achieved. But not all syndicate configurations perform equally — the social benefit-cost outcome for tax exempts and 'at risk' syndicates is very borderline (see BIE 1994a).

### *High transaction costs*

The legal and contractual complexities of syndication mean that the scheme is very expensive for participants, both in terms of administrative costs and managerial burden. The BIE estimated the average cost per syndicate was around \$190 000 (based on 42 syndicates surveyed). Disputes over syndication arrangements are said to be increasingly finding their way into the courts.

However, the view that transaction costs are 'high' has been disputed. Schultz, for example, suggested that:

The market mechanism for reducing transaction costs is competition and increased efficiency. There is considerable evidence to suggest that competition is working. Packagers' returns from syndicates have more than halved over the last four years. Lender debt margins have more than halved. Valuation costs have come down by a third. Legal costs have come down by two-thirds (1995, p. 7).

The Fallon Group (Sub. 312) expressed similar views but also indicated that because legal and accountancy expenses will always be a significant cost of any arrangement of this type, there is likely to be a limit to the extent to which the cost of syndication can fall.

### *Lack of transparency*

The complexities of syndication also result in a lack of transparency. While syndication provides some degree of tax benefit transfer, from the point of view

of the revenue authorities it is not regarded strictly as tax benefit transfer, because it is not transparently so (although that is patently what it is).

In the complicated arrangements associated with syndication, much appears to be happening as various legal entities are set up. It is important to realise that in many cases the bulk of the money involved never actually moves from the financial institution. The largest payments are effectively made by the financial institution to itself and are invested as they would have been had syndication not existed. Syndication is in essence designed to achieve:

- a payment for new R&D to the firm undertaking the new project;
- a payment to the promoter; and
- a tax deduction for the financier.

A lack of transparency in the actual operation of the scheme by the IR&D Board also received critical comment:

At present (the decision/approval) process is protracted, disjointed, and highly subjective. We are aware of significant inconsistencies in the decision process. Not all of the criteria for acceptance of some proposals are published. There is no clear avenue for review of the Board's decisions on critical aspects of syndicated R&D proposals. ... The decision/approval process is therefore *not* transparent and is a significant source of delay and uncertainty (Sub. 312, pp. 6–7, emphasis in original).

### *Losses transferred can arise from activities unrelated to R&D*

A firm obtains maximum advantage from syndication when it uses up all its tax losses. These losses may arise from any activity. But it is not clear from a policy perspective that it is desirable to allow losses from all sources to be cashed in. While transfer of tax deductions from any source would be a desirable policy if the tax system accurately measured income (that is, taxable income was equal to true economic income), this is not the case. The tax system is overly generous in a number of instances and transfer of losses so generated would make it more so. So if syndication allows a surrogate form of general tax benefit transfer it encourages other activities that are currently (desirably) restrained by the absence of tax benefit transfer.

### *Potential for over-stimulation of R&D in the future?*

Firms with little prospect of using their accumulated tax losses might be tempted to pursue syndication simply as a means to obtain some value from tax losses that might otherwise have very little value. Currently, projects are vetted by the IR&D Board which discourages this.

### *Syndication only assists large projects*

Syndication has large set-up costs which effectively confine it to projects involving substantial R&D expenditure. Because the amount of R&D funding is directly related to the tax losses which must be traded for that funding, the only companies that can participate in syndication are those with a minimum level of required tax losses (typically, several million dollars).

To overcome situations where SMEs are prevented from taking part in syndication because their tax losses are not sufficient to justify the high transaction costs, the Strategic Industry Research Foundation (SIRF) has set up a syndication plan such that:

... small businesses must have at least \$1 million in tax losses and be prepared to attempt to commercialise an R&D project which has nothing to do with their business (*Herald Sun*, 20 March 1995, p. 38).

It is difficult to see how this development will lead to beneficial R&D in the long term. If firms have little control over the R&D being performed and it is not related to their activities, they are likely to attribute a low value to it and volunteer tax losses only when they attach little value to them.

### *Private tax exempts benefit too freely*

Tax exempt entities can create a tax deduction for a financier without themselves giving up tax deductions as tax loss companies must do. If it were not for the need for Board approval for syndication projects, the limit to the amount of finance tax exempt entities could create for themselves would be set only by the amount that they have already spent on R&D (setting the value of the core technology) and the extent of taxable profits in the financial institutions.

At the hearings, the IR&D Board commented on the very substantial use of syndication by private tax exempts to fund medical research:

... syndication is providing half as much per annum today in medical research as the NHMRC [National Health and Medical Research Council]. ... [W]hat is happening is that the big institutions are not only funding their medical research through syndication, they have got block grants from NHMRC, and I think NHMRC, which is the overriding body, is losing control of that situation (transcript, p. 3368).

Public tax exempt entities have been excluded from participating in fully at risk syndication arrangements for some time. The 1995–96 Budget announced that private tax exempts would similarly be excluded.

## Assessment

In assisting firms in tax loss to perform additional R&D, syndication serves a potentially valuable function. The BIE found it currently to have benefits that exceed its costs.

However, the impact it currently has on tax loss firms is rather uneven. Potentially, it can provide very large incentives to some firms to undertake additional R&D, especially if firms have large accumulated tax losses. These need not necessarily have arisen from the performance of R&D. It is possible that through syndication, firms could trade losses that have very little current value to them for R&D projects that also have very little value, although there is no evidence that this has occurred yet.

The high transactions costs associated with syndication are of concern both because they are created by activity which is in broader social terms unproductive, and because they form a barrier to the participation of smaller firms.

The use of syndication by tax exempt entities cannot be rationalised in terms of unevenness in the tax system, as it can for tax loss firms, and is likely to be providing excessive incentives for their R&D.

**The Commission sees potential benefits in the use of syndication. But it has concerns about its transactions costs and the potential way in which its access to losses accrued in activities other than R&D may lead to the danger of costs becoming excessive and R&D being performed of marginal value.**

**The Commission considers that use of syndication in the fully guaranteed form by tax exempt entities is inappropriate. It concurs with the Government's decision, some time ago, to exclude public tax exempt entities and the more recent decision, in the 1995–96 Budget, to exclude private tax exempt entities.**

**The Commission notes that deductions from all sources are potentially useable to finance syndication and considers that this has potential to create excessive incentives for R&D. It recommends that syndication should be limited to losses derived from expenditure on R&D. In calculating losses eligible for syndication arising in a given tax year, firms would have access either to their total unclaimed tax losses for that year or to the total deduction in respect of R&D, whichever was the smaller.**

## **D7.4 Competitive Grants for R&D**

In principle, selective assistance for R&D should allow greater scope to target projects with the highest social payoff and to induce those socially valuable projects which otherwise, through lack of private profitability, would not have proceeded. But in practice, the five IR&D Board grant schemes that operated prior to being combined into a single scheme did not necessarily operate in that way. Like the tax concession, the new Competitive Grants scheme has advantages and disadvantages.

### **Advantages of selective grants**

#### *Targeting of government priorities*

The former grant schemes targeted companies/activities/technology areas that were accorded priority under the Commonwealth Government's industry policy objectives, including:

- companies unable to benefit adequately from the tax concession, or those developing and trialing products for a public sector buyer;
- particular areas of technology ('generic' or 'enabling' technologies considered to be vital for industrial innovation and Australia's economic growth); and
- projects involving collaboration between business and public sector research organisations.

Selective programs can therefore play a complementary role to the support available under the tax concession. For example, Nucleus considered that a variety of R&D support measures are appropriate to cater for companies in the different phases of the profitability cycle, as they progress from start-up to maturity:

Some companies are profitable early while others are unprofitable and 'cash strapped'. For such companies, R&D grants are vitally important in sustaining R&D effort and providing cash flow. ... As companies mature and become profitable, the variety of tax concession arrangements become important (Sub. 93, pp. 3–4).

#### *Up-front nature of funding*

Because grants provide 'up-front' funding, they are likely to be more influential on firms' R&D decision making than those mechanisms which provide support after the expenditure has been undertaken (such as the tax concession). In this respect, the Victorian Employers' Chamber of Commerce and Industry (VECCI) argued that:

The responsiveness of small-to-medium businesses is likely to be greatest to a cash subsidy payment due to its up-front nature rather than a tax concession, which has a delayed effect in benefiting the company (Sub. 60, p. 9).

Similarly, Runes Business Services stressed the beneficial cash flow effect of grants:

Grants are up front money in the bank, whereas the concession is only a book entry some time after the R&D is paid for. An IR&D Board grant provides money up front at specified intervals related to R&D milestones being achieved. This provision of cash flow enables projects to be done more efficiently, and within a time frame which may allow the company to take better advantage of the market opportunity (Sub. 66, p. 5).

### *Inducement effect*

The extent to which the former competitive grant schemes encouraged projects to proceed that would not have done so in the absence of assistance was greater than for the tax concession. Across the DGS, GTGS and NPDP schemes as a whole, the Invetech survey of grant recipients found that 60 per cent of projects that received IR&D Board support would not have proceeded without this support (Sub. 219, p. 80).

By contrast, tax concession registrants would probably have carried out between 10 and 17 per cent less R&D in the absence of the 150 per cent tax concession (BIE 1993a). As noted previously though, survey responses on the inducement effect of the grant schemes are more likely to be biased upwards than for the tax concession. Further, the transfers are still quite substantial for a selective scheme — at least one-half of outlays for the former Discretionary Grants Scheme was in respect of projects that would have been carried out anyway, and companies supported under that scheme will dominate the new single combined Competitive Grants scheme.

## **Disadvantages of selective grants**

### *Discretion available to grant awarding committees*

Since the inception of the grant schemes, the Board has increasingly favoured projects where the applicant can demonstrate an ability to commercialise the results of the R&D. The approach is therefore not so much one of selecting projects with the highest commercial returns as one of selecting projects that are likely to succeed (Sub. 363, p. 33).

But despite targeting potentially successful ventures in a commercial sense, the rate of winner picking has not been especially high. The IR&D Board has described the degree of commercial success of supported projects as ‘one-third

succeeding, one-third failing and one-third hanging on', which is not atypical of market outcomes generally.

Where wide discretion can be exercised in assistance schemes, this can encourage rent-seeking and positioning that favours those companies with the resources or better information about programs. Bottrill Research commented that:

One prominent patent attorney made the observation that there are companies that spend their time chasing grants (on which they become dependent) and invariably are unsuccessful in the long term (Sub. 101, p. 3).

### *Some recipients do a lot better than others*

A related feature of the former grant schemes is that while the majority of applicants missed out on any support at all, funds awarded tended to be concentrated in a relatively small number of firms. For example, over the seven-year period to November 1993, 73 companies received half the funds awarded under the former Discretionary Grants Scheme, 334 companies shared the other half, and 670 applicants received nothing. Moreover, the majority of potentially eligible companies did not even apply for a discretionary grant.

Similarly, the former Generic Technology Grants Scheme was characterised by a very high degree of multiple grant involvement — over the seven-year period to 1992–93, just 26 companies were involved in projects that accounted for nearly half of the \$123 million in funds awarded.

### *Information problems confronting grant awarding committees*

The selection procedure on the part of grant awarding committees is undertaken in the context of very imperfect information. As Fölster has noted, a feature of all selective grant-based schemes is that:

... firms are often forced to exaggerate a project's social value and to present a project as though it would not be conducted without the subsidy (1991, p. 13).

Indeed, to increase the probability of being awarded a grant, the likelihood is that some applications will be optimistically slanted. One participant reported their experience with two grant applications as follows:

We had to present full development budgets, and also estimates of future sales for the years ahead and also forecast profitability ratios in comparison to R&D expenditures. We tried not to be too optimistic about future sales. Needless to say, we did not get a grant (Harry Sebel Consultancy, Sub. 75, p. 9).

As an indication of the upward bias that can occur, the Commission noted in its review of the NPDP (1992) that the actual sales that resulted from projects differed markedly from the projections that were made at the time grant

applications were lodged. For example, of the 23 grant recipients who responded to the Commission's survey and who had completed their projects by the end of 1991, 10 had achieved sales which in total amounted to \$12 million. By contrast, 16 of the 23 companies had indicated in their grant applications that they expected commercial sales by that time totalling in excess of \$200 million.

A related concern was expressed to the inquiry about whether the grant committees have the expertise to assess adequately the merit of projects which involve novel technology. As one participant commented:

For R&D that is not directed at mainstream development, it is very difficult to convey what you are doing to the various IR&D Board committees (Martin Communications Pty Ltd, Sub. 47, p. 4).

The IR&D Board acknowledged this complaint as a problem with the grant programs under earlier arrangements, when applications were assessed by separate scheme-specific committees (Sub. 252, p. 4). The Board's grant awarding committee structure since 1993 has been re-organised along industry lines, with committees comprising representatives from business and research fields in five industry areas (section D4.1 above). However, a further potential problem with industry-based committees is that they may see their role as providing support for particular companies rather than for the activity of R&D itself.

### *Higher administrative costs*

Selective schemes like the competitive grants program are also administratively more costly than general mechanisms such as the tax concession. Information provided by the IR&D Board suggested an expense ratio of 4.7 per cent for the range of enterprise development programs conducted by DIST — including NIES and Export Access as well as the R&D grant programs (Sub. 219, p. 92).

### *Higher compliance costs*

In recent years, the IR&D Board has sought to reduce the burden on applicants by introducing a two-stage application procedure, with applicants firstly registering an Expression of Interest (involving minimal information) and only those with some likelihood of receiving a grant invited to develop a full application.

The problem of compliance costs is compounded by the fact that because the grant schemes are competitive (with applications assessed on the basis of merit criteria) the majority of applicants miss out. Over the lives of the former grant schemes, around one in three applications were successful, though there were variations across individual schemes (for example, a 42 per cent success rate for the National Procurement Development Program, but only a 25 per cent success

rate for the Generic Technology Grants Scheme — refer appendix E). Under the new two-stage procedure, the Chairman of the IR&D Board indicated that for every ten applicants that are invited to make a full application, about five or six will generally be successful (transcript, p. 851).

This problem of compliance costs, combined with some applicants missing out, was suggested by participants as a source of some dissatisfaction with the grant schemes. The submission provided by the New South Wales Government reported on one company's experience, which illustrates the problem that compliance costs pose for unsuccessful applicants:

... a company applied for a [Discretionary] grant of \$125 000 and, although favourably considered initially, the application was ultimately unsuccessful. [In the following year] the company made another application for a grant of \$600 000, [but] again the application was unsuccessful. The company used an external consultant for preparing these submissions at a cost of \$25 000 plus their own time in information gathering, evaluation and presentation (Sub. 260, p. 15).

With a competitive, merit-based selective grant scheme, many applicants miss out, but the unsuccessful applicants may well be seeking to undertake R&D that socially is equally beneficial. Hence, there are problems from both an equity and an efficiency viewpoint.

### **Assessment**

The eligibility criteria for the single scheme are considerably broader than under previous arrangements. In general, the competitive grants scheme has evolved into a form of support primarily for potentially successful companies rather than assistance to R&D as an activity subject to appropriability problems and spillovers.

While selectivity can in principle bring additional benefits relative to more general schemes, the information requirements create insuperable difficulties for administrators. It is not really possible for administrators to select, in a competitive scheme, only those projects that (a) would not otherwise have proceeded and (b) rank highest in terms of spillovers. The criteria that do apply tend to promote an approach focussing on commercial success, which has no necessary connection with the market failures that provide the real rationale for government intervention.

Despite their selective nature and inducement of R&D, the selective grant schemes have features that reduce cost effectiveness: in particular, a higher rate of support, and administration costs which are a relatively large share of overall program costs.

This is not to argue that companies such as those not earning taxable profits should not receive assistance for R&D. The Commission considers them to be just as important a source of spillover and economic growth as the larger companies benefiting from the tax concession. The Commission's judgement is simply that they would be better served by more generally available arrangements.

**The Commission finds that while the competitive grant schemes may have yielded net benefits in the past, their administrative processes have a number of drawbacks. The Commission endorses the need to support R&D in companies making tax losses, but notes the problems associated with selective schemes used to achieve this.**

## **D7.5 Broad-based support for tax loss companies**

### **Desirability of support for tax loss companies**

Given the Commission's conclusion that an across-the-board subsidy for R&D is desirable, the most important deficiency of current arrangements is their failure to provide broad-based assistance to companies in tax loss. The tax concession is able to provide immediate benefits only to companies in tax profit, while the Competitive Grants for R&D scheme provides support for only *some* companies in tax loss.

Syndication also can provide some assistance to companies in tax loss, but its transactions costs prevent it from achieving widespread applicability.

The Commission has concluded that the former Discretionary Grants Scheme operated in only a very limited way as a complement to the tax concession, and that there are more general problems with selective grants.

Many participants supported the need to provide assistance to tax loss companies. The Australian Academy of Technological Sciences and Engineering stated that:

Small businesses frequently have difficulties, particularly in the start-up phase, which in our experience and knowledge can be commonly three to seven years. Small business requirements [should] be particularly addressed through [providing] ... tax benefits which give positive cash flow assistance to start-up ventures in the loss phase, ie companies [should] receive a subsidy for R&D equivalent to the tax deduction received in the profit making stage (Sub. 186, p. 6).

Similarly, Australian Water and Wastewater Association Inc stated that:

Fledgling companies with a prospect of several years before initial R&D work can yield a net return do not receive any early benefit from the [150 per cent tax concession] scheme. Perhaps more effort could be made to provide avenues [of support] for those not-yet-profitable businesses (Sub. 79, p. 3).

Not all participants, however, were in favour of providing cash grants to tax loss companies, and considered that the ability of only tax profit companies to benefit immediately from the concession was a good feature of the scheme. In their view, the taxpayer 'investment' in tax profit companies was more likely to result in successful commercialisation of the R&D outcomes and thereby provide a positive return to society. For example, Critec Pty Ltd stated that:

For companies to successfully commercialise R&D they need positive cash flow and [to] be profitable. They need to get all parts of their act together, especially marketing and finance, and not just an ability to do good technical research. Companies without sufficient profitability to commercialise their R&D are not likely to be successful (Sub. 180, p. 8).

An IR&D Board survey of 213 companies which had received DGS grants up to 1991–92 revealed that 12 per cent had gone into liquidation (IR&D Board 1992, p. 13). But as the Board itself noted, in some of these cases the funds expended on the projects were not wasted and survived company failure because the technology was taken up and exploited by other firms.

In respect of possible failures among start-up companies, Lake DSP Pty Ltd noted that:

In other countries such as the USA, investors will accept a 10:1 ratio of failure to success in start-up companies. Our government could do the same. Of the ten companies, one will return very highly and probably pay for the other nine, while two or three will live for more than five years before their technology is eventually bought by someone else. All ten will employ people, and those that fail will help to educate the industry and possibly create successes later (Sub. 174, p. 2).

**In the Commission's view, tax loss companies are no less likely to produce external benefits than those more established companies in tax profit. For this reason, the Commission accepts the need for support for tax profit and tax loss companies to be put on a more comparable basis.**

### **Problems in designing tax-equivalent support**

How might an approach of providing a subsidy equivalent to the tax concession be operationalised? As noted in section D3.5, there is no single rate of grant that can be given to tax loss firms to leave all shareholders with the same benefit that they would get from the tax deduction in a tax paying firm. This is because there is a wide variation in the value of a tax deduction in the company to different types of shareholders. For example, if the 50 per cent component of the

deduction of 150 per cent of expenditure is treated as the concessional element, the value of the concession could vary as follows:

- top rate taxpayers could benefit from the tax deduction to the extent of perhaps 25 per cent of expenditure;
- low rate taxpayers (eg superannuation funds) pay tax at only 15 per cent — an additional deduction of 50 per cent in a tax paying company is therefore only worth a maximum of 7.5 per cent to them; and
- the benefit that everyone receives varies according to the extent that they can reduce capital gains tax, which in turn depends on when they realise their shares.

In short, the provision of a direct subsidy to companies in proportion to their eligible expenditure would not provide a uniform rate of assistance because the subsidy amounts to a form of income for a company, and is thus worth more to shareholders with *lower* tax rates — the opposite of tax concessions, which are worth more to shareholders with higher tax rates.

Although this conclusion is perhaps more readily seen in the case of a cash grant, it is equally true for syndication. After all, syndication is in essence a way of obtaining a cash value for tax losses, which is then applied to R&D. Thus, *de facto* trading of accumulated losses through syndication can provide some shareholders in R&D companies with quite different incentives for R&D expenditure to those that would have been provided by the underlying tax deduction had the company been in tax profit.

Thus, if changes to improve the position of firms in tax loss are then to be introduced, it is not possible to design them in a way that makes equivalent the position of shareholders in tax profit and tax loss firms. For example, suppose that incentives are designed to give shareholders on the top marginal personal tax rate the same incentive to invest in R&D whether they own a tax loss or tax profit company. In that case it will generally not be possible to provide an equivalently neutral choice for taxpayers on other marginal tax rates.

This implies that in looking at tax loss companies it will be important to make sure that arrangements for R&D subsidies do not inadvertently become so generous for some shareholders that a clientele shareholder group is created. For example suppose tax deductions were, by one means or other, given their full cash value (deduction multiplied by the company tax rate) in tax loss companies. This would mean that low rate taxpayers (such as superannuation funds) would receive markedly greater incentives to invest in tax loss companies than their incentives to invest in tax profit companies. Their incentives would also be markedly greater than the incentives given to any investor in a tax profit company.

**Should grant assistance for R&D be given to *all* companies?**

One option for alleviating this problem, which was raised in the Commission's draft report, is to compensate firms for the external benefit of their research by providing a taxable grant. This may be thought of as the 'purchase' of valuable R&D by the wider community. It would benefit both companies in tax profit and tax loss.

Under this proposal, gross income from the taxable subsidy would be taxed in the hands of shareholders in the same fashion as income earned by the firm from other sources. Thus a low tax rate shareholder such as a superannuation fund ends up (after imputation) paying a low rate of tax on income received through a company by way of taxable grant, just as it does on income received through a company from its normal trading activity. Under the taxable grant, the relative weight it would place on investments that attract the subsidy and those that do not are relatively unaffected by the tax system.

An implication of this option that gives rise to concern is the position of foreign shareholders, who would be likely to receive additional incentives to undertake R&D relative to the tax deduction. As the BIE (1993c) made clear, when foreigners receive subsidies for R&D that would otherwise occur, assistance is less likely to produce net benefits.

As a taxable grant, the subsidy would implicitly carry with it imputation credits, which would tend to make investors pay tax on the subsidy according to their marginal tax rates. Alternatively, if the subsidy were paid in the form of imputation credits themselves, the subsidy would tend to take the same money value for all shareholders.

Either of these options would involve fundamental structural changes to the tax system which could have wider implications beyond the issue of subsidisation of R&D. The Commission received very little positive feedback on the possibility of broadening the subsidy for R&D in this way in comment on the draft report.

Although these alternatives have attractions in principle, the tax concession is now well-entrenched in the business community's understanding, and there is a danger in introducing further confusion and uncertainty at this time with a change that fundamentally alters the subsidy arrangements for firms in tax profit as well as those in tax loss.

## D7.6 Preferred options

For the reasons discussed in preceding sections, the Commission favours a general rather than selective approach to assistance for R&D. For tax profit companies it considers that the tax concession, on balance, has merit. However, there remains a question of how assistance might be delivered to tax loss companies, and how it would mesh with assistance given to companies in tax profit.

In its draft report, the Commission proposed that all tax loss companies be given a subsidy equal in value to the 50 per cent component of the 150 per cent tax deduction multiplied by the company tax rate.

The Commission argued that this would provide a measure of support for tax loss companies that broadly corresponded to the tax concession which could be claimed by companies in tax profit.

To assess the impact of providing more broadly-based support for tax loss companies, the Commission examined the likely impact on the level of R&D undertaken, and the cost effectiveness of the suggested changes in comparison with the current arrangements. The conclusion was that the Commission's proposal could be expected to induce additional R&D and generate a positive social benefit-cost outcome. These details, including a comparison with current R&D support arrangements for tax loss companies under Competitive Grants, are reported in appendix E.

The Commission presented two options in the draft report for delivering this support:

- (a) maintain the 150 per cent tax concession but replace the competitive grants for tax loss companies with a generally available grant at a comparable rate to the tax concession (at that time 16.5 per cent);
- (b) replace both the tax concession and competitive grants for tax loss companies with a non-taxable credit (equal, at that time, to 16.5 per cent) applied against tax payable, which would take the form of a refund for tax loss companies.

### *Tax credit*

Option (b) considered in the draft report was to replace the tax concession by a subsidy to *all* firms (tax profit as well as tax loss) equal to some fraction of eligible R&D expenditure. The subsidy could operate as a non-taxable credit, and could be refundable for tax loss companies.

The principal attractions of such a mechanism are twofold:

- being *non-taxable*, the after-tax subsidy it provides does not vary with the company tax rate; and
- being *refundable* for tax loss companies, there would be less discrimination against such companies than under the tax concession.

Tax credit mechanisms for R&D operate in many overseas countries, such as the United States, Canada, France, Japan, Taiwan and Korea. In those countries the tax credit is normally non-taxable — the approach suggested here — though Canada and the United States are exceptions.

The after-tax cost of R&D in the company varies with the company tax rate for both a tax concession and a non-taxable tax credit (table D7.1). However, the after-tax subsidy provided (ie the *reduction* in the after-tax cost) is constant with a non-taxable tax credit. By contrast, the after-tax subsidy provided by a tax concession varies directly with the company tax rate — the lower the tax rate the lower the subsidy. A tax credit of 18 cents in the dollar would provide the same subsidy as the 150 per cent tax concession for a 36 per cent company tax rate.

As the Chairman of the IR&D Board noted in relation to the level of the concession:

When we do decide on the next figure [for the concession rate] let's set that figure as a number of cents per dollar and then we won't ever have to worry how the [company] taxation rate changes from then on (transcript, p. 831).

The Nucleus Group suggested that:

... it would be much better if we could find some sort of formula ... so that the [company] tax rate could go up and down but the effective R&D support level would remain constant (transcript, p. 1039).

These concerns could be met if the instrument of support were changed from a tax concession to a (non-taxable) tax credit. But although such a mechanism removes the sensitivity of the value of the incentive to changes in the company tax rate, there is no difference between a tax credit and a tax concession in terms of the eventual benefit to shareholders in tax profit companies of a given reduction in company taxation. Essentially both reduce by the same amount the company income that could be paid out as a franked dividend and both allow income to be reinvested in the company and sheltered as a capital gain with a lower rate of taxation. In both cases benefits from company tax reductions could also be eliminated ('washed out') if companies chose to pay unfranked dividends.

The introduction of a tax credit would, however, introduce another change into the delivery of R&D assistance to tax profit firms, when one of the principal criticisms of it has been uncertainty over its future. The Commission has accepted that the tax concession, on balance, should be retained.

**Table D7.1: Support provided by a tax concession and a non-taxable tax credit**

<i>Tax mechanism</i>	<i>Company tax rate (%)</i>	<i>After-tax cost (cents/dollar)</i>	<i>After-tax subsidy (cents/dollar)</i>
150 per cent tax concession	33	50.5	16.5
	36	46.0	18.0
	39	41.5	19.5
	46	31.0	23.0
20 per cent (non-taxable) tax credit	33	47.0	20.0
	36	44.0	20.0
	39	41.0	20.0
	46	34.0	20.0
18 per cent (non-taxable) tax credit	36	46.0	18.0

Under the 150 per cent tax concession, the after-tax cost =  $\$[1 - (1.5)t]$ , where  $t$  = company tax rate; and the subsidy =  $\$(c \times t)$ , where  $c$  = concessional rate of tax deduction (50 per cent).

Under a tax credit, the after-tax cost =  $\$(1 - t - k)$ , where  $k$  = rate of tax credit; and the subsidy =  $k$ .

Source: IC estimates.

### *Non-taxable grant*

Option (a) was to maintain the 150 per cent tax concession but introduce a generally available non-taxable grant for tax loss companies equal in value to the 50 per cent component of the tax deduction — 18 cents in the dollar for a company tax rate of 36 per cent. While for a tax profit company an 18 per cent non-taxable grant is equivalent to a 28 per cent taxable grant (in after-tax terms) the same is not the case for a tax loss company — because their payment of the tax is delayed. Because companies are not taxed on their tax deductions, to provide a benefit to tax loss companies equal to the value of a tax deduction to a tax profit company, the grant should be non-taxable.

These automatic grants would differ from the selective grants currently available under the Competitive Grants scheme in the following main respects:

- *greater firm coverage* — being non-discretionary, *all* tax loss companies would be able to receive support;

- *different coverage of R&D expenditure* — the whole of a company's R&D might be eligible whereas only an individual project is supported under Competitive Grants (though under the former DGS, around two-thirds of the projects supported represented all the R&D undertaken by the recipient companies — refer appendix E); and
- *differences in definition of eligible R&D* — under the proposed arrangements, only the tax concession definitions of R&D would apply. There would be some differences relative to Competitive Grants — for example, purchase of core technology would become eligible but R&D-related market research expenditures would be ineligible.

One aspect of this proposal in the draft report that provoked a critical response was the question of the *timing* of the automatic grant. In the draft it was suggested that for consistency with the tax concession, the grant could be provided as part of the normal process of taxation, after a company has submitted its return. Companies could therefore carry out R&D with the knowledge of a certain cash refund being forthcoming at the end of the year.

However, because many companies in tax loss are small start-ups, some participants stressed the importance of up-front funding to maintain cash flow. For example, the Fallon Group commented that:

A cash refund up to 12 months ... in the future is not likely to be an effective incentive for a company struggling to find funds today (Sub. 312, p. 3).

To enable up-front funding of the automatic grant, the scheme could be operated by the IR&D Board along the following lines:

- companies would need to register with the Board in respect of their planned R&D expenditure (on a project basis, as under the R&D tax concession);
- the Board would need to determine whether projects were eligible (against the same criteria as the tax concession); and
- the same agreement, payment and monitoring procedures required for Competitive Grants could apply to these automatic grants.

This automatic support could adopt a similar eligibility criterion to the former Discretionary Grants Scheme — restricting it to companies unable to obtain full benefit from the tax concession in the year in which the R&D expenditure is made, because of inadequate taxation liability; or in cases where the company is part of a larger organisation, the company that controls the company in tax loss is unable to obtain full benefit from the tax concession.

Any practical difficulties associated with an applicant having to demonstrate being in tax loss *ex ante*, or any incentive that might be provided to create a tax

loss would need to be addressed in operationalising any up-front payment of the grant.

## **Recommendations**

**The Commission recommends that more broad-ranging support for tax-loss companies be introduced. It proposes that the 150 per cent tax concession be maintained, but that a generally available non-taxable grant be introduced for tax loss companies at a rate equal to the nominal value of a tax deduction of 50 per cent of the cost of undertaking R&D (18 per cent for a 36 per cent company tax rate).**

**The grant could be paid as part of the normal process of taxation, after a company has submitted its return; or alternatively, the scheme could be operated by the IR&D Board and the grant paid up-front.**

**In whatever way this subsidy is delivered, acceptance of the subsidy in the firm must extinguish any further right to make a tax deduction in respect of the concessional 50 per cent of that expenditure. The firm would, however, retain the right to deduct the remaining 100 per cent of that expenditure at some time in the future when it moved into tax profit.**

## **The need for further support?**

Some participants (such as Nucleus Group, Sub. 321; Fallon Group, Sub. 312) commented that a grant of this kind would not provide equivalent support to the subsidy implicit in the entire 150 per cent deduction available to tax profit companies, because tax loss companies cannot immediately claim the deduction on the first 100 per cent of their R&D expenditure. The IR&D Board said that:

... the proposal in the draft report would require [firms] to pay one and a half times more for R&D than would profitable firms (Sub. 363, p. 39)

The Commission agrees that its proposal does not put tax loss companies in the same position as companies in tax profit. Therefore there remains a question about what scope there is to supplement the automatic 18 per cent grant.

However, the Commission does not favour providing a cash subsidy for the full 150 per cent amount to all tax loss companies.

As already discussed, a subsidy at this level would provide a much higher subsidy to low tax rate shareholders in tax loss companies than they obtain by virtue of the 150 per cent tax deduction in tax profit companies. This might not only provide excessive subsidies for R&D but also provide opportunities to manipulate companies' activities to generate excessive claims.

The Commission also considered various options for providing grants under conditions of repayability or to pay the grant only to some tax loss companies. The Commission has already stated its views on the problems which it considers militate against selective grant programs for tax loss firms.

Although repayable grants have some attractions in reducing costs to revenue and reducing applications by firms which would proceed anyway and would find the level of subsidy less attractive than a non-repayable grant, the Commission does not, on balance, favour them. They:

- would involve large monitoring costs if offered on an automatic basis;
- would encourage firms to find ways to remain in tax loss to avoid repayment; and
- may, depending on the interest rate, still generate sufficient subsidy to attract firms which would have done the R&D anyway.

The Commission notes that so long as companies in tax profit are favoured by use of tax deductions for R&D — and the Commission has indicated its reasons for favouring the retention of this method of assistance — there appears to be no scheme that will effectively achieve equivalence.

In a world in which perfection in program design is not possible the Commission reiterates its view that its recommendation for the introduction of an automatic grant for tax loss companies would achieve better outcomes than the existing Competitive Grants Scheme. In that sense the incentives produced under the Commission's proposal result in a *better* set of outcomes than under the existing scheme.

While companies in tax loss would still suffer disadvantages relative to those in tax profit, the extent of disadvantage can be overstated. Firms in tax loss:

- have access to syndication arrangements for their tax losses;
- receive the value of tax deductions for 100 per cent of R&D as soon as they move into tax profit;
- will, under the Commission's proposal, receive an upfront non-taxable grant of 18 per cent of their expenditure on R&D, which can be more valuable to some shareholders than the nominally equivalent tax deduction (50 per cent).

### **D7.7 Implications for grant arrangements**

If the forgoing proposals were fully implemented, this would have implications for the Competitive Grants for R&D scheme. The key alternate eligibility criteria for Competitive Grants are set out in box D7.1.

**Box D7.1: Key eligibility criteria for competitive grants**

- 7 The applicant, or a company that controls the applicant, is unable to obtain full financial benefit under the 150 per cent Tax Concession for Research and Development to undertake the project while in receipt of a Competitive Grant for Research and Development;  

**or**
- 8 The project involves a significant proportion of activities (trials, demonstration and marketing) that are outside the scope of eligible activities under the 150 per cent Tax Concession for Research and Development;  

**or**
- 9 The project involves a graduate working on a specific company based research and development project which results in the formation of new and appropriate linkages between a company and a tertiary/research institution.

**Tax loss companies**

In the draft report, it was proposed that a generally available grant *replace* the current system of Competitive Grants for tax loss companies. The IR&D Board was highly critical of this proposal and argued that:

The reality of the proposal for automatic grants is that the majority of smaller, developing firms in Australia will drastically reduce their R&D investment (Sub. 363, p. 42).

Similarly, the Fallon Group stated that:

Reduction of the cash payment from 50 cents to 16.5 cents per dollar would clearly not have the equivalent encouragement effect on new R&D projects, even after allowing for the reduced compliance cost (Sub. 312, p. 3).

But comments like these seem to be implying that all tax loss companies currently receive discretionary grants. The reality is that the overwhelming majority of tax loss companies receive little if any support under the current grant arrangements — only relatively few actually receive grants.

The Commission's proposal of an automatic non-taxable grant to *all* tax loss companies at a rate of 18 cents in the dollar would provide a lower degree of support than that currently enjoyed by those (relatively few) recipients of Competitive Grants — who receive a taxable grant at a rate of 50 per cent of project costs. But the approach would also mean providing some support to all tax loss companies who currently do not get a grant — unsuccessful applicants and (eligible) non-applicants.

**The Commission recommends that the Competitive Grants Scheme no longer provide support to firms by virtue of their tax loss status.**

### **Other recommendations for Competitive Grants**

Eligibility criterion 8 mainly caters for projects that were supported under the former National Procurement Development Program (NPDP) and Advanced Manufacturing Technology Development Program (AMTDP), and involve trial and demonstration projects between technology developers and potential customers. Trialing and demonstration are early commercialisation activities.

In its earlier evaluation of the NPDP (IC 1992), the Commission's preferred option was that the NPDP should be terminated. But in recommending options to improve the efficiency and effectiveness of the scheme, the Commission considered that:

... assistance should be by way of a loan (to the government agency — repayable if the project succeeds) or in return for a share in the rights to any intellectual property generated by the project; ... [and] the program should aim to be self funding (in the sense that successes compensate for losses) (1992, p. x).

The Commission reaffirms these conclusions.

**But if it is considered that support should continue to be provided for these activities, the Commission recommends that projects qualifying for Competitive Grants through eligibility criterion 8 should be transferred to the Concessional Loans scheme.**

Eligibility criterion 9 mainly caters for companies that were supported under the former National Teaching Company Scheme (NTCS). The rationale for such projects is to encourage linkages between industry and public sector research institutions, and while this overlaps with ARC programs, it is differentiated by focussing on industry-initiated proposals. The Commission sees merit in continuing support for projects of this kind which promise to enhance the long-term generation of spillovers through human capital mobility.

**The Commission recommends that projects should continue to qualify for Competitive Grants through eligibility criterion 9.**

Collaborative projects between research institutions and commercial partners are also eligible for Competitive Grants under the first of the alternate criteria — applicants must not be able to fully benefit from the R&D tax concession.

However, that allows a variety of collaborative arrangements. Tax loss firms can apply, as can universities and other research bodies such as CSIRO; but these organisations can also apply for grants for projects where they will collaborate with companies who *are* able to fully utilise the tax concession

(Sub. 461, p. 1). While the commercial collaborators provide their own funds for their contribution to the project, they can gain the twin benefits of the government funding of the research carried out by the research partner, as well as eligibility of their own contribution under the 150 per cent R&D tax concession.

Collaborative grants generally have the following features:

- they typically involve pre-competitive, high risk R&D;
- grant payments are made to the research institution partner; and
- in most cases, ownership of the intellectual property is vested in the research partner, and commercial partners do not get exclusive rights to the technology (Sub. 363, p. 35).

In principle, the Commission considers there is a role for a scheme supporting pre-competitive, generic research by companies in association with public sector research organisations. However, as discussed in chapter D4, the Commission notes that many (if not most) projects supported under the former Generic Technology Grants Scheme involved a single commercial partner, and dissemination of research results was never accorded priority under the merit criteria of the scheme.

The Commission considers that if the scheme is to continue, it should incorporate additional eligibility criteria to enhance the pre-competitive, generic R&D intent of the scheme.

**The Commission recommends that competitive grants (at a rate of 50 per cent of eligible project costs) should be retained for projects involving collaboration with research institutions.**

**Eligibility criteria for collaborative projects should require that projects involve *more than one* commercial partner, together with the research institution(s); or if there is only one commercial partner, it should not have exclusive rights to the technology.**

**The annual funding for these collaborative projects should be no more than under the former Generic Technology Grants Scheme.**

#### *'Contamination provisions' of the tax concession*

Currently, for an R&D project funded by a competitive grant, the 'contamination provisions' of the tax concession do not eliminate a future claim to tax deductions on that R&D expenditure, as is appropriate for such a large grant. Currently these provisions only reduce the rate of concessional deduction — usually from 150 per cent to 100 per cent (IR&D Board 1994a, p. 70).

**The Commission recommends that the ‘contamination’ provisions of the tax concession be revised so that companies receiving an automatic or competitive (selective) grant lose an equivalent value of tax deduction.**

## **D7.8 Levy-based research associations?**

### **Rationale for Research Associations**

Individual firms have little incentive to carry out pre-competitive, generic research (relating to industry-wide issues) on their own, because they cannot individually capture enough of the benefits. However, where the number of firms in an industry is small, mechanisms may emerge to facilitate carrying out such research on a collaborative basis, so that those companies that jointly fund the research are able to gain the benefits.

In industries with many firms, there is a greater problem of encouraging cooperative research unless there are mechanisms that ensure that all beneficiaries contribute to the cost. Collective research arrangements that involve levying of industry members already apply in the case of the Rural Research Corporations (see part E of this report).

At the Commission’s conference on economic growth, Professor Paul Romer proposed ‘self-organising industry investment boards’ as a mechanism to facilitate pre-competitive, generic types of R&D. According to Romer, that framework could proceed in the following steps:

You would have legislation [whereby] any potential group can get together and declare themselves a group; they can vote on the proposition that they are required to make mandatory contributions of some kind. ... What they would do with those contributions is allocate them between particular types of entities which I have called industry boards. ... Then what the boards do is provide industry-specific public goods and give these public goods away free (Conference transcript, p. 28).

The industry boards envisaged by Romer have the features described in box D7.2.

**Box D7.2: Romer self-organising industry investment boards**

- a (compulsory) levy system would operate, with companies in an industry contributing (say) a fixed percentage of sales;
- the funds would be used to commission research, carried out by organisations such as universities, government research agencies, etc;
- the research projects would benefit the entire industry, with outcomes freely distributed to all levy contributors;
- there should be more than a single board within an industry, to allow choice for levy contributors as to where they direct their contributions; and
- there should be freedom to create new boards.

*Source:* Romer 1993.

**Recent experience**

As noted in section D2.4, Australia has had a long history of research associations (RAs) in the manufacturing sector. Some of these were established under the former Research Associations Program, which operated for a period of some forty years from 1947 to 1988 (and entailed matching government funding, generally dollar for dollar with funds raised through levies), while others were established from the outset without any government funding but joined the program after its inception. However, only eight RAs participated in the program (see BIE 1986).

Following the removal of government funding in 1988, not all the RAs have persisted with voluntary levy funding — there has been a trend away from levies and funding of generic research to an approach of conducting research on a fee-for-service basis for individual companies.

For example, in 1991 the Sugar Research Institute changed from a cooperative research association, dependent on voluntary levies, to a commercially orientated research and development organisation, funded less from levies and mainly on a fee-for-service basis from sugar millers (Sub. 121, p. 13; Sub. 291). More recently, the Bread Research Institute (BRI) has also been restructured with an end to funding through a levy collected on flour sales. Much of the BRI's focus is now directed to contract research for large bread manufacturers and the Australian Wheat Board (Sub. 452, p. 7).

Australia's best-known example of a cooperative research mechanism is the Australian Mineral Industries Research Association (AMIRA). But AMIRA is not organised along levy funding lines. Rather, collaborative research projects conducted through AMIRA proceed if companies are prepared to fund them,

and the research results are confidential to those companies — firms directly contribute on an individual project basis. This approach ensures that those companies that contribute to funding the research gain the benefits of that research.

As the CEO of AMIRA noted:

We see the major benefit to our members is ... through leverage. We might have 10 to 15 members joining in any one project and clearly if its not something which is confidential and its pre-competitive, ... people are quite happy to share the knowledge amongst the group and the cost is reduced accordingly (transcript, p. 2966).

In respect of the types of collaborative projects conducted through AMIRA:

... [in the mineral industry] the emphasis tends to be more on production work rather than on product. .... The great benefits from R&D come from production research, rather than in producing a new product (transcript, p. 2966).

One country where RAs appear to be relatively important is New Zealand:

An unusual feature of [science and technology] in New Zealand's private sector is the prominence of Research Associations. Each of ten major industries has such an association, and together they account for about a quarter of all private sector R&D. Their purpose is to provide R&D and technology transfer capabilities that individual companies would be unable to afford or that help an entire industry rather than a single competitor (CRS 1994, pp. 67–8).

But of the ten New Zealand RAs which exist, five are primary industry-based — dairy, meat, wool, logging, and coal — and the rest comprise leather and shoes, textiles, cement and concrete, heavy engineering, and construction. Hence, there has not been a widespread emergence of RAs outside of the rural sector.

### **Views of participants**

In the draft report, the Commission expressed the view that research associations of the Romer kind appear an attractive means of potentially increasing useful R&D that is generic but also market driven, and as a complement to other policies that seek to encourage companies individually to carry out R&D. But there appear to be practical problems in creating an institutional framework under which companies can jointly make decisions about research priorities and how the research is to be financed.

The successful organisation of RAs in industries with many firms requires the power to levy members. But if compulsory levies are to be imposed, there needs to be widespread industry support. Hence, legislation enabling the creation of RAs would need to include features such as:

- the degree of support by constituent firms needed to form an RA. In this respect, support of more than a bare majority should probably be required — Romer (1993) suggested support by at least 90 per cent of industry members;
- processes for establishing the rate of levy; and
- the composition of the board.

Problems could also arise in defining industry boundaries, though under the earlier Research Associations Program, industry support for the creation of an RA was in many cases a direct result of links between the RA and an already existing industry association.

In the draft report, the Commission sought participants' view on the merit of the Government introducing legislation to facilitate the establishment of levy-based industry research associations. This met with a mixed response.

The Chamber of Manufactures of NSW considered that the concept of RAs was inappropriate for most areas within manufacturing for a number of reasons.

First, they suggested that the need for generic research to solve industry-wide problems is unlikely to be widespread enough to justify the creation of RAs because companies in most manufacturing industries use research and design to differentiate their products to gain a competitive edge.

'Generic' research 'problems' for which 'generic' solutions can be applied are much more likely to arise in industries which produce 'generic' products using 'generic' processes. Hence the predominantly rural/commodity based coverage of the manufacturing research associations already established in Australia and New Zealand (Sub. 452, p. 6).

Second, difficulties arise in respect of whether levy mechanisms can achieve an equitable matching between what participants contribute to the costs of carrying out the research and what share of the benefits they derive.

It was issues of this nature, ie equitable distribution of competitive advantage arising from cooperative research, which caused the restructure of the Bread Research Institute ... [and] brought an end to whole-of-industry participation and ... to funding through a levy collected on flour sales (Sub. 452, p. 7).

Finally, they suggested that in the majority of manufacturing industries, vertical collaboration between companies (customer/supplier links) appears to be more important than horizontal (intra-industry) cooperation.

These vertical links are formed between firms on the basis of recognised mutual advantage; are often project specific (at least in the first instance); and may involve participation of research organisations. Such vertical links are necessarily concerned with near-to-market research (Sub. 352, p. 7).

The Queensland Government expressed opposition to the introduction of legislation to create RAs:

Collaborative arrangements between firms should be encouraged, but the Government's role must be one of a facilitator, not a legislator, to allow voluntary participation and self-selection by firms (Sub. 442, p. iv).

The Australian Electrical and Electronic Manufacturers' Association (AEEMA) expressed disagreement with the suggestion that the levy on firms to finance research in the RA should be compulsory:

AEEMA does not support legislation directed at enforcing compulsory levies on members of industry research associations. Decisions to join and contribute to research associations should be voluntary (Sub. 460, p. 6).

On the other hand, some participants endorsed the proposal for enabling legislation facilitating establishment of levy-based RAs (for example, Australian Industrial Research Group, Sub. 329) though no guidance was provided on what features that legislation should contain.

**On balance, the Commission considers that in view of the apparently limited interest in, and practical problems associated with, enabling legislation for the creation of research associations with the power to levy, there is no need to augment the current voluntary arrangements for collaborative R&D.**

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**PART E**

**RURAL RESEARCH**

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## **PART E RURAL RESEARCH**

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## **PART E RURAL RESEARCH**

Part E examines the way rural research is organised and funded in Australia.

Chapter E1 attempts to ‘dissect’ the total expenditure on rural research by government spending and by private spending, and describes briefly the various research institutions which undertake rural research, including the States, the universities and CSIRO.

Chapter E2 examines the characteristics of rural industries, to determine whether they are such that worthwhile research will be left undone if governments do not intervene. It also examines the benefits from rural research, noting that they are perceived to be large. It categorises benefits into those justifying government funding and those not justifying government funding.

Chapter E3 examines how the rural research and development corporations (RDCs) operate, including various aspects of the levy system, priority setting, collaboration between the RDCs, and accountability provisions.

Chapter E4 examines the government contribution to RDC research expenditure and makes some recommendations on how the incentives provided by the system can be improved. It also looks at research by small and emerging industries and at how regional research needs are dealt with.

Chapter E5 examines how State government departments of agriculture set priorities and also looks at extension, a role traditionally performed by the States.

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## E1 INSTITUTIONAL FRAMEWORK

Australian governments have a long tradition of being involved in rural research. While the first experimental farm in Victoria, established in 1857 on the outskirts of Melbourne, was originally under the control of a farmers' committee, the Victorian Board of Agriculture took over its management in 1859, and a government laboratory was established in 1873. The other States, too, have a long history of involvement in rural R&D.

From the first year of Federation, the Federal Government, also, showed an interest in the application of science to agriculture, and the Advisory Council on Science and Technology, which later became CSIRO, was established in 1916. Universities also have long been involved in rural research.

While the rural industries' research and development corporations and councils (RDCs) are relatively young in their present form, for some industries levies for funding research have been in existence for more than 30 years.

This chapter describes how rural research is organised in Australia. More detail about some of the rural research arrangements is provided in appendix F.

### E1.1 Overview

Total recorded expenditure on rural research in Australia in 1992–93 was \$698 million, or about 11 per cent of total expenditure on R&D. The bulk of rural research is performed by the Commonwealth Government, the States, and higher education institutions (see figure E1.1).

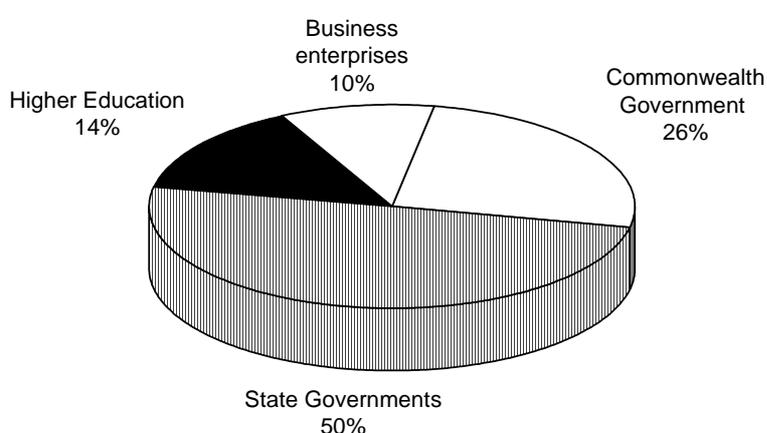
Of the total rural research performed in public institutions in 1992–93, pure basic research formed nearly 3 per cent, strategic basic research 20 per cent, applied research 63 per cent, and experimental development 14 per cent. As expected, pure basic research comprised a higher proportion of higher education research (13 per cent) than of government agency research (less than 1 per cent). Governments performed more applied research (including experimental development) than universities (83 per cent versus 47 per cent).

In 1992–93 rural research performed by business enterprises was around \$71 million, or around 10 per cent of total rural research (see figure E1.1). Levy contributions (and other privately sponsored rural research performed by governments) are not separately recorded but are included in statistics on rural R&D performed by governments and universities. The \$71 million *performed*

by business enterprises therefore understates total private *expenditure* on rural R&D.

Adding levy collections from rural industries in 1992–93 of \$95 million to the \$71 million performed by business enterprises, provides an estimate of private funding of rural research of \$166 million, or 23 per cent of the total. This is considerably more than in 1990–91 when the Commission estimates private funding of rural research to have been about 18 per cent of the total.

Figure E1.1: Performance of rural research, 1992–93



Source: ABS Cat. No. 8112.0.

The overall estimate of 23 per cent of rural research funded privately does not, of course, say anything about individual industries. The Australian Cotton Growers' Research Association said the cotton industry funds 58 per cent of total cotton research. This privately funded cotton research includes \$8.4 million of on-farm research, or nearly four times that contributed through levies.

Several other participants said the Commission, in its draft report, had underestimated private contributions to research. They said there is a considerable amount of experimental development performed on-farm which does not find its way into the official statistics. Farmers also provide land, labour and other facilities to CSIRO and State government departments of agriculture for instance for testing new methods and processes, and trying out new fertiliser and pesticide regimes.

Many participants said that farmers incur considerable costs in this way. For instance the Australian Avocado Growers Federation Inc said:

The nature of most projects requires a significant 'in kind' contribution from growers, processors and marketers. This 'in kind' contribution is a mix of product, farm space, time and practical activity (Sub. 416, p. 3).

The Apple & Pear Growers Association of SA Inc. said:

Every day the orchardist is conducting some form of research/extension. This work may not fit the definitions of pure basic research, applied research, etc. but it should be recognised ... (Sub. 290, p. 6)

All said such contributions to R&D are difficult to estimate. However, the Queensland Fruit & Vegetable Growers provided some information on land used for trials (see box E1.1).

**Box E1.1: Size and duration of on-farm research sites provided by the North Queensland banana industry**

Integrated Pest Management		8 sites x 10 ha for 4 years
Dust residue trial	growers not usually compensated for fruit lost	4 sites x 1 ha for 1 year
Alternatives to dust	growers not usually compensated for fruit lost)	6 sites x 1 ha for 2 years
Beetle borer trial		1 site x 2 ha for 3 years
Mocap trial		2 sites x 1 ha for 1 year
Leaf spot prediction trials		14 ha (3 sites) for 2 years 1 site x 15 ha for 1 year
Nematode trial	alternative nematicide, no fruit harvested	½ ha for 1 year
	population dynamics	¼ ha for 2 years
	trash trial	½ ha for 3 years
Nutrient balance	research site	2 ha for 5 years
	best practice sites	6 x ½ ha for 3 years

In most cases growers modify their farm management to accommodate these trials, and in some cases forego all the fruit because experimental or unregistered chemicals are being used. Input costs to get to harvest (growing costs) estimated at \$9 500 per hectare.

*Source:* Queensland Fruit & Vegetable Growers Sub. 309.

## E1.2 R&D corporations and councils

The RDC arrangements for rural research are seen by some to be the counterpart to the 150 per cent tax concession scheme for industry (Sub. 200), that is, they involve a government contribution to privately allocated R&D funds. However, many participants said that, for a number of reasons, the RDC arrangements do differ from the tax concession scheme, and that this justifies different funding

rates by the Government (see chapter E4). A brief description of how the RDC system operates follows below, with more information provided in appendix F.

Most of the rural RDCs were established under the *Primary Industries and Energy Research and Development Act 1989* (PIERD). The three exceptions, the Meat Research Corporation (Meat RC), the Horticultural Research and Development Corporation (Horticultural RDC), and the recently established Australian Wool Research and Promotion Organisation (AWRPO) were established under their own legislation (see figure E1.2). Although strictly not established to do R&D for the agricultural sector, the Energy RDC and the Land and Water Resources RDC are included in figure E1.2 for completeness.

Funding for most of the commodity-based RDCs is through a statutory levy on output at farmgate, matched by the Commonwealth on a dollar for dollar basis up to 0.5 per cent of GVP. The subsidy is paid as levies are spent.

Levies are generally based on units of production, for instance tonnes of sugar cane, but in a very few cases on the value of production, as for some of the grains. Farmers growing a mix of leviable commodities contribute to the relevant RDC for each of those commodities. The size of the levy is determined each year by the relevant industry. Levy payments are tax deductible at 100 per cent as a normal business expense.

In the past, many industries had statutory marketing arrangements in place, which facilitated levy collection. Currently, a variety of collection mechanisms are in place, selected for ease of administration and efficiency. Some industries rely on a system of trust. For instance, the Cherry Growers of Australia said:

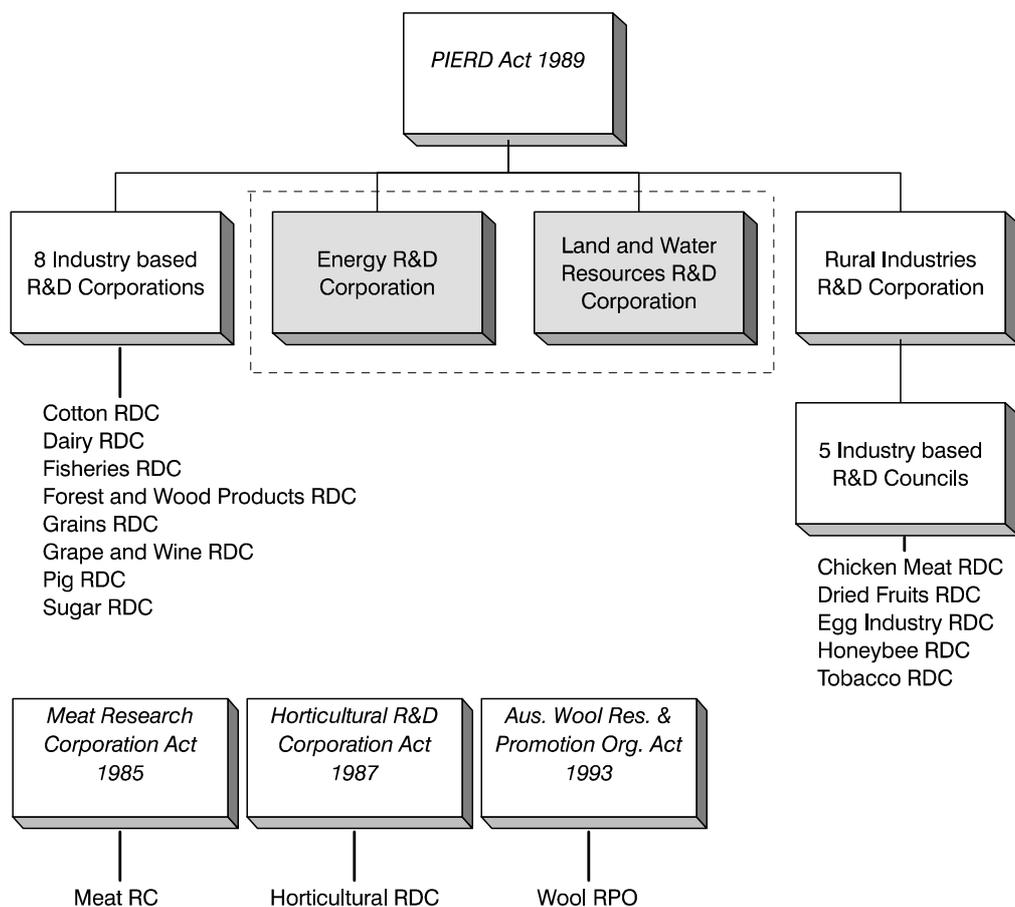
... it's an honour system I suppose. We send out the forms and they fill in the amount, how many kilograms they have, and send us a cheque (DR transcript, p. 3004).

The functions of an RDC as set out in the PIERD Act. Apart from co-ordinating and funding R&D, they include the monitoring and evaluation of that R&D, reporting to the Parliament, the Minister and the relevant industry, and facilitating the dissemination, adoption and commercialisation of the results of the research. Expenditures by the RDCs on those activities are matched by the Commonwealth Government up to a maximum of 0.5 per cent of the gross value of production (GVP).

The Fisheries Research and Development Corporation (Fisheries RDC) receives matched levy receipts up to 0.25 per cent of GVP, but in addition receives an amount equivalent to 0.5 per cent of GVP. The Commonwealth Government makes this contribution to the Fisheries RDC outright, on the grounds that it is the Commonwealth's role to manage the fisheries resource on behalf of its owners, the community (Kerin and Cook 1989).

The Horticultural RDC also has some features not found in the other RDCs. Firstly, its legislation permits government matched funding for voluntary contributions to R&D on behalf of any group of growers, firms, or single entity, in any horticultural industry, where there is no statutory levy in place. Matched funding can be provided for research into regional or local problems, by any organisations or firms no matter where located in the production chain. For instance a firm in the business of transporting horticultural produce will qualify.

Figure E1.2: **Structure of the R&D corporation system**



Secondly, where there *is* a statutory levy in place, groups of growers or firms can get together and apply for additional matching funding for regional benefit R&D. In both these cases, the application will automatically fail if the government contribution is already up to 0.5 per cent of GVP (of the combined horticultural industries). If not, three criteria are applied in accordance with ministerial guidelines:

- the urgency of the problem;
- whether it is a highly regional issue; and/or
- whether the problem is of short term duration.

The most recent addition to the family of RDCs, the Forest and Wood Products RDC, commenced on 1 January 1994. Foreshadowed in the policy statement announcing the formation of the RDCs (Kerin and Cook 1989), the need for negotiations with the relevant industry bodies delayed its establishment. At the time, the Government did not intend to make a direct contribution to this RDC because:

... the structure of the forestry and forest products industry is not as fragmented as for some agricultural industries and there is less justification for arguing that the benefits accruing from the research will be difficult to internalise to the researcher (Kerin and Cook 1989, p. 63).

In the event, the Government decided to contribute \$1 for every \$2 raised by the industry, up to a maximum of 0.25 per cent of GDP. According to the second reading speech:

The reason for the Commonwealth contribution being set at \$1 for \$2 and not dollar for dollar, as is the case with other primary industries, is given as being because only half the industry has a primary industry focus — in particular, of course, that refers to tree production and to small rural sawmills — while the other half has an essentially manufacturing basis (Commonwealth of Australia 1993b, p. 2566).

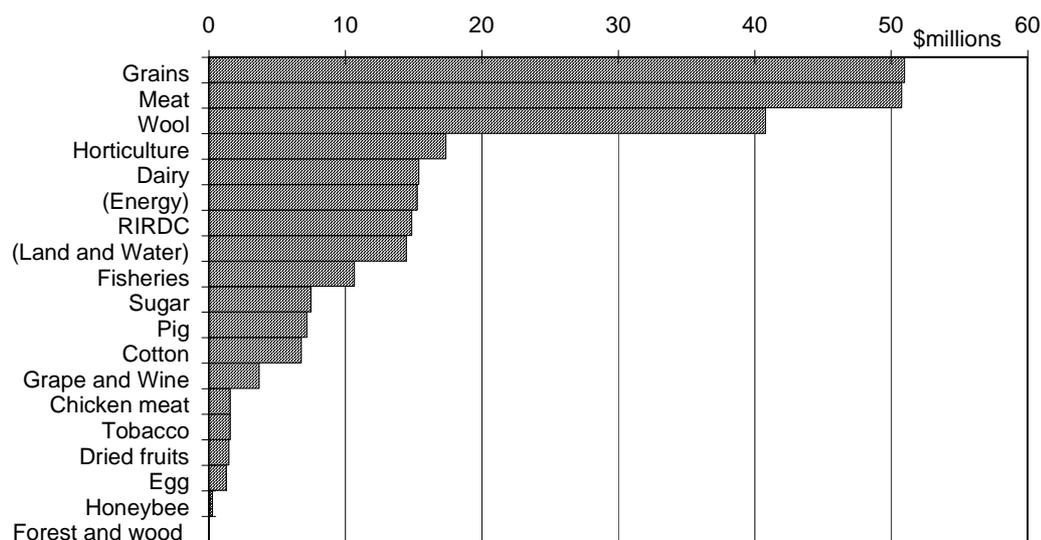
The Rural Industries RDC was established to look after the needs of the smaller, and emerging rural industries, as well as to take up the more generic research areas, which might otherwise be neglected. It is funded by Parliamentary appropriation. This is apart from the R&D councils which come under its umbrella and which are funded by levies matched by the government in the same way as the commodity-based corporations.

The Land and Water Resources RDC was formed in 1990 by bringing together the funding from the National Water Research Fund and the research component of the National Soil Conservation Program. It is wholly funded from Parliamentary appropriations and receives a little over \$10 million annually.

Total expenditure for all RDCs is estimated at \$262 million in 1993–94 (Sub. 181), with around 60 per cent contributed by the Commonwealth Government. Excluding the Energy RDC (estimated expenditure \$15.3 million) and the Land and Water Resources RDC (estimated expenditure \$14.5 million) reduces the total to about \$232 million, with about 53 per cent contributed by the Commonwealth. The four largest RDCs account for 69 per cent of that amount. Estimated 1993–94 expenditure for individual RDCs is shown in figure E1.3.

The RDCs do not perform R&D themselves but allocate funds to various research providers (see figure E1.4). As shown, around 84 per cent of RDC-funded research is performed within the public sector.

**Figure E1.3: R&D corporations and councils — estimated expenditure, 1993–94 (\$million)**



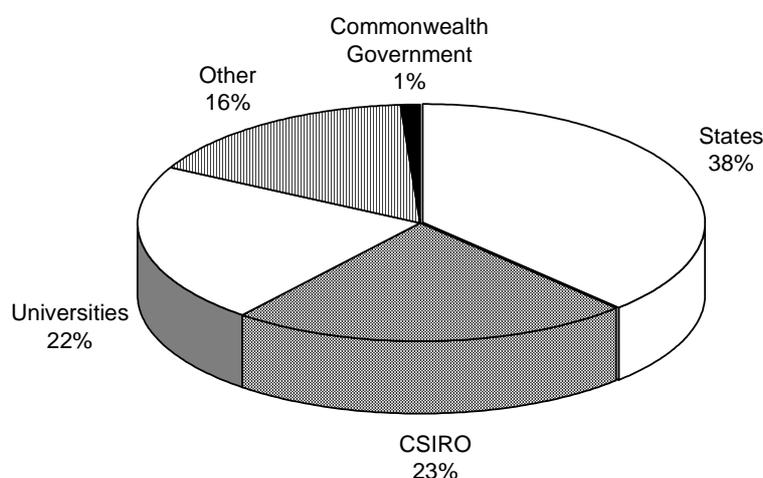
Source: DPIE, Sub. 181.

The legislation requires the RDCs to prepare five-year plans and annual operating plans, in consultation with their ‘representative organisation’ which is appointed by the government. Generally the representative organisation is the peak industry body, but in some cases there are more than one. Most of the corporations are involved in funding all aspects of innovation, including basic, strategic, and applied research, market research, extension and technology transfer, commercialisation, and education and training.

### E1.3 State governments

State departmental involvement in agricultural research commenced in colonial days, and continued after Federation, when land management remained a State responsibility. State rural R&D was, and is, performed not only for the advancement of agriculture in the State concerned, but also to assist in the development of land use and land management policies, and regulation.

Figure E1.4: Allocation of RDC expenditure, 1994–95



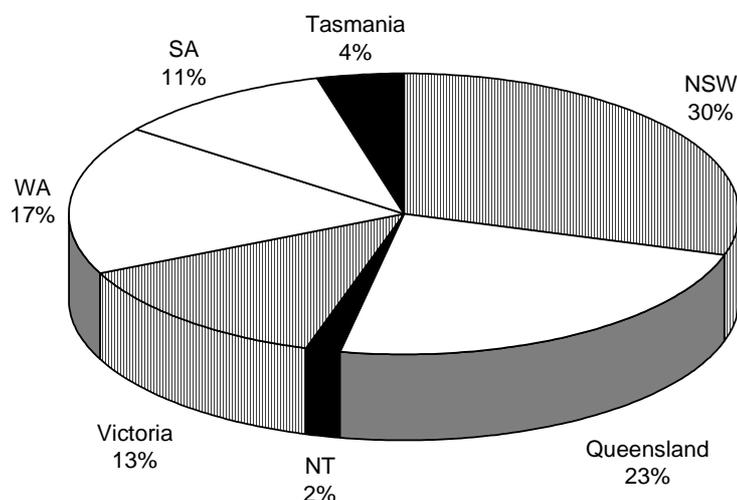
Source: Ralph 1994.

As shown in figure E1.1, about half of all recorded Australian rural research (\$346 million in 1992–93) is performed by State governments. This represented 56 per cent of all research performed by State governments. Since data for 1992–93 by individual States are not yet available from official sources, the proportion performed by each State, as shown in figure E1.5, refers to 1990–91.

Research activities given priority differ between the States, with priority being given to State-wide and regional problems. For instance, while Victoria gives high priority to research to solve salinity and waterlogging problems, more than a third of Western Australia's expenditure on rural research is on grains related issues. In New South Wales the meat, dairy and intensive livestock industries are the beneficiaries of nearly one fifth of total expenditure, closely followed by agricultural resource management and horticulture.

The amount of research *performed* by each State is not necessarily the same as the amount *spent*. While the bulk of the funds comes through State governments, some comes direct from the Commonwealth, for instance for special programs or for research performed on contract. State government rural R&D facilities also carry out a considerable amount of research on contract to other agencies and the RDCs. The relevant data are not available from official statistical sources but some of the States provided information. This is given in the sections on individual States. As shown in figure E1.4, the States combined are expected to perform about 38 per cent of the RDCs' research in expenditure terms in 1994–95. In 1993–94 this amounted to close to \$100 million.

Figure E1.5: **State government performance of rural research, 1990–91<sup>a</sup>**



<sup>a</sup> Rural research by the ACT is not shown; it represents around 0.1 per cent of total rural research in Australia.  
 Source: DIST 1994a.

### **New South Wales**

The amount of rural research performed by New South Wales Agriculture in 1993–94 was \$118 million. This included funding from external sources of about \$26.7. About 95 per cent of agency expenditure in New South Wales is on applied research (Sub. 264).

New South Wales Agriculture is a core participant in the CRC for Viticulture and the CRC for Cattle and Beef Industry (Meat Quality). NSW Fisheries is a core participant in the CRC for Aquaculture.

### **Victoria**

The Victorian Department of Agriculture performed rural research worth \$52 million in 1991–92, of which \$11 million was provided by the Commonwealth Government and around \$8 million was otherwise externally funded (Sub. 241). However, since a large proportion of the external funding came from the RDCs, the proportion of government funded R&D performed by the Department is larger than at first it seems.

The Department has some 600 scientists, and performs research at a number of locations within the State. For instance, the Victorian Department of Agriculture has a major food processing research institute at Werribee. It also administers the State Chemistry Laboratory, which carries out a mix of analytical and research work. The Department is a core participant in the CRC for Viticulture.

Research into salinity and waterlogging has high priority in Victoria. As much of this research is seen as the responsibility of the Department of Conservation and Natural Resources, the amount of rural research performed by the Victorian Government may be understated.

### **Queensland**

The Queensland Department of Primary Industries estimates performing rural research in 1992–93 of \$100 million, including some \$22 million of external funding (Sub. 253). However, this is likely to underestimate the Queensland Government's performance of rural related research. For instance, the Queensland Department of Lands carries out research into such problems as pest plant and animal control.

The Queensland Department of Primary Industries maintains 14 research centres, 38 research stations and 10 laboratories in various locations throughout Queensland. An additional four facilities are given the status of 'research institutes' and operate relatively independently. The Department is a core participant in four rural based CRCs.

### **Western Australia**

The Department of Agriculture of Western Australia (DAWA) has no dedicated research agency within the Department and research is carried out in parallel with other functions, such as policy development, extension services, regulation and conservation. R&D is not a separately identifiable activity for statistical purposes. However, in a paper prepared for the Western Australian Department of Commerce and Trade, Marinova estimates that DAWA's R&D budget for 1993–94 amounted to about \$53 million of which 76 per cent was State funded and 24 per cent externally funded. Agricultural research comprises more than 60 per cent of total WA State research expenditure.

Nearly 37 per cent of the total expenditure was on grains related research, making the grains sector by far the largest recipient of research funds.

The Western Australian Government's funding for the Department of Agriculture has decreased by 23 per cent in real terms between 1989–90 and

1992–93 (Sub. 192). While offset to some extent by an increase in external funding of about 20 per cent, this increase had been from a small base, resulting in a net decline in funding.

DAWA is a core participant in the CRC for Legumes in Mediterranean Agriculture and the CRC for Premium Quality Wool.

### **South Australia**

Total agricultural research performed by the South Australian Government was \$26.8 million. Of this total, the South Australian Government provided \$18 million, and funding from other sources including the RDCs was \$8.8 million (Sub. 289).

Agricultural research by the South Australian Government is undertaken through the South Australian Research and Development Institute (SARDI), established in 1993, primarily from the research resources of the former Departments of Agriculture and Fisheries (see also chapter E5).

The Department of Agriculture and SARDI are core participants in the CRC for Viticulture and the CRC for Aquaculture respectively.

### **Tasmania**

In 1993–94 the Tasmanian Department of Primary Industry & Fisheries performed research worth nearly \$9.6 million. This included \$4.3 million agricultural industry based R&D, \$2.3 million fisheries R&D and nearly 2.9 million land and water resource protection R&D.

Overall, 39 per cent was externally funded. Of the agricultural industry based R&D 36 per cent was externally funded; of the fisheries R&D 31 per cent was externally funded, and of the land and water resources protection R&D 50 per cent was externally funded.

The Department of Agricultural Science of the University of Tasmania spent a little over \$1 on agricultural industry based R&D (Sub. 277, attachment 2).

The Tasmanian Government is currently in the process of consolidating the State's agricultural research effort through the establishment of the Tasmanian Institute of Agricultural Research (see also chapter E5).

The Tasmanian Department of Primary Industry and Fisheries is a core participant in the CRC for Aquaculture.

## E1.4 CSIRO

When CSIRO was first established, a high proportion of its research expenditure was devoted to rural research. The Commission understands that this proportion has declined over time. However, changes in classification methods over the years make it difficult to verify this.

Recently there has also been rationalisation of agricultural research sites. This, together with the decision to move CSIRO's West Ryde establishment to Geelong, has given rise to concerns amongst rural groups and agricultural researchers, leading to the Senate Committee inquiry into the funding of rural research by CSIRO.

For that inquiry, CSIRO provided an analysis of its rural research. Table E1.1 reproduces this information. It shows a reduction in the proportion of CSIRO's expenditure on rural research of about two percentage points between 1990–91 and 1993–94. However, rural research still appears to represent roughly half of CSIRO's expenditure.

Table E1.1: Rural research by CSIRO<sup>a</sup> (\$million)

Category	1990–91		1993–94	
	Total all sources	Appropriation	Sponsored	Total all sources
Inputs to farm	12.56	11.99	5.08	17.07
On-farm production	200.92	158.71	61.85	220.56
Post-farm processing	62.24	38.77	26.20	64.96
Other rural related	45.40	34.50	13.81	48.31
Total rural	321.13	243.97	106.94	350.90
CSIRO total	621.43	498.27	206.43	704.70
Rural as % of total	51.7%	50.0%	51.8%	49.8%

a As provided by CSIRO to the Senate Economics References Committee Inquiry.

Note: Totals may not add due to rounding

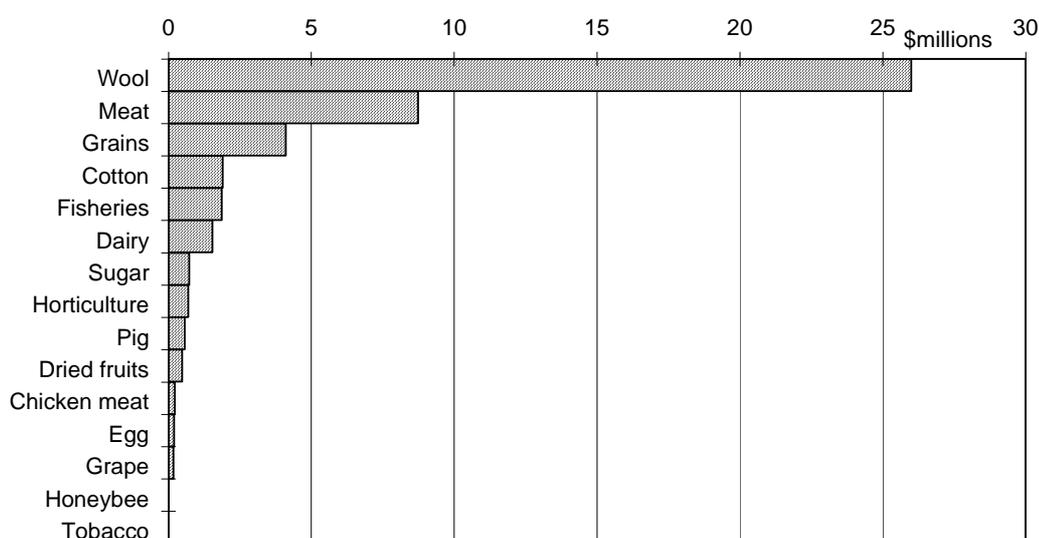
Source: Senate Inquiry transcript, pp. 940–1.

About half of CSIRO's sponsored rural research comes from the RDCs. The Cattle Council of Australia said:

CSIRO is an extremely valuable resource to Australian agriculture. The fundamental scientific research undertaken by this body has led to a host of new technologies and helped to lift the performance of the beef industry (Sub. 183, p. 6).

While CSIRO performs nearly a quarter of the RDCs' research (see figure E1.4), there is a great deal of variation between RDCs in the amount of research allocated to CSIRO, as shown in figure E1.6. Some of this may be historical in origin, for instance CSIRO has long specialised in wool research and has invested significant resources in wool research infrastructure. In 1992–93 it performed 60 per cent of the research funded by the Wool RDC. The Meat RC allocated 20 per cent of its 1992–93 research expenditure to CSIRO.

**Figure E1.6: RDC allocations to CSIRO, 1992–93**



*Source:* RDC Annual Reports and Research Reports

## E1.5 Universities

Expenditure by universities on agricultural sciences research in 1992–93 was a little over \$97 million. The bulk of the agricultural sciences research was funded by the Commonwealth Government (90 per cent). State and local governments funded around 3.5 per cent, business enterprises around 2.5 per cent. A little over 3 per cent came from private non-profit and other Australian sources, and nearly 0.5 per cent came from overseas (ABS, Cat. No. 8111.0).

## E1.6 Cooperative Research Centres

At the end of 1994 there were fifteen agricultural or rural based manufacturing cooperative research centres (CRCs) (see appendix F for a listing). All rank CSIRO amongst their core participants. Most of them also list one or more State

Government departments as members. Four list an RDC amongst their core participants: the CRC for Sustainable Cotton Production (Cotton RDC), the CRC for Sustainable Sugar Production (Sugar RDC), the CRC for Quality Wheat Products and Processes (Grains RDC) and the CRC for Weed Management Systems (Grains RDC). However, a number of the other RDCs participate in CRC programs.

Total resources committed to agriculture and rural based CRCs over the initial period of the CRC program are around \$728 million, around 27 per cent of the total. The funds are to be provided over several years, and include \$206 million from the Commonwealth Government CRC Program, about \$96 million from industry participants, and about \$426 million from other organisations, such as CSIRO, universities and the States.

### **E1.7 Australian Bureau of Agricultural and Resource Economics**

The Australian Bureau of Agricultural and Resource Economics (ABARE) is one of three research bureaus maintained by DPIE. The other two, the Australian Geological Survey Organisation and the Bureau of Resource Sciences (BRS) do not strictly perform rural research, although the BRS has some connection with primary industries through its role in supporting sustainable development of Australia's natural resources.

ABARE is a professionally independent research organisation established in 1987 by merging the former Bureau of Agricultural Economics and the Bureau of Resource Economics. Its purpose is to:

... provide economic data and analyses to aid decision makers, in both the public and private sectors, concerned with Australia's agriculture, minerals, energy, forestry and fishing industries (Sub. 196, p. 4).

ABARE's budget in 1992–93 was more than \$15 million. It is required to achieve a reduction of 30 per cent of its 1992–93 budget appropriation by 1995–96, by either generating external earnings or by savings (Sub. 181).

### **E1.8 International comparison**

Little reliable evidence is available about agricultural research undertaken overseas. And, even where data are available, comparisons need to be treated with caution, as like is not always compared with like.

Alston, Chalfant and Pardey (1993) calculated research intensities for public sector agricultural R&D expenditure for the OECD countries, research intensity

being defined in their paper as nominal agricultural research expenditure as a percentage of the corresponding nominal agricultural GDP. Unfortunately, their most recent estimates are for 1985.

Alston et al. found that in 1985 Australia's level of public sector research intensity in agricultural research was the second highest out of the OECD countries, with 5.04 per cent<sup>1</sup>, after Canada with 5.31 per cent. The next highest after Australia was the United Kingdom with 3.77 per cent. The United States was ninth, with 2.24 per cent.

Alston et al. said that some segments of agricultural research in some countries are becoming dominated by private R&D. Therefore:

... the differences in total research intensities are probably greater than the differences in public-sector research intensities among countries. In addition, the sources of funds for research investments and the nature of the research being undertaken are not known (Alston et al, 1993, p. 12).

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<sup>1</sup> Using Australian data, public sector agricultural research intensity in 1992-93 was 4.6 per cent.

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## **E2 WHY SUPPORT RURAL RESEARCH?**

Nearly all participants commenting on rural R&D said that underinvestment in research is more of a problem in agriculture than in other sectors of the economy. The two reasons put forward for this relate to the nature of rural industries and to the nature and size of the benefits generated by rural research. A common thread in both is the inability of those who fund the research to appropriate most of the benefits.

This chapter analyses the characteristics of agricultural industries and examines the benefits which accrue from rural research. Subsequent chapters draw on the conclusions arrived at in this chapter to determine whether the current arrangements for subsidising rural research by industry are appropriate.

### **E2.1 The nature of rural industries**

Participants suggested that industries in the rural sector differ from industries in other sectors of the economy, in the sense that structure and other characteristics are more likely to lead to underinvestment in rural research. At the same time, it is the structure of agricultural industries which makes it possible for collective industry arrangements to operate successfully.

#### **Many small enterprises**

The rural sector of the economy is characterised by many small, family-owned enterprises. The National Farmers Federation (NFF) said:

Australian agriculture comprises 124 000 farms that are typically family owned and operated enterprises, and which are individually small in relation to the whole farm sector (Sub. 203, p. 11).

The CIE, in a paper prepared for the Rural Industries RDC, said:

In some industries ... the structure of firms and the nature of the production process is not amenable to large size firms. In agriculture, for example, while there are some corporate farms, the small family farm seems to be a reasonably robust economic unit (Sub. 124, p. 21).

Many participants said that farmers undertake considerable on-farm experimentation and provide in-kind resources to research providers. However, this is generally not the kind of research involving specialised scientific knowledge and equipment, and likely to be small-scale. Some participants

suggested that many farms are so small that they are not likely to have the financial capacity to engage individually in such R&D. The NFF said:

...small farming enterprises typically lack the resources ... to undertake their own research (Sub. 203, p.11).

About the dairy industry, the United Dairyfarmers of Victoria said:

Dairy farmers are predominantly owner operators and individually do not have the resources, expertise or financial capacity to undertake research ... (Sub. 216, p.1).

The Pork Council of Australia said:

The majority of Australia's 4,750 pig farms are relatively small businesses who lack the capacity and usually the incentive to undertake significant R&D. Eight-six per cent of Australian pig farms have less than 100 sows and are mostly owner-operated (Sub. 375, p. 4).

The available statistics appear to confirm these claims: more than 25 per cent of farms in the broadacre industries<sup>1</sup> in Australia in 1992–93 had a negative cash income (defined as the difference between total cash receipts and total cash costs), and 50 per cent had a cash income of less than \$18 300. Only 12.5 per cent had a cash income of more than \$102 800. The dairy industry fared a little better: while 12.5 per of farms had cash incomes of less than \$11 800, 50 per cent had cash incomes exceeding \$44 100 (ABARE 1993b).

Apart from lacking the resources to invest in R&D, there is also a view that farms are not large enough to capture a significant proportion of the gains from investment in R&D. According to the CIE:

Fragmented industries face the problem that individual firms do not have the scale to capture the gains from a lot of risky, costly and long term R&D ... there [is] a strong possibility of worthwhile research going unfunded (Sub. 124, p. 47).

Participants said fragmentation was an impediment to research and industry development, particularly in the horticultural industries, and that the RDCs and the statutory levies had the ability to unite industries. The Riverland Horticultural Council said such unity was necessary for its export drive to succeed (DR transcript, p. 2230). The Horticultural RDC said the horticultural industries used to operate in an environment of mistrust, but that it had been able to some extent overcome that mistrust and introduce a national focus into the industries' thinking (DR transcript, pp 2650–1).

There are other characteristics possessed by agricultural industries, perhaps more typical than firm size, which lend themselves to collective research and

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<sup>1</sup> Comprising the wheat and other crops, mixed livestock and crops, sheep, beef, and sheep-beef industries.

which suggest a convenient mechanism for funding it. These lie in the nature of farm processes and products.

### **Similar production processes**

Within agricultural industries similar inputs are used to produce similar outputs. This leads to a certain commonality of problems. While problems encountered by farmers can be confined to specific regions, for instance soil erosion, soil acidification and salinity, those farmers in regions not (yet) affected by such problems can also benefit from research into those matters.

Furthermore, farm production processes are very ‘visible’ and thus easy to observe. Often they are also easy to copy. Therefore, if an individual farmer developed an improved production process, the initial advantage might be short lived. This reduces the incentive of individual farmers to invest in innovation. However, it increases the incentive to collaborate.

Even between agricultural industries there are common inputs and processes, with all farm production based on the same basic resource, ‘the land’. Soil characteristics may differ between areas, and soil fertility requirements may differ for different crops and for grazing, but increasing collaboration between RDCs is evidence that even different agricultural industries have common problems.

### **Relatively homogeneous products**

While there is some scope for differentiation, farm output is relatively homogeneous, at least within many agricultural industries. This lends itself to collective funding of research. The fact that farm output is not sold direct to consumers but is marketed through intermediaries, also facilitates the collection of funds, and reduces the resources required for ensuring compliance.

### **Dependence on input suppliers**

Agricultural industries produce few of their own inputs and are therefore to a significant extent dependent on innovation in the sectors providing those inputs. The CIE, in their paper prepared for the Rural Industries RDC, stressed the importance of access by agricultural industries to the best equipment and inputs. It said:

Unresponsive suppliers of machinery and inputs will constrain advances (Sub. 124, p. 17).

It is argued by some that where these industries do not undertake sufficient research, the agricultural sector (through the RDCs) is filling the gap, with consequent benefits for those industries.

The issue of benefits to upstream — and downstream — activities will be returned to later in this chapter.

## E2.2 The benefits from rural research

The Commission examined a range of studies carried out in Australia and overseas, which typically find that the returns to society from investment in rural R&D are high. Box E2.1 shows a sample of Australian studies (with more listed in appendix QA). Estimates of rates of return of more than 50 per cent are not unusual, some exceeding 300 per cent.

### Box E2.1: Estimates of the rate of return for selected Australian agricultural R&D projects

<i>Study</i>	<i>Product field</i>	<i>No. of projects</i>	<i>Return %</i>
Gross et al. (1990) <sup>a</sup>	Pasture & onion sectors	2	17-260
Grains RDC (1992) <sup>b</sup>	Grains sector	21	30-2970
IAC (1975) <sup>a</sup>	Animal health	1	50
IAC–CSIRO (1980) <sup>c</sup>	Entomology	13	23
Meat RC (1991) <sup>c</sup>	Meat & livestock sector	6	138
Mullen & Cox (1994a)	Broadacre		50-328
Mullen & Cox (1994a)	Broadacre		85-562
Parham & Stoeckel (1988) <sup>a</sup>	Control of sheep blowfly	1	6

a Ex ante project evaluation.

b A combination of ex post and ex ante project evaluation.

c Ex post project evaluation.

*Source:* Commission calculations based on the above studies.

Participants in the inquiry also provided — mainly qualitative, but some quantitative — evidence of the benefits from rural research. They provided examples of benefits not only to farmers themselves, but also to upstream and downstream activities, to different agricultural industries, to unrelated industries, and to consumers. The high returns confirm participants' observations — but they are claiming that this justifies more government investment in agricultural research.

High returns can be a rationale for greater investment in rural research, but this does not necessarily imply that government assistance should be increased. For instance, a recent empirical analysis of the relationship between productivity growth in Australian broadacre agriculture and expenditure on research found that there is little evidence of under- or over-investment by government in agricultural research (and extension) in Australia (Mullen and Cox 1994d). If the high returns are such that industry can capture them, it is industry which should look to increasing its investment in research. In a more recent paper Mullen said:

... the existence of high rates of return to an industry from research is not a sufficient condition for further government funding of research ... Rather, it indicates that the industry should consider how best to increase its involvement in research, perhaps by increasing its R&D levy (Mullen, 1995, p. 11).

In 1976 the private sector contributed approximately 7 per cent of total rural research recorded in Australia. The available evidence suggests it contributes about 23 per cent today. However, despite evidence of high returns, there still appears to be reluctance on the part of some rural industries to contribute to research.

One reason why agricultural industries may find it difficult to devote more resources to research was discussed in the previous section, and is related to the nature and structure of the industries. This problem can be addressed by farmers imposing a levy on their output, and collectively funding research.

In fact, in spite of a degree of reluctance, more and more agricultural industries are becoming aware of the potential benefits of funding research in this way. And while some of the older agricultural industries still have a way to go to bring their levy payments up to the current government funding ceiling of 0.5 per cent of GVP, some of the smaller and newer agricultural industries are starting off well over that limit.

Another reason for possible underinvestment in rural research is that it is difficult for farmers to appropriate all the benefits from the research they fund. This problem is, of course, not unique to research by farmers, and forms the main rationale for government funding of research in general, as discussed in part A.

However, many participants argued that lack of appropriability was more of a problem for those undertaking rural research. They said the ratio of social to private benefits from rural research is so large, relative to that from manufacturing research, that rural research deserved a proportionately higher rate of government support than manufacturing firms.

While the proportions in which they occur vary significantly with the category of research (basic, strategic or applied), there are, in effect, three kinds of benefits which derive from rural R&D, as they do from most research. They are:

- the benefits to the farmer, generally in the form of productivity increases, and which result in reduced unit production costs, but sometimes in higher prices for better quality;
- the kind of benefits commonly known as externalities, or spillovers, and which are generally in the form of new knowledge, which can be used in turn by other farmers or industries to produce cheaper or better products, or by the community in general to improve quality of life.
- benefits which are passed on to others through cheaper or higher quality food products, sometimes known as ‘pecuniary’ spillovers; and

Participants listed a range of other, more indirect benefits in addition to the above. These included a reliable food supply, improvements in the balance of payments, and the maintenance of viable rural communities (see box E2.2).

However, the rationale for government funding of rural (or any other) research is not that spillovers or other benefits exist or are particularly large, but that socially worthwhile research may not be undertaken without it. Where the expected private returns to research are insufficient for farmers to undertake the research, but the magnitude of the expected social returns makes the research desirable, government support is justified.

At first sight this implies that governments have no need to support those research projects which are expected to generate sufficient private returns to go ahead anyway. Any social returns in addition to the private returns are a bonus. As the BIE put it:

... the government is not concerned about the projects that the private sector would have undertaken anyway. This is despite the fact that such projects also generate spillover returns to other firms and consumers. If the market system operates in such a way that innovators bestow spillover benefits on the rest of the community, then so be it. Public subsidies for R&D are not designed in any sense to ‘properly compensate’ innovators for benefits accruing to the rest of the community. It is only where market decisions have failed, by rejecting socially valuable projects, that a subsidy may be warranted (BIE 1994b, p. 14).

To apply such an approach, the government would have to make a judgment about the amount and type of research any firm, or industry, would be willing to undertake, and then subsidise research up to the point where even the social returns would no longer be sufficient to make research worthwhile. This is clearly very difficult to do.

In practice, therefore, when governments subsidise industry research, they also subsidise research which would have been undertaken anyway. However, the expectation is that it will induce additional research, and, as a result, generate more worthwhile spillovers than would otherwise have occurred.

**Box E2.2: Some participants' comments on wider benefits from rural research**

... lower input costs [are] likely to be reflected in prices to consumers in a competitive market, and a more competitive industry is more likely to develop export markets (Riverland Horticultural Council Inc, Sub 271, p.3).

... research designed to increase financial returns to individual farms also helps maintain viable rural towns and regional infrastructure ... (Australian Institute of Agricultural Science, Sub. 282, p. 3).

Obvious benefits to the Australian community which cannot be compensated to industry through the marketplace include an improved environment, better environmental amenity in rural areas, a more wholesome product and increased information in general. [These] are in addition to those resulting from the expenditure of industry money in the economy and the operation of the multiplier (Australian Banana Growers Council, Sub. 288, p. 5).

Rural research keeps Australia competitive in the international market. ... The public community benefits substantially through improved resource and environmental management, better quality food, fibre and wide community benefits from basic research, as well as through a strong farm sector (Australian Cotton Foundation Ltd. Sub. 295, p. 2).

... much of the reproductive technology now used in human medicine was developed as a result of technological advances in domestic livestock reproduction. Similarly, technological advances that have been made in the treatment of effluent from wool scours have been widely used in the general treatment of industrial and domestic waste-water ... spillovers that occur along the processing and marketing pipeline where the price rewards for R&D advances are only partially trapped by the production sector that funded the research (NSW Farmers' Association, Sub. 315, pp. 9–10).

... benefits to the community in general ... can be summarised as increased export earnings, reduced Australian dollar expenditure on imports, avoidance of regional and social dislocations, [and] security of food supply to the Australian public (Australian Vegetable & Potato Growers Federation, Sub. 323, pp 5–6)).

Benefits [not included in project analyses] include reduced residue levels, reduced exposure of producers to chemicals, reduced pesticide drift, reduced pesticide resistance, and reduced disruption of biological control. Many of these benefits accrue to the community, with reduced conflict between rural and urban neighbours as an added benefit (Australian Macadamia Society, Sub. 326, p. 3).

Reduced costs to Government of rural adjustment and welfare expenditure (Western Australian Department of Agriculture, Sub. 456, p. 2).

Another consideration in the decision to subsidize industry research is the cost of raising the funds. To make a subsidy worthwhile, the research induced by it

should earn a sufficiently high return to cover the cost of raising the funds. It will also need to generate benefits sufficient to cover costs associated with administration of subsidy schemes and any costs of compliance on the part of the recipients.

The following sections examine in more depth the characteristics of the different types of benefits which flow from rural research, how they are distributed and whether they constitute grounds for government support.

### **Benefits to farmers**

The benefits to farmers from research arise mainly from productivity improvements. Those farmers first taking up a new technology or process are likely to gain the greatest benefits since, as 'first movers', they will not be under competitive pressure to lower their prices. But, as more farmers take up the new technology or process, competitive pressures and increased supplies are likely to result in lower prices, bringing profits back to 'normal' levels.

How long this process will take depends on the nature of the competition experienced in the market. The fiercer the competition, the faster the initial advantage will be eroded, but also the more necessary the research to remain competitive.

Farmers compete in different markets. For those products competing in the domestic market prices are likely to be relatively responsive to changes in supply and the initial advantage gained from greater productivity is likely to be of relatively short duration. Prices in overseas markets are generally less responsive to changes in supply and the initial advantage may be held for longer (however, once the new technology is adopted overseas, world prices will fall).

Ultimately the benefit from research to farmers is being able to continue in the business of farming. However, this is not unique to farming. In all industries competition forces firms to become more productive, or to develop new products if they are to maintain profitability over time. Rather than the market failing it is the market at work.

Some participants from rural industries said that because they are 'price takers' they cannot appropriate the benefits from research. For instance the Australian Dairy Industry Council said:

... we tend to take prices, so farmers and manufacturers have a very limited ability to seize [the] benefits in terms of price returns (DR transcript, p. 2898).

Some participants said that because the price of fruit and vegetables had not increased for more than 10 years, and in some cases even had fallen, they had been unable to pass on the cost of the research. The Flower Industry Association

said the Commission was incorrect in asserting that the cost of research is incorporated in the price of the product because:

Prices in the flower industry are universally determined by supply and demand: in this industry, concepts such as 'cost plus' are irrelevant (Sub. 377, p. 8).

Some participants said that, as a result of research, there could be an increase in supply, leading to a fall in price so large that producers would be worse off rather than better off. For instance the Horticultural RDC provided a hypothetical example of a situation in which the control of a pathogen resulted in a production increase of 10 per cent, and a fall in price of 10 per cent:

The position of growers has worsened. ... [Growers] have the same revenues as before but must pay for the cost of the research and for the packing, packaging, distribution and marketing costs of extra production. The industry may have been better off not to control the pathogen (Sub. 317, p. 9).

It is true that price takers cannot affect the price they receive for their product, and so cannot charge a higher price to incorporate the cost of the research. But, where a fall in price occurs, that fall will be governed by the extent of the cost reduction created by the research. So long as all growers obtain the benefits of the cost-reducing research, the fall in the price would be unlikely to exceed the net cost reduction.

As to the costs of packing, packaging, distribution and marketing, those are costs that again are faced by all growers and would normally be added to market prices. Growers will not be worse off in this situation because prices would change in response to cost changes and not independently of them.

ABARE raised the issue of the time scale of research. It said that while research is often carried out and applied over decades, farmers produce a range of products, and frequently change their product mix in response to changes in relative prices and other factors. This means they may not be able to reap the benefits from research funded in the past:

From year to year, a farmer may contribute to different research programs and stand to gain from others. For any individual farmer ... there is no guarantee that the research effort will be directed to solve problems of particular relevance to that farmer's operations. Nor is it clear that a farmer leaving the industry or sector will receive any market compensation for contributions to research funding in the same sense that a firm can sell the licences, patents and ongoing research programs (Sub. 382, pp. 15–6).

## **Spillovers**

The spillover benefits from rural research come mainly in the form of knowledge which can be used by others to develop processes or products more

cheaply than would have been possible if they had had to undertake the research themselves. The BIE describes them as:

... value that is passed on to other parties who are *not* in a market relationship with the innovating firm (BIE 1994b, p. 7).

Umali says they occur:

When the actions of one person affect the environment of another other than by affecting prices (Umali 1992, p. 12).

The existence of these kinds of spillover benefits from research are the major rationale for government involvement (see also part A).

In the case of industrial research, patent and copyright laws can provide some measure of protection for the funder of the research, but some participants have argued that in agricultural research the ability to make use of patent protection is limited. For example, even under the revised plant breeders rights legislation, growers are permitted to retain seed. The Western Australian Department of Agriculture said:

Under our plant varieties rights legislation, ... farmers have the right to retain seed, they don't have to go and buy seed from the producer every year. So there is no attraction to a private plant breeder because they can only capture a benefit once — in the year the plant is released. From then on it's self-perpetuating in the industry. With a hybrid plant, where you have to go back for the seed every year, then the private company has a market. So we do see the private sector in the hybrid seed industry but not in areas where they're self-producing (transcript, p. 47).

The Grains Council of Australia also said,

At the moment farmers' rights [to retain seeds] tend to be a bit of a disincentive, although correcting wouldn't do anything, wouldn't serve any purpose, it would be impossible to police (transcript, p. 1326).

It is also the case that where the funder of the research and the person or persons undertaking the research are not the same, as is almost always true in rural research, the persons undertaking the research can use their new knowledge in undertaking further research, either for their own benefit, or for others.

There is little empirical evidence of the magnitude of the spillovers from rural research. This is despite the many studies on returns to rural R&D. The Horticultural RDC said that an as yet uncompleted study commissioned by it has estimated the levels of spillovers from approximately 450 projects currently supported at 47 per cent. Benefits to individual groups are as listed in box E2.3. Since the study is not yet available, the Commission cannot verify that all the benefits listed as spillovers are true spillovers and not pecuniary spillovers in some cases. Furthermore, the apportionment of the benefits does not say

anything about whether the total returns from the projects examined were high enough for them to go ahead.

**Box E2.3: Estimate of distribution of benefits from Horticultural RDC-supported research**

The Horticultural RDC commissioned a study by Dr van Velsen on the apportionment of benefits from each of approximately 450 projects currently supported. Preliminary findings are provided below:

Group 1	Industry contributors	53%
Group 2	Participants from the same industry sector who are not contributors but who will gain a commercial benefit	5%
Group 3	Participants from different horticultural sector, who are not contributors but who will gain a commercial benefit	9%
Group 4	Participants from a non-horticultural industry sector, who are not contributors but who will gain a commercial benefit	11%
Group 5	General Economic/commercial benefit to the Australian community	10%
Group 6	Non-commercial benefit to the Australian community	12%

*Source:* Sub. 317.

However, the Commission received much — qualitative — evidence indicating that the spillovers from rural research are large, and possibly larger than those from industrial research (see box E2.4). This could lead to relatively greater underinvestment by the private sector in rural research, in the absence of government intervention. But in rural research, as in most other research, a hierarchy of spillover benefits can be identified. They are:

- spillovers between farms in the same industry (intra-agricultural industry spillovers);
- spillovers between farms in different industries (inter-agricultural industry spillovers);
- spillovers to other, non-rural sectors of the economy; and
- spillovers to the community in general.

These are discussed in turn below.

*Spillovers between farms in the same industry*

Spillovers which flow from farmer to farmer within the same industry occur, for instance, where a farmer has developed (or has paid a researcher to develop) a better way to harvest a crop, and the new technique is observed and copied by other farmers growing the same crop, and who did not contribute to the cost of

the research. Such intra-industry spillovers are thought to be large, partly because of the nature of farming, discussed previously.

If the number of farms involved were small, it would in theory be possible for the farmers to get together and collectively fund the desired research, without any government intervention. In small groups there can be close interaction, and agreement about the amount each beneficiary is to contribute is relatively easy to achieve.

Where the number of farms is larger, organising voluntary collective action becomes costly and difficult to police. In some cases these can be overcome. For example, the Commission learnt at a roundtable meeting with farmers that egg producers collectively and voluntarily financed and commissioned research into the allegedly harmful effects of cholesterol on human health.

However, the incentive to free-ride, always present, but to a greater extent in large groups, can take over, making it administratively difficult to obtain agreement to finance the research. Currently, the compulsory levy system is the way in which this problem is addressed. Through the levy system the government ensures that all farmers in the same agricultural industry collectively pay for research.

While addressing the free-rider effect, there are some limitations with a system of compulsory contributions. For instance, farmers should contribute to collective research according to the benefits they receive. But not all research funded collectively is likely to benefit all farmers, and those who do benefit are not all likely to benefit to the same extent. Some farmers may prefer to switch to growing some other commodity when their current crop is no longer profitable. Where the research results in some new technology, some farmers may not have the resources to introduce it. In such cases, when their competitors do adopt it, farmers may face losses rather than gains, a situation which their own contribution to the research has helped to bring about.

Furthermore, the levy is imposed at the wish of the majority and once the levy is in place, all farmers must pay, whether they agreed to the levy or not. ABARE's view that a levy is like a tax has already been discussed earlier in this chapter.

It is extremely unlikely that a system could be devised which would ensure that all farmers contribute to research to the extent they benefit. The present system, which levies farmers on the basis of their production, may well be the best which can be achieved. Those who produce more, pay more, but may also benefit more.

### Box E2.4: Selected participants views on extent of externalities from rural research

The nature of rural and fishing industries and the similarity of production processes lends itself to spillovers such as improved land, water and marine resource management, reduced pesticide use and so on. The spillovers from agricultural R&D are substantially greater than those from other R&D ... (Tasmanian Government, Sub. 277, p.5).

The Federation strongly believes that more than in any other industry, the R&D effort in the rural industry has considerably more spillovers to the community (WA Farmers Federation, Sub. 280, p. 13)

The Horticultural RDC believes that spillovers from agricultural research, and from the horticultural R&D program in particular, are likely to be larger on average than spillovers from research occurring in other sectors of the economy (Horticultural RDC, Sub. 317, p. 7).

... it may be argued that the spillovers to the general industry and the community from investments in rural R&D are greater than for other sectors of the economy (CSIRO, Sub. 356, p. 6).

It is hard to conceive of a level of public benefits arising from R&D done by private companies which would be remotely comparable (Meat RC, Sub. 360, p. 3).

... much greater spillover benefit from the current rural research structure than the tax benefit ... (National Fishing Industry Council Ltd, Sub. 366, p. 6).

Spillovers in agriculture include a range of benefits (land care, lower cost food, human health) that are additional to the spillovers associated with secondary industry. Measuring these is problematic, but they are larger in primary than secondary industry (Rural Industries RDC, Sub. 367, p. 3).

... the government in making these commitments [to rural research] was reflecting its judgment that the spillovers associated with the RDCs are considerably greater than those with the 150 per cent tax concession (Joint RDCs, Sub. 368, p. 3).

... the extent of spillovers with the RDCs is likely to be much higher than with the firm-based tax concession (Grains RDC, Sub. 369, p. 2).

It is likely that the externalities from rural research would be higher than for the same research undertaken in other industries because the results of rural research are more widely disseminated (ABARE, Sub. 382, p. 3).

The fact that the scope of firms engaged in industrial R&D is much greater than that of the RDCs establishes a *prima facie* case that the spillover benefits from agricultural R&D are substantially larger than those from other R&D (Professor Bob Lindner, Sub. 378, p. 2).

Measuring the total spillovers is problematic; but they are likely to be larger in primary than in secondary industry (DPIE, Sub. 435, p. 6).

The Victorian Department of Agriculture considers that agricultural research tends to create greater spillovers than other industry sectors, justifying a higher level of public funding (Victorian Government, Sub. 454, p. iii)

### *Spillovers between farms in different industries*

Spillovers between industries in the agricultural sector occur when, for instance, information about better ways to construct fencing, pasture improvements, fertiliser and pesticide application, and irrigation techniques is potentially useful to farmers in different agricultural industries and difficult to withhold.

In any case, withholding it would not be efficient, where the cost of transmitting the information is less than the benefits gained. It would be impossible to withhold where, as is often the case, farmers grow more than one crop.

Again, some mechanism is required to ensure that farmers pay according to the benefits they receive. However, all the reasons why this would be difficult to implement within an industry on a voluntary basis, apply here too. Furthermore, there are many industries within the agricultural sector, making the groups involved even larger and more heterogeneous. Benefit flows between industries may vary from zero to large depending on the research, and are not always likely to be reciprocal.

Attempting to levy all farmers to account for inter-industry spillovers might be one approach. However, it would face a number of difficulties. For instance, with farmers producing many different commodities, what would be the basis for the levy? And would this levy be in addition to the current levy, or in place of it? Would a new organisation need to be established or could for instance the Land and Water Resources RDC or the Rural Industries RDC manage such research? And what about those farmers who would pay but not receive any benefits?

In any case, all the larger and many of the smaller agricultural industries are covered by the levy system, and the Commission received much evidence that many of the RDCs are involved in joint and collaborative projects. As discussed in chapter E3, the Rural Industries RDC was established in part to pick up issues which the commodity-based RDCs would not have sufficient incentive to tackle. However, the Rural Industries RDC indicated that there are some difficulties in setting up collaborative arrangements (see discussion in chapter E3), and there was generally scope for more collaboration and joint action.

While more and more agricultural industries are joining the levy system, by no means all are so far covered by it. However, in the majority of cases those not included are small or emerging industries, in niche areas. These industries are likely, at least initially, to have need for very specialised research, with limited potential for free riding by other industries (but later entrants to the industry may be able to do so).

### *Spillovers to other sectors*

Spillovers to sectors other than the rural sector can, for instance, consist of information about the chemicals used in the production of fertilisers and insecticides and their effect on human and animal health, and the environment more generally. This can be useful to the pharmaceutical industry in the development of new medicines. For instance, the development of human in-vitro fertilisation techniques in Australia built on information generated by research into the freezing and transferring of cattle embryos.

The Meat RC provided a number of examples of its research programs benefiting industries in sectors other than agriculture. For example, dung beetle R&D has resulted in a dramatic reduction in bush fly numbers in the North and West of Australia, helping the tourism industry. Research into genetically-engineered rumen bacteria has led to the isolation of an enzyme with the potential to reduce chlorine usage in paper pulp production. And research on environmentally clean technology has led to the resurgence of Australia's fellmongering and tanning industries.

It is clearly difficult as well as impractical to devise a way to induce benefiting industries to share the cost of the research. The most efficient way is likely to be for governments to contribute directly to the agricultural research. That said, it is less easy to establish what the size of such a contribution should be.

As with spillovers within the agricultural sector, spillovers between agricultural industries and industries in other sectors are not likely to flow in one direction only. However, the agricultural sector's dependence on innovation in other sectors (see earlier in this chapter) is likely to mean that the benefit flows from other sectors to agriculture consist mainly of pecuniary benefits.

### *Spillovers to the wider community*

Many participants provided examples of community spillovers from agricultural research. Most of these examples were in the areas of human health and the environment. For instance, the Grains RDC (Sub. 369) pointed to benefits from research into climate variability, plant biomass and the energy cycle, landcare, and breeding technology and genetic resources.

It also pointed to its human nutrition program, with investigation into the effects of fatty acids on cardiovascular disease and diabetes, and research into the possible beneficial effect of the high-fibre content in grain legumes in diminishing the risk of a number of cancers. The Meat RC said it had funded projects on human nutrition, the results of which:

... have been accepted by medical authorities and all are of real value to the community at large (Sub. 360, p. 3).

There are other potential health benefits from agriculture related research, for instance from reduced use of pesticides and better use of fertilisers. The Australian Banana Growers Council, at the public hearings, alluded to substantial benefits for the community from the development of a banana-derived health food which can be beneficial for certain conditions in humans and animals and in particular those patients in intensive care (DR transcript, p. 2435–6).

Some of the health benefits from agricultural research accrue to overseas consumers. While they could be seen as ‘lost’ to Australia, they are not entirely, as they serve to promote Australia’s food exports. ACIAR said:

... agrichemical pollution has major implications for the nation’s exports — and Australia’s ‘clean and green’ image (Sub. 400, p. 5).

Not all health benefits are of the spillover kind. For instance where they lead to the community consuming more of a certain, possibly improved, food type, some of the benefits will be appropriated by growers in the form of increased incomes. Increased food exports benefits growers. But, for instance, where the knowledge generated by the research allows consumers to make better informed decisions about what constitutes a healthy diet, spillovers have occurred.

A large number of participants responding to the draft report laid particular emphasis on the environmental benefits that accrue to the wider community from agricultural research. The Horticultural RDC (Sub. 317), for example, pointed in particular to agricultural research which results in the development and maintenance of a body of knowledge pertinent to environmental management. It said this knowledge is made use of for the purpose of mine reclamation, wilderness and recreation park management and the development of tourism facilities such as those in the Great Barrier Reef.

Participants believed that environmental spillovers from rural research made it particularly important that appropriate subsidies were given to performers of rural research. However, the case for a government contribution for environmental research is perhaps not as clear as many participants claimed it to be. It is, for example, not clear that all research that aids farming is necessarily compatible with improved environmental outcomes.

Certainly some environmental research undertaken by rural industries generates knowledge which has a wider application than merely in agriculture. However, environmental research can be viewed in two ways. From one perspective it can be regarded as generating positive spillovers because it can lead to greater environmental amenity and reduced costs to the community. Many participants saw environmental research this way. The other way is to see it as reducing the negative spillovers associated with farming.

For instance water tables have risen through faulty irrigation practices, damaging public infrastructure, and excessive amounts of salt are ending up in rivers, increasing the costs for those depending on them for their water supply. In other words, farmers have, in the past, imposed costs on the community beyond those imposed on themselves, often as a consequence of past innovations in farming techniques.

For that reason a case can be made for farmers to be responsible for funding research to address the environmental problems induced by farming. But farmers have argued that they acted on government advice and that it was past generations who caused most of the damage, so current generations should not be held responsible. Farmers may have paid high prices for farm businesses in the expectation of incomes which may not eventuate if environmental problems have to be addressed.

Increasingly, farmers are becoming aware that environmental improvement is also in their own interests. Where farm productivity is declining due to soil erosion, salinity, rising water tables or any other cause, farmers would appear to have a powerful incentive to fund research which will enable them to restore the soil to more productive capacity. As the Queensland Government said, farming will not be economically sustainable if it is not ecologically sustainable (Sub. 442). To the extent that farmers benefit from environmental research through improved income and higher land values, they benefit, and they should contribute to the cost.

In manufacturing, where remedial environmental action is not in an individual's or firm's interest, it is often possible to achieve it by regulation or taxing. When such regulations can be imposed on an industry there are then strong incentives to undertake research to find low-cost methods of compliance. Research that is stimulated in this way is in the direct interest of firms because it reduces their costs. It does not, therefore, produce conventional spillovers which would justify additional subsidies.

However, even where the adverse environmental impacts were known it has been difficult to regulate and/or police good environmental practice by farmers. This is because, as CSIRO pointed out (Sub. 356), the adverse environmental impacts of farming are often diffuse, or 'non-point' in nature. That is, they arise from a myriad of farmers who are very difficult to identify, let alone regulate or tax.

In the current climate of environmental awareness, even without regulation, there is pressure on farmers to reduce their impact on the environment. And the expectation that future advances in technology may make effective regulation feasible may add to the incentive already provided by community perceptions about the adverse effects of farming on the environment.

Farming, by its nature, makes greater direct use of natural resources than manufacturing industries. Rural industries are therefore likely to undertake relatively more environment related research. The Commission considers that much rural research yielding health or environmental benefits can provide sufficiently large private benefits to give farmers an incentive to fund it. However, it is also true that much environment related research will not generate large enough private benefits for it to proceed without a subsidy.

### **'Pecuniary' spillovers**

Some benefits from rural research come in the form of lower user prices, or higher quality products, and can flow either upstream to suppliers or downstream to purchasers. The BIE described those benefits as:

... value that is passed on to other parties who are in a market relationship with the innovating firm (BIE 1994b, p. 8).

Tisdell calls these 'pecuniary economies', a type of externality 'embodied in the product' (Tisdell 1994, pp. 40–1, see also part A).

Pecuniary economies are not necessarily all positive. For instance, innovation in one sector which raises productivity, cuts costs and reduces price in another sector which it supplies creates new benefits for consumers and may increase profits in the user industry. But the productivity improvement, by definition, involves the use of fewer resources to produce the same amount of output. So even if output is increased in the user industry, there may be losses for those supplying it with inputs.

Another, more specific example, is research into the relatively new concept of integrated pest management. The whole purpose of this research is to reduce the use of chemical pesticides. Successful research outcomes will mean the manufacturers of pesticides will suffer a loss of income and may even be forced out of business.

Pecuniary benefits — and pecuniary costs — come about mainly because competition in product markets exerts pressure for better value for money. In order to increase, or even maintain market share, producers are always searching for ways to reduce costs, or create new products, and research is one strategy in that process. Many participants said that because farmers cannot appropriate these benefits, they form part of the justification for government funding. For instance, the Meat RC said:

... most of the research benefit becomes a public good by way of cheaper food for consumers. It is actually very difficult for producers to capture the benefits for themselves (Sub. 360, p. 4).

In response to the draft report the Australian Processing Tomato Research Council said:

... the IC Report states that benefits to downstream firms from cheaper or improved agricultural products as a result of rural R&D is 'not a valid reason for government funding of rural R&D'. We disagree with this statement. If, for example, tomato R&D results in improved varieties and methods of improving quality, that lead to efficiencies in processing ... surely this must lead to improved prices for consumers or better profits for shareholders in the processing company (Sub. 332, p. 2).

However, as shown in the diagram in box E2.5, net cost reductions are rarely fully passed on to downstream purchasers. The extent to which they are passed on depends on market conditions. Where prices are relatively responsive to changes in supply conditions, as is the case in the domestic market, a relatively higher proportion of the cost reduction is passed on to purchasers. In the international market, where prices are less responsive to changes in supply conditions, a relatively lower proportion will be passed on.

For instance, domestic gardeners, when buying garden plants or fruit trees at lower prices than previously, will gain some of the benefits from research in that way. But to the extent that the full cost reduction is not passed on, they will also pay for some of the cost of the research.

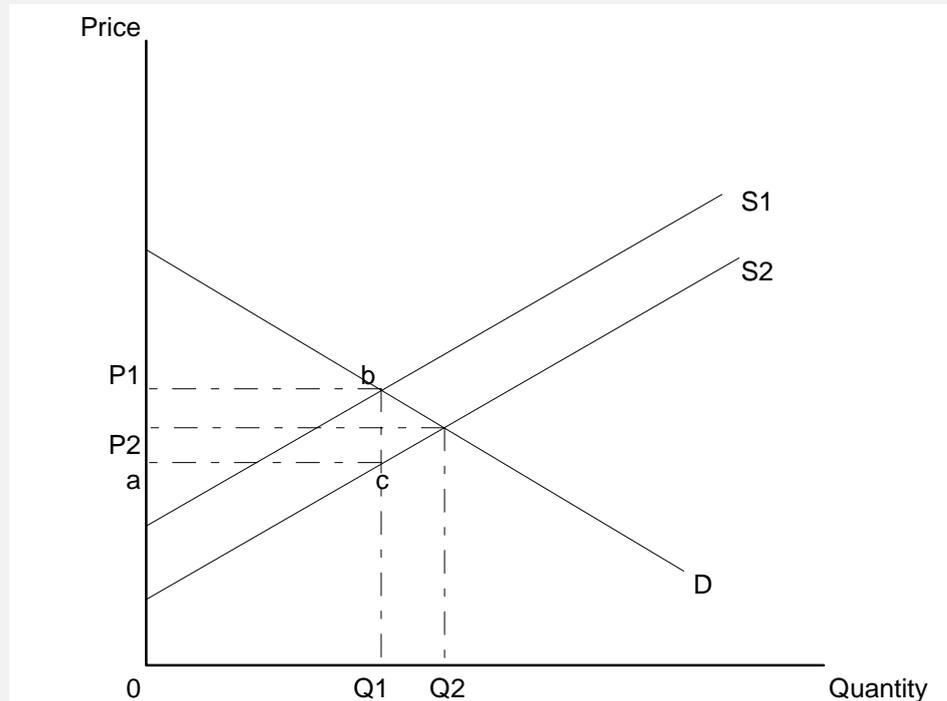
However, knowing that pecuniary benefits occur, and that they depend, in principle on supply and demand conditions, does not provide much insight into the actual distribution of the benefits from research. The studies examined by the Commission estimated total benefits, not their distribution.

The point made here is that research is one of the strategies employed in response to the operation of the market, and market pressures force some of the cost savings to be passed on to purchasers. Again, it is competition at work, rather than the market failing.

### **Indirect benefits**

As noted earlier, and shown in box E2.2, many participants considered that where research led to improvements in the balance of payments through increased exports and/or reduced imports, job creation, the maintenance of viable rural communities, the maintenance of Australia's standard of living, reliable food supplies and so on, a public good was generated. For instance the Australian Processing Tomato Research Council said:

If [tomato R&D] also leads to an improvement in international competitiveness for the business, it could lead to exports which in turn lead to improvements in the balance of payments etc. This debt reduction is good for Australia as a whole, so as a result of rural R&D, a public good has been generated (Sub. 332).

**Box E2.5: The distribution of research benefits**

In general the demand for a product increases as the price falls. This is represented in the diagram by the downward sloping demand curve D. Before any research is undertaken, producers face the supply curve S1. The price received by producers is determined by the intersection of the demand and supply curve, and is marked on the diagram as P1.

Research is undertaken, funded through a levy on production, and resulting in a productivity improvement, reducing unit costs of production. The new supply curve S2 incorporates both the reduced production costs and the levy. The fact that it has shifted down indicates that the reduction in unit production costs exceeded the cost of the research.

The new price, determined by the intersection of the original demand curve and the new supply curve is P2. Unit costs have dropped by bc, or P1a, but prices have fallen from P1 to P2, or by less than the total savings in unit costs. Consumers benefit to the extent of the fall in price. Producers, on the other hand, receive a gain of P2a per unit on output up to the level Q1.

It can be shown that the greater the response of prices to changes in demand, relative to changes in supply, the more of the (pecuniary) benefits will accrue to consumers. Conversely, the less responsive prices are to changes in demand, relative to changes in supply, the more of the benefits will accrue to producers.

The Pork Council of Australia said:

PCA believe that it is a responsibility of government to maintain Australia's standards of living through provision of cheaper and high quality food. It is a retrograde and

short-term approach to consider the future of Australia's food production as a wholly private sector responsibility (Sub. 375, p. 8).

The benefits referred to above are real, and certainly do occur. However, they are not spillovers in the true sense. They occur because of the pecuniary benefits generated by the research. For instance, lower prices result in more exports. Rural communities remain viable because farmers' incomes are maintained or increased. The competitive process helps to bring these benefits into existence.

The Riverland Horticultural Council said:

Why would the Commonwealth on one hand fund export enhancement programs, and on the other hand not fund R&D which would lead to lower production costs which in turn would also assist in achieving increased exports (Sub. 271, p. 5).

The Western Australian Department of Agriculture said one of the spillover benefits from agricultural R&D was:

Reduced costs to Government of rural adjustment and welfare expenditure. These costs would be higher with a lesser R&D effort because productivity and quality of products would be lower and more farm businesses would fail (Sub. 456, p. 2).

The benefits from rural research are likely to be many and varied, including, sometimes, improvements in the balance of payments, or a reduction in rural adjustment costs.

However, the reason for subsidising R&D is that in the absence of that subsidy some socially worthwhile R&D would not be undertaken. In other words, subsidies for R&D are intended to correct for market failure in the incentive to perform R&D. Market failure in other areas is also likely to be more effectively corrected through measures directly aimed at the causes of that market failure.

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## **E3 THE RESEARCH AND DEVELOPMENT CORPORATIONS**

Around 30 per cent of the rural research performed in Australia is commissioned by the RDCs, which themselves do not perform R&D. This chapter examines how the RDCs operate.

### **E3.1 The evolution of the corporation model**

The R&D corporation model evolved out of the Rural Industry Research Funds system which had been in existence for some years. Under that system, statutory or voluntary research funds were established for rural industries, as the result of agreement within an industry to levy its members, and the contributions were matched by the Commonwealth, generally dollar for dollar.

A number of other schemes also existed, and the system was characterised by fragmentation. For instance, the Grains RDC assumed the functions of fourteen former Commodity Research Councils and State Research Committees. There was also a heavy bias towards the supply side of research. The Grains RDC said:

The research areas and priorities were being determined largely by the researchers and administrators of the State and Commonwealth institutions providing an R&D capacity. There was little, if any, consideration of the areas of demand for research nor the appropriate level of funding (Sub. 132, p. 3).

The Department of Primary Industries and Energy (DPIE) said the reforms were:

... specifically motivated by a desire to increase the contribution made by R&D to the international competitiveness of Australia's primary industries and to the sustainable use and management of its natural resources (Sub. 181, p. 2),

and:

In particular, the Government sought to provide a framework which would make R&D more responsive to the needs of industry by increasing industry's involvement, improving research efficiency, effectiveness and accountability, and substantially improving the rate of adoption of its outcomes. Another key Government objective was to achieve an increase in the total funds available for R&D (Sub. 181, p. 2).

It was considered that greater autonomy in R&D decision making, and a more demand-led system, would provide the industries with 'ownership' of the R&D,

encourage greater funding, and generally better meet the needs of end users including industry, government and the general community.

The RDCs are widely seen as having been successful in making rural R&D more responsive to industry needs, and many participants said the RDCs had 'changed the culture of rural research' for the better. The Task Force on Review of Rural Research found:

The RDCs have made significant progress in improving the interactions between the R&D process and industry and in making R&D more responsive to industry needs. They are providing mechanisms to ensure industry is closely involved and has an interest in identifying R&D priorities, monitoring research and facilitating adoption of outcomes (DPIE 1994, p. 13).

A comment by the South Australian Government on the importance of the RDCs sums up participants' views:

The importance of the Primary Industries and Energy Research and Development Corporations to the Australian research community is well known. The role of the R&D corporations is essential as they provide a consistent supply of research funding but more importantly, enable the industries they serve to contribute to research and to establish ownership of that contribution, the research, its directions and outcomes (Sub. 289, p. 21).

### **E3.2 The levy system**

The system of levying farm output to fund research as it currently operates was described in chapter E1. Such a system can ensure that all those who potentially benefit from rural research share in the cost of that research. However, to ensure that levy payers 'own' the research, it is also necessary to give farmers a deciding voice into what research is done. For some of the corporations' predecessors, decisions about the research to be undertaken were made more by the research providers than by the funders and users of the research.

The RDCs were established to enable farmers to express their preferences, not only about the level of the levy, but also about what research needs to be done. Since this makes the levy system an integral part of the RDC model, it is discussed in that context.

#### **Compulsory or voluntary?**

As discussed in the previous chapter, in the case of small groups a voluntary levy arrangement could be successful. And indeed, in some of the smaller agricultural industries covered by the Horticultural RDC (for example, the mushroom and tomato processing industries), voluntary levies are in place.

But in larger and geographically dispersed industries ‘free rider’ problems are likely to emerge.

Of course there are also some problems with a compulsory levy. There will always be some who do not wish to contribute to the research, and/or who feel they do not benefit. It is important to take full account of this when deciding whether or not to set up a levy system in the first place. And once established, it is important to provide full opportunities for those subject to the levy to express their preferences and influence the decision making process.

Another possible difficulty lies in defining an industry for levying purposes. For instance, should all the different horticultural industries be defined as one industry, and if so, what should be the basis of the levy?

Nevertheless, in the draft report the Commission said in its view a compulsory levy system was an appropriate way to overcome the free rider problem in rural research. There was general agreement by participants with this view.

As the Queensland Government said:

Compulsory levies ensure that significant contributions to the cost of ... research are made by the principal users (Sub. 442, p. 22).

The NSW Farmers’ Association said:

NSW Farmers’ Association supports the current compulsory levy system and believes that the current levy arrangements are an effective means by which producers contribute to industry research (Sub. 315, p. 6).

Currently, a number of agricultural industries are in the process of putting a statutory levy in place. One of those is the flower industry. The Flower Industry Association said:

The development of a statutory levy is seen as a major step towards developing the industry’s true potential ... (Sub. 377, p. 1).

Other participants who said they had recently introduced, or who were about to introduce a compulsory levy were the Cherry Growers of Australia (Sub. 339) and the Australian Vegetable & Potato Growers Federation (Sub. 323). The Emu Farmers Association of Australia have recently requested the Minister to put a compulsory levy in place for its industry.

### **Who should be included?**

In some industries (sugar, meat, tobacco and potatoes) processors are levied as well as growers. For instance, the levy of 14 cents per tonne of sugar cane is shared equally by producers and processors.

In some cases processors are levied at the request of the industry. In the meat industry, originally it was only processors who contributed to research through a levy, farmers joining a system already in place.

The Horticultural RDC (Sub. 53) said that there generally was a lack of cooperation and mutual support between farmers and the non-farm sector, and that including downstream activities in the levy system can lead to a better relationship. In an attempt to involve these other sectors, the potato industry has set up an Australian Potato Industry Council with equal representation from growers, processors and traders. Growers and processors both contribute to the levy. However, because traders are not 'producers' under the terms of the enabling legislation, they have been excluded from the levy.

Allowing downstream activities to be included in the levy system may be seen as more equitable in the sense that R&D expenditure is apportioned between beneficiaries.

However, where the levying of processors is no more than a re-apportioning of the levy, and does not result in more R&D funds becoming available, it can be irrelevant who actually provides the funds. This is because prices paid by processors and received by farmers will reflect the way the research cost is shared (as discussed in the chapter E2).

Currently, other than in the Horticultural RDC, the legislation precludes the contributions from most downstream activities from being matched by the government, even if their contribution to levy receipts resulted in total levy receipts remaining below the 0.5 per cent ceiling. In any case, including downstream activities in the levy system may result in conflict over what are priority areas for research. Furthermore, those engaged in downstream activities will generally have access to business R&D support programs, such as the tax concession.

In the draft report, the Commission said it could see no reason why firms in downstream activities such as processors should not be included in the levy system, if the majority of those firms wished it.

Many participants commenting on this matter were in favour of including processors, for reasons mostly associated with cost sharing. The Grain Research Foundation said:

GRF considers that as many benefits from R&D funded by growers flow on to processors ... it would be realistic to expect some contribution from this sector of the industry (Sub. 394, p. 5).

The University of New England said:

... where appropriate, firms in downstream processing should be involved in the levy system. This is likely to enhance the revenue available for R&D and increase the commitment of processing firms to the value of R&D (Sub. 350, p. 12),

Some had reservation, however. The NSW Farmers' Association said in some industries including downstream firms would be difficult to administer. It said it supports the voluntary inclusion of downstream processors but believes that:

... the most suitable mechanism for capturing research funding from this sector is via appropriate marketing of intellectual property arising from such R&D (Sub. 315, p. 6).

**The Commission reiterates that the inclusion of downstream processors should be on a voluntary basis and only where a majority of firms wishes to be included.**

### **Volume-based or value-based?**

There is a question about whether a levy should be based on volume of production, such as tonnes of wheat, or value of production. Currently nearly all levies are based on volume. For instance, in 1992–93 the levy on cotton production was \$1.75 per 227 kg bale, and the levy on beef and lamb producers is calculated in cents per animal. The exception is the wheat levy, which was changed to an ad valorem (or value) base in 1989. The intention is for all other leviable crops covered by the Grains RDC to be levied on an ad valorem basis (Sub. 312). The levy on dairyfarmers of 1.8 cents per kilogram of milk fat can to some extent be seen as value-based as the milk fat content of milk is quality related.

There are advantages and disadvantages in each system. A volume based system is simple and enables producers to calculate their levy payments as soon as they know what their production volume will be. Prediction of total levy receipts will also be easier, without the uncertainty about prices added to any uncertainty about quantities produced.

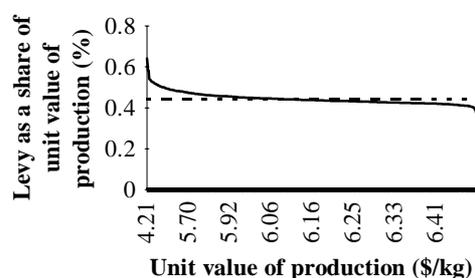
The rate of variability in levy receipts is important as funds need to be committed for several years for many research projects. Total levy receipts are likely to be more variable when calculated based on value, as value is determined both by quantity and by price. However, Brennan, analysing past data in a study carried out for the Grains RDC, found that relative variability is similar for production volume and gross value of production, and that therefore:

... over a period of years, the relative variability of levy receipts would be expected to be similar, on average, whichever of the levy bases is used (Brennan 1992, p. 13).

Another advantage of an ad valorem system is that farmers growing different crops, and who contribute to the same research, can be more easily levied to contribute the same proportion of their revenue.

In the draft report the Commission also suggested that an ad valorem system may be more equitable (see also box E3.1), but sought participants' views on that issue. Many participants responded, some in support of value-based levies, some in support of volume-based levies. Arguments of practicality as well as equity were given as reasons for supporting or opposing either way of setting the levy (see box E3.2).

### Box E3.1: Grower contributions to tobacco R&D



Tobacco R&D is partially funded through industry quantity-based levies. The solid line in the graph shows that the current levy on tobacco products represents a greater proportion of returns for producers supplying lower value tobacco leaf than for producers supplying higher value leaf. The dotted line shows, that with a value-based levy the proportion would remain constant across growers regardless of the unit value of the leaf.

Source: Commission estimates

The Commission agrees with the Joint RDCs, which said:

The RDCs, recognising the considerably different circumstances they each face, believe there is no single, right answer to the choice between volume-based and value-based levies and that each industry should retain the flexibility to adopt the methodology which best meets their circumstances (Sub. 368, p. 25).

### Fluctuations in research funding

The levy system, because it is based on production, can involve significant fluctuations in funds available for R&D. For instance, as a result of the current drought in Queensland and New South Wales, wheat production has fallen considerably and consequently levy receipts are reduced. Some participants said these fluctuations are highly unsatisfactory. The (then) Wool RDC gave two reasons:

### Box E3.2: Selected participants' views on value- versus volume-based levies

#### Those in favour of volume-based levies:

This information [about widely fluctuating world prices] leads SRDC to conclude that a volume based levy will provide a more stable funding base for sugar R&D than a value based levy. Irrespective of these arguments SRDC submits that it is the levy payers (industry) who should choose the rate of levy (within the guidelines) and the basis of the levy (Sugar RDC, Sub. 292, p. 6).

We would suggest to the Commission that a value based system tends to be biased against the better producer, eg, if one producer has a high quality and is receiving a higher return per kilogram for his product ... he will be paying a higher levy than the grower who commits very little effort to quality assurance. Therefore the grower making that commitment to quality is paying a penalty for doing so (Australian Fresh Stone Fruit Growers Association, Sub. 301, p. 1).

... price fluctuations would make accurate budgeting almost impossible. Also, such a system [of value-based levies] would act as a disincentive to apply research to high value crops (Victorian Apple & Pear Growers' Council, Sub. 304, p. 3).

We do not favour a value [over] a volume based levy. There are significant differences in value both within a season and from year to year and because it is an unknown factor until the season progresses a value-based levy would make research and development planning extremely difficult (Cherry Growers of Australia, Sub. 339, p. 4).

One of [the] problems that we have with a levy on an input such as pots is that as the price of pots fluctuates so does the amount of our levy, and it doesn't truly represent the value of the industry (Nursery Industry Association of Australia, DR transcript, p. 2674).

#### Those in favour of value-based levies:

The [Australian Vegetable Growers Federation] membership has decided that a value based levy is the most effective and equitable for the industry (Australian Vegetable & Potato Growers Federation, Sub. 323, Industry Consultation paper, p. 4).

The FIAA supports the principle of value based charging of levies. The process of 'levying' in the flower industry has, however, been determined by pragmatic considerations of possible collection points and costs of collection. These factors alone have dictated that the flower industry will use a value base for the domestic industry and a volume base for the export charge (Flower Industry Association, Sub. 377, p. 10).

The IC suggests that predicting levy receipts with an ad valorem levy is less certain than a quantity based levy. This has not been the experience in the grains industry. Movements in prices and quantities are generally in opposite directions so the fluctuations in receipts brought about by large movements in quantities produced are to some degree moderated by price responses. The real issue is the impact that a value based levy has on the variability of RDC funds and not one of ease, or otherwise, of prediction. Research undertaken by the GCA at the time of imposing the value based levies indicated that only once in forty years were there large simultaneous declines in both price and quantity. **It was not then, and not now, correct to assume that increasing the variables (by the inclusion of price) increases the variability in the amount of levy funds collected** (Grains Council of Australia, Sub. 381, p. 4, emphasis in the original).

R&D expenditure is most effective if it is reasonably constant and predictable. Wild fluctuations, both up and down, result in less than optimum outcomes with too much effort going into either retrenching experienced staff or training new staff in research organisations ... (Sub. 59, p. 3);

and:

Times of low GVP are when it is important to maintain demand building R&D, not reduce it, as must be done under the current arrangements (Sub. 59, p. 3).

The Grains Council of Australia said a large drop in world wheat prices during 1990–91 and a large drop in Australian wheat production in 1991–92, together with a reluctance and/or difficulty in borrowing, and the government methodology of calculating matching funding, had resulted in much disrupted research and worthwhile new projects not being funded. It said its:

... desire to enable [Grains RDC] to meet its targeted expenditure and to avoid a large disruption to research programs has resulted in the grains research and development levy being well in excess of the maximum Commonwealth matching of 0.5 per cent of GVP (Sub. 132, p. 14).

Government matching of levy contributions (when spent) means that a fall in levy receipts can result in a twice as large fall in research expenditure. On the other hand, government matching contributions are calculated on a three year average of GVP. This has somewhat of a smoothing effect on the maximum availability of R&D funds. When GVP is falling, maximum possible government matching payments will be higher than 0.5 per cent of GVP. They will be lower when GVP is increasing. Nevertheless, to maintain funding it may be necessary to raise levies that will not be matched.<sup>1</sup>

An option proposed by the (then) Wool RDC to smooth out peaks and troughs in research funding was:

... a fixed Government contribution of (say) \$20 million per annum, conditional on woolgrowers continuing their contribution at 0.5 per cent of GVP, indexed for inflation, guaranteed for three years but with an annual review to establish the level of the contribution in the third year (Sub. 59, p. 14).

The question of countercyclical funding of rural R&D was one of the issues under review during a recent Senate Economics References Committee inquiry (SERC 1994). This was included, in particular, because of the reduction in funding to CSIRO by the wool industry, from around \$6.1 million in 1989–90 to

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<sup>1</sup> But money collected as unmatched levies in some years may be eligible for matching in later years as it is spent and if levy collections fall below the three-year average GVP estimate for that year.

about \$1.4 million in the current year (Senate inquiry transcript, p. 304). The Committee recommended that:

CSIRO, in collaboration with industry and government, formulate a package of mechanisms to buffer research programs from wide fluctuations in rural industry research levies (SERC, 1994, p. 61).

It is not clear whether this was intended to involve making available to rural industries some of CSIRO's appropriation funding.

The term 'countercyclical funding' implies that the Government should increase its funding during lean years, and perhaps decrease it during prosperous years. As noted by Senate Economics References Committee, there are some problems with such an arrangement. First, it would be difficult to design a formula which would not affect the incentive for the industry to manage its funding during either the prosperous years or the lean years, or on a longer term basis. Second, it would be necessary for the Government to distinguish between a cyclical downturn and the more permanent decline of an industry.

In the case of the RDCs, there are other options available. For instance, the RDCs can, under certain conditions, borrow. Another is the building up of reserves, which can be called upon when levy receipts plus government contributions fall below committed expenditure. In effect, most of the RDCs have such reserves.

The magnitude of those reserves is another question. The Wool RDC said that although it had built up reserves of \$75.4 million (more than 100 per cent of annual expenditure), it had found that those large reserves had not been sufficient to maintain R&D at an adequate level during the recent lean years. Of course, not many industries have experienced anything like the severe downturn in the wool industry.

ABARE does not consider maintaining reserves to be a suitable way of ensuring a smooth flow of funds. It said:

... maintaining reserves as a method of smoothing the flow of funds to researchers [is] taking over part of the risk management responsibilities of farmers (Sub. 196, p. 39);

and:

... building up reserves would not be the strategy pursued by most farmers and could be an inefficient use of farmers' funds (Sub. 196, p. 39).

However, since farmers can influence the level of reserves through raising or lowering the level of the levy, the existence of significant reserves for most of the RDCs could be seen as evidence that levy payers do not object to maintaining reserves. In fact, the NSW Farmers' Association said:

Building up of a reserve in more prosperous years could be considered as displaying a considerable commitment to sustaining the level of R&D over time (Sub. 315, p. 8).

The NFF believes that the RDCs should be responsible for smoothing the fluctuations which will inevitably occur. It also said, however, that research should be undertaken to investigate the optimum level of reserves that is needed to satisfactorily stabilise investment spending.

Downturns and upswings are a fact of life in agriculture. The Commission sees no need for any countercyclical funding to offset the effects. In its draft report it said the RDCs should be free, in consultation with their industry, to determine what reserves, if any, they wish to maintain. That is because reserves have to be created out of levy receipts and do not involve a government contribution until they are spent (see chapter E1).

Participants, while agreeing, emphasised that adequate consultation and communication with stakeholders both within and outside industry were important. The South Australian Farmers Federation said:

... industry and government representatives, as owners of the RDCs, should be consulted on the matter of reserves (Sub. 402, p. 4).

The NSW Farmers' Association said:

It is entirely appropriate for individual RDCs and associated industries to make independent decisions on the matter of reserve funds. It is also critical that these RDCs clearly communicate their reserve funding policies to stakeholders to alleviate misunderstanding of the nature of any such reserves (Sub. 315, p. 7).

As already noted, borrowing is another option. The South Australian Government sees borrowing from the Commonwealth Government as a way to free RDCs from being at the mercy of seasonal conditions:

It is believed that an appropriate remedy to this would be the freeing up of the one-for-one dollar arrangements with the Commonwealth so that there is provision for 'anti-cyclical' funding arrangements. In other words the R&D corporations are able to seek 'bridging' funding from the Commonwealth Government during periods of poor levies (bad seasons) to be repaid from levies derived during favourable years (Sub. 289, p. 21).

In the draft report the Commission said research funded from borrowed funds should not be matched by the government. Some participants disagreed. The Cattle Council of Australia said:

This recommendation would seem illogical. It would seem perfectly legitimate to bring forward research expenditures providing it meets with stakeholder approval. There is no reason why projects funded from borrowings would have less of a public good element or spillover than other research (Sub. 370, p. 10).

The Grain Research Foundation said:

The suggestion that borrowed funds not attract a Government contribution is quite ludicrous, given that the Corporations are responsible for the debt. Grower funds will obviously be required to satisfy any debt and interest on borrowings and it is the expenditure by the Corporations that attracts government contributions not the amount contributed by the growers (Sub. 394, p. 5).

The Grain Research Foundation went on to say that Government accountability requirements could be satisfied by making borrowing by the corporations subject to ministerial consent.

Apart from accountability, there are other problems with borrowing by the RDCs. One is that the matching of borrowed funds by the Government could be seen as an interest free loan, effectively reducing the cost of financing the industry's share of the R&D funded by borrowing.

Another problem is that, as already noted, it is difficult to distinguish between a cyclical downturn and a more permanent decline in an industry. In the case of a more permanent decline, the industry might have difficulty repaying any borrowings.

**The Commission remains of the view that the RDCs should be free, in consultation with their industry, to determine what reserves, if any, they wish to maintain.**

The use of borrowed funds should be permitted only on the condition that expenditure funded from borrowings does not attract the government contribution, and that industry — for instance through the representative organisation — be made responsible for the debt.

### **E3.3 Setting priorities for RDC research**

The legislation requires the RDCs to prepare five-year plans and annual operating plans, in consultation with their 'representative' organisation which is appointed by the government. Generally the representative organisation is the peak industry body, but in some cases there are more than one. Plans must be reviewed annually and before variations are made the RDCs must consult with their industry. Plans have to be submitted to the Minister for approval.

Most of the corporations have developed individual ways of consulting their industry. As well as industry representatives, researchers and government officers are included in the consultation process. Consultation takes place formally, at meetings between corporations and representative organisations, but also informally, at workshops and discussion groups, field days and through the print and electronic media. For instance, in preparing its five-year plan, the

Grains RDC circulated a consultative letter to approximately 200 institutions with an interest in grains industry research.

Regionally based committees are a feature of the Grains RDC and the Fisheries RDC. The then Wool RDC ensured a market driven approach to wool R&D through Research Committees and Technical Panels: an On-farm Research Committee and an Off-farm Research Committee, each assisted by a number of Technical Panels, formed the interface between the industry and the corporation, advising the corporation on the needs of industry and reporting back to industry the results of R&D programs and projects.

Some of the RDCs have full time communication officers who not only inform farmers of the corporations' plans, but who report back to the corporations on farmers' research needs.

At the broadest level, the priority setting processes of the RDCs appear to result in industry driven R&D. This is in contrast to a decade or so ago, when, in spite of many rural producers contributing to rural research through product levies, rural research priorities were mostly set by the research community.

### **Basic versus applied research**

Some participants said the corporations were not commissioning sufficient basic and long term research. They said this would eventually undermine Australia's knowledge base and consequently its capacity to undertake useful applied research. The NSW Science and Technology Council said the neglect of long term projects could have serious consequences for agriculture. It said:

Few projects are today funded for longer than 3 years, yet in most biological systems, including agricultural systems, it takes much longer to identify significant change ... A nation which is so dependent on its primary industries cannot afford to neglect the long term R&D necessary to sustain these industries (Sub. 234, p. 11).

The University of New England (Sub. 223) said that the short term perspective of the RDCs is resulting in a shift in the balance between basic research and applied research. It said basic research, which is long term, and essential for maintaining our knowledge base, is being neglected.

Nevertheless, the RDCs commission a considerable amount of basic and/or strategic research. For instance, the Sugar RDC said it considers at least 60 per cent of its portfolio to be of a strategic nature (Sub. 76, p. 30). The Meat RC spends around 20 per cent of its annual expenditure on basic and strategic research (Meat RC 1991, p. 55) (see also chapter E4).

### **On-farm versus off-farm issues**

Many of the RDC research programs include research projects into issues related to farm inputs such as farm machinery, chemicals, fencing and other equipment, and down stream activities such as processing, transport and other off-farm activities.

A recent survey of the RDCs found, that on average more than 40 per cent of the RDCs' research expenditure is on off-farm activities (Ralph 1994). Of total expenditure, 18 per cent was on processing related issues, 6 per cent on distribution, storage and marketing issues and 5 per cent on handling issues. Five RDCs invest 50 per cent or more of their budget in off-farm research.

While those initially benefiting from off-farm research may be firms or individuals in industries other than agriculture, as discussed in the previous chapter, benefits will often flow back to upstream activities and forward to downstream activities. The (then) Australian Meat and Livestock Research and Development Corporation described how a farmer could potentially benefit more from processing research than from on-farm research:

... when processors increase their productivity, they become more profitable. Processors now have an incentive to sell more product on the domestic or export market. They now have an incentive to move extra product through their works. But how do they get this extra product? They have to go to the markets and buy the extra livestock. In so doing they bid up prices. That is, the farmer receives a price increase. This price rise gives the farmer an incentive to increase production. So the farmer ends up producing more output and receives a higher price. The farmer is better off on both counts and so gets a greater share of the gains than in the case of a farm sector productivity improvement (AMLRDC 1991, p. 81).

It is the role of the RDCs to commission research which reflects industry needs. If those industry needs are perceived to include research into off-farm matters, and provided farmers have sufficient input into the setting of research priorities, the RDCs should be free to commission such research.

### **Gaps, duplication and collaboration**

One of the criticisms levelled at the RDCs is that there are gaps in the coverage. In this context the CIE, in a paper prepared for the Rural Industries RDC (Sub. 124), said that there is a propensity for the R&D to be directed at the status quo, and for controversial issues to be avoided. It cited the Wool RDC failing to commission research into the Wool Reserve Price Scheme, and the Sugar RDC not commissioning research into the implications of import and production controls.

Since the latter arrangements were perceived by many in the industries concerned to be of benefit to them, it is perhaps not surprising they were not seen as research priorities. Nevertheless, the point remains that some public good research into the activities of an industry will not be picked up by the RDC process. Research into such matters may need to be separately commissioned by the Government on behalf of the community which most often ultimately bears the costs of such schemes.

Duplication of research, resulting from insufficient coordination and collaboration between the RDCs is another concern. The Meat RC, commenting on the *National Strategy for Agricultural Research* (see box E3.3) currently being developed, said that initiative originated in part from the views of research organisations that there is duplication and fragmentation in agricultural R&D, and that important cross-commodity issues fall between the corporations.

The corporations dispute these claims, some providing lists of collaborative projects currently being managed (see box E3.4). The Dairy RDC said:

While inter-RIRC coordination may have been 'slow off the ground' ... there is now a soundly established system of coordination in a wide range of areas. Some RIRCs act as lead agencies by their very nature (eg Land and Water, Rural Industries RDC); and other RIRCs have taken lead roles (Sub. 134, p. 29).

Formal mechanisms for promoting collaboration exist in the regular meetings of corporation chairpersons. The Land and Water Resources RDC and the Rural Industries RDC were established at least in part with the objective of addressing cross-commodity issues.

Apart from formal arrangements, the Meat RC pointed to several informal arrangements promoting coordination, including an inter-corporation workshop on technology adoption. Ralph provided evidence of increased collaboration:

In 1993–94, \$9.5 million — or 4.0% of the total projected agricultural RDC expenditure — was committed to collaborative ventures involving one or more Corporations. In 1994–95 this figure has grown to \$12.5 million or 5.0 % of the budgeted expenditure. All but two RDCs are engaged in collaborations with other Corporations and Councils (Ralph 1994, p. 35).

NSW Agriculture said it was the different structures and modes of operation developed by individual RDCs which inhibit collaboration. It said this is partly because the technical committees and panels established to assess project proposals all have different deadlines and budget meetings, and no effective mechanisms exist for joint consideration of collaboratively funded projects.

The apparently conflicting views expressed before the draft report led the Commission to ask participants for their views on how coordination and collaboration between the RDCs could be improved. Some, for instance the

Meat RC (Sub. 360) said coordination and cooperation was very good, the RDCs having greatly encouraged and implemented linkages across research agencies, States and industries. The Pastoral Group (Sub. 428) said it believed coordination and collaboration was evolving as the RDCs were consolidating, and any further legislated mechanisms would not be effective in further promoting cooperation between the RDCs.

**Box E3.3: Extract from the National Strategy for Agricultural Research (vision and outcomes)**

**Vision**

Australian agriculture encompassing the business systems of commodity production, processing, transport and marketing is a vital component of the economy. It will be world-renowned as profitable, highly competitive in the international market place, and recognised for quality products, produced through its environmentally and socially responsible use of resources.

...

Society will recognise that research and innovation combined with the responsible use of labour, capital and natural resources are primary drivers of economic development. Although many governments continue to see food security as a primary component of their development policies, industry is now sharing responsibility with government for the maintenance of national R&D resources and for determining the R&D investment programs aimed to underpin continuing innovation in national economies.

**Outcomes for industry:**

- 1 Australian agricultural industries are internationally competitive and sustainable and remain recognised as a vital part of the economy.
- 2 Industry innovation and development is enhanced.
- 3 Skills are available for participants in the agricultural industries and in the research services supporting them to achieve maximum benefits through innovation.

**Outcomes for research:**

- 4 Research is firmly focused on outcomes which meet the needs of industry, consumers and the community.
- 5 Research priorities that seek improved competitiveness through innovation are clearly defined, are consistently applied, and are periodically reviewed.
- 6 Efficient and effective use of research resources for the national benefit.
- 7 Contestability is increased in the allocation of resources to research programs.

**Outcomes for the community**

- 8 Resource use in Australia's agri-food and fibre industries is sustainable for the benefit of today's community and future generations.
- 9 The processes of the agri-food and fibre industries are responsible and safe.
- 10 The products of the agri-food industry are nutritious and healthy.

*Source:* A National Strategy for Agricultural Research in Australia, April 1995.

**Box E3.4: Selection of jointly funded projects****Projects jointly funded between Rural Industries RDC and Horticultural RDC**

Improved Quality & Marketability of Chestnuts by the Control of Phomopsis Nut.  
Production of Vegetable Green Soybean for the Domestic Market and Trial Shipment to Japan.

**Projects jointly funded between Rural Industries RDC, Land and Water Resources RDC, Murray-Darling Basin Commission**

Fast Growing Eucalypts with Moderate Salt Tolerance for Agroforestry.  
Assessment of the Effects of Shelterbelts on Pasture and Crop Production in Victoria.  
The Effect of Windbreak on Crop Growth in the Atherton Tablelands of North Queensland.  
The Impact of Trees on the Physical Environment and Productivity of Farmlands.  
Trees for Profit Integrated Economic Model — Farm Level & Regional Study.  
Impact of Trees on Winds, Temperatures & Evaporation Rates in Farmlands.  
Sustainable Hardwood Production in Shallow Watertable Areas.  
Modelling Crop Growth & Yield Under the Environmental Changes Induced by Windbreaks.  
The Effect of Salt on Wood & Fibre Formation in Eucalypts.  
Investigating the Conservation Characteristics of Native Trees Planted on Agricultural Land.  
The Use of Trees & Fodder Shrubs in Reducing the Rate of Soil Acidification.  
Review the Effects of Agroforestry on Soil Amelioration.  
The Effects of Trees on Native Pasture in the Southern Tablelands.  
Identifying the Economic & Social Constraints to the Adoption of Agroforestry.

**Projects jointly funded between Rural Industries RDC and Grains RDC**

Effect of Windbreaks on Crop and Pasture Productivity in South Australia.  
Farmfacts & Sustainable Technology (Fast).  
New Crops: Development & Application of Improved Selection & Evaluation Procedures to Produce.  
Development of Adzuki Bean Production for Export Markets.  
First Australian Sesame Workshop.

**Projects jointly funded between Rural Industries RDC and Land & Water Resources RDC**

Adoption of Technologies for Sustainable Management in the Grazing and Cropping Industries.  
Improved Handling of Chaffy Grass Seeds.  
Analysing Drought Strategies to Enhance Farm Financial Viability.  
Decision Support for Climatic Risk Management in Dryland Crop Production.  
Productivity, Socio-Economic & Natural Resource Impact of Changing Catchment Enterprises.

**Project jointly funded between Rural Industries RDC and the International Wool Organisation**

The Australian Collection of Rhizobium Strains for Temperate Legumes

**Project jointly funded between Rural Industries RDC and Meat RC**

Commercialisation and Development of an Agronomic Package for *Microlaena Stipoides* for Forage and other Purposes.

*Source:* Rural Industries RDC, Sub. 367, Attachment 1.

However, there were also some who said there was still room for improvement. The Queensland Graingrowers Association said:

The Association supports the meeting of chairs of the RDCs but remains to be convinced that adequate coordination in planning and funding is currently occurring at a regional level (Sub. 395, p. 9).

The Rural Industries RDC said that it increasingly uses joint ventures to achieve collaboration between RDCs. Some examples it provided were:

- an agroforestry joint venture involving the Land and Water Resources RDC, the Grains RDC, the Forest and Wood Products RDC, the Murray Darling Basin Commission and the Rural Industries RDC, managed by the Rural Industries RDC;
- a climate variability joint venture involving the Land and Water Resources RDC, the Grains RDC, the Meat RC, the AWRAPO, and the Rural Industries RDC, managed by the Land and Water Resources RDC; and
- a plant biomass in the energy cycle joint venture involving the Energy RDC, the Land and Water Resources RDC, the Rural Industries RDC, the Grains RDC, DEST and several State departments, managed by the Energy RDC.

It said it was currently in the process of developing joint ventures with other RDCs on electronic information systems for rural communities and businesses, on plant pest and disease control, and on emerging environmental and phytosanitary barriers to trade.

However, while it said the level of collaboration it had been able to generate between research agencies was very pleasing, it said there was a problem with collaboration within the RDCs because:

... people are standing back, realising that [certain research] is not being done but no-one is specifically identified as having the responsibility for doing it (DR transcript, p. 3194).

The Rural Industries RDC suggested a greater role for the Land and Water Resources RDC and the Rural Industries RDC on generic or more strategic issues would facilitate collaboration within the RDCs. It said the Land and Water Resources RDC had recently received a special appropriation of \$2 million for drought related research. This had generated an \$11 million program in collaboration with other RDCs. The Rural Industries RDC said:

... the action in designating some specific funds for a co-ordinated program ... actually provided the catalyst for a higher degree of collaboration than ... seen in other areas (DR transcript, p. 3194).

Clearly, additional funding, contingent upon collaboration, would provide an incentive for the RDCs to collaborate.

It is difficult to see why the commodity-based RDCs, all of whom are likely to have levy payers affected by the drought, should not have been willing to cooperate in drought related research. Nevertheless, there might be areas of research, with benefits to the entire agricultural sector, but where the RDCs would have insufficient incentive to undertake even collaborative research. This could be so where there would also be very substantial benefits to the community, for instance in climate research.

In such cases the Commission sees merit in providing the additional funding to bring about collaborative research which would otherwise not occur.

### **E3.4 Assessing research outcomes**

The evaluation of research outcomes is essential for determining whether funds have been spent on worthwhile research. In addition, valuable lessons can be learnt from project and program evaluations about whether priority setting procedures are effective, or need to be changed. The assessment of research outcomes also enables the RDCs to report back to their levy payers, and levy payers to make a judgment about the effectiveness of the RDC concerned.

As part of the requirements for evaluation, the RDCs all have developed, or are in the process of developing, criteria for assessing whether projects will satisfy priorities identified in five-year plans and annual operating plans.

The most common criteria include:

- potential benefit to growers;
- anticipated effect on quality and/or competitiveness;
- potential for commercialisation;
- extent to which the project will enhance sustainable resource use; and
- contribution to priority area.

Research providers are often required to include in their plans proposals on how research results are to be implemented. Often, corporations perform some form of ex ante evaluation of projects. Others, for instance the Grains RDC, now require an ex ante cost benefit analysis to be submitted with research proposals.

Most research contracts contain a provision for progress reports at regular intervals, to enable the corporations to assess whether research is proceeding according to plan. Cost benefit analysis is increasingly carried out on the

completion of projects. However, thus far, projects chosen for analysis have generally been those perceived successful, or those most easily quantified, perhaps creating a too favourable impression of rural research outcomes. The Auditor-General said that the RDCs have concentrated on evaluating individual projects, but that they:

... are developing sub-programs and strategies and there is now more scope for them to define aims and measure performance in these terms also (ANAO 1994a, p. 27).

Extensive evaluation of research outcomes can be very costly. Using funds for evaluation reduces the funds available for research, and a trade-off has to be made between the need for evaluation and for research.

Elsewhere in this report, studies of the returns to rural R&D investment have been reviewed. What is striking about that body of work (apart from the high returns often found) is the variation in method and in the comprehensiveness of the projects covered and the costs and benefits included. There is clearly room for further evaluations, and better methodological procedures. While not suggesting that the outcomes of each and every research project should be evaluated in detail, **the Commission draws attention to the clear benefits which arise from rigorous and comprehensive ex post evaluation of research programs. Such evaluations provide valuable information, and should be used to guide the design of future research programs.**

### **E3.5 Accountability**

The RDCs are headed by boards of directors which are appointed by the Minister on the recommendation of a selection committee, which in turn is appointed on the recommendation of the industry concerned.

Persons nominated as directors must collectively possess an appropriate balance of expertise in a wide range of fields. Nominations must be invited by advertisements placed throughout Australia as well as from the representative organisation(s) of the RDC concerned. One director is appointed directly by the Government.

The directors report to both the Government and the relevant representative organisation(s) by means of an annual report. Only two RDCs — the Meat RC and the Wool Research and Promotion Organisation — are required to report to levy payers at an annual general meeting (AGM). The remainder has to make arrangements to attend the representative organisation's annual conference, or a meeting of the representative organisation's executive, for the purpose of considering the annual report.

In addition to statutory requirements the RDCs have developed further ways of keeping their levy payers up to date on how their levies are spent and on the outcomes of research projects and programs. These include regular newsletters, field days and discussion groups.

### **Accounting to members for levies**

The legislation and associated regulations prescribe that levies should be set having regard to industry recommendations.

For those RDCs required to hold an AGM, voting on the size of the levy for the following year must take place at that meeting. The meeting must be advertised widely and the 'representative' organisation(s) (see appendix F) notified. Those who newly became levy payers during the preceding year must be given an opportunity to be placed on the list of eligible levy payers. All eligible levy payers may attend the meeting and vote on any matter to be determined at that meeting. In this way all levy payers are provided with an opportunity to have an input into the activities of their RDC, including the level of the levy.

Where the RDCs report at the representative organisation's annual conference, there may be an opportunity for levy payers to present their views, but voting on the level of the levy may be by delegation only. Where the RDCs report at a meeting of the representative organisation's executive, individual levy payers clearly cannot participate.

This does not mean that levy payers have no opportunity for input. Regional bodies pass on the outcome of their discussions to State bodies which in turn send delegates to the national organisation.

While preparing the draft report, the Commission was concerned about the effectiveness of the process by which industry preferences are conveyed to those setting the levy. It proposed the RDCs hold AGMs at which levy payers could vote on the level of the levy, with those unable to attend having the option of voting by mail.

Some participants agreed in principle with the idea of AGMs, but, on the whole, the proposal was considered costly and unwieldy. The main thrust of the arguments was that there was scope, in some instances, for improving accountability but that such arrangements would be too costly in a country as large as Australia, that RDCs vary in coverage and homogeneity and required industry-specific reporting arrangements, and that, in any case, current reporting arrangements were, on the whole, satisfactory. Box E3.5 shows a selection of participants' quotes. The Joint RDC submission provides a summary of the arguments:

### Box E3.5: Selected participants' comments on the merit of holding an AGM

The concept of an Annual General Meeting either at commodity level (apples and pears) or RDC level (HRDC) would be most cumbersome and, we believe, totally ineffective (Apple & Pear Growers Association of SA, Sub. 290, p. 4).

SRDC submits that the additional costs associated with an AGM are not warranted in the sugar industry as the accepted democratic processes will ensure input to decisions affecting SRDC's levy. These processes, including district consultations with growers and millers, are likely to produce priorities more representative than would be gained from an AGM (Sugar RDC, Sub. 292, p. 7).

... the [NSW Farmers] Association does not believe that a legislatively required AGM is the appropriate mechanism [to improve accountability]. Apart from the logistics of bringing such large numbers of farmers together, the high costs of holding an AGM would outweigh its benefits to accountability (NSW Farmers Association, Sub. 315, p. 14).

An AGM would impose extra costs on growers and the Corporation and, in absence of costly incentives to growers, would be likely to be poorly attended. ... An AGM would be particularly difficult to conduct effectively in the horticultural sector because of the structure of the industry. Horticulturists tend to have a strong sense of industry identity, but little identification with other industries within the horticulture sector (Horticultural RDC, Sub. 317, p. 16).

The diversity of industries covered by RDCs mean that annual general meetings will be appropriate for some RDCs but not for others. RDCs, in collaboration with the industries they serve, should be able to develop systems for reporting and consulting which best serve those industries (AWRAPO, Sub. 355, p. 5).

The proposal has some merit for larger industries with single line levies but has some practical down-sides for smaller and more fragmented industries and also for Corporations such as RIRDC, which manage broad ranging programs (Rural Industries RDC, Sub. 367, p. 13).

This suggestion, while at first appearing the epitome of democracy, is unnecessary as this industry has based its R&D program 'from grass roots up' (Australian Banana Growers Council Sub. 288, p. 7).

... the Pastoral Group is of the opinion that an AGM is a poor and expensive method of reporting to members. ... The reason for the ineffectiveness of the AGM is due to the size and nature of rural industries. The size of Australia and the cost and time of travel is a disincentive of levy payers to be represented at AGMs (The Pastoral Group, Sub. 428, p. 7).

The RDCs see merit in the Commission's proposal in principle — the question is whether in practice accountability, and hence levy payers influence, would be improved sufficiently to warrant the additional cost involved. The RDCs believe that this issue should be progressed in consultation with their representative industry (Sub. 368, p. 31).

With regard to voting by mail, this was endorsed by the Pastoral Group. One industry currently using a postal ballot is the wool industry. However, the AWRAPO arrangements differ from those proposed by the Commission in the Draft Report, in that even those growers attending the AGM cast their vote by

mail and there is no requirement for the ballot to coincide with the AGM. The Wool Council said it opposes this system, saying:

The level of tax is best set via a vote at the AGM following discussion and adequate industry knowledge of the issues for consideration (Sub. 371, p. 8).

**The Commission considers that accountability to levy payers is of the utmost importance. It considers that RDCs, in consultation with their industry, conduct regular reviews of the way they report to levy payers to continue to ensure sufficient input in the levy setting process.**

### **Accounting to the community**

The current funding arrangements with industry and government each contributing roughly half the funds, imply equal responsibility to levy payers and the community. Accounting to the community is via the annual reports presented to the government and through five-year plan and annual operating plan approval procedures. The Government — and therefore the community — is represented on the Board of each RDC by the government member.

In accounting to the Government the RDCs could reasonably be expected to report on the public benefit component of the research they undertake. The Task Force said:

Since one of the fundamental reasons for Government contributions to R&D is to foster the public good element of research, an important criterion against which it will assess the effectiveness of its investment will be the benefits achieved in areas beyond the confines of the RDCs' client industries (DPIE 1994, p. 17).

It also said:

The majority of RDCs are currently poorly equipped to report to Government on these aspects and have generally placed little emphasis on doing so (DPIE 1994, p. 17).

The Task Force recommended that the Government provide the RDCs with a clear explanation of, inter alia, its expectations in regard to public good issues, and that the RDCs be required to respond specifically on how they are meeting these expectations. Subsequently, in August 1994, the Minister wrote to the RDCs, suggesting they take into account a number of Government priorities relating to international competitiveness, food processing capacity, a focus on Asian-Pacific markets, and ecologically sustainable development. The Commission understands the RDCs are required to report shortly on how these areas have been incorporated in their R&D programs.

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## E4 THE GOVERNMENT CONTRIBUTION

For the majority of the commodity-based RDCs the Government matches levy receipts — as they are spent — dollar for dollar, but only up to a ceiling of 0.5 per cent of GVP.

In the policy statement associated with the establishment of the RDCs (Kerin and Cook 1989) some policy principles with regard to funding were stated. These included:

- beneficiaries from research should pay roughly in proportion to the benefits received; and
- the greater the spillover benefits, the greater the proportion the Government should contribute.

It could be concluded from this that the Government expected that around half the benefits from the commodity-based RDCs' research would accrue to farmers and the other half to the community. While it could also be concluded that the government considered that beyond 1 per cent of GVP invested in research, the social benefits — private returns plus spillovers — would no longer be sufficient to warrant further subsidies, this appears not to have been the case, as is discussed below.

This chapter looks at the effects of the ceiling and the appropriateness of the funding ratio. It also examines the problems of small and emerging industries in undertaking research under the current arrangements and the implications of the Commission's recommendations.

The wide variety of soil and climatic conditions existing in Australia result in many regions having specific research needs. While the RDCs generally have a national focus, quite a number have arrangements in place to facilitate regional research needs. This chapter also examines how the RDCs meet those needs and how arrangements can be improved.

### E4.1 The ceiling

The 0.5 per cent of GVP ceiling on government matching of agricultural levies was already in place before the advent of the RDCs. For instance, some industries such as wool and wheat had been receiving matching funding for many years. While with the passing of the *Rural Industries Research Act 1985*, the Government gave a broad undertaking to match industry levies up to 0.5 per

cent of GVP across all industries (Lovett 1994), the Government has never provided an explicit rationale for that ceiling.

Some say it was intended to provide a signal to industry about the amount of research the government considered desirable, as another of the policy principles stated at the time was:

The aggregate level of spending for research and development should continue to expand as long as the expected social benefits of further funding are greater than or equal to the additional social costs (Kerin and Cook 1989, p. 3).

However, in discussing the level of resources which should be spent on agricultural research, the policy statement read:

The Government does not believe that total spending of 1 per cent of the commodity's gross value of production is the appropriate level of industry research and development activity. It should, for most industries, be regarded as a minimum. By the time this minimum is reached, however, industry should itself determine whether increased funding is warranted. If it is, industry should fund it (Kerin and Cook 1989, p. 5).

This is consistent with the dollar for dollar matching up to a cut-off point being seen as an inducement to change growers' perceptions of the value of R&D. That is, it would bring farmers into the system, get them focused on R&D and the benefits it could generate; thereafter farmers would be in a position to increase their R&D spending without government support.

### **Growth in industry levies**

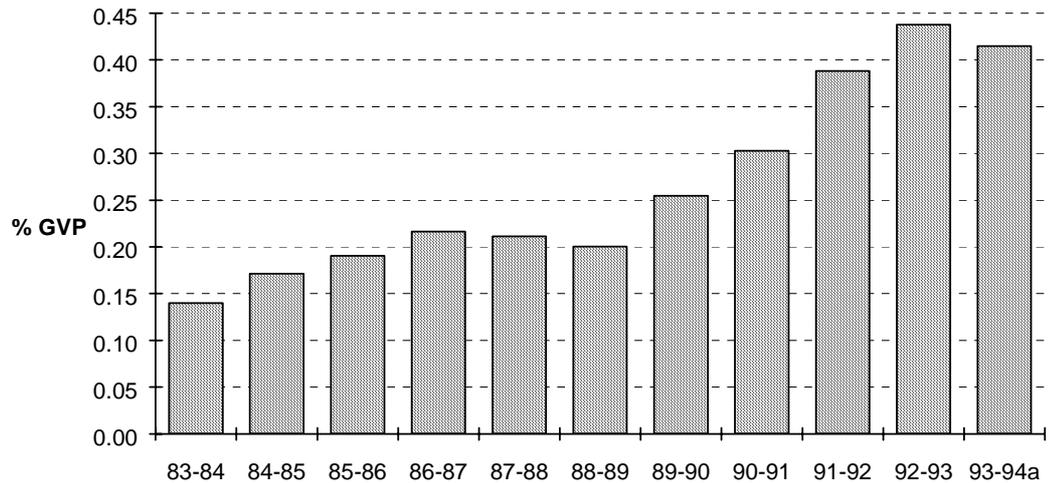
Agricultural industries have increased their contributions to research as a percentage of GVP. In aggregate, the value of industry contributions is over 0.4 per cent of GVP (see figure E4.1). While expenditure varies among RDCs, that by five of the larger RDCs was around the ceiling in 1993–94 (see figure E4.2).

Only one, the Grains RDC, had industry contributions substantially above the ceiling, at 0.7 per cent of GVP. Its spending levels may reflect a need to avoid disruptions to its existing research programs, resulting from falling world prices (DR transcript, pp. 3420–1). Nevertheless, it is now receiving no government support for a proportion of its spending on R&D.

Some of the smaller rural industries are also facing the fact that any research beyond one per cent of GVP will not be subsidised. In particular there are a number of small and emerging rural industries, aware that R&D is vital for industry development, and which raise funds well in excess of 0.5 per cent of GVP. The deer industry is one of those. It raises as much as 5 per cent of GVP but the current ceiling limits the government contribution to only one tenth of industry funds. In some cases this means those industries have difficulty raising

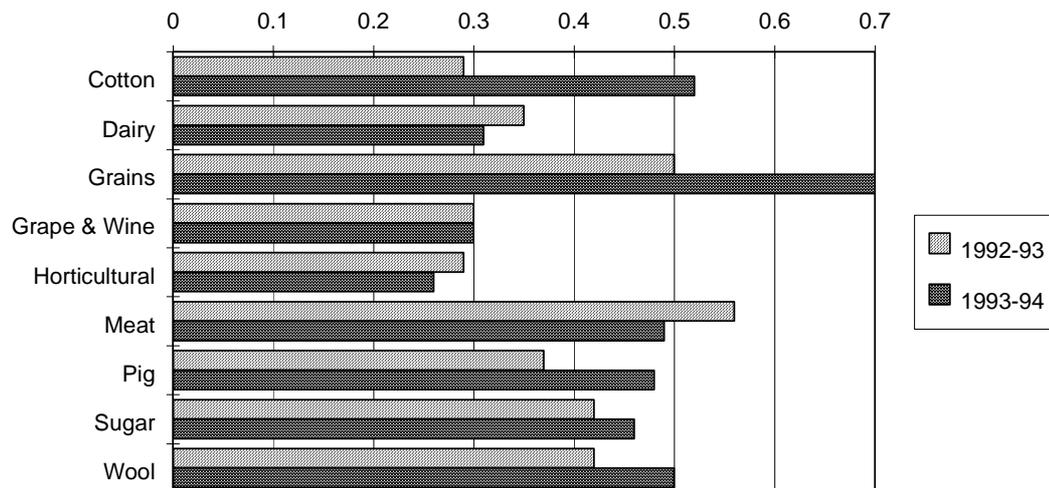
the \$400 000 which the Rural Industries RDC said was the ‘absolute threshold’ (DR transcript, p. 3192) for a small research program.

**Figure E4.1: Total levy contributions as a percentage of total agricultural GVP**



a Using preliminary data for GVP  
 Source: Cook 1994a, ABS, Cat. No. 7503.0.

**Figure E4.2: Selected RDCs’ levy receipts as %GVP**



Source: Sub. 200.

### **Advantages of abolishing the ceiling**

A ceiling might be appropriate if it could be established that spillover benefits decline with increasing expenditure. It is not at all clear, however, that this is the case. And even if they did decline, it would be virtually impossible to know at what proportion of GVP spent on R&D the spillovers fell below a worthwhile level. Furthermore, this point is likely to vary industry by industry. Consequently, any ceiling is arbitrary.

Effectively, the price of R&D to levy payers doubles at the ceiling. In the absence of a ceiling, each industry would decide what to spend on R&D, without being influenced by any false notions of optimality created by an arbitrary limit to government support which was actually quite arbitrary.

The absence of a ceiling would also provide greater flexibility for agricultural industries in managing their R&D funds. They would be able to make choices between maintaining, increasing, or spending reserve funds, or, alternatively, maintaining or increasing the level of the levy without losing the government contribution.

When the RDCs were first established, even those industries which already had levies in place were a long way from the 0.5 per cent of GVP ceiling and it may have been useful in giving farmers a goal to aim for. It may still serve that purpose for some industries. The Australian Dairy Industry Council said:

... it's certainly our objective to lift the level of levy funding from about 0.3 per cent of GVP where it is now in the dairy industry, to 0.5 per cent as soon as possible (DR transcript, p. 2891).

And the Australian Banana Growers Council said:

... we are achieving at present 0.3 per cent of GVP so we're still 0.2 away from the goals that were set, or the target that was put down by Kerin and Cook in their report (DR transcript, p. 2430).

However, now that several industries have reached that goal, the ceiling is likely to distort and reduce the incentive for rural industries to contribute further to R&D. The Joint RDCs said:

... as the number of corporations having industry levies at or approaching 0.5 per cent of GVP rises the time is fast approaching when it will be necessary for the government to determine what kind of incentives should be given to stimulate a commitment to research and development by rural industry beyond 0.5 per cent of GVP. Under the present formula there is a zero government incentive for RDCs to do this (Sub. 368, p. 23).

Many participants supported the removal of the ceiling, although those representing industries with levy receipts well below the ceiling, said removing the ceiling would not be of great benefit to them. A selection of quotes from

submissions is presented in box E4.1. The Victorian Apple & Pear Growers' Council said:

Removal of the ceiling on Government contributions to horticultural R&D is unlikely to benefit the industry in the foreseeable future because very few horticultural industries have reached even fifty per cent of the ceiling (Sub. 304, p. 3).

#### **Box E4.1: Participants' comments on proposal to remove the ceiling**

The Tasmanian Government commends the arguments made by the Commission for [the removal of the ceiling] (Tasmanian Government, Sub. 277, p. 5).

This submission supports the recommendation that the ceiling on matching contributions be removed but opposes the proposed changes to the Commonwealth contribution to 1:4 (South Australian Government, Sub. 289, p. 2)

This ceiling certainly has created a psychological barrier within meat industry R&D funding deliberations. If [the removal of the ceiling] is found to be unpalatable then the ceiling should at least be lifted to 0.75 per cent ... as recommended in our original submission (Cattle Council, Sub. 370, p. 7).

Another barrier for the industry is the limit of matching funds from the Commonwealth of 0.5% of gross value of production. ... Unless the ceiling is changed, a maximum of \$500 000 (approximately) is available for R&D before the matching funds are withdrawn (Australian Macadamia Society, Sub. 326, p. 4).

As the arbitrary figure presents a psychological barrier to increased contribution by farmers, the Pastoral Group is firmly in favour of the recommendation to remove the 0.5 per cent of GVP ceiling on Government matching of agricultural levies (Pastoral Group, Sub. 428, p. 5).

It is our opinion that the ... removal of the ceiling would make little or no difference to the individual industries and in particular, to the horticulture industry which is at present no more than 0.3% of GVP (Australian Fresh Stone Fruit Growers Association, Sub. 301, p. 2).

NSW Farmers believes that the 0.5% ceiling should be raised to 0.75% of industry GVP. This would encourage industry to increase its own contribution to R&D if it saw fit, with the incentive that any additional funds would be matched by Government (NSW Farmers' Association, Sub. 315, p. 9).

The industry believes the concept of a funding ceiling should be maintained. The funding ceiling provides a tangible measure of Government interest in apple and pear research and reinforces the Government's confidence in the industry. However, the industry would support an increase of the ceiling, possibly to 0.75% of GVP (Apple & Pear Growers Association of SA. Sub. 290, p. 6).

The existence of some sort of ceiling allows government matching, which provides incentive for industry contributions, while making it quite clear there is a limit to government funding. It stops rural industries from becoming complacent and assuming that government matching will always be there (SA Farmers Federation, Sub. 402, p. 5).

There were others who had reservations, mainly for Commonwealth budgetary reasons. The National Farmers Federation (NFF) said:

... in reaching its recommendation for removal of the ceiling the Commission has not considered the need for Government to limit its expenditure exposure in order to maintain control of its budget outlays ... For this reason NFF has opted for raising rather than removing the limit on Government contributions and urges the Commission to support NFF's request to raise the limit to 0.75 per cent of GVP (Sub. 379, p. 1).

Most of those against, however, opposed the removal of the ceiling if it was accompanied by a reduction in the overall government contribution to rural R&D spending.

Clearly, budgetary implications would arise with an open-ended government contribution. But they would depend in part on the ratio of support relative to farmers' own contributions.

## **E4.2 The ratio**

In the draft report the Commission argued that the relatively high dollar for dollar support for rural research relative to that for manufacturing research was not justified, given that the RDCs in themselves served to internalise inter-farm spillovers, which were the main source of spillovers. In the absence of evidence that the remaining relevant spillovers were larger than those from R&D in other sectors, the Commission proposed that the ratio of government to industry contributions be reduced to 1:4, closer to the rate of assistance provided by the 150 per cent tax concession.

The Commission's conclusions were widely challenged in submissions to the draft report and during public hearings. Many participants argued that research undertaken by RDCs could not be compared with that undertaken by manufacturing firms under the 150 per cent tax concession, and spillovers from RDC research exceeded those from manufacturing research.

In principle, the rate of government support should depend on the net social benefit generated by the research. This in turn depends on:

- how much additional research is induced by government support; and
- the spillover benefits that result from the induced research (less the costs of funding it).

These elements are addressed in turn.

### **How much additional research does the subsidy induce?**

The Commission's views in the draft report were in part based on the assumption that the amount of research induced by the dollar for dollar arrangement was relatively low — that the levy mechanism was in itself sufficient to generate significant additional R&D, so that even a sizeable reduction in the government contribution, if gradually implemented, would not lead to a significant reduction in R&D. This was challenged by participants.

Many participants said the benefits from rural R&D by farmers are difficult to appropriate. This is because the nature of the R&D required to support rural industries is such that it generates substantially larger spillovers than does manufacturing R&D. This issue is discussed in detail in chapter E2.

Greater spillovers were also said to arise because often it is the RDCs which develop research programs and projects on behalf of their industries. The RDCs are more likely to take a long-term view than farmers, and therefore to fund relatively more basic and strategic research.

A number of participants argued that the RDCs should not be seen as the rural sector equivalent to private firms in manufacturing obtaining the 150 per cent tax concession. Box E4.2, reproduced from the Joint RDCs' submission, summarises participants' views. The key point, which the Commission accepts, is that farmers do not have the same control over the R&D undertaken by the RDCs, as do firms over R&D undertaken under the tax concession scheme.

While many of the industry associations acting as representative organisations for their RDC, told the Commission they have considerable input into the research undertaken, often developing research programs in the first place, farmers individually clearly have limited input into the decision making processes.

ABARE said that farmers do not closely associate levy payments with the benefits generated by the research funded through the levy, and that therefore they are likely to discount the expected benefits quite heavily. It said:

Regardless of the individual benefits, the government is likely to have to provide a greater subsidy to the farmer in order to produce the same incentive. Whether to subsidise and at what level depends on how producers will respond ... (Sub. 382, p. 18).

The question of how much additional research is induced is therefore crucial for determining the right level of subsidy.

There is some limited empirical evidence of the inducement effect of the dollar for dollar subsidy. As shown in figure E4.1, total levy contributions as a proportion of total agricultural GVP have increased over the past decade. Although that can be seen as evidence that farmers have been willing to increase

the amount they devote to research, that does not necessarily mean that total levy contributions have increased in absolute terms. However, as seen in figure E4.3, levy contributions have also increased steadily, in nominal as well as in real terms, over the past ten or more years.

**Box E4.2: Joint RDCs comparison of the 150 per cent tax concession and the RDC matching funding arrangements**

*Tax concession for manufacturing research*

- 1 Objective is to stimulate research and development and improve international competitiveness.
- 2 Recipients are firms.
- 3 Firms are free to decide what research and development is performed:
  - aimed at own needs
  - mostly short to medium projects
  - applied rather than basic or strategic research
  - no explicit public good requirement
- 4 Most R&D performed in in-house facilities, although a small proportion is contracted out.
- 5 Results are incorporated in products and processes produced/used by the firm.

*Matching funding for RDC research*

- 1 Objective is to stimulate research and development, improve international competitiveness and contribute to environmental sustainability.
- 2 Recipients are RDCs, not individual farmers.
- 3 RDCs decide what research and development is performed:
  - substantial part is off-farm
  - mix of short, long and medium term projects
  - mix of applied, strategic and basic research
  - explicit public good requirement
- 4 Most R&D is performed in Commonwealth and State government laboratories by researchers at arm's length from the rural RDCs.
- 5 Results are available to the industry as a whole and tend to enter the general knowledge pool.

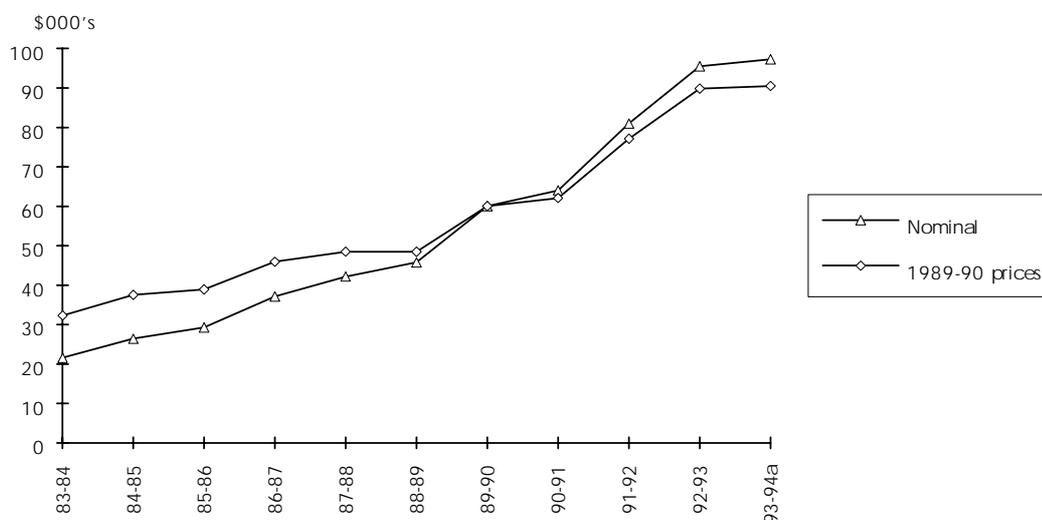
*Source:* Sub. 368.

An increase in the average rate of growth of industry contributions has occurred since the RDCs were established. The Task Force said:

The figures ... suggest that the RDCs have been successful in increasing the funds invested by industry for RDC-managed R&D, despite difficult economic circumstances for many rural industries (DPIE 1994, p.15).

For individual industries, there are some striking increases. For instance, the meat industry more than doubled its contribution in the two years from 1988–89 (but has decreased it slightly since then). But the greatest rate of increase (if from a low base) has been achieved by the horticultural industries, which increased their contributions to research from \$200 000 in 1988–89 to \$9.32 million (estimated) in 1993–94.

Figure E4.3: Levy contributions to research, 1983–84 to 1993–94



a Estimate

Source: Cook 1994a, 1995.

However, matching funding was in place before the RDCs were established and industry contributions increased during the entire period as shown. While the evidence seems to suggest that the RDCs had a favourable impact on the amount of R&D performed, it makes it difficult to draw conclusions on the specific impact of matching funding.

Many participants, however, offered their assessments. Most said that if funding were reduced to the level recommended in the draft report, the amount of R&D undertaken would be reduced (see box E4.3). Others said some of the smaller industries which had only recently joined the levy scheme, or which were about to join, were likely to withdraw their support. Some of those industries, told the Commission it was the matching funding which made a research levy acceptable to growers. For instance, the Australian Custard Apple Growers Association said:

The Custard Apple Industry has worked hard to implement a compulsory research levy in recent years ... A levy system was only achieved due to the positive line being taken by the Commonwealth Government towards research and development (Sub. 447, p. 1).

As well, the larger industries said they were not likely to increase their levy payments to compensate for the reduction in government funding. ABARE, also, said:

It seems unlikely that farmers as a whole would be willing to increase their levy payments in the face of a decrease in government commitment to research (Sub. 382, p. 22).

**Box E4.3: Participants' comments on effect of reducing the government subsidy for levy-funded research**

Comments received by us would indicate that if there was a cut back, then farmers would immediately seek to withdraw from the National arrangement. ... There is little doubt that the availability of funds would be severely reduced (Tasmanian Farmers and Graziers Association — Vegetable Council, Sub. 274, p. 2)

Having worked hard to get good grower support for the concept of grower funded R&D for the cherry industry (with many reluctant growers joining in) the proposed reduction may give some growers an excuse to reduce/opt out of involvement (Mr Ted Domeney, Sub. 275, p. 1).

The Tasmanian Government maintains that [the increase in the level of private sector investment] in agriculture and fisheries has been a direct result of the current level of matching funding of the Government together with the innovative RDC model. To withdraw a major part of this incentive would be a retrograde step (Tasmanian Government, Sub. 277, p. 5).

It is clear, however, that if the IC recommendation was implemented then it would significantly reduce the SRDC budget (Sugar RDC, Sub. 292, p. 4).

All the evidence available to us based upon a long history of industry associations suggests that a reduction in government funding to rural RDCs from 1:1 will not necessarily be taken up by rural industry. Given drought and institutional constraints, a reduction in the government contribution will lead directly to a reduction in overall funding (Queensland Farmers' Federation, Sub. 310, p. 17).

Reducing the funding ratio from 1:1 to 1:4 would reduce the funds available to the RDCs by over 30 per cent almost immediately, and projected funding would fall by over 80 per cent in the case of the HRDC (Horticultural RDC, Sub. 317, p. 10).

It is most unlikely that the present level of support for the proposal [of joining the levy scheme] could be maintained in the industry if the level of Government support should be reduced to the level of one dollar from the Government to every four dollars from industry ... (Australian Vegetable and Potato Growers Federation, Sub. 323, p. 4).

While the pay-back on RDC research may be high in most cases — it is difficult to conclude that effective withdrawal of much of the Government funding would be replaced by private funding. In fisheries it would certainly lead to a sharp decline in stock assessment work which is the long-term core requirement of successful fisheries management (National Fishing Industry Council, Sub. 366, p. 6).

Total funding for rural research and development would fall sharply as the government incentives for industry to spend on research and development more than halved ... The effects ... would be felt directly by the research and development performers: the State Departments of Agriculture, the CSIRO and the Universities (Joint RDCs, Sub. 368, p. 21).

However, it is not obvious why farmers would support the levy system — and willingly increase the level of the levy as they have over the years — if they did not feel that there was some connection between their payment and benefits to themselves from the research.

The dollar for dollar subsidy for rural research halves the price of research to farmers. It could reasonably be expected that such a reduction in price would induce significantly more research to be undertaken. While farmers have some incentive to overstate the magnitude of a reduction in research undertaken if the current subsidy were to be reduced, it would be reasonable to conclude from the evidence that the subsidy has resulted in a fairly large increase in research, possibly as much as doubling it.

### **Evaluating the additional spillover benefits**

The Commission's recommendation to reduce funding to one to four was partly based on two further considerations. First there was the belief that the RDCs concentrated more on the applied end of research, in contrast to their science-dominated predecessors, and that therefore the spillover benefits generated by the levy funded research were less than in the past.

Second, the Commission considered that there should be no requirement on the RDCs to fund specific public good research for the Government. The RDCs were established to encourage farmers to contribute more to research, and it is unlikely that farmer needs and government needs would always coincide. Where the Government's specific research requirements cannot be achieved by assisting RDC research in a non-directive way, it can be funded separately. This is why government funds CSIRO and bodies such as the Land and Water Resources RDC.

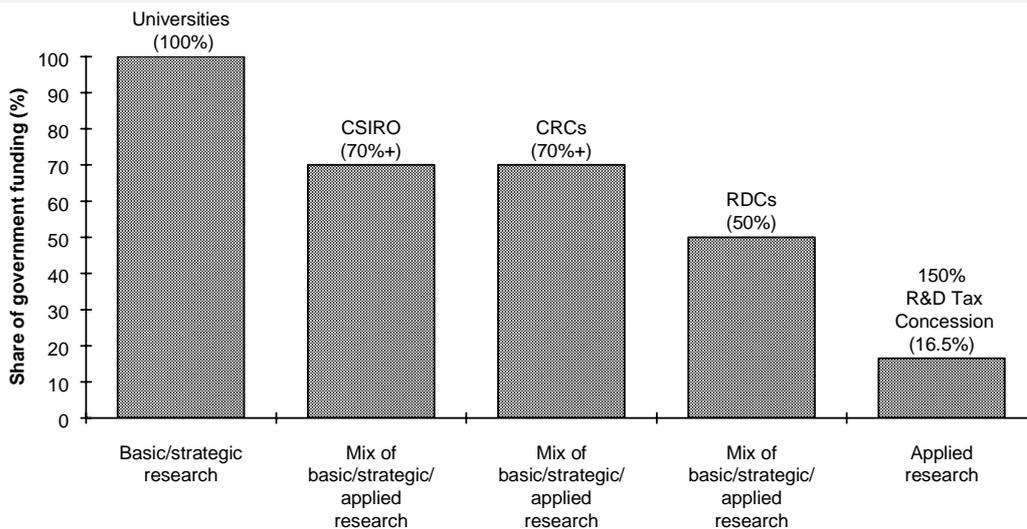
That does, of course, not mean, that some types of public benefit research, not attractive enough for one RDC to fund on its own, may not become beneficial when undertaken in collaboration by two or more RDCs combined. Collaboration, internalising as it does the spillovers between different rural industries, can ensure that research, otherwise unprofitable, will get done. But the decision to undertake research, whether collaborative or otherwise, should be based first and foremost on whether there are expected to be sufficient benefits for the farmers who contribute through their levies.

Even without taking into account the required public benefit research, participants strongly disputed that most of the spillovers were internalised. As discussed in the previous chapter, participants provided evidence indicating that the spillover benefits from rural R&D to other, related as well as unrelated, industries, and to the community in general, were likely to be considerably larger than those from manufacturing research. That was because it was in the nature of agriculture that more long term strategic research was necessary. The Joint RDCs compared the RDCs, in the mix of basic, strategic and applied research they undertake, with the CRCs, rather than with firms, which undertake

mainly applied research (see box E4.4). The Australian Wool Research and Promotion Organisation said:

RDCs fund a much higher level of public good R&D than does manufacturing industry in general (Sub. 355, p. 3).

#### Box E4.4: Joint RDCs' comparison of research mix



Source: Joint RDCs, Sub. 368, p. 16.

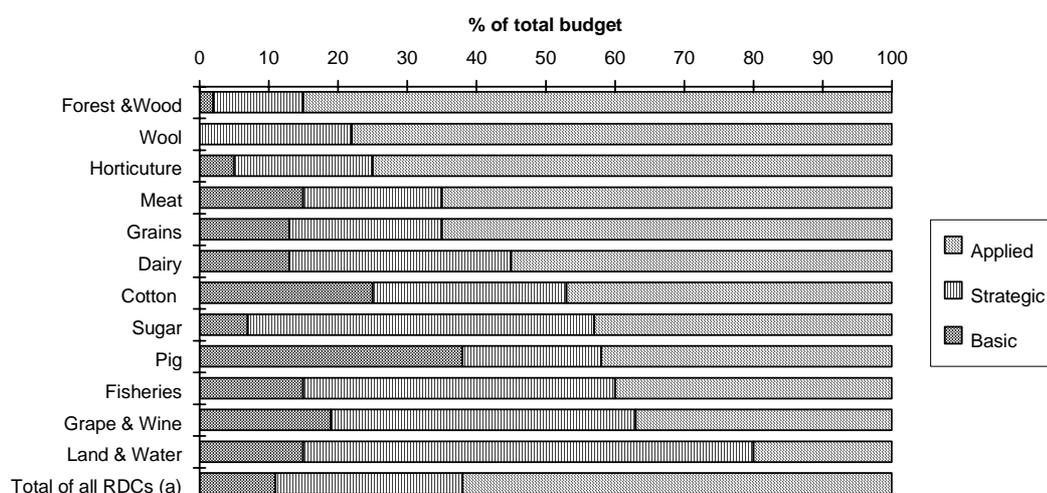
The Grains RDC (Sub. 451) conducted a survey of the RDCs and found the mix of basic, strategic and applied research undertaken by individual RDCs to vary significantly among them (see figure E4.4). Overall, 11 per cent of RDC expenditure was found to be on basic research, 27 per cent on strategic research, and 62 per cent on applied research. The proportion of their expenditure devoted to basic and strategic research is high compared to the 6 per cent spent by business enterprises (ABS, Cat. No. 8112.0).

In response to the Commission's perception that the RDCs have made research more relevant and responsive to industry needs, some said there was not necessarily a connection between the movement to more relevant research and a shift to applied research. The Grains RDC said:

The RDCs by focusing the *whole* research process on high priority issues, both for the industry and public good (eg sustainable development) aspects, may not *necessarily* change the basic, strategic and applied research balance very much or at all (Sub. 451, p. 2).

While it is a virtually impossible task to quantify the spillover benefits from research, it is generally accepted that basic and strategic research are likely to have greater spillovers than applied research. The larger amount of basic and strategic research undertaken by the RDCs appears to strengthen the Commission's conclusions in the previous chapter, that spillover benefits from rural research are likely to be larger than those from manufacturing research.

**Figure E4.4: Percentage of basic, strategic and applied research undertaken by the RDCs**



a Weighted average of all RDCs.

Source: Grains RDC, Sub. 451.

## Benefits and costs of government support

As noted throughout this report, the spillover benefits from research are difficult to measure. However, many attempts have been made to estimate the social benefits from rural research. The Commission's review of those attempts can be found in appendix QA and a small sample in the previous chapter.

Clearly, if research by the RDCs were reduced, some benefits would be lost. There would also be some gains, for instance the costs of raising the funds used for the subsidy. ABARE (Sub. 382) submitted its estimates of what the magnitudes of those gains and losses might be, if the subsidy to RDC was reduced to the level of 1:4 (see table E4.1).

Assuming rates of return of between 50 and 300 per cent, as found for broadacre research (see appendix QA) ABARE calculated losses for three scenarios, with scenario 2 seen as the most likely.

Table E4.1: **Estimate of benefits lost from reducing the government contribution to RDCs to 1:4<sup>a</sup>**

	<i>Current research expenditure maintained</i>	<i>Current levy rates maintained</i>	<i>Industry contribution reduced to zero</i>
Current expenditure	\$158m	\$158m	\$158m
New industry contribution	\$126.4m	\$79m	0
New government contribution	\$31.6m	\$19.8m	0
Total new expenditure on R&D	\$158m	\$98.8m	0
Reduction in R&D performed	No reduction	\$59.2m	\$158m
Losses:			
Return achievable	50-300%	50-300%	50-300%
Benefits lost from R&D not done			
Minimum	No loss	\$30m	\$79m
Maximum	No loss	\$180m	\$474m
Increased cost of raising additional levy <sup>b</sup>			
	\$10m	n/a	n/a
Savings:			
Cost per dollar of raising funds	33c	33c	33c
Admin costs of raising gov funds	\$15.6m	\$19.5m	\$26.1m
Cost per dollar of raising levy funds <sup>b</sup>	n/a	n/a	33c
Admin cost of raising levy funds	-	-	\$17.4m
Total savings	\$15.6m	\$19.5m	\$43.5m
Net gain/(loss) to society			
Minimum	\$5.6m	(\$11.5m)	(\$35.5m)
Maximum	\$5.6m	(\$199.5m)	(\$430.5m)

a Using 1990-91 data.

b Assumes cost of raising funds through levy is two thirds of that of raising funds through the tax system.

Source: ABARE Sub. 382; Commission estimates.

The Commission does not necessarily agree that losses of such magnitude would occur. Rates of return on rural research projects are not always as high, even, as the lower rates used by ABARE. At least 25 of the 42 econometric studies examined in appendix QA (see table QA13) show returns of less than 50 per cent. Of the 20 case-studies examined (see table QA14) nine show returns of less than 50 per cent.

However, in view of the less than robust nature of the evidence, the Commission considers that any changes in the funding arrangements should be such that the risk of a reduction in RDC research is minimised.

### **What rate of support?**

It is desirable on efficiency grounds for the ceiling on government contributions to be removed, to provide an ongoing incentive for farmers to increase their contributions to R&D generating spillover benefits.

The optimal rate of support in an open-ended scheme would be that rate which maximised net social benefits, taking into account its inducement effects on R&D and the value of the consequent spillovers relative to the cost of support. In practice, the information needed to make those calculations is not obtainable.

More pragmatic considerations therefore inevitably must play a role in determining the rate, as they have in the past. One constraint that the previous analysis suggests, however, is that the risk of a reduction in RDC funded R&D should be minimised in any change that is introduced.

One option would be to simply maintain dollar for dollar funding beyond the current 0.5 per cent of GVP barrier. This is, in effect, what the NFF and some other rural industry representatives have proposed, although they are adopting an incremental approach to raising the ceiling (initially asking to have it raised to 0.75 per cent of GVP).

Maintaining dollar for dollar funding has the attraction for the rural sector of simplicity and continuity, with all industries clearly better off and no risk of a reduction in R&D. However, the Commission has several reasons for not favouring this option.

Firstly, the dollar for dollar funding regime can be interpreted as a relatively generous rate of initial support to encourage the involvement of farmers in R&D and promote awareness about the benefits achievable from R&D. The scheme envisaged that beyond 0.5 per cent of GVP, government contributions would no longer be necessary to induce additional industry contributions. The Commission considers that while it is desirable to maintain assistance at the margin, there is evidence that rural industries have a heightened appreciation of the benefits of R&D and a greater willingness to contribute than at the outset of the program. Several industries have reached, and some have exceeded, the ceiling. Thus, the rate of support needed to induce additional industry contributions, while not necessarily zero as originally envisaged, is likely to be less than dollar for dollar.

Moreover, maintaining dollar for dollar funding in an open-ended scheme would be unprecedented in its generosity by international standards. It would imply that a dollar of government support for R&D by rural industries yielded net social benefits three times greater than a dollar of support for manufacturing R&D. And it would neglect the fact that governments already provide

substantial support for public good research in agriculture through CSIRO and the State research bodies, much of it spent in collaboration with the RDCs.

Finally, the budgetary implications of open-ended dollar for dollar funding would cast doubt on its sustainability in fiscally stringent times.

The Commission now accepts, however, that it would also not be appropriate to reduce government support to one dollar for four dollars from industry, to be in line with that for companies receiving the 150 per cent tax concession. As discussed, farmers will generally have less incentive to fund R&D, even with the RDCs, than a company. Rural research is also more basic in nature and there is the likelihood of greater beneficial community spillovers than in manufacturing research.

**An intermediate rate of support, namely one dollar for every two dollars spent by industry on R&D, would in the Commission's view provide a more appropriate ongoing incentive.**

This ratio has received some support from the RDCs themselves, who collectively proposed a sliding scale of support which:

- maintained 1:1 funding to 0.5 per cent of GVP;
- then declined to 1:1.5 to 0.75 per cent of GVP;
- levelling out at 1:2 thereafter,

with its continuation being reviewed when the industry contributions reached one per cent of GVP (Sub. 368, p. 24).

The rationale offered was based on the prospect of a declining ratio between social and private returns at higher levels of R&D spending.

The likelihood of such a relationship was disputed by the NFF, however, which considered that at higher levels of spending more strategic research (with higher spillovers) would be done (Sub. 459). As noted by the NFF, the issue would need to be resolved empirically. RDCs are beginning to collect relevant information, but there is no basis for conclusions yet.

Another possible rationale, with some empirical support in the manufacturing sector, is that because the private returns to R&D are likely to fall as more R&D is done, the external or spillover returns are also likely to fall. A fixed relationship between private and spillover returns was assumed by the BIE in its report on the tax concession (BIE, 1993c). However, the Commission has some doubts about the validity of this proposition (see part A).

While there is not a strong theoretical or empirical basis for a sliding scale of support based on returns to R&D, the Commission does see value in

maintaining dollar for dollar funding for initial contributors, who may need the extra encouragement to participate and increase their involvement.

As in the RDCs' proposal, one option would be to maintain dollar for dollar funding to 0.5 per cent of GVP, reducing it to 1:2 only for industry contributions beyond that. This would involve no risk of a reduction in R&D. And those at 0.5 per cent of GVP would have a greater incentive to do more R&D. All farmers would also clearly be better off than under current arrangements.

This approach, however, would require the Commonwealth Government to increase its spending on RDCs from the outset. The Commission considers that more effective use of Government funds could be achieved by *redistributing* support — to induce more R&D for the same outlay.

**The Commission considers that an assistance regime involving dollar for dollar funding to 0.25 per cent of GVP and one dollar for two dollars from industry thereafter would achieve this.**

Under this regime, government funding would increase beyond that currently possible only when industry contributions exceeded 0.75 per cent of GVP.

In the Commission's judgment this scheme would remain sufficiently generous to induce new industries into the RDC arrangements, while providing ongoing encouragement for industries to contribute to research. The Commission considers that the subsidy continuing beyond 0.5 per cent of GVP is sufficient to offset any disincentive provided by the small reduction in subsidy below that level.

The immediate effects on individual industries would differ depending on the existing level of industry contributions:

- The research funds for industries currently below 0.25 per cent of GVP in their levy contributions would not be immediately affected.
- Industries currently around 0.5 per cent of GVP would have to increase their contribution to 0.58 per cent of GVP to maintain existing R&D expenditure. Once at that level they would be better off, because increased contributions would continue to attract a government contribution.
- Industries currently between 0.25 per cent of GVP and 0.5 per cent of GVP would be affected to a smaller extent than those already at 0.5 per cent of GVP. For instance, an industry currently at 0.35 per cent of GVP would have to increase its contributions to 0.38 per cent of GVP to maintain expenditure. Beyond that (as well as beyond 0.5 per cent of GVP), the incentive to increase contributions remains, as there will no longer be a ceiling.

Overall there is greater potential under the Commission's proposal for an expansion in beneficial R&D through the RDCs than under current arrangements, which inhibit the growth of R&D beyond 1 per cent of GVP. Nevertheless, to minimise the risk of any disruption to current research programs, the new arrangements could be phased in. The Commission favours the immediate removal of the ceiling, with the GVP level at which the rate changes moved back, for instance, as follows:

- Year 1: 0.45 per cent of GVP;
- Year 2: 0.40 per cent of GVP;
- Year 3: 0.35 per cent of GVP;
- Year 4: 0.30 per cent of GVP; and
- Year 5: 0.25 per cent of GVP.

**The Commission recommends that the present levy matching scheme through RDCs, involving dollar for dollar contributions by the Commonwealth up to 0.5 per cent of GVP, be amended as follows:**

- **The Commonwealth to continue to provide one dollar for every industry dollar spent on R&D up to 0.25 per cent of GVP; and**
- **thereafter to contribute at the rate of one dollar for every two dollars from industry, with no ceiling.**

**That component which involves a reduction in the ratio of government support should be phased in over five years.**

The RDCs undertake a number of activities in addition to R&D. These include facilitating the dissemination, adoption and commercialisation of research results. Some of these activities generate little in the way of spillover benefits. The Commission suggests that the Task Force, about to undertake the second stage of its review of the RDCs, examine the appropriateness of including these activities for the purpose of receiving government support.

### **E4.3 Small and emerging industries**

The Rural Industries RDC said R&D in new industries has potential for increasing returns and major spillover benefits, and the chances of worthwhile R&D going unfunded are high, especially given that the R&D is riskier than that for established industries.

However, it also said the levy mechanism, in the way it operates for larger industries, is inefficient for small industries:

They impose higher operational costs on the Corporation, limit our ability to increase funding for research from small industries and constrain the optimum scope of R&D programs for new industry development (Sub. 124, p. 13).

It added that although small and emerging industries have demonstrated their preparedness to establish levies, often at rates well above the 0.5 per cent GVP level, the amount collected, while relatively high in proportion to that collected for the larger industries covered by other RDCs, is small in absolute terms and insufficient to support a viable R&D program. It said that adding to the difficulties is that GVP is difficult to calculate and subject to significant error as statistics for smaller production units are not collected.

In its policy statement (Kerin and Cook 1989) the Government stated that it was inappropriate to apply the 0.5 per cent GVP ceiling to infant industries. It argued that research on behalf of such industries was particularly likely to have significant spillovers. However, the benefiting industries were expected to make a contribution. The Rural Industries RDC agreed. It also said early involvement in research is beneficial because:

... industry involvement in the management of research programs enhances an innovative culture, earlier adoption of research results and industry preparedness to increase their funding for relevant research (Sub. 124, p. 9).

It further said the wildflower, emu, ostrich, horse and tea tree oil industries currently all wish to make an increased contribution to research for their respective industries, but there is no viable levy mechanism to collect or match the funds. The Emu Farmers Association of Australia has, however, requested the Minister to impose an R&D levy (Sub. 245).

The Rural Industries RDC (Sub. 124) recommended that the funds invested by emerging industries should be matched up to a limit of \$200 000 to encourage these industries to contribute to research well above the 0.5 per cent GVP threshold to enable more viable research programs. To minimise the costs of levy collection, it proposed that funds collected through a levy be paid directly to the corporation, the corporation to account for the funds in its annual report.

However, a major difficulty with providing an additional subsidy for these industries is identifying them and separating them from industries that are not new and emerging.

It also suggested the use of gross value of processed product, rather than farm gate product, for matching purposes (Sub. 251). However, there might be some problems with this proposal, not the least of which would be that an arbitrary stage in the value adding process would have to be selected.

There are likely to be significant benefits from research on behalf of small and emerging industries where that research results in the expansion of an industry.

It is not clear, however, what proportion of those benefits would be of the kind justifying government support. For instance, the cost of research into new varieties of fruits or nuts will be partly incorporated in the price of the seeds or plants new entrants into the industry will have to purchase to get established. The same applies to new fertilisers and farm equipment required to grow the new crop successfully. The fact that some small and emerging industries are willing to spend relatively large amounts on research may well mean they are able to capture a large proportion of the benefits.

Nevertheless, the research funded by first movers is likely to reduce the risk for new entrants and provide a considerable amount of knowledge not available without the research.

A change in funding like that proposed by the Commission would be of great benefit to those small industries currently well beyond the 0.5 per cent of GVP ceiling. For instance a small and emerging industry currently contributing 5 per cent of GVP would be able to fund a research program to the value of 8.25 per cent of GVP, rather than the 5.5 per cent of GVP under the current system.

#### **E4.4 Addressing regional problems**

Collectively funded research should benefit those who have contributed. However, with the diverse nature of the Australian agricultural environment, not only as regards climate, but also with respect to soil fertility, prevailing pests, and the availability of water, farmers in different parts of the country may have different problems.

Some agricultural industries are more likely than others to have problems which are confined to well-defined regions. For instance, certain diseases of grapes are concentrated in particular areas. And, as pointed out by a participant in the independent inquiry into the *Wine Grape and Wine Industry*, the King Valley Grape Growers Association, newly developed viticultural areas have different viticultural priorities and problems and need particular research to be undertaken. The problems of horticultural industries are also often confined to specific regions, and even wheat growers have different research needs depending on their location in one of Australia's three main wheat growing areas.

By contrast, intensive beeflots, or egg producers, are not so dependent on specific soil or climatic conditions and a national research program with benefits for all is relatively easy to design.

The Grape and Wine RDC, in presenting evidence to the *Wine Grape and Wine Industry Inquiry*, said that in the past, State departments of agriculture took

responsibility for solving regional problems, but that reduced resources have resulted in viticulture receiving relatively lower priority.

The Horticultural RDC is the only RDC which, under its own — separate — legislation can obtain matching government funding for voluntary contributions to R&D into regional problems (see also chapter E1). Even where a statutory levy is in place, groups of growers, or firms anywhere in the production chain, can get together and apply for matching funding for regional benefit R&D. Three criteria are applied in accordance with ministerial guidelines:

- the urgency of the problem;
- whether it is a highly regional issue; and/or
- whether the problem is of short term duration.

Under the current arrangements there may, however, be a catch. If levy contributions are already up to 0.5 per cent of GVP, an application for funding of regional R&D may fail. That is because it is not clear whether the funding ceiling applies to an individual product GVP or to overall horticulture GVP. And an opportunity to test the system has not yet arisen.

The remainder of the RDCs are not able to obtain matching government funding in this way. A number of the RDCs have, however, developed ways of dealing with regional differences, for instance by developing research programs for particular regions with common problems. The Dairy RDC said:

This challenge [of addressing local problems due to differences in climates, soil types and farming systems] has been met by the formation of a three tiered approach comprising National Programs, which benefit the majority of dairy farmers; Regional Programs, with focus on tactical and farming systems research to optimise R&D for 'manageable' regions which exhibit sufficient commonality of production and environmental system to warrant management as an entity ... (Sub. 134, p. 18).

Under the Producer-Initiated R&D Scheme, developed by the Meat RC, groups of farmers can apply for funding of up to \$10 000 to help them manage their own R&D projects, and to focus their efforts on the areas of greatest relevance to them.

In the case of the Fisheries RDC, it has been directed by the Minister to:

... spend industry funds raised from a particular fishery, region, State or Territory ... on R&D projects that are directly relevant to the fishery, region, State or Territory ... (Fisheries RDC, 1993, p. 7).

The Grains RDC, also, has an arrangement in place which recognises that regional differences in research needs exist. Its structure is based on advisory Panels covering the northern, southern and western grain growing regions of Australia. These panels recommend priorities to the Board across a spectrum of

regional sub programs. The system ensures that specific research is undertaken as required in different regions.

In its draft report the Commission canvassed participants' views on the feasibility of funding additional regional R&D by way of voluntary collective funding or by differentiated levies. However, many participants said the arrangements put in place by RDCs to accommodate regional research needs were working well.

For instance, the United Dairyfarmers of Victoria said:

A key feature of the [Dairy RDC's regional development] program is that ownership of the program remains largely within regionally based industry groups with the DRDC providing resource support and assistance with planning, development and review of the performance and outcomes of projects delivered through the program. These regional programs are able to attract voluntary local funding and resource support including from farmers, to complement the DRDC contribution (Sub. 345, pp. 3–4).

The Cattle Council of Australia said it believes that the Meat RC deals well with regional research. It said:

... the idea of funding additional regional R&D through either some voluntary collective levy or by differentiated levies would seem totally unnecessary, at least in the meat industry's case. Furthermore, it would potentially cause fragmentation of research and would involve considerable administrative complexity (Sub. 370, p. 11).

The Pastoral Group, an autonomous commodity group within the Victorian Farmers Federation, said differentiated levies would be costly to administer. The NSW Farmers' Association said the existing structures within the RDCs enabled regional problems and issues to be targeted, and:

[The Commission's] proposal overlooks the need to maintain a critical mass of research capability, and ignores the considerable administrative and other problems that would arise from the implementation of such policies (Sub. 315, p. 13)

While participants in general appeared satisfied with the arrangements developed by their RDCs for tackling regional problems, some said the arrangements in place for the Horticultural RDC should be extended to other RDCs. The Tasmanian Government said it had found a number of advantages from that system, in addition to the ability to fund regional research:

- industry is directly involved facilitating a greater uptake of results;
- it provides a mechanism to stimulate industry collectives;
- direct accountability of researchers to funders; and
- major beneficiaries pay (Sub. 277, p. 7).

The Commission sees merit, in principal, in the arrangements for undertaking regional research as they apply to the Horticultural RDC. It suggests the Task

Force, in the second stage of its review of the RDCs, examine the feasibility of extending the system to other RDCs.

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## **E5 STATE INVOLVEMENT IN RURAL RESEARCH**

Well before Federation the Australian colonies established agricultural departments to look after the needs of local farmers. The wide diversity of climates, soil properties, water availability and other environmental conditions in the various regions in Australia have resulted in farmers in each State having different problems and research needs. As a consequence, the modern State departments of agriculture have developed considerable expertise in particular areas of agricultural research, mostly of an applied nature. The States generally see their role as performing public benefit, but applied research.

As shown in chapter E1, the State departments of agriculture perform about half of the total rural research carried out in Australia. The bulk of this research is block-funded by the relevant State government. However, some departments of agriculture also receive some funding from the Commonwealth Government under specific programs, such as for salinity research or other landcare problems. Also because of their specialised expertise, the State departments of agriculture perform a considerable amount of sponsored research for each other, the RDCs, and for CSIRO and other public agencies (for information on individual State spending see chapter E1).

As well as examining how the State governments set priorities for their rural research, this chapter will look at another traditional State activity, extension.

### **E5.1 Priority setting by State departments of agriculture**

Over recent years, with diminishing resources available from State governments, some State departments of agriculture have been reviewing their priority setting procedures. Some areas traditionally their realm, including extension, have been cut back and some departments have had to compete more aggressively for outside funding.

#### **New South Wales**

New South Wales Agriculture employs a two stage priority setting process. First it establishes whether a proposed project accords with corporate objectives. Then it ascertains whether the project is in line with the various national industry bodies' priorities (Sub. 264).

The New South Wales Government, in 1994, conducted a survey of the State's involvement in R&D (Sub. 264). Spending by New South Wales Agriculture on agricultural research was reported in chapter E1. The survey revealed that in New South Wales 55 per cent of total R&D expenditure is on agricultural R&D.

However, it said it is not possible, from the survey, to determine whether its spending on R&D is too high or too low, or just right. It said this was because:

- data collection for such purposes is inadequate;
- there are measurement problems; and
- it is difficult to attribute accurately the proportion of any aggregate economic gains to particular R&D investments.

The Commission understands that there has been a decline in block funding for agricultural research in New South Wales and that this has put pressure on its scientists to attract industry funds for any research they wish to undertake. Since the RDCs are the main sponsoring bodies, it has become difficult to fund R&D away from RDC priorities. The Commission also understands that this applies to other State and Federal research providers as well.

## **Victoria**

A review of the (then) Department of Agriculture and Rural Affairs (DARA) in Victoria (Baker et al. 1990) found that in spite of its strong science base, DARA lacked a relevant research strategy. It made a number of recommendations aimed at improving DARA's ability to produce relevant, high quality research. These included the 'separation of the quality control functions' from the operational function, and better ex ante assessment of the potential payoff of research. Another important study was the *Review of Field-based Services in the Victorian Department of Food and Agriculture* (DFA 1992).

A number of the recommendations of these reviews have been implemented, resulting in major structural changes within the Department. The Chief Scientist, supported by a small Science Unit, is responsible for the quality and direction of R&D within the Department. Ten industry teams coordinate the research and development performed on behalf of their industry. Another part of their function is to develop five-year industry R&D plans.

The Victorian Government suggested that the administration and operation of publicly-funded R&D should be separated from policy and funding bureaucracies. Quoting the Commonwealth Government arrangements for supporting rural industry research as an example, it said it may be appropriate for the funding body to be a statutory authority:

Such organisations have been shown to be an efficient way of allocating funds, notwithstanding any weaknesses that may be present in particular organisations (Sub. 241, p. 29).

## **Queensland**

A review of the rural research activities by the Queensland Department of Primary Industry (QDPI) found that a more systematic approach for setting priorities was desirable, and made some specific recommendations on how that could be achieved (Henzell et al. 1993). It also recommended a more participative approach to research planning and priority setting, and closer collaboration between research agencies in Queensland.

Following this review QDPI made a commitment to increase the contribution to its research from external sources. This currently stands at 27 per cent (Sub. 253). QDPI is currently developing more rigorous systems of research prioritisation at three levels:

- research projects undertaken by QDPI;
- Broad Activity Areas (linked groups of projects targeting identified objectives and meeting output targets); and
- whole of QDPI research portfolio (providing the strategic direction applied through the priorities at lower levels).

A process has been developed for the first of the above and a draft manual prepared. Work is still underway on the latter two areas.

All prioritisation will be done in conjunction with industry and research providers and applied and experimental development research will receive the highest priority. An ex ante benefit cost framework or scoring system will be applied, and projects ranked within groups. A monitoring process is also proposed (Sub. 442).

## **Western Australia**

The Western Australian Government does not have a formal mechanism for setting R&D priorities for the State. Instead, it sets the total budget for each individual department which then allocates the funds internally. The Department of Agriculture of Western Australia (DAWA) has not had a separate R&D budget since 1991–92. At that time the Department adopted program management in which research is carried out in parallel with other functions (Marinova 1994). The four programs currently in place are:

- industry and market development, aimed at identifying market opportunities and facilitating the development of new and improved products;
- sustainable agricultural systems, aimed at ensuring economic returns are maximised while conserving land resources;
- industry support and assistance, aimed at better management; and
- protection, regulation and control.

All these activities involve significant R&D activity of an applied rather than basic nature. DAWA said decision making is hierarchical but new ideas for R&D can come from any level within the Department. New projects must meet at least two criteria: there must be market failure in that the private sector would not do the research, and a quantitative analysis must show prospects for benefits 'well above costs'. However, it said judgment remains an important factor in expenditure allocation.

DAWA said it was concerned about the trend to reduced State government funding for R&D. It said:

In some states the rate of withdrawal of State funds had been very rapid (Sub. 192, p. 7).

and

This could be costly to the economy given the evidence of higher rates of return to public investment in agricultural R&D and given that much of this R&D is by its nature not the kind of investment that is highly attractive to the private sector (Sub. 192, p. 7).

## **South Australia**

The South Australian Research and Development Institute (SARDI) was created in 1993 to:

- create a better focus and direct the State's research capacity;
- ensure research outcomes are more relevant and available to industry;
- ensure research and its management operate with commercial and industry standards; and
- increase South Australia's national R&D profile and influence.

SARDI has prime responsibility for the development, coordination and provision of science, research and development policy advice, initially focusing on the rural sector. It has identified nine strategic areas needed to fulfil its mandate (see box E5.1). The SARDI Board is responsible for the allocation of

research funds through SARDI, Primary Industries SA, Treasury and other sources.

The South Australian Government, with regard to priority setting procedures, said:

Examination of past practices suggested that South Australian Government research expenditure was largely determined by historical patterns rather than by perceived areas of growth for the South Australian economy (Sub. 289, p. 17).

It said new mechanisms for government R&D management are still being developed:

It is envisaged that the South Australian Development Council will establish economic development policies and subsequent overall R&D objectives for South Australia. SARDI will be responsible for implementing/facilitating the R&D objectives (Sub. 289, p. 17).

#### **Box E5.1: South Australian Research and Development Institute**

SARDI has identified nine strategic areas it needs to address to fulfil its mandate:

- Identify new strategic opportunities
- Enhance Primary Industries
- Development research collaborations and consultancies
- Establish effective marketing and communications
- Protect and develop natural resources
- Develop and promote a State Science Policy
- Implement effective strategic and performance management
- Provide the optimum work environment
- Develop the appropriate organisation culture

*Source:* South Australian Government, Sub. 289.

## **Tasmania**

The Tasmanian Government (Sub. 277) is in the process of establishing a Tasmanian Institute of Agricultural Research (TIAR). The TIAR will be a merger of the research activities of the Department of Primary Industry and Fisheries (DPIF) with the Department of Agricultural Science at the University of Tasmania.

It is envisaged that there will be significant involvement by Tasmanian agricultural industries. The closer links between industry and research providers made possible through the TIAR are expected to result in the widening of the range of R&D expertise, and the positioning of research and training closer to industry and community needs (see also box E5.2).

**Box E5.2: Tasmanian Institute of Agricultural Research (TIAR)**

The Tasmanian Government identified the following advantages from the creation of the TIAR:

- A transparent orientation and prioritisation of research and development relevant to Tasmanian industry needs.
- Better quality research infrastructure for the same outlay of funds.
- Underpinning the future of the University of Tasmania's Department of Agricultural Science.
- Access to a wider range of staff with specialist expertise for undergraduate and postgraduate students.
- A significant increase in Mechanism A funding flowing to the University of Tasmania.
- An opportunity for the DPIF to refocus its effort in the pursuit of its core business.
- Significant benefits for many DPIF staff in terms of career path development.
- An improved focus for support and involvement by industry.
- Stakeholder investment and external collaboration for outcome oriented research, development and extension.
- Strategic research and its application to improve the sustainability and competitive position of Tasmanian agriculture at a regional, national and international level.
- The creation of critical mass allowing for the integration of industry development, research and extension and the establishment of multidisciplinary teams.
- Consolidation leading to research synergies and tighter management of research activities.
- A means for coherent research and development policy formulation.
- Refocusing the University of Tasmania from the periphery of agricultural research to the mainstream.
- More freedom for commercial activity than is available to Government departments and hence the facilitation of greater collaboration with the private sector and may allow researchers to receive a share of the returns on intellectual property.

*Source:* Tasmanian Government, Sub. 277.

In addition, the Tasmanian Government has been reviewing its processes for priority setting for agricultural research. In July 1994 the DPIF held an agricultural research symposium to initiate a strategic approach to agricultural research and to seek industry's view on current and planned research. The symposium consisted of six one day industry workshops, followed by a conference during which, among other things, participants were asked to identify criteria for establishing R&D priorities (Sub. 277).

Three year industry plans are being developed as an integral part of the planning process. The Tasmanian Government said such a symposium is intended to be an annual event (DR transcript p. 2034).

**Some implications**

Little information on agricultural research by the State governments is available from official sources. And while initially not all the State governments were able to supplement the publicly available data, after the draft report the

Commission received useful additional information from all the State governments.

Traditionally, the State departments of agriculture, along with CSIRO, initiated most of the research performed for the rural sector. This was justified by the atomistic structure of rural industries and the high potential for spillovers within the sector. With the establishment of the RDCs, a mechanism now exists for the farm sector to initiate its own research. About 38 per cent of all RDC research is performed by State departments of agriculture (see chapter E1).

From the evidence available during the lead-up to the draft report it seemed that reductions in funding for State departments of agriculture, and the need for external funding, were resulting in significant cross-subsidization of, in particular, RDC-commissioned research. It may also have reduced the scope for State departments of agriculture to pursue the research priorities most appropriate to their State.

### *Externally commissioned research*

The Commission considered that State departments of agriculture now had two roles:

- one was to act as providers of commissioned research including for the RDCs;
- the other was to undertake research of particular benefit to the State concerned, that is not being picked up by the RDCs or other providers (such as the universities and CSIRO).

The Commission also said it was the second one which now justified direct State government involvement in agricultural research.

A number of participants said they disagreed with these statements. Their arguments mainly centered around such things as the limited number of research providers willing or able to undertake rural research, historical factors and the special skills developed by State research agencies (Queensland Government, Sub. 442), critical mass in disciplines not covered by other institutions, and the ability to benefit from strategic alliances (Western Australian Department of Agriculture, Sub. 456).

The Commission believes participants partly misunderstood the intention behind the statements. The statements refer to two related principles. Firstly, State departments should be free to undertake externally commissioned research. However, such externally commissioned research should be fully costed and charged for. Secondly, they should not use appropriation funds to undertake research with sufficient private benefits for industry — and the RDCs on behalf

of rural industries — to fund it itself. Neither should they undertake research which is already being undertaken by other research providers, in other words they should avoid duplication.

With regard to costing and charging for research, many participants commented on this, most saying that when State departments of agriculture perform research for the RDCs it should be seen in terms of partnerships. For instance, the Australian Wool Research and Promotion Organisation said:

The principle of cost recovery in commissioned R&D causes no problems for AWRAP. However, it should be recognised that many research organisations ... have wool R&D priorities which are consistent with AWRAP R&D priorities. Therefore, the concept of shared investment in a partnership to achieve shared objectives becomes attractive to both AWRAP and some research providers (Sub. 355, p. 4).

The Queensland Government said:

The issue of full cost recovery for research cannot be treated as a simple principle. ... it will not apply where there are benefits to both the provider and the receiver of the service.

In a state organisation which rigorously assesses its research priorities and applies that rigour to both internal and external funding, research that does not seek to satisfy the organisation's goals is not likely to be supported. This means that commissioned research which does not provide a particular benefit to the state will not be undertaken.

It ... follows that a state agency would not necessarily fully charge for externally commissioned research (Sub. 442, p. 36).

The Rural Industries RDC said that in its experience business would only be done when the issue is of sufficient priority to both the funder and the research agency:

... it is RIRDC's experience that research agencies are choosing not to seek financial support from R&D corporations or to respond to identified industry priorities if the issue is not an identified agency priority, even if the agency has the expertise and facilities to undertake the research (Sub. 367, p. 14).

The Sugar RDC said that joint funding was appropriate where priorities overlap. It went further, saying that priorities don't have to be identical, but:

... if they don't overlap enough to find a partnership you have got to ask whether [your priorities] are right or not (DR transcript, p. 2310).

The Joint RDCs said whether the RDCs pay the full cost of the research should depend on whether the RDCs alone prescribe the subject, objectives and scope of the research, but that in the case of collaborative research, where several parties, including the research providers, are involved:

... the full cost of the research and development should be identified (including overheads) as a prerequisite for negotiation on what proportion of costs each party will contribute (Sub. 368, p. 32).

**The Commission considers that State departments should cost all externally commissioned research and price it to recover full costs unless additional social benefits not already subsidised are identified.**

**If there are further exceptional public good benefits arising from the research, perhaps which extend beyond the industry or interests for which the research is commissioned, a further subsidy may in some circumstances be justified. In such cases the benefits would need to be identified and explicitly funded.**

#### *Separation of prioritising and provision of research*

At the time of the draft report the Commission was unclear on the extent to which some State governments had effective mechanisms in place for setting priorities for publicly funded agricultural — or any other — research. More information has since been received from a number of State governments.

Most of the States said they make extensive use of cost benefit analysis for priority setting. The Western Australian Department of Agriculture said it:

... has in place a system of benefit cost analysis in addition to a system of input from industry. Both these components are integral to priority setting and strategic planning. As with all research institutions in Australia, there is scope for improving the system, but with respect to benefit cost analysis, the Western Australian Department is in a position of leadership (Sub. 456, p. 2).

In the draft report, the Commission said that in principle it saw merit in separating the prioritising and funding of research from the provision of research. It made a draft recommendation that State governments consider the feasibility of separating the prioritising and the funding of agricultural research from the agencies responsible for doing research.

The advantages of separating those functions include that the research is more user-driven and that the client, be this the government, the RDCs, or any other research funder, can purchase its research from that provider which offers the most competitive, but fully costed, service. It would also improve the accountability of government research agencies, as well as the transparency of government funding programs.

These principles appear to have been strongly influential in the South Australian Government's restructuring of its research arrangements, and the Tasmanian proposal to establish the TIAR. The South Australian Government said SARDI was:

... a unique ... innovation for a State government to bring research resources into a stand-alone research agency and not have it associated with one of the other administrative agencies of government (DR transcript p. 2263);

while the Tasmanian Government said:

The proposed Tasmanian Institute of Agricultural Research will be established to consolidate the State's research effort and will in effect separate the prioritising and funding functions to allow the provision of research to be client focused (Sub. 277, p. 10).

In Queensland, also, there appears to be a more systematic external perspective to priority setting of government rural research. A new Rural Development Group is being established within QDPI to ensure coordinated interaction between industry, rural communities and government agencies. The Queensland Government said:

This Group will play a strong role in influencing future research priorities within Queensland's rural and agribusiness sector (Sub. 442, p. 21).

While some of the States appear to be moving towards separating the prioritising and funding of research from the agencies responsible for doing research, some participants saw problems with such an approach. For instance, the Victorian Government said that:

... while separation has advantages, it may bring disadvantages in the form of increased costs, increased bureaucracy and less robust policy (Sub. 454, p. 3).

The NSW Farmers Federation said:

The recommendation to remove priority setting and funding mechanisms from research organisations will lead to duplication of administration. This is a major concern to the rural sector, as it leads to a needless waste of industry and Government funds that could be spent more productively on research (Sub. 315, p. 20).

The Sugar Research Institute said that they are concerned that separating those functions would create as many problems as it would solve.

Nevertheless, the Commission sees advantages in the States at least creating separate research institutions, at arm's length from the bureaucracy, to achieve greater transparency and accountability, as well as a clear identity and purpose. It supports the initiatives of the Tasmanian and South Australian Governments in this regard.

Such arrangements also need to be supplemented by priority-setting mechanisms that draw on a range of stakeholders within government, industry and the wider community, to help identify those areas that are most important to each State (the symposium held by the Tasmanian DPIF is a good example of this). And, as in the case of CSIRO and other Commonwealth Government

research agencies, it is important also that performance indicators be developed and reported publicly on a regular basis.

**The Commission recommends that:**

- **those State governments which have not already done so, consider establishing their agricultural research departments as separate corporations or institutes;**
- **States establish forums for the purpose of developing explicit State priorities for agricultural research; and**
- **States establish performance indicators to assist in monitoring and evaluating the effectiveness of their research agencies.**

Over time, these changes would also allow State governments to better evaluate the role and contribution of their agricultural research activities and determine whether further reforms are needed.

## **E5.2 Extension**

In the draft report the Commission said extension involved the transfer of information (technical as well as management related), which has become available as a result of research and development activity, to farm managers. It quoted a definition provided by the Queensland Government:

... the targeted flow of information designed to assist firms and individuals to build up their knowledge and improve their capacity to better manage an area's agricultural and natural resources (Sub. 257, DPI section, p. 2).

The Commission went on to say that extension was about the diffusion of research outcomes, and that speedy diffusion was essential if the benefits of R&D are to be realised as quickly as possible. This is because the rate of diffusion will influence the rate at which new technology is adopted. The Western Australian Department of Agriculture found the rate of return to R&D to be very sensitive to when farmers start to adopt a new technology, and also to the level of adoption:

If strategies that increase [feed] utilisation by 0.7 t/ha are adopted by 30 per cent of Western Australian dairy farmers within 5 years rather than 10, then the benefit cost ratio of R&D is 2.9 rather than 1.7 (Sub. 192, p. 3).

Some participants said the definition of extension adopted by the Commission was too limited, and gave a very narrow view of the role of extension. They said extension should be seen as a very significant aspect of any R&D program. The Bureau of Sugar Experiment Stations said:

... the critical question for any serious investment in research and development is not whether the service or products were **delivered** or **promoted**, nor even whether they were **adopted** or **used**. Rather, it is the **BENEFITS** from the adoption of the outcomes which ultimately must drive any research and development agenda. It should no longer be acceptable for research and development to simply develop and promote outcomes of research investments.

It went on to say:

Modern extension literature sees extension as a facilitation or change agent type activity rather than a simple salesmanship/advertising type role (Sub. 297, p. 3).

The South Australian Government said extension as a discipline has changed markedly in recent years, and, as a function of government, and in relation to research, has a much wider and more interactive role (see box E5.3).

#### **Box E5.3: South Australian Government view of the role of extension**

Extension involves interaction with customers, stakeholders and with other service providers and involves:

- development of two-way communication on needs and opportunities and information;
- development of user-accessible information services;
- development of a market and quality consciousness amongst our customers;
- development of our customers' skills in marketing and business, as well as skill in management of more sophisticated production systems;
- encouraging industry to become more self reliant for the provision of service delivery through development of partnerships;
- development of a regional and a community focus for industry and commodity projects and services; and
- definition of constraints to development as inputs to research and government planning (Sub. 289, p. 26).

*Source:* South Australian Government, Sub. 289, p. 26.

Traditionally, in Australia, extension has been the role of State departments of agriculture. That is not to say that there is no private sector involvement in the business of providing advice to farmers. For instance pesticide and fertiliser firms provide information about the use of their products and suppliers of irrigation equipment provide advice about the best system to use under given conditions. Agricultural consultants, but also veterinarians, accountants and banks are in the business of providing advice to farmers.

The provision of extension services, even with partial cost recovery, represents a cost to the community. This cost is not insignificant, and certainly larger than

that of merely transmitting information, as some participants pointed out. The Tasmanian Government said:

Some extension programs will require funding at levels similar to or in excess of that required to undertake the R&D work (Sub. 277, p. 11).

The question is whether these costs are justified, or whether the market, left to itself, can be expected to provide an adequate amount of extension services.

### **The public provision of extension services**

Little reliable information is available publicly about agricultural extension services. The *Review of Field-based Services in the Victorian Department of Food and Agriculture* (DFA 1992) found that in 1990–92 spending by all sources on extension in Victoria was \$12.6 million compared with \$26.6 million on research.

The Queensland Government said expenditure on extension services in 1992–93 was \$79 million. This included extension services in the areas of production, sustainability, marketing, forestry, water resources and community services.

The NFF expressed its concern about a decline in extension services in recent years, saying:

State budgetary outlays for extension decreased from 23 per cent of agricultural outlays in 1981–82 to 16 per cent in 1989–90 (Sub. 203, p. 17).

Prinsley et al. (1994), analysing unpublished data, found that overall, State extension resources had remained steady between 1983–84 and 1991–92, but that in Queensland they had fallen sharply in the two years from 1989–90 and that in New South Wales they had increased sharply during that period. They do, however, point to the unreliability of their data for various reasons. For instance, in New South Wales, for the latter part of the period, regulatory staff were included amongst extension staff.

During the 1960s and 1970s the Commonwealth supported State extension activities directly through the Commonwealth Extension Services Grant (CESG). According to Watson et al. (1992) this resulted in a rapid expansion in extension services to farmers and implicitly demonstrated the Commonwealth's belief that:

... farmers would not adopt improvements to farming practices at a desirable rate, if left unaided (p. 14).

A major reduction in staff numbers between 1980–81 and 1981–82 was thought to reflect the abolition of the CESG in 1981 (Evans, Campbell and White 1990).

The Rural Industries Business Extension Service is a Commonwealth Government program currently in place which aims to improve the access of agricultural and related businesses to both professional business and marketing support services. Under this program farmers can claim up to 50 per cent of the cost of employing a consultant or facilitator who can provide professional help on value-adding and/or technology transfer projects. This program appears to be similar to the National Industry Extension Services, but specifically targeted at agricultural businesses.

### **Current trends in extension**

With the changing nature of farming and farmers, and better communication technology, as well as State governments operating in a climate of resource constraints, State governments have been reviewing the extent to which they are involved in extension. The South Australian Government said:

[Primary Industries SA] is shifting from the provision of technical services to the facilitation of economic development at a commodity/industry level, and extension services ... are increasingly mirroring these strategic aims (Sub. 289, p. 25).

In some cases the result has been a greater emphasis on providing such services on a partial cost recovery basis. In Tasmania, fees for field-based services to farmers were introduced as early as 1982. These fees were aimed at partial cost recovery.

Where services are still provided free of charge, there is greater emphasis on group delivery rather than one-to-one. QDPI (1993) said:

The focus of QDPI extension will be on industries (industry bodies, producer groups, producers, and associated input and output industries) and geographically defined communities as the clients. It will not be about providing publicly subsidised services to individuals ... (p. B-3)

Improved methods of communication allow some services, previously handled by farm visits to be dealt with by telephone or facsimile. For instance, in 1992, the Western Australian Department of Agriculture handled 60 per cent of requests for extension services by telephone (DFA 1992).

There appears to be a trend to greater provision of private sector extension services. CSIRO said:

... we're in a position of seeing a number of changes in ... extension services. Some states are maintaining them. We're getting higher quality technical advice emanating out of private sector agribusiness firms where it used to be just a salesman. There is more use of consultants (DR transcript, p. 3149).

According to Prinsley et al. (1994), a trend towards greater use of private sector advisory services and the concept of trading information as a commodity is also evident overseas. In some countries (for instance Denmark) extension services have been owned and operated by farmer associations for many years.

In Australia, also, primary producers' associations are active in providing advice to members. For instance, the United Dairyfarmers of Victoria have regional research and extension committees in place. Greater involvement by farmers themselves may be due to a perception by farmers that State governments are, to some extent, withdrawing from extension services. The Macadamia Society said:

... they're really being squeezed to the point that extension from the various departments is non-existent, so in our case we have picked up most of the extension — technology transfer side of things within our own organisation. ...

### **The rationale for government involvement in extension**

There is some limited evidence that the partial withdrawal of the public sector from extension services has resulted in an increase in the number of private consultancies engaged in extension activities (Hone 1991). However, extension has a number of characteristics which may prevent the market from providing it in desirable quantities.

For instance, although not as obvious as in the case of research, there are spillovers from some extension activity. Like those from research, those spillovers are related to the public good nature of information. The community at large benefits from increased rural amenity, the prevention of exotic diseases in cattle, and the reduction of harmful residues in fruit and vegetables.

It could be argued that it is the research which provides the necessary knowledge; but only the dissemination of that knowledge through some form of extension can transmit the knowledge to farmers for implementation. These kinds of spillovers may justify government funding of extension.

Where the information is of benefit only to those farmers within an industry, or within a region, the case for government funding is less clear. Collective funding of extension may be more appropriate in such a situation.

Where the information is useful only to an individual farmer with a specific problem to solve, the spillovers will be close to zero. About such a case the Western Australian Department of Agriculture said:

... information which is customised for and presented to individual farmers does not involve market failure; considerable investment is required per farmer so that low marginal costs no longer apply and it is not difficult to exclude farmers from this kind

of extension or to administer a charge for its use. That kind of information ... clearly should not be provided by the Department of Agriculture (Sub. 192, p. 5).

Watson et al. (1992), in addition to noting the spillover benefits from some extension services as a source of market failure, suggest another reason why the private sector is likely to underinvest in the provision of extension services. This is related to the cyclical nature of farming, which results in an unstable demand for information by farmers. They also point to other possible sources of market failure, related to education and training of farmers and specialised personnel, and the need for governments to maintain an adequate infrastructure and technical expertise to handle outbreaks of exotic diseases, droughts, fires and floods.

Another factor inhibiting private provision, suggested by Prinsley et al., is the culture amongst farmers in many industries to receive free information. They say:

If free services were withdrawn a major cultural change would be required for many farmers to commence paying for services (Prinsley et al., p. 52).

ABARE said:

The government probably doesn't have much of a role in extension services for things which are private and patentable goods because there's somebody who has an incentive to more them around and will make the choice on a profit-maximising basis of how much to spend and where to spend it (DR transcript, p. 3587).

On the other hand, ABARE also said that there may be situations where there is a substantial role for government, for instance when:

... government organisations have produced the research and there are potentially wide benefits and it's difficult, if not impractical, to try to sell the benefits ... (DR transcript, p. 3587).

To some extent extension services can be seen as an educational activity. In general, not all the benefits of education can be appropriated by those investing in it. Individuals may therefore underinvest in education, unless governments intervene.

In the draft report the Commission said it supported the States' withdrawal from those extension services with predominantly private benefits, and which can profitably be provided privately, but said a case could be made for the public funding of certain extension services on the grounds of market failure.

A different, but related issue is the mechanism by which the public extension services should be provided. Should extension be delivered through a separate body or by the organisation doing the research? And if so, should it be done by the researchers themselves or specially trained persons?

Extension requires a highly skilled expertise. Not only does an extension officer need to be know a significant amount of scientific detail involved, but communication skills are essential. Researchers in general are likely to be overqualified in the science component and lack training in communication. But close coordination and cooperation is desirable, if not necessary, between those doing the research and those performing the extension services.

The Commission believes that the most appropriate way to provide extension services is likely to be in conjunction with the research function, but by specially trained persons. The Tasmanian Government agreed with that view. It said:

Achieving high adoption rates (> 50%) in short time frames requires particular extension expertise to be deployed in designing, implementing and managing extension programs (Sub. 277, p. 10).

This will also enable extension activity to serve as a useful feedback mechanism from research users to research providers. As the NFF said:

Extension facilitates a two way communication link between researchers and producers, enabling researchers to be more attuned to the needs of industry so producers are more likely to adopt new scientific developments (Sub. 203, p. 17).

Accepting this, the appropriate organisation to provide the services is likely to be that which provides and/or funds the research. Where the research funding and research providing have become separate functions — and research funding is project based — extension of the research results could be included into the research contract as considered necessary.

In the draft report the Commission said it considered that the RDCs were well-placed to provide extension services. In effect, facilitating dissemination of research results is specifically mentioned in the legislation as one of the functions of an RDC.

To fulfil that role, a number of RDCs have developed communication strategies to disseminate research results. Some, for instance the Cotton RDC, employ a full-time technology transfer co-ordinator. The Horticultural RDC is currently supporting 10 Industry Development Officers located within production areas, and is also funding extension activities carried out by State Departments of Agriculture (Sub. 53).

The Dairy RDC has developed a program entitled *Target 10* (operating in Victoria) in which farmers enrol in courses and participate in project design, management, evaluation and delivery (see box E5.4). Similar programs operate in New South Wales (Project 20) and Tasmania (TOP Project) (Sub. 134).

**Box E5.4: Target 10 — an extension program with a difference**

The objective of *Target 10* is to enhance the viability of the Victorian dairy industry through programs which profitably increase the consumption of pasture per hectare by 10 per cent on 50 per cent of dairy farms over five years. To achieve this objective *Target 10* brings together dairy farmers, dairy factories, private consultants, industry organisations, government, research organisations and other interested parties, focusing on one goal: improving pasture consumption. Funding of \$300 000 annually is provided by the Dairy RDC (30 per cent), the Victorian Government (50 per cent), sponsorships (10 per cent) and voluntary labour (10 per cent).

It started in February 1991 with a meeting of representatives from all major stakeholders in the dairy industry. A *Target 10* State Executive Group was formed, and four *Target 10* sub-committees developed in each of the four major dairying regions of Victoria. Each regional sub-committee was allocated a budget, and then developed its own projects. Regional sub-committees have sufficient autonomy to provide them with a feeling of ownership, while the Central Executive Committee provides an overall State focus and purpose.

The following are examples of the varied ways the program is delivered:

- The Gippsland region committee provided funds to develop an extension program in intensive grazing management. This required the production of notes, a grazing ready reckoner and an inexpensive pasture measuring device, all of which have application, with some modifications, to other regions of the State.
- The Western region formed a working group to develop a project to address farm layout for better grazing. They are in the process of producing a set of notes drawn from keynote speakers at a series of district seminars on the subject. They will be professionally prepared and provide the basis for a course module to be offered by the Victorian College of Agriculture and Horticulture.
- The Northern region held a major annual conference addressing a wide range of dairy management issues. Not all of these are directly related to the objectives of *Target 10*, and *Target 10* funds will therefore support part of the cost only.
- In the North East region a collaborative research project has been initiated to complement the grazing management focus of the program. Discussion groups and seminars are held in conjunction with agribusiness on a range of technical issues impacting on pasture production and utilisation..

*Target 10* programs commenced officially in June 1992. After 18 months of operation approximately 25 per cent of Victorian dairy farmers have participated in the program. Preliminary evaluations have shown that some program participants have increased pasture consumption by more than 30 per cent, with subsequent improvements in farm returns of around \$20 000.

*Source:* Discussions with Mr J.Boomsma, Department of Agriculture Project Leader for Target 10, Senior Industry Officer Dairy, Gippsland Agriculture Centre, Ellinbank, Victoria.

In addition, most of the RDCs require applicants for research funds to establish how the results are to be adopted by industry.

In spite of the above, some participants said the RDCs had been slow or reluctant to become active in this area. The South Australian Government said:

RDCs may well be one appropriate source of funds for the extension that arises from research, but it would seem unlikely that the RDCs would develop the charter or the infrastructure to provide the extension. In fact there appear to be significant impediments to RDCs playing a greater role in extension (Sub. 289, p. 26).

The Tasmanian Government said it endorses the principle of including extension in research contracts, but said:

RDCs have focused on scientific rigour and management especially when making on-site assessments of projects. Assessment teams have lacked inputs from trained extension personnel and herein lies a symptom of the problem with RDCs past interest in extension (Sub. 277, p. 11).

The Commission has not changed its view that extension should be carried out in conjunction with the research. How the extension is to be conducted is appropriately part of the R&D contract, but should also depend on the outcome of the research. In many cases the RDCs will be the appropriate organisation to carry out — and/or fund — the extension. In other cases, the research providers may be the better organisation to undertake that role. That may be the case particularly where the research provider is a State government department, which has the necessary expertise. Where the research was commissioned by an RDC, the cost of extension should be included in the contract.

That there are, possibly, some inadequacies in the RDCs' extension activities so far, is perhaps not surprising. While they now have some years experience in developing and undertaking research programs, their experience with extension is probably much more limited. That is because most research projects take at least three years and the need to undertake extension largely arises after completion of the contract. As the RDCs gain more experience, they are likely to become more effective in undertaking extension. The question of the appropriate balance of expenditure on extension relative to research by the RDCs is likely over time to respond to the needs of their constituents.

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**PART F**

**LINKAGE MECHANISMS**

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## **PART F LINKAGE MECHANISMS**

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## **PART F LINKAGE MECHANISMS**

This part of the report looks at linkages between the major components of Australia's innovation system and the role governments play.

Chapter F1 provides a general overview of linkages in the innovation system, many of which occur naturally. Other linkage mechanisms — such as university commercial arms and similar bodies created by public research agencies — are not separately funded by government though they in part reflect institutional responses to governmental pressures to be more relevant to industry and other research users. Following sections of the chapter assess the rationale for government intervention in promoting R&D linkages and canvass issues raised by some specific linkage programs.

The Cooperative Research Centres Program is analysed separately in chapter F2.

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## F1 LINKAGES IN THE INNOVATION SYSTEM

Formal and informal linkages play a key role in the functioning of national systems of innovation. Linkages provide a means to access existing sources of technological knowledge. Even more importantly, linkages facilitate the continuous interaction which is necessary to sustain advances in that knowledge.

Strong personal networks have long characterised research ‘communities’. Firms can, and do, choose from a wide range of organisational options in developing networks with suppliers and customers and in coming together with other firms to collaborate in R&D and exploit new technologies.

Governments establish and fund higher education and public research agencies, subsidise private sector research and provide the property rights framework, all of which underpin the workings of the innovation system. However, given the way governments have structured public sector institutions and the different specialisations of the various components of the innovation system — the educational functions of universities, public good research of public sector research bodies, and firms innovating for profit — linkages between these major components are themselves of policy concern (box F1.1).

### Box F1.1: Linkages in the innovation system

Metcalf (1994, p. 940) has provided the following synthesis of much work on innovation systems and the links within them:

‘the innovation system is based upon a division of labour in terms of function and domain, the different institutions reflect different cultures, have different objectives and respond to different incentives mechanisms. As with any division of labour principle the co-ordination of the various institutions is the key issue. Policy must therefore be concerned with the interface between institutions, to draw scientific and engineering knowledge more effectively into the design and development activities of firms. No institution can expect to be self contained in its knowledge generating activities, even large firms have to rely on external sources of knowledge to innovate successfully. Policy can effect greater connectivity in a number of ways, although collaborative programmes and schemes to promote the mobility of scientists and engineers are the most developed formal mechanisms. Recent work which has emphasised user-supplier networks and the informal trading of knowledge is also consistent with the general theme of co-operation in technological development. Indeed informal networks appear to be important routes for technology transfer, reflecting the fact that scientists and technologists, whether in university or industry, are members of a common community of practitioners’.

Creating and strengthening effective R&D linkages between firms, universities and public research agencies became a major focus for government R&D policy during the 1980s. ASTEC's 1980 report on interaction was an early forerunner of a succession of reports on mechanisms for increasing linkages between industry and public sector institutions in Australia (ASTEC 1980). Over the decade, however, governments in almost every OECD country were turning their attention to creating and formalising such linkages (OECD 1992a, p. 72).

The reasons for linkage interventions have varied but common motives include the desire to generate new research, to commercialise more of the research carried out within universities and public sector research agencies, to enhance training for both public and private sector researchers and to diffuse technological knowledge and skills. Linkages with manufacturing industry and firms have been seen as a particular problem area.

### **F1.1 Types of R&D linkages in the innovation system**

Linkages between the institutional elements of a nation's innovation system — the higher education sector, public sector research agencies and individual firms — and links to foreign innovation systems have a major bearing on the success with which technological knowledge is created, modified, transferred and used. As discussed in part A, innovation systems can be characterised as 'mazes' of overlapping networks.

Many of these linkages operate day-to-day as a result of personal contact and as firms respond to normal market incentives. The higher education institutions and public sector research agencies also have established mechanisms specifically to handle their linkages with business and other users, and potential users, of their research. These linkages are surveyed briefly as a backdrop to examining the more activist policies and programs of governments to create linkages, especially between businesses and universities.

#### **Personal and informal linkages**

Linkages can be personal or institutional, and informal or formal. Personal and informal linkages are of longstanding:

Informal networks, between individual researchers and between laboratories situated in different institutional settings (universities, government laboratories, industrial associative laboratories and firms) and/or in different countries are as old as organised science and technology. They are inherent to the existence of 'communities' of scientists and of engineers belonging to the same discipline or industry and working in the same or related fields (OECD 1992a, p. 70).

Not surprisingly, personal networking is also a characteristic of Australian R&D activity. A proposition consistently put to the Commission in discussion was that 'good' researchers and 'good' firms know, and are in contact with, the key people in their fields, both domestically and internationally. For example, Professor Carnegie (Murdoch University) said:

The academics have got very strong networks, very strong international networks, to other academics by and large, and to individual people in industry (transcript, p. 109).

Sir Gustav Nossal wrote of the 'power elites' or 'invisible colleges' operating in major discovery areas of the health sciences which enable technology transfer to 'insiders', short-cutting the nine to eighteen month time delay between discovery and promulgation of new ideas and technologies. As a result of such networking:

... scientists at the Ludwig Institute in Melbourne are now able to apply the most advanced monoclonal antibody techniques in the world (largely developed overseas) to the treatment of cancer patients. Much of their work is based on information that is still unpublished ((Sub. 233, p. 2).

A participant in the Commission's Business roundtable on R&D, though from a small company, spoke of knowing everyone else in the world doing research in their area.

The Internet system provides a worldwide network for personal communication between researchers and the ability to readily access the information systems of major research institutions.

Personal relationships arise from, and are reinforced through, a variety of activities which have a more formal basis. The teaching and training of graduates and postgraduates in higher education institutions, the peer-review screening processes used to allocate R&D funding, the publication of research results, conferences, secondments and exchanges of staff, the use of public sector testing facilities, contracted research and fee-for-service consultancies are just some of the ways in which knowledgeable people are identified and can be drawn into a multiplicity of personal networks.

The NBEET (1993b) study of linkages between industry and universities in Australia found:

... it is strikingly clear that personal communication and individual initiatives are at the heart of creative, innovative and productive research links. This central position of personal links was also underlined by the survey of [higher education] institutions: it was almost always personal relationships between the academic researcher and the industrial collaborator that was viewed as the prime factor in establishing and maintaining such links (p. 71).

The major role that personal linkages play in the creation, transfer and use of knowledge highlights the important function mobile people can play in the innovation system. Mobility encompasses the ease with which people can move within institutions — say, between teaching responsibilities and research activities, between basic R&D and more applied applications, and across research disciplines — between universities and public sector research agencies, between public sector research institutions and agencies and business, and the flow of researchers and innovators into and out of Australia.

Dr Neill of the AIRG said:

There's no doubt about it, if you want to transfer knowledge or technology, the best way to do it is to transfer people. So if you haven't got this capability then it's very inefficient in trying to transfer knowledge from one organisation to the other (DR transcript, p. 3340).

A recent report to the Australian Manufacturing Council on linkages and innovation concluded:

More movement of people between science and business is needed to foster a greater exchange of ideas and information, and facilitate the transfer of technology to business (AMC 1994, p. iv).

The mobility of researchers has also been identified as an issue to be addressed in the Commonwealth Government's forthcoming *Innovation Statement* (Cook 1995a, p. 1.9).

Increased understanding of the role 'tacit knowledge' can play in the dissemination of technological knowledge (see chapter A4) reinforces the need to remove unnecessary barriers to mobility. Firms are looking to secondments to and from institutions to achieve the transfer of person-embodied knowledge. For example, Biotech Australia (Sub. 81) considered encouraging staff secondments from universities and government research organisations into industrial R&D laboratories ought to be one of the new initiatives to boost industry-based R&D.

The lack of portability of superannuation is one factor said to inhibit mobility. For example, as discussed in part B, CSIRO encourages staff secondments to the private sector. While employment terms and conditions are not in themselves constraining factors, it said superannuation and workers' compensation may become complicated. From what the Commission learnt about CSIRO and research agencies overseas, it seems our researchers are less mobile domestically than is observed elsewhere. Adey and Larkins (1994) provide information that difficulties in processing immigration approvals are being experienced in ARC programs.

The Commission sought additional information in its draft report on these and any other impediments to the mobility of researchers and to increased professional exchanges, and sought suggestions to overcome such impediments.

The University of Melbourne (Sub. 313), the Western Australian Department of Commerce and Trade (Sub. 283) and the Australian Industrial Research Group (Sub. 329) variously noted that lack of portability of superannuation and possible changes to benefits under different schemes, and difficulties in processing immigration approvals, do impede the mobility of researchers. The South Australian Government argued that greater compatibility and transportability of personal financial management arrangements, such as superannuation, need to be pursued in order to provide for greater interchange of research staff (Sub. 289, p. 23).

In presenting the draft report submission of the South Australian Government, Mr Rob Lewis (chief executive officer of SARDI) commented on the difficulties of bringing in specialist researchers from overseas:

... just recently it took us in excess of a year to bring in a highly qualified mathematical modeller, because we had to meet all sorts of requirements as to whether the capability was in Australia or not. We knew the capability wasn't in Australia because we tried first ... we had to go overseas, but it put us back a year (DR transcript, pp. 2288–9).

On the other hand, Dr Peter Young (Chief of the CSIRO Division of Fisheries) reported 'no trouble whatsoever' in obtaining immigration approval for scientists from overseas (DR transcript, p. 2728).

The superannuation and immigration issues raised in this inquiry impinge on labour market operations generally, not just on researchers. As for other groups, governments need to be diligent in ensuring that superannuation arrangements and immigration policies do not unintentionally impede the mobility of researchers and increased professional interchanges necessary to sustain technological innovation in Australia.

The AIRG also drew attention to a range of other factors impeding the mobility of researchers that relate primarily to negative 'cultural' attitudes about the role of secondments between research institutions and industry in developing career paths and which span basic and applied research activities (Sub. 329, p. 7). In regard to the mobility of scientists, the IR&D Board nominated as a major concern the poor recognition (by both government institutions and researchers) of the importance of spending sabbaticals in the research laboratories of Australian companies (Sub. 363, p. 60). Cultural factors which impinge on mobility are discussed later in this chapter.

## Linkages among firms

Firms themselves perform a linkage function by identifying markets for new products and processes and organising the array of inputs, including R&D, necessary to profitably exploit market opportunities. Considerable empirical and theoretical research since the 1960s on successfully innovating firms demonstrates:

... unambiguously the vital importance of external information networks and of collaboration with users during the development of new products and processes (Freeman 1991, p. 499).

Linkages among firms can take a variety of forms such as: joint ventures and research corporations; joint R&D agreements; technology exchange agreements; direct investment; various licensing arrangements; subcontracting; and customer-supplier relationships. The role of customer-supplier relationships in underpinning the ability of firms to compete effectively through innovation was discussed in chapter A4.

The motives for inter-firm technology cooperation and collaboration are diverse (see Hagedoorn 1993). The advantages of collaborative R&D include: lowering the costs and spreading the risks of R&D; reducing the appropriability problems a single firm might face; exploiting available economies of scale in R&D; and market access and development. The organisational form chosen for partnerships can be influenced also by the nature of the research — whether it is in the pre-competitive or subsequent stages of the innovation process. And inter-firm networking arrangements need not be static. As new generic technologies become more familiar, firms may seek, through takeover and other means, to internalise some of the networks which were initially based on cooperation.

In the Australian context, private sector initiatives supporting collaborative R&D in the mining industry are the Australian Mineral Industries Association Ltd (AMIRA) and Australian Coal Research Ltd. AMIRA manages more than 80 collaborative contracts worth about \$35 million (transcript, p. 572). The Association said:

In some cases companies can gain benefit from sharing inputs and outcomes of research and tackle problems collaboratively. The industry set up AMIRA specifically to manage this collaborative work and much of it is contracted into the publicly funded R&D infrastructure such as universities and CSIRO (Sub. 32, p. 1).

AMIRA estimates that collaborative work makes up something less than 10 per cent of the total R&D spending of the mining industry. In addition, the mining industry is characterised by joint ventures aimed at achieving the same effect. CRA said:

Mining corporations are either merging or creating joint ventures seeking economies of scale in technological development (Sub. 44, p. 22).

The effect of collaboration is to share the risk and return from the project concerned and this can be particularly important for small firms (MTIA, Sub. 133, p. 10). A survey by DITAC (1990) revealed that for Australian firms (for example, in communications, software and services, and computer hardware), more than 70 per cent of all alliances were concerned with marketing.

The Chamber of Manufactures of New South Wales pointed to the difficulties in identifying a sufficient number of generic research problems to justify R&D linkages between firms in much of the manufacturing sector in the following terms:

‘Generic’ research ‘problems’ for which ‘generic’ solutions can be applied are much more likely to arise in industries which produce ‘generic’ products using ‘generic’ processes. Hence the predominantly rural/commodity based coverage of the manufacturing research associations already established in Australian and New Zealand.

In most manufacturing industries, however, the basis of competition is the ability to differentiate their product through unique attributes acquired through research and design (Sub. 452, p. 6).

The Chamber also drew attention to the difficulties of ensuring ‘an equitable distribution of competitive advantage’ amongst manufacturing firms arising from cooperative research and instanced the restructuring of the Bread Research Institute. That restructure brought an end to whole-of-industry participation and an end to funding through a levy collected on flour sales. The Institute now concentrates on contract research for large bread manufacturers and the Australian Wheat Board (Sub. 452, p. 7). Voluntary research associations in the manufacturing sector are also discussed in Part D.

The Australian Electricity Industry Supply Board, which functions under the auspices of the Electricity Supply Association of Australia (ESAA), is funded by a voluntary levy of ESAA members and is governed by a board of industry and academic representatives (Sub. 437, p. 4). Originally established to channel industry money to support research in university electrical departments, the scope of the Board’s activities has widened to include support for research in other subjects relevant to electricity production and to realise the direct benefits from sponsored research by ensuring that the results were published and disseminated.

Another initiative in the services sector is the recent establishment of the Construction Industry Institute for the purpose of collaborative research.

The TCG group of companies provides one example of the linkages that firms themselves form because they are in their own best interests (box F1.2). TCG-ILID has a world-patented method of sending messages through lighting systems and is developing customer-driven applications of the technology with the customers as partners: electronic shelf labels with Coles-Myer; in-store advertiser panels with K Mart; and prospectively, in-house paging with Telecom. Linkages are a key element of its R&D strategy:

... we don't do any R&D unless there's a customer ready to work with us. So given we have identified a possibility for an area of business, we then consider who the customer might be for that business and we start working with them (DR transcript, p. 397).

### **Box F1.2: Inter-firm R&D networks: an Australian example**

Mathews (1993) provides the following description of an inter-firm network, Technical and Computer Graphics. TCG, a small group of firms operating out of Sydney, has been networking with one another and overseas to become the largest privately-owned computer services operation in Australia.

TCG consists of a cluster of around 24 autonomous firms, each of which specialises in a particular facet of information technology services or product development. TCG member firms seek contracts which they can bring back to the network and spread through sub-contracting aspects of the job to each other. 'Implicit' rules govern entry and exit from the network, the preference given to each other and the avoidance of head-to-head competition.

The TCG triangulation strategy consists of:

- identifying a niche market for which one of its existing products can be adapted;
- seeking out a firm which has complementary skills, markets or technologies, to be a partner for the development; and
- bringing in a major potential customer for the innovation as a third partner.

Though each party retains its independence, the collaboration provides access to new markets for TCG, to new technologies for partners and to new products for customers.

For example, TCG Systems Automation Marketing (TCG SAM) developed hand-held data terminals for use in the retail trade and identified a possible extension of the product to airport refuelling activities. It enlisted the partnership of an established aviation fuel metering supplier, ACME, and Mobil Oil was joined as the customer partner. The Rapid Aviation Refuelling Information System (RARIS) developed to Mobil's specifications enables refuelling data to be recorded on the tarmac, data downloaded at the end of a shift into a PC at the airport office, and invoices for fuel supplied to be despatched within 24 hours.

TCG acquired the worldwide rights to RARIS software, ACME secured manufacturing contracts and the rights to extend the concept into new areas of fuel metering and data logging and Mobil acquired the rights to license the RARIS product to other airports and to other aviation fuel suppliers.

Other products developed using this TCG strategy have included field service terminals (with Toshiba and Telecom), data processing terminals for cash registers (with Fujitsu General and others), electronic identification systems (with AEG/Telefunken and others) and a system (ILID) for in-store shelf label updating in supermarkets (with Bull and Coles-Myer).

TCG-ILID also has linkages with other companies in the TCG group by way of sharing office facilities, and informal and ad hoc exchanges of ideas and business leads.

Private sector firms performing intermediary services — such as advisory and brokerage functions — also play a part in creating and maintaining linkages. Invetech, for example, has been established for nearly 20 years and is Australia's largest private sector organisation providing R&D and technology application services to the manufacturing sector (Sub. 142, p. 1). In addition to advising on R&D grants applications, Runes Business Services helps client companies develop their R&D projects and identifies higher education institutions that would best assist those companies with the particular R&D in which they are engaged (transcript, p. 610). Industry associations, patent attorneys and financiers also perform intermediary roles in the innovation system.

From a policy perspective, it is not the difficulty of documenting the full complexity of inter-firm networks and the organisational forms they can take that is overly important.

**It needs to be recognised that networks between firms can occur spontaneously to enable firms to share the risks of developing new technologies and markets, benefit from economies of scale in joint R&D and production, and access external sources of scientific and technological know-how.**

Unless carefully targeted, government interventions can crowd out the development of market-based responses that would otherwise lead to linkages between firms that would sustain R&D and innovation. Selective funding to individual firms needs to have regard to the impact on competing firms, the way industry structures may evolve, and resource use generally.

### **University commercial arms**

Notwithstanding the importance of informal relationships between university personnel and users of research, universities and other higher education institutions have increasingly established formal mechanisms to manage university-industry links. While the number of 'commercial arms' of various types has grown rapidly, the mechanisms also encompass the establishment of research institutes which provide direct outlets for the industrial application of departmental research and university 'spin-off' companies. Other linkage measures are also in place: for example, like those of the ESAA (Sub. 120, p. 13), which sponsors university professionals, academic staff positions and scholarships.

Early initiatives in formalising links with business were Unisearch Ltd, established at the University of New South Wales in 1959 and Tunra Ltd at the University of Newcastle in 1969, and research institutes originally funded by industry such as the Julius Kruttschnitt Mineral Research Centre at the University of Queensland established in 1970 and the Warren Centre for Advanced Engineering at the University of Sydney. The number of what is commonly termed the 'commercial arms' of higher institutions grew rapidly in the 1980s. The Australasian Tertiary Institutions Commercial Companies Association (ATICCA) estimates that 12 such entities existed in 1980 and by 1990 the number had grown to about 50, of which 10 were based outside Australia (Sub. 262, p. 1).

ATICCA itself performs a networking role and is linked to other networks and groups — such as the International Licensing Executives Society and the Intellectual Property Society — whose members are in the business of R&D management and intellectual property commercialisation (Sub. 305, p. 2).

The activities of commercial arms are diverse and can include:

- research commercialisation such as licensing, joint ventures, and syndicated R&D;
- intellectual property management, development and marketing;
- technology transfer;
- commercial market planning and research;
- consulting services;
- industry-based training;
- continuing education courses;
- exports of education services; and
- product testing.

This listing of activities focuses on the direct outputs but the commercial arms are seen as performing other more indirect functions:

... one of their main functions I think is to keep quality people in universities by giving them opportunities to augment remuneration and experience through involvement in industrial research (Professor Gilbert, AVCC, transcript, p. 1289).

ATICCA estimated its members' turnover in 1990 to be more than \$150 million. Of this, only \$46 million was from intellectual property development and commercialisation while \$68 million was obtained from consulting and \$35 million from courses (Sub. 262, p. 1). Activities are not just concentrated in the science and technology fields: commercial returns from research in the social

sciences and humanities are among the fastest growing sources of revenue (NBEET 1993b, p. 80).

Not all commercial arms undertake all of the activities listed above and some have relied on other activities — such as providing conference management services and the sale of computers and software, instruments and books — to raise revenue. Some arms appear to have only tenuous links to the university to which they are supposedly attached. Not all started off for the purpose of commercialising research. For example, Anutech, the commercial arm of the Australian National University, was formed in 1979 to manage a small solar thermal power station project being funded by the New South Wales Government. Researchers at the ANU had begun investigating solar power in 1971 using thermo-chemical processes but difficulties in attracting research funds led them to switch attention to electricity generation using solar dishes. Anutech did not become a ‘properly’ commercial company until 1982.

Some universities, for instance the University of Western Sydney (Sub. 84), have more than one commercial arm, usually because they used to belong to former Colleges of Advanced Education which were amalgamated under the Unified National System. In Western Australia, four universities each have their own commercial arms but have also combined to form a non-profit company, Technology and Innovation Management Pty Ltd.

Institutional strategies in managing their commercial arms also vary. Many are incorporated and are expected to be profitable. However, some are non-profit associations — an example is Techsearch, the commercial arm of the University of South Australia. Around 10 universities currently rely on their administrative units to commercialise research. For example, the Business Liaison Office at the University of Sydney is part of the Vice-Chancellor’s Office. At the Swinburne University of Technology each faculty carries out its own commercialisation activity. Approximately 60 per cent of ATICCA members operate as independent corporate entities (limited by guarantee or propriety limited companies) and the remainder operate with varying degrees of authority and autonomy within their parent institutions.

University commercial arms have encountered a number of problems in fulfilling a commercialisation role. For instance, there were, and still are, attitudinal barriers to commercialisation in academic institutions. According to Uniquet:

The commercialisation process is not always appreciated on our campuses: nor would we expect otherwise. Universities are not naturally comfortable with commercial imperatives. But universities, like all the other institutions in our society, are made of individuals who react differently to current pressures for cultural change.

There are academics and university administrators who resist moves to relate their activities to the market place. There are others who accept the need for change but are not quite sure how to go about it. Yet another group is enthusiastic about playing an entrepreneur role and welcomes the challenge of achieving commercial returns on intellectual endeavour (Sub. 94, p. 5).

Uniquist also pointed to limits on the role universities can play in commercialising their R&D:

... speaking from the point of view of a company whose function is to commercialise university technology, the university is not there to take commercial risks. It doesn't have surplus funds to apply to that sort of purpose and, very understandably, it's reluctant to be involved as a university in making commercial judgments or making commercial investments (transcript, p. 1086).

A number of commercial arms have experienced difficulties and have had to rethink their activities. For instance, the Illawarra Technology Corporation Ltd, the commercial arm of the University of Wollongong, found its original aim of being an 'incubator' facility for new technologies and providing assistance to new and existing companies, without a large capital base, proved too costly. It submitted:

In spite of some successes, effective commercialisation of the research and development capabilities of universities has been harder to achieve than expected and looks like taking longer to achieve than many people would wish (Sub. 89, p. ii).

Professor Gilbert noted that Unisearch had been operating for over 30 years and had gone through a number of iterations in its relationship with industry and had provided models for many more recent university research companies (transcript, p. 1288).

Though not directly focused on the performance of commercial arms in enhancing university-business linkages, the NBEET (1993b) study reported that commercial arms:

- were often described by industry as 'getting in the way of knowledge transfer', complicating the process of gaining access to academic expertise (p. 76); but
- could play a constructive role in managing projects and contracts that result from personal relationships, rather than being an initial and driving force for such links (p. 81).

**In the light of the information available to it, the Commission considers that the commercial arms of universities can play a useful role in linking university researchers to users.**

Consultancy and education services currently dominate the activities of the commercial arms. Each institution needs to make its own assessment as to how

its commercial arm can best contribute to furthering the university's R&D objectives and enhancing the skills of its researchers, to meeting the training needs of students, to facilitating links between researchers and industry and to disseminating the results of university research while avoiding risky involvement in commercialisation activities. The wide variety of functions and organisational forms currently operating suggests a continuing need for experimentation.

### **Other public sector based linkage mechanisms**

As outlined in part B of this report, the Commonwealth Government introduced a 30 per cent external earnings target for CSIRO in 1988, and for AIMS and ANSTO in 1990, in order to improve linkages with industry and other research users. However, some agencies had linkage mechanisms that pre-date this initiative. The linkage mechanisms created by public sector research agencies are considered below.

#### *CSIRO*

Sirotech was established in 1983, initially for a three-year period, to promote the commercialisation of CSIRO research and technology. It sought commercial opportunities for CSIRO's in-house inventions and other intellectual property, brokered CSIRO's research services with industry and was CSIRO's principal patent agent and adviser. In performing these functions, Sirotech was seen as having the potential to increase the range of links between CSIRO and industry (ASTEC 1985, p. 35). Even then, a concern was that Sirotech should supplement, not supplant, direct researcher-to-industry contacts.

Sirotech was disbanded in 1993 for reasons explained by Dr John Stocker:

... the main flaw in the model was that it tended to separate accountabilities in a way which is entirely artificial. It is very important for the CSIRO of the future that managers in the organisation regard themselves as accountable not just for the process of discovery, but making sure that discovery is useful to, and effectively transferred to, an end user ... For that reason, the CSIRO Board took the strategic decision about a year ago that we would increase the business skills in our operating units in our divisions, and that leads to a much happier situation from industry, too, that it doesn't want to come to an intermediary or some small company to do its dealings with CSIRO. Typically these companies want to come straight to the people who can actually talk turkey to them, people who understand the science and technology of the organisation (transcript, p. 1409).

CSIRO has also created links through seconding staff, on a short-term basis or permanently, to set up spin-off companies. For example, the Preston Group Pty Ltd was established in 1987 by four CSIRO staff from the Division of

Manufacturing Technology who moved out to commercialise scheduling software developed within CSIRO. After five years of losses, the Preston Group now has worldwide markets, is trading profitably and employs 50 people. CSIRO initially took a 50 per cent equity holding in the Group — to reflect ownership of the intellectual property developed by CSIRO — but has since reduced this to 17 per cent (valued at \$784 000), though it retains a position on the board. CSIRO intends to reduce its equity as the company grows.

CSIRO also holds equity in Queensland Metal Corporation NL (shares to the value of \$1 655 000), Gene Shears Pty Ltd (\$501 000), Mineral Control Instrumentation Ltd (\$260 000), GroPep Pty Ltd (\$101 000) and has lesser involvement in Bio-Coal Briquette Pty Ltd, Dunlena Pty Ltd and Ceramic Fuel Cell. CSIRO's policy is to avoid equity involvements unless there is no other way of catalysing a desirable transfer of CSIRO research.

The Commission endorses CSIRO's position that such involvements should be a last resort and exited as quickly as possible. Commercialisation is a high cost and a high risk activity not appropriate to the core functions of government research agencies. These issues are discussed in Part B.

### *DSTO and other government agencies*

A trial Industry Support Office (ISO) was established by DSTO in 1992 at its Aeronautical Research Laboratory in Melbourne to market skills, facilities and research products which might have commercial potential. Drawing on lessons learned from the ISO experiment, DSTO decided that a DSTO-wide Business Office should be established from January 1995 with branches at its Melbourne and Salisbury laboratories. The role of the Business Office is to promote and facilitate DSTO's interactions with industry and other external bodies (Sub. 405, p. 7).

While defence security considerations exclude some areas, DSTO has developed industry links through licensing arrangements (such as the Barra sonarbuoy and laser airborne depth sounder), cooperative research agreements (for example, with Telecom), and private contract work. The 1994 Department of Defence review of commercialisation strategies recommended a range of measures to increase the dissemination and commercialisation of DSTO technologies and establishment of linkages with industry.

ANSTO and AIMS are discussed in appendix C. ANSTO effects its linkages with users principally through its Business and Technology Park and activities with four commercial outlets but its links with industry have been assessed by ASTEC (1994e, p. 63) as immature. AIMS undertakes linkage functions directly with users or through collaborative arrangements with other organisations.

DSTO, ANSTO, AIMS and AGSO also all rely on the Commonwealth-funded Cooperative Research Centres as linkage mechanisms.

## **F1.2 What role for government in creating linkage mechanisms?**

Inadequate linkages in the innovation system between institutions and the users of research, or in the diffusion of research, can reduce the national returns to R&D. An in-principle case for government intervention to improve linkage functioning can be made so long as the all-up costs of that intervention are less than the private and social benefits it produces. However, specific linkage failings and the source of those failings need to be identified before government can frame responses which enhance rather than detract from the wealth creating potential of the innovation system.

Rationales for government intervention specifically directed to institution-user linkages and the spread of new technology across its potential market can be classified to three broad groups:

- not enough of the ‘right’ research and research skilling is being produced by universities and public sector research agencies because they are insufficiently user oriented;
- useful knowledge has been created in public sector institutions or elsewhere which should be transferred but which, for some reason, is not being transferred to potential users to commercialise; and
- compensating for other impediments to the efficient functioning of the innovation system.

### **Orienting public sector research**

Governments have an important role to play in financing research where spillover benefits are likely to be pervasive — and hence appropriability problems most severe — and market incentives for R&D the weakest. But one drawback of the existing arrangements for funding of public sector research institutions has been the tendency for institution-driven or researcher-driven activity which lacks focus on research or skills training that matters most to the wider community.

The ‘linkage’ issue here is how to set public good research priorities in public institutions which reflect and serve the broad community interest. Earlier parts of this report have canvassed issues relating to the operation of public sector research institutions and looked at how better decision-making processes can

improve their performance. Issues relating to national priority setting for R&D are discussed in part G.

Leaving too great a discretion to these research performers in deciding their priorities necessarily weakens linkages to other players in the innovation system. A key reform is for government to bring greater community influence to bear in setting the research priorities of government research agencies, and in particular, CSIRO (see part B). The Commission also sees merit in the ARC drawing more systematically on the views of outside bodies and groups to inform its priority setting decisions (see part C).

Setting priorities and funding public good research to a greater degree on the basis of explicit community preferences will improve linkages between public agencies conducting that R&D and potential users. The interests of industry and other users can be taken into account early in the process of deciding what R&D is to be funded from the public purse. Government provision of separate and indirect linkage mechanisms to overcome deficiencies in prioritising public sector research is a second best option to directly ensuring a more user-oriented focus in publicly funded research.

Sponsorship of collaborative research is another mechanism by which R&D in public institutions can become more directed by industry and other research users. Government funding and support for this form of linkage has increased significantly in recent years. The strongest rationale for such subsidies lies in the public good nature of both the R&D activity itself and the skill enhancement it provides for those undertaking the research. The spillovers from the research are seen to be so extensive that the firm, industry or other potential sponsors are unwilling to bear the full costs of commissioning the research.

Publicly-funded collaborative R&D programs therefore need to be designed to ensure that only projects with significant spillover benefits are selected and information on R&D outcomes are efficiently disseminated. Linkage mechanisms which simply allow private firms to appropriate publicly-funded research constitute little more than firm-specific subsidies.

In addition to specific R&D outcomes, collaborative research may also generate spillovers in the form of skills formation and training benefits that would not be sufficiently appropriable if funded by private individuals or firms.

Another rationale advanced for government intervention to enhance collaborative linkages between firms and institutions relates to the perceived need to bridge the 'culture gap' between them. In part, such problems stem from inadequate recognition of industry-based public good research in setting the R&D agendas of public institutions. Transactions costs and a range of information deficiencies may also play a part.

A spillover argument predicated on the basis of cultural differences is that external benefits could be generated by those firms and institutions *which are the first to collaborate* (BIE 1991, p. 9). The strength of this rationale is severely diminished where extensive linkages already exist, albeit informally and personal. Furthermore, mere leakage of knowledge about the benefits of collaborating *per se* with public sector R&D institutions and possible demonstration effects on other firms would have to be major disincentives to firms initiating collaborative arrangements in order to justify government intervention for ‘pioneering’ collaborators.

### **Impediments to the transfer of knowledge**

The most robust justification for government intervention in support of R&D activity is its strong public good characteristics — the fact that it is hard to exclude others from deriving benefits. Government finances the production of such research and much of the knowledge generated in universities and government research agencies is documented or otherwise codified in ways which should help to make the costs of transmission relatively low. Nevertheless, firms and other potential users of research can find it difficult gaining access to public sector research resources.

One source of difficulty in better utilising the existing knowledge and expertise of researchers in universities and government research agencies is held to be the ‘cultural’ differences between them and users (see box F1.3 and earlier discussion in parts B and D). This characterisation is by no means new nor confined to the Australian innovation system. Nor is it universal, judging by the range of personal linkages and the longstanding industry linkages with the agricultural, mineral and mineral processing sectors in Australia.

In part, the difficulties firms face ‘doing business’ with public sector research institutions reflect their different objectives and specialisations. For example, the core functions of universities relate to teaching functions and their research dimensions and incentive structures are built around disseminating research findings. Firms often seek appropriable research that will provide them with a competitive edge. In addition, university researchers must usually divide their time between research and teaching and this may compromise the speed of their research. Firms, on the other hand, require results quickly.

**Box F1.3: Some views on Australian research ‘cultures’*****Professor Alan Trounson, Monash University***

There is an attitude among funding bodies that maintenance of ‘peer reviewed papers’ is the major (and often only) criterion for continuing research support which still leads to the dictum of ‘publish or perish’. In the case of technology with commercial potential, much of the technology transfer, and development and applied phases are not publishable, nor is this desired by commercial partners. For example, I was asked by an NHMRC Interviewing Committee why my publications had ceased in Nature and Science. The inference being that I was ‘over the hill’ as a reputable scientist. In fact, I still publish as extensively as ever but my work is more closely orientated to development and application at the moment, rather than basic mainstream science, and the published papers reflect this ... Australian science still suffers from the doctrine that there is a taint about researchers being involved in downstream events, particularly any commercialisation of research developments (Sub. 36, pp. 2–3).

***Professor Pat Carnegie, Murdoch University***

... people in industry tend to think: ‘OK, you give it to an academic and ten years later they might come up with an answer to a different question.’ That isn’t true, and we need the cultures to blend together and get a better appreciation of how each other carries on and does things. Industry also ... tends to think that they can come in with a particular problem and the academics are sitting there waiting for them to come in with that problem and then they will go straight onto it and get a result in three weeks time, and they don’t work like that (transcript, p. 109).

***Dr Steve Gumley, Critec Pty Ltd***

Generally, universities and CSIRO have totally unreal expectations of the value of their part-finished R&D projects when they attempt to sell the [intellectual property] to firms to commercialise. They traditionally try to recover costs, without recognising that these costs might be much higher than market value because the R&D was not targeted or inefficient. In many cases, the quantity and time delays inherent with their contractual paperwork makes it very difficult for firms to deal with them ... Compared with Universities and CSIRO, firms seem to have an increased perception of the value of TIME as the fourth factor of production (Sub. 249, p. 1).

***Dr Mark Hochman, University of South Australia***

[The University of South Australia] has a goal that by 1998 it would aim to be recognised as one of Australia’s top three universities for the application of knowledge in collaboration with the end users of that research. To do that obviously the university must encourage its academic staff to be heavily involved with industry ... it encourages each member of academic staff to be involved in consultancy with relevant industry and in fact the university gives 13 days per quarter at full pay to its staff to engage in such consultancy activity. A second mechanism of encouraging this collaboration is by recognising the value of consultancy or the value of such collaboration with industry in such things as criteria for internal promotion or criteria in assessing internal research grants. So there are several mechanisms too, but they are the major ones, that just encourage each member of academic staff to be in touch with their industry (transcript, p. 177).

***Dr Brian Hickman, personal submission***

... the culture within Universities and CSIRO has often in the past not encouraged collaboration with industry and applied research. The emphasis on peer review, on publication performance and on scientific excellence at the expense of outcomes has been a severely inhibiting factor. Applied research, consulting with industry etc generally received little recognition in promotion considerations and budget allocations. Within CSIRO, an organisational structure where division chiefs, appointed for their scientific stature not their management skills ran their divisions as personal fiefdoms undertaking research, often with little relevance to Australia, was the norm until recently ( Sub. 82, p. 3).

Greater user involvement in setting broad research priorities in public institutions and agencies, greater collaboration in public good research programs and increased mobility for researchers will go some way to redressing 'cultural' differences. In the interim, linkage programs based on ameliorating information deficiencies each party has about the other may have a sound basis. However, it is questionable whether programs funding one-to-one contact between firms and public sector researchers are the most effective means of overcoming general information deficiencies about the benefits of cooperative and collaborative relationships.

### **Compensating for other impediments**

Government interventions to improve linkages are also predicated on the basis of perceived deficiencies that have their source outside the innovation system. Chief among these are alleged capital market failures, especially in relation to the provision of finance to small and medium sized businesses (see discussion in part D). Consequently, governments have felt it necessary to provide assistance across the range of R&D activities of firms, including commercialisation activities. Subsidising collaborative research with public sector researchers has been one element in government strategies to selectively reduce costs for innovating firms.

Linkage programs can also aim to compensate for labour market rigidities. Collaborative and other linkage programs may be seen as a way of overcoming institutional and other barriers to the movement and interchange of researchers between universities, government research agencies and firms.

The costs and other difficulties experienced by those with mutual research interests in trying to locate close to each other appear to have motivated governments to intervene by facilitating the provision of technology parks and similar developments. Proximity to public research resources can be an important consideration for some firms. Zoning and other land use controls implemented by State and local governments may prevent the geographical concentrations that would otherwise develop. Government sanctioned and subsidised technology parks may mitigate these constraints.

While impediments in all these areas provide reasons why R&D and innovative activity may be less than socially desirable, linkage interventions which seek to compensate for such impediments are unlikely to be an efficient way of addressing them. Where they can be substantiated, capital, labour market and locational impediments are best addressed directly. General remedies also reduce the likelihood in compensatory programs that the assistance ends up being provided to a select few firms.

### **F1.3 Linkage mechanisms funded by governments**

A classification of the types of linkage programs initiated by governments is complicated by the fact that programs can have direct and indirect linkage effects. The nature of the innovation system is such that no element of it can avoid having some links, even if informal, with other elements. Many linkage programs have multiple objectives, in particular, combining research tasks with training objectives. Some programs specifically target international linkages. No comprehensive listing of programs is attempted here though some of the more important ones are outlined here and elsewhere in the report.

#### **Major linkage programs**

The major linkage programs of the Commonwealth Government are listed in table F1.1 and further details are provided in appendix G. These programs are:

- the Cooperative Research Centres program, which is analysed in chapter F2;
- Special Research Centres, which though initially established as special units of concentration of research workers and resources in universities, are increasingly linked with firms and users through applied research projects and postgraduate training;
- Key Centres of Teaching and Research, some of which attract significant levels of funding from private and public sector clients in their research and teaching activities;
- the Collaborative Research Grants Scheme in which industry matches government funding for collaborative research projects with university researchers;
- the three Advanced Engineering Centres which effect linkages through advanced education courses and consultancies to assist in the application and commercialisation of technology;
- Australian Postgraduate Awards (Industry) which focus on teaching and research elements of university-business links at the masters and doctorate degree levels;
- a variety of projects supported by the university-business subprogram of National Priority (Reserve) Fund; and
- the collaborative schemes funded under the Industry Innovation Program (and now folded into the new Competitive Grants for Research and Development program and discussed in part D).

**Table F1.1: Principal industry linkage programs and government funding levels**

<i>Program</i>	<i>Selecting body</i>	<i>Year commenced</i>	<i>Funding (\$m)</i>	<i>Comment</i>
Special Research Centres	ARC (Institutional Grants Committee)	1981	13	Funding in 1995.
Key Centres of Teaching and Research	ARC (Institutional Grants Committee)	1985	6	Funding in 1995 for continuing centres and new centres from mid-1995.
Collaborative Research Grants	ARC (Collaborative Research Grants Panel)	1992	16	Commonwealth funding of new and continuing grants in 1995 (including \$6 million for on-going grants paid in December 1994).
Advanced Engineering Centres Program	NBEET	1992	2	Three centres established for which funding of establishment costs ceased in 1994. From 1995 funding only for operating costs.
Australian Postgraduate Awards (Industry)	ARC	1990	8	Funding in 1995 for new and continuing awards.
National Priority (Reserve) Fund	DEET	1990	2	Funding in 1995 for improving links between higher education, industry and other sectors, particularly vocational education and training.
Generic Technology Grants Scheme	IR&DB	1986	18	1993–94; since May 1994, rolled into the Competitive Grants for Research and Development Scheme.
National Teaching Company Scheme	IR&DB	1984	1	1993–94; since May 1994, rolled into the Competitive Grants for Research and Development Scheme.
Cooperative Research Centres	Cooperative Research Centres Committee	1990	127	Funding in 1995–96.
<b>Total</b>			<b>193</b>	

Sources: DEET 1994f, Cook 1995a.

Funding at around \$200 million a year is five times the level at the end of the 1980s. The ARC (Sub. 361, p. 12) argued that Special Research Centres should not be included as a major linkage program but developments discussed in appendix G warrant their inclusion. The programs listed principally cover linkages between public sector agencies, business and other users. Some programs involve relatively small expenditures and all have been eclipsed in size by the Commonwealth's funding commitments to the Cooperative Research Centres (CRC) program which commenced in 1990. The CRCs account for about two-thirds of the linkage funding listed.

### **Other Commonwealth linkage programs**

The listing of programs in table F1.1, however, does not adequately indicate the range of government linkage programs.

In the higher education sector, the ARC's Research Infrastructure Equipment and Facilities Program (also called the Mechanism C program) aims to forge cooperative links between institutions so that expensive infrastructure facilities can be shared. Wherever possible, this program encourages cooperative arrangements outside the education sector.

DEET administers the Targeted Institutional Links Program which aims to stimulate academic research cooperation between Australian universities and their counterparts in Asia. Overseas Postgraduate Research Scholarships assist overseas students to undertake full time postgraduate research in Australia thereby enhance the national research effort. The ARC International Fellowships Program involves reciprocal fellowship agreements with agencies in France, Germany and Korea. In addition, the selection criteria for ARC Large Grants in 1995 and subsequent years include an emphasis on projects involving international collaboration. Memoranda of Understanding between the ARC and agencies in Austria, China, France, Germany, Japan, Korea, The Netherlands and Switzerland have been signed, or are being negotiated, to facilitate joint funding of such collaborative research (Sub. 361).

There is a plethora of programs and policies which aim to link public sector agencies with firms and other users. As discussed in part B, the external earnings targets for CSIRO, ANSTO and AIMS were aimed at promoting links between government research agencies and users. The Australian Technology Group Ltd was established in 1992 to commercialise technology drawn, but not exclusively so, from public sector research. A range of industry assistance programs and policies — such as the Partnerships for Development and Fixed Term Arrangements Program, the Factor f scheme, the Space Industry Development Centres Program and the Marine Science and Technology Program — either directly or indirectly promote linkages.

In *Working Nation*, the Government allocated \$63.5 million over four years to encourage the development and application of technology in industry. The Technology Access Program is to encourage the formation of a national access and diffusion network to improve industry access to institutional sources of technology and technical advice, and to accelerate the uptake of appropriate technology. The first round of funding for the National Technology Access and Diffusion Network occurred in April 1995. The Network will provide competitive grants to groups of institutions for feasibility studies or for seed funding directed at enhancing the services and facilities offered to firms in applied research, technology transfer, technical advice or related training (Cook 1995a, p. 2.11). A Technology Development Program is to provide financial assistance to projects which accelerate the development or diffusion of 'strategic technologies' which would not otherwise proceed.

DIST's International Science and Technology Program aims to stimulate Australian involvement in international research collaboration and generate awareness of Australian capabilities in science and technology. The Program's longer term aim is to build commercial opportunities through collaborative research. DEET's Research and Development Internships in Asia Program aims to promote Australian R&D capabilities through the development of long-term collaborative links between Australian research institutions and commercial research organisations in the Asia-Pacific region.

### **State Government programs**

State governments are also active in creating linkage mechanisms. For example, the Victorian Government's Strategic Industry Research Foundation (SIRF):

... specialises in the establishment of industry led collaborative research initiatives which are of long term economic and scientific benefit to Victoria and Australia (Sub. 241).

The SIRF was established in 1993 through the restructuring of the existing Strategic Research Foundation with the objective of strengthening the links between industry and the research community. The Victorian Government made a commitment to provide \$16.5 million over three years for R&D projects identified by industry. While the SIRF has an independent board, without government representation, its strategic plan must be approved by the Minister.

In another linkage mechanism, the Victorian Government holds a 35 per cent shareholding in a pharmaceutical and biotechnology company, the AMRAD Corporation. Various public medical research institutes have 9 per cent of the equity and have given AMRAD a first right to negotiate funding for certain of

their projects. AMRAD's activities include R&D, manufacturing, marketing, sales and distribution.

The Victorian Government is also working with the Commonwealth Department of Industry, Science and Technology in funding a study into technology diffusion so as to identify which linkages small and medium enterprises in Victoria use and to assist those governments identify appropriate options to extend existing linkages in Victoria (Sub. 454, p. 20).

### **Technology parks**

Most of the State governments have provided infrastructure for technology parks and related property developments (table F1.2). The first Australian technology park, Technology Park Adelaide, opened in 1984 and was an initiative of the South Australian Government. It now forms part of the Multifunction Polis (MFP) site. The New South Wales Government has recently provided land, and the Commonwealth Government has committed more than \$11 million under the Better Cities Program, for a technology park involving three universities — and with industry and government representation on the board — to be located adjacent to the Sydney CBD.

Technology parks are clustered developments, sometimes near a university, sometimes in an urban environment, where research institutions and commercial firms are located together. The philosophy behind technology parks is that co-locating researchers and high-technology firms will encourage and facilitate interaction between them and result in successful collaboration, technology transfer, and the commercialisation of research:

Technology parks ... have emanated from the belief that proximity and interactions (of humans and their equipment) ferment the exchange of ideas that results in innovation. In their most successful manifestations, technology parks and incubators are physical environments expressly designed to breed these kinds of exchanges between academic and industrial scientists and engineers (Klein 1992, p. 13).

Technology parks and the like have also been seen as instruments for regional economic development and, in particular, as a means to attract high-technology industries.

Table F1.2: **Some Australian technology parks and precincts**

<i>Location and name</i>	<i>Size (hectares)</i>	<i>Type and status</i>
<b>South Australia</b>		
Technology Park Adelaide (1984)	85	Now part of the MFP.
Science Park Adelaide (1991)		Now part of the MFP.
<b>Western Australia</b>		
WA Technology Park (1985)		Technology park adjacent to Curtin University. It now has 4 universities and 6 centres of excellence participating.
<b>Victoria</b>		
Monash Technology Precinct (1988)	850	Technology precinct surrounding Monash Science and Technology Park.
Monash Science and Technology Park		
La Trobe Technology Precinct (1988)		Technology precinct having La Trobe R&D at its core.
La Trobe R&D Park		Located at La Trobe University's Bundoora campus with an incubator facility under construction.
<b>Queensland</b>		
Brisbane Technology Park	33.5	
Mount Gravatt Research Park	13.2	Research park adjacent to Griffith University.
Gold Coast Technology Park	51	Also called the Labrador Industrial Park.
Townsville Aviation Technology Park	23	
<b>New South Wales</b>		
Australian Technology Park	13.8	Technology park under construction with incubator facilities and participation by 3 universities.
New England Technology Park (1990)	10	Adjacent to University of New England.
<b>Tasmania</b>		
Tasmanian Technopark	5	Technology park with incubator and training facilities.
<b>Australian Capital Territory</b>		
Fern Hill Technology Park	37	
<b>Commonwealth agencies</b>		
CSIRO's Riverside Corporate Park	29	The site is at North Ryde Sydney and is under redevelopment.
ANSTO's Business and Technology Park		Adjacent to ANSTO's Lucas Heights facilities.

Sources: Ford 1993, DITAC 1989.

The experience with technology parks appears variable. Critec Pty Ltd (Sub. 94, p. 4) indicated that its location in the Tasmanian Technopark was ‘not really an issue one way or the other’. In the case of CRA’s research facility at Bundoora, its interaction with the nearest university is minimal — the R&D park is conveniently close to the airport and head office and the company has a greater level of interaction with another university. The BIE (1994c) evaluated the form and level of the Commonwealth’s support for the MFP, including its impact on Australian industry and international linkages, and assessed its performance as ‘disappointing’.

Professor Roger Holmes reported that science and technology parks are proliferating in the Asia-Pacific region (transcript, p. 1183). The Commission’s impressions from the experience in Japan, Korea and Taiwan with such parks are that success requires industry involvement through investment from the outset, that proximity to transport and urban facilities and services as well as to universities and research infrastructure is crucial, and that small start-up and spin-off companies cannot be relied upon to be the core of a park’s activities.

Professor Trevor Cole of the Warren Centre for Advanced Engineering submitted that, mediocre Australian examples notwithstanding, technology parks:

... form a key component in effective and vibrant industrial developments in many centres throughout the world ... Of course Parks cannot be used simply as a cargo-cult approach to attract industry unless key elements of infrastructure, markets, human resources, useful knowledge, finance and incentives are there. But as part of an integrated program, there is no doubt of success of key parks. A considered judgement is that the Australian Technology Park has such an integrated program (Sub. 266, p. 10).

Dr Ed Sciberras nominated the technology transfer function as the critical factor in the success of a technology park and stressed the importance of linkages between those in the park as well as with the local economy (DR transcript, pp. 2687–97).

The BIE (1994c) review of the international experience with technology parks and science cities concluded that:

... there is only weak evidence that science and technology parks and high technology cities make a substantial contribution to national economic development. Successful science parks seem to reflect the inherent strengths of the city’s industrial and research base, rather than to contribute strongly to it. They should be seen as special-purpose property developments, which may conveniently contain business incubators and other institutions to facilitate technology transfer and the commercialisation of academic research — as symbols rather than drivers of economic development (pp. 61–2).

## **F1.4 Some issues arising from linkage programs**

Notwithstanding the maze of informal and formal linkages that characterise Australia's innovation system, governments have felt impelled to intervene to strengthen existing linkages and create new ones. These efforts, which increased over the 1980s, were focused on collaborative links between 'industry' and public sector institutions and research agencies. Even at the beginning of the decade, ASTEC (1980) had formed the view that linkages with firms in the manufacturing sector were inadequate while interaction with the agricultural, mining and mineral processing industries was 'generally satisfactory'.

Given its impact, the CRC program is discussed separately in the next chapter.

An overall assessment of government linkage interventions outlined in this chapter, and their impact on the innovation system and resource use generally, is a huge task:

- there is a plethora of programs at both the Commonwealth and State levels which directly and indirectly are targeted at linkage issues;
- although some government programs date from the early and mid 1980s, many are of very recent origin and there is little information yet on which to base an assessment; and
- there is generally insufficient information available to assess the extent to which various programs are being used simultaneously, over time and/or sequentially across different programs by the same set of collaborators.

However, some common issues emerge from even a brief review of the major Commonwealth linkage programs. On the positive side, access to most programs is based on competitive selection processes, and by their nature or program design, funding is for defined periods or cannot be renewed unless re-applied for in open competition with other proposals.

Cooperative and collaborative programs have brought a greater focus on the research needs of users in deciding priorities in publicly-funded research programs. Over time, the SRCs and KCTRs have developed links with researcher users even though their original rationales were more firmly tied to institutional objectives such as building concentrations of researchers and developing teaching and research capabilities. Under collaborative programs, firms and other users are required to make some contribution towards project costs and they can get involved early in decision-making processes even though the public sector researchers appear to be the prime initiators in applying for program grants. A major benefit of collaborative research is that it can broaden the range of research experience of the researchers involved. Research training

and skills formation can be major 'joint' products of the research output and can cover the more applied aspects of research fields.

Against these positive outcomes has to be set the strong possibility that these programs provide subsidised research to some firms without a commensurate spillover benefit to the community as a whole.

The cooperation and collaboration engendered in these programs are often not new, nor do some research tasks appear to have strong public good characteristics. That leaves the research training element as the only major benefit for the wider community.

Where information is available — such as for the CRG, GTGS and NTCS programs — assistance has often gone to those firms and users who have already had a previous research relationship with the academic researchers. As the BIE (1991a) review of the NTCS concluded, the scheme:

... is effective in increasing firms' usage of institutional R&D expertise only for those firms with prior informal links in the institution (p. 66).

The paucity of data on usage of government R&D programs means it is difficult to determine how general this is. Government programs may have played a past role in bringing people together, but the circumstantial evidence is that personal relationships pre-date the upsurge of government linkage programs and the anecdotal evidence is that many personal linkages are formed informally. So new learning about cooperation and collaboration is unlikely to be a significant outcome in at least some current linkage programs.

It is also difficult to determine the extent to which public good research is being produced in linkage programs. No program is prescribed in those terms and where the possibilities for such research seemed greatest — in the GTGS — there has been a shift away from generic technologies to the more privately appropriable product-oriented R&D. In the CRG program, patents and confidential R&D are sometimes the *expected* outcomes rather than being incidental and unpredictable outcomes. While not all projects can be characterised in this way, the scope for linkage programs to deliver more private benefits than social benefits seems substantial.

Levels of assistance to firms through linkage programs are difficult to determine but are potentially quite high where programs deliver benefits which largely can be appropriated by individual firms. As noted in Part D, the NTCS could provide a subsidy of around 36.8 cents in the dollar. Overall assistance levels in other programs can exceed project funding because of the interaction with other entitlements (such as the 150 per cent R&D tax concession), assistance from other programs, and the contribution of public institutions and research agencies to overhead and other infrastructure costs for the project. Assistance is also

provided when universities and public research agencies perform consultancy R&D services for industry which do not properly reflect the costs involved.

The impact of the assistance to firms through cooperative and collaborative linkage programs is also difficult to assess because R&D per se is but one factor in successful innovation. Without the range of complementary assets and capabilities outlined in part A, the assistance to firms provided through linkage programs will not generate effective or sustained innovative behaviour.

Notwithstanding the benefits to be had from some diversity in sources of government funding, the proliferation of linkage programs over the last decade also raises the prospect of unnecessary duplication in the types of assistance on offer. For example, the BIE (1991a, p. ix) noted the potential for overlap between the APA(I) and NTCS grants and recommended that a ‘close watching brief’ be kept on the extent of the overlap. As programs such as the SRCs and KCTRs have evolved and the CRGs program expanded, it is becoming increasingly difficult to differentiate them from one another. The scale of the activity being supported varies but all have a mix of research and research training functions. The Commission has recommended continued funding of NTCS grants now catered for under eligibility criterion 9 of the Competitive Grants for R&D scheme (see part D).

The Commission has not attempted an in-depth assessment of individual linkage programs. However, there appears sufficient information available, even on programs established relatively recently, to come to some broad findings:

- **linkage programs are often providing assistance to those in industry who had a previous research relationship, although it is not clear to what extent this relationship emerged naturally or was a consequence of past access to government programs;**
- **levels of assistance are difficult to determine but can be quite high where programs deliver benefits that are largely exclusive to individual firms;**
- **programs have proliferated and there appears to be considerable overlap; and**
- **the programs focus on particular aspects of the innovation process — especially the creation of knowledge — but are unlikely to lead to economic benefits unless firms possess the complementary assets and capabilities necessary for innovation to succeed and be sustained.**

The Cooperative Research Centres program, which commenced in 1990, raises similar issues and has significantly compounded the scope for duplication in linkage programs. The CRC program is the subject of the next chapter.

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## F2 COOPERATIVE RESEARCH CENTRES

### F2.1 Introduction

One recent and large scale attempt to develop linkages between universities, government research agencies and industry in Australia has been the establishment of Cooperative Research Centres (CRCs). Such centres have participating organisations — universities, CSIRO, other government research agencies, firms and others — contributing cash and/or in-kind resources and collaborating in the management and production of research over set time periods, mostly seven years.

The Commonwealth Government is committed to provide nearly \$850 million to the CRC program over the lives of the 61 centres which were established following four selection rounds between 1991 and 1994. The outcome of the fourth selection round for 10 new centres and additional funding for two existing centres announced in December 1994 will soon take the Commonwealth's direct funding for the CRC program to about \$145 million a year and make the CRC program one of the major initiatives in recent Australian science and technology policy.

In addition, in October 1994 the Government announced as part of its Cultural Policy Statement that initial funding of \$20 million would be provided over four years for the establishment of up to six Cooperative Multimedia Development Centres based on the CRC model. As part of the Government's package of greenhouse response measures announced in March 1995, a new CRC on greenhouse gas abatement technologies is to be established at a cost of \$1.6 million over three years beginning in 1996–97.

Commonwealth funding for the CRC program is estimated to be \$127 million in 1995–96, around 3.5 per cent of the \$3.6 billion the Commonwealth Government has budgeted for major programs of science and innovation (Cook 1995a, p. 3.13).

Creating new research centres that would improve linkages between private industry and the public research sector was a key recommendation of ASTEC's 1989 report on *The Core Capacity of Australian Science and Technology*. Like one of its reports a decade earlier (ASTEC 1980), ASTEC judged that, for the most part, policies promoting linkages had been effective in agriculture and mining. Manufacturing industry was the particular concern. ASTEC noted the growing range of programs targeted at manufacturing — such as the 150 per

cent tax concession for R&D, GIRD, Partnerships for Development, NIES and policies at that time being developed by DEET — but considered that these needed ‘more of a focus’ if they were to be effective. It saw improved linkages requiring: a critical mass of people and facilities better able to respond to industry demands than single researchers or small teams; other core programs not being disturbed by projects undertaken for industry; and collaboration of researchers across conventional disciplines.

ASTECC also noted that other OECD countries had established centres for science, engineering and technology aimed at promoting interaction between higher education, government and industry R&D, increasing levels of scientific, engineering and technological activity, focusing research effort on perceived national priority areas and overcoming fragmentation in research. Examples included the Interdisciplinary Research Centres supported by the Science and Engineering Research Council in the United Kingdom; the Science and Technology Research Centres and the Engineering Research Centres supported by the National Science Foundation in the United States; and networks of Centres of Excellence in Canada.

ASTECC recommended Commonwealth Government support for the establishment of interdisciplinary Science and Technology Centres in Australia aimed at increasing research links between higher education, government and the private sector by addressing interdisciplinary science and technology issues of national importance.

In order to conduct high quality research, ASTECC considered total funding for each centre would need to be at least \$2 million with contributions from the Commonwealth and industry, and from the institution in which the centre was located. Users or beneficiaries of research results were to make a significant contribution to the establishment and support of the centres. ASTECC envisaged such centres could be established in either the public or private sectors, as happens overseas. Progress in achieving anticipated outcomes in centres would be monitored and Commonwealth funding would be withdrawn after a specified period (five or seven years) by which time the centres should have become self supporting. Many of these features of ASTECC’s proposal were reflected in the CRC program announced the following year.

## F2.2 Objectives of the CRC program

When details of the CRC program were announced in March 1990, the principal objective of the initiative was to ensure that Australian research and research training remained at the forefront in areas of greatest importance to the country. Particular concerns were:

- that the geographic and institutional dispersion of Australia's scientific and technological resources meant it was difficult to establish the concentrations and networks of researchers and the associated facilities needed to keep pace with rapid international scientific and technological changes and to avoid unnecessary duplication of expensive equipment and facilities;
- the quality of Australian undergraduate and graduate programs in science and technology was not always of 'world class', thereby jeopardising future research performance in the public and private sectors; and
- jobs for researchers — up to 1000 jobs were to be provided for Australian researchers 'unable to find sufficiently challenging and rewarding jobs', expatriate researchers would be attracted back to Australia and a supply of scientists, engineers and technologists would be available to fill expected vacancies through retirements in the late 1990s (Walsh 1990).

The CRC program would relocate and link outstanding university, CSIRO and other research groups into integrated collaborative research teams and develop research consortia and information networks for laboratories and researchers not in close physical proximity. Wherever possible, CRC centres were to be located on, or adjacent to, university campuses so as to facilitate research training for undergraduates and graduates. Because CRC funding would be an injection of additional money, researchers not directly participating in the program would benefit through reduced pressure on the research grants provided by the ARC, the NHMRC and other granting bodies.

The then Chief Scientist, Professor Ralph Slatyer, who developed the CRC initiative, has stated the rationale for it in the following terms:

Most research funding in Australia is from institutional sources and flows down from management through administrative channels to operational units and individual researchers. Except in the Commonwealth science agencies and the Institute of Advanced Studies at the Australian National University, this pattern of funding has not enabled large integrated research teams to be built and, even in those organisations, has caused difficulties. Competitive funding sources, such as the Australian Research Council, the National Health and Medical Research Council and the Rural industry research bodies have also, with few exceptions, had difficulty in building such teams (Slatyer 1993, p. 121).

Thus the pattern of research funding in Australia was held to have contributed to a relatively low level of cooperative research in Australia even within institutions and between universities, between universities and CSIRO, between State organisations and those funded by the Commonwealth, between corporate sector research groups and those which were publicly funded and between different firms.

In redressing this perceived deficiency in Australia's research effort, CRC resources were to be 'linked as effectively as possible to the various sectors of the economy', the work of the centres would be focused on research areas which 'underpin existing or emerging industry sectors' and industrial firms were to provide a commercial focus 'where necessary' (Walsh 1990).

More explanation of what the linkage between the centres and research users would entail was provided in the guidelines for the first round of grant applications which were promulgated in June 1990:

The program aims to link advances in science and technology with their eventual application in industry and in other areas of national interest. This does not mean that there is an emphasis on short-term near-market research at the expense of long-term strategic research. Some Centres may be selected for basic research without direct or immediate application (PM&C 1990, p. 2).

Strong interactive linkages were to be developed between individual researchers, between participating institutions and between the performers and users of the research. The challenge was to support research — primarily in the natural sciences and engineering — that would not be undertaken otherwise. Health and the environment were nominated as examples of the 'other' areas of national interest, besides industry, covered by the program.

With only minor modification, the program objectives enunciated in 1990 have been restated through all four rounds for selecting CRC centres. The current program objectives are listed in box F2.1.

Notwithstanding consistency in objectives, there has been a change over the last four years in the nature of research activity intended to be supported by the CRC program. In particular, there has been a growing emphasis on shorter term applied research and on the commercialisation of research.

For example, the guidelines for the second round of applications called for a 'balance' between strategic and applied research:

Centres will be expected to establish and maintain long-term programs of strategic research, which may not have immediately identifiable applications. It is expected that this will be complemented by a series of shorter-term, more applied research projects which will be embedded in the overall programs of the Centre (PM&C 1991a, p. 5).

**Box F2.1: CRC program objectives**

- to contribute to national objectives, including economic and social development, and the establishment of internationally competitive industry sectors through supporting long-term, high quality scientific and technological research;
- to capture the benefits of research, and to strengthen the links between research and its commercial and other applications, by the active involvement of the users of the research in the work and management of the centres;
- to promote cooperation in research, and through it a more efficient use of resources in the national research effort by building centres of research concentration and strengthening research networks; and
- to promote the active involvement of researchers from outside the higher education system in educational activities, thus stimulating a broader experience in education and training, particularly in graduate programs and to offer graduate students opportunities to be involved in major cooperative, user oriented research programs (PM&C 1993a, pp. 5–6).

In relation to private firm involvement in CRC centres, these guidelines also stated:

... given its strategic focus, the Program is aimed at the development of generic ideas and technologies with potential benefits to a range of users rather than being a specific research support scheme for individual firms (ibid, p. 8).

For the third round of grants in 1992 the ‘balance’ being sought in CRC research was extended to include the potential for commercialisation:

It is expected that each Centre will develop balanced programs of research which will include longer-term strategic elements of a pre-competitive nature, and shorter-term more tactical elements, the results of which will lend themselves more directly to application or commercialisation (PM&C 1992, p. 5).

However, in spite of incorporating a commercialisation related objective, other sections of the 1992 guidelines reiterated a preference for developing generic ideas and technologies useful to a range of firms.

While maintaining a preference for research which benefits sectors rather than individual firms, the guidelines for the 1994 round of grants stipulated that in developing research programs:

Centres will be expected to be aware of the complexities of the commercialisation/ adoption processes and to put in place mechanisms to monitor needs and capabilities of the sector(s) using their research (PM&C 1993a, p. 9).

The original concept of CRCs sought to rectify a perceived gap in the institutional organisation of the natural sciences and engineering in Australia — the absence of large integrated research teams — and the adverse consequences this lack of ‘critical mass’ had for keeping up with international developments and for skill formation. The centres were to link researchers together and to link

them to users of research whether in government departments and instrumentalities, government business enterprises, industry bodies or firms. 'Users' were to constitute a wider group than just industry.

Nevertheless, the CRC program quickly came to be seen as having a major role assisting private sector R&D in Australia:

One of the major aims of the CRC program is to provide leverage that will see an increase in research and development undertaken by the private sector in Australia (PM&C 1993a, p. 2).

Responsibility for the administration of the CRC program was transferred from the Department of Prime Minister and Cabinet to the Department of Industry, Science and Technology early in 1994 'as it forms an integral part of industry policy' (Willis and Beazley 1994, p. 3.225).

## **F2.3 Features of the CRC program**

### **CRC selection criteria and assessors**

The current selection criteria for CRCs cover five broad areas:

- the nature of, and the commitment to, cooperative research;
- the quality of the research program and the capabilities of the researchers;
- the application of the research, including the significance of the economic or social benefit to Australia, the involvement and resource commitment of key user groups, and the utilisation or commercialisation strategy for research results;
- education and training programs; and
- project viability and management skills.

No formal guidelines set priorities as to research areas for CRC activity except that the social sciences are specifically excluded. An initial assessment of applications is undertaken by two panels of experts, one for the life sciences (covering medical, rural and other predominantly biological research topics) and the other panel for the physical sciences covers manufacturing, minerals, information technology, engineering and physical aspects of environmental sciences.

These two panels make recommendations to a Cooperative Research Centres Committee on the basis of excellence assessed against program criteria outlined above. Through its life, members of the CRC Committee have been drawn from public sector research granting bodies, public sector research agencies, the

universities and business (box F2.2). Johnston (1991, p. 6) reports that industry representation on the Committee was at the instigation of the then Minister for Science and Technology. As at August 1993, the Committee of fifteen also included the current Chairs of two CRCs.

**Box F2.2: Membership of the Cooperative Research Centres Committee**

While individual appointments have varied since 1990, members of the CRC Committee have typically been:

Chief Scientist business	Chief Executive, CSIRO	4–5 people from business
Chief Science Adviser	Office holder from the Australian Vice-Chancellors' Committee	
Chair, ARC	2–3 people from universities or research institutes	
Chair, NHMRC		
Chair, IR&D Board		

The Committee makes its recommendations to relevant Ministers also on the basis of excellence but ‘tempered by the need for overall balance’:

In practice both the Panels and the Committee were conscious of the overall thrust of the government’s policies and the Committee was given the opportunity for balance in each round because several proposals usually came forward from the Panels ranked at essentially the same level (Slatyer 1993, p. 125).

The Committee has also been influenced by CSIRO’s priority setting study based on the feasibility and attractiveness of research. Ministers have accepted all the Committee’s recommendations.

The Cooperative Research Centres Committee can, as it sees appropriate, take an active role in the development of centres, seeking to bring research groups together or calling for applications in specific research areas. For example, the CRC for Aquaculture selected in the third round covers both temperate and tropical environments on the urging of the Committee:

We put in a bid in the second round with a much smaller group concentrating in the temperate area and it fact it was recommended for funding by the scientific panel. But the CRC Committee recognised that it could only justify funding one aquaculture CRC altogether and there were signs that people in the tropical areas were interested and so they turned it down and said, “Go away and try and put together an Australia-wide one”... (Professor Hamilton, University of Tasmania, transcript, p. 1842).

Some 270 applications, including repeats of previous applications, were received over the first three CRC selection rounds. The success rate has been a little under 20 per cent, though nearer to 25 per cent if repeat applications are excluded (Sub. 240, p. 10).

Applicants are competitively assessed against published selection criteria though different funding can apply. For example, 11 centres in the second selection round were allocated total grants of \$13.3 million but the range varied from \$28.6 million for the Australian Photonics CRC to \$9.3 million for the CRC for Polymer Blends. About half of the CRCs have program grants of between \$13 million and \$15 million over their lives.

The CRC Committee has elaborated on the basis for different funding levels in the following terms. In addition to the funding constraint of an average of \$2 million per centre a year:

In practical terms, funding is determined on the basis of the financial and staffing information provided by applicants on each of the research programs in their initial application and at interview. The Committee assesses whether the level of human resources proposed is justified and whether the costs associated with the proposed work (including staff and equipment) is reasonable. ... Not infrequently, particular research projects are excluded from receiving support under the CRC Program at the time the grant offer is made, with an appropriate reduction in overall funding provided. The Committee is assisted in this task by its Expert Panels, invited expert consultants and Australian and international referees who are asked to comment specifically on the merit of the research programs and the appropriate level of resources (Sub. 387, pp. 1–2).

### **Organisational arrangements**

In order to establish a centre, participants must enter into two formal agreements. ‘Core’ participants — those organisations providing the major contribution to the centre’s activity, staffing, infrastructure and other resources — are each required to sign a legally binding agreement with the Commonwealth Government which defines the commitments made over a period of 5 to 7 years, and the specific objectives, strategies, milestones, outcomes and performance indicators that apply to the centre’s activities in research and technology transfer, linkages, cooperation and education.

Core participants also have to enter a joint venture agreement with each other covering matters such as staffing and employment conditions, ownership of intellectual property and other assets, and the commercialisation and licensing of research results.

Each centre must include at least one higher education institution among its core participants in order that the education and research training objectives are met.

Beyond these requirements, the CRCs demonstrate a wide variety of organisational arrangements.

### *Location*

An original aim of the CRC program was to overcome the dispersion of Australia's scientific and technological resources and to save duplicating expensive equipment and facilities. Co-locating the groups participating in each CRC in the same buildings and facilities was also seen as a way to promote effective cooperation. It was recognised, however, that some groups would not be able to relocate. In these cases more than one node of research activities, linked together as a network, could still qualify for a CRC grant.

Of the 51 centres established before December 1994, 19 operate from a single city location, all bar three being established in the 1991 selection rounds. Two-thirds of the CRCs established in those early rounds had participants located in one or two cities. That proportion fell to under one third in the 1992 round. The CRCs for Tropical Pest Management, Waste Management and Pollution Control, Distributed Systems Technology and the Cattle and Beef Industry and the Research Data Network CRC each operate from five locations. The CRC for Aquaculture operates from locations in Townsville, Brisbane, Launceston, Hobart, Newcastle, Sydney and Darwin. Even where CRC partners are located in the one city there can be a number of different research nodes involved in CRC activities.

Multi-node CRCs, and especially those in which each location is largely staffed by researchers from one institution, are likely to face greater difficulties in developing and maintaining joint projects (Slatyer 1993, p. 128).

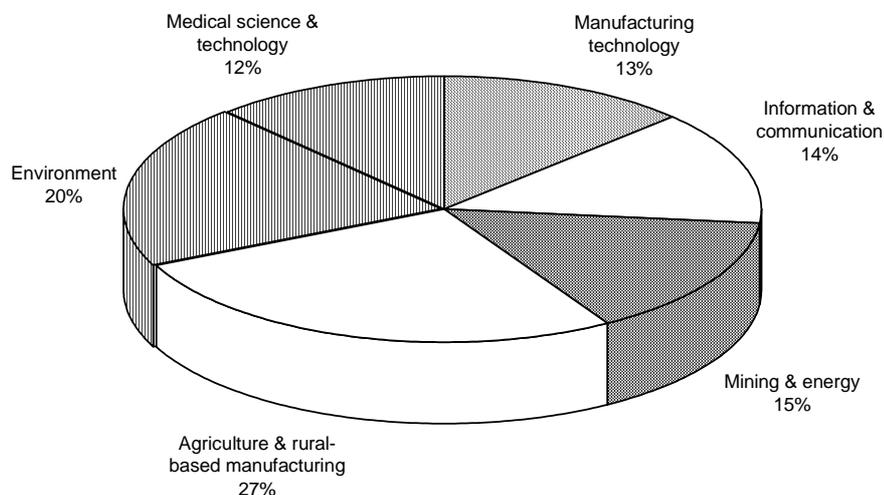
### *Coverage and size*

The 61 CRCs that have been funded to date have been classified to the following six broad fields of research:

- manufacturing technology (9 centres);
- information and communication technology (8 centres);
- mining and energy (9 centres);
- agriculture and rural-based manufacturing (15 centres);
- environment (12 centres); and
- medical science and technology (8 centres).

The projected distribution of total resources across these areas is shown in figure F2.1.

Figure F2.1: **Distribution of CRC resources across broad activity groups**



Source: CRC Secretariat data.

The allocation is somewhat arbitrary and several centres classified under medical science and technology and agriculture and rural-based manufacturing could be also allocated to manufacturing. Overall, the centres are predominantly focused on manufacturing activities.

The largest CRC, the Australian Photonics CRC, has a \$100 million total budget projected over seven years while a number of the smaller ones are projected to have budgets around \$20 million.

### *Participation in CRCs*

There are no limits on participation in a CRC, subject to the requirement that the number and type of organisations being core partners should reflect the objectives of the CRC program and each centre. The recent guidelines note, however, that program experience suggests 'problems of coherence and management arise if the number of participants is too large' (PM&C 1993a, p. 8)

The higher education sector has made a \$590 million commitment to the CRC program. Each CRC must have at least one university as a core partner but a half of the CRCs have two or more. The CRC for Sensor Signal and Information Processing, for example, has the Universities of Adelaide, South Australia, Flinders, Melbourne, and Queensland contributing as core participants. The University of New South Wales is the sole university core partner in the CRC

for Food Industry Innovation but its Departments of Food Science and Technology and Biotechnology and Schools of Biochemistry and Molecular Genetics and Microbiology and Immunology are all involved.

The CSIRO is a participant in 52 of the 61 CRCs. It is involved as a core participant in all the CRCs in mining and energy, and agriculture and rural based manufacturing and all but two of the CRCs in the environmental field. CSIRO's estimated commitment over the life of the CRC program is \$400 million.

Other government research agencies participating in CRCs include the DSTO (which is a core participant in seven CRCs) as well as ANSTO, AGSO, AIMS, and the Australian Antarctic Division. Other Commonwealth agencies and State Government departments and agencies are also core participants.

More than 200 companies were involved in the CRCs operating before December 1994 either as core participants or through contracting research projects, providing supporting technology or in marketing arrangements (Sub. 240, p. 4). Industry can participate as core partners in a variety of ways:

- as individual enterprises — of which BHP and Telecom and other large private and government business enterprises figure prominently, but small and medium sized enterprises are also core contributors;
- through groups such as AMIRA, the Australian Membrane and Biotechnology Research Institute, the Pulp and Paper Manufacturers Federation of Australia and the Association of Marine Park Tourism Operators; and
- through rural R&D corporations such as those for the wool, cotton and dairy industries.

Other linkage mechanisms to industry are developing. The CRC for Plant Science has established an 'Industry Associate' category in which, for an annual fee, companies receive advance notice of research information and access to the Centre's research staff and can provide input to the Centre's research and education agenda. Six CRCs have 'associate' or 'affiliate' programs and the model is being copied by other CRCs.

Other arrangements with industry apply, even where the CRC research is of the public good type. The CRC for the Antarctic and Southern Ocean Environment has no industry member as a core participant:

When we were drawing up the agreements for [the CRC] ... we joked about not having to worry about intellectual property or commercial development and so on because there wouldn't be any. Even if you found a pile of gold in the Antarctic the international treaty would prevent you from exploiting it. But in fact, because of some of the biological work, microbiology activities going on down there, we do have quite a

lucrative agreement now with a big firm to give them first claim on the interesting organisms that they're digging up each time we bring a shovelful of soil back from the Antarctic. They can take it into the lab and take it apart and they have found a whole series of beasts in that that looked to very likely have commercial outcomes (transcript, p. 1838).

The CRC program is not confined to companies which are wholly Australian owned and Australian based. Companies based and owned overseas may participate in the CRC program provided that there is a benefit to Australia and program objectives are achieved. Such participation is assessed case-by-case.

CRCs are encouraged to develop appropriate links with researchers and research programs in other countries. The guidelines indicate that overseas university and government research groups may be considered for formal participation in CRCs provided that program funds are used within Australia to conduct research of benefit to Australia. In most recently selected centres, the New Zealand Institute for Crop and Food Research is a core participant in the CRC for Quality Wheat Products and Processes and Manaaki Whenua Landcare Research (NZ) is a core participant in the CRC for Conservation and Management of Marsupials.

### *Corporate structures*

CRCs have adopted different corporate structures (see Liyanage & Mitchell 1993, 1994). Most CRCs have remained unincorporated joint ventures but others — such as the CRCs for Aerospace Structures, Waste Management and Pollution Control, and Polymer Blends — have incorporated. Although the CRC for Tissue Growth and Repair remains an unincorporated joint venture, GroPep Pty Ltd is responsible for commercialising all the intellectual property developed by centre staff. Shareholdings in GroPep reflect the agreed value of the intellectual property brought into the centre and commitments by partners to the CRC.

The CRCs provide various mechanisms for industry and user involvement in managing and influencing CRC activities. However, the effectiveness of that input cannot be assessed easily.

Users and industry are generally represented on CRC controlling bodies but their status varies. For example, BHP (a contributing partner) and two others (CRA and Telecom Research Laboratories, which are not contributing partners) are non-voting members of the Board of Management of the CRC for Robust and Adaptive Systems: control is effectively in the hands of the university, CSIRO and DSTO members. In the Australian Maritime Engineering CRC, six companies are represented on a board of twelve. In the CRC for Aerospace Structures, the two contributing companies (Hawker de Havilland and Aero-

Space Technologies of Australia) each have a representative on a management board of seven but together they control 45 per cent of the voting rights.

Business participation on management boards can be obtained in other ways. For example, in addition to their own representatives on the board of the G K Williams CRC for Extractive Metallurgy, the University of Melbourne and CSIRO each have a nominee from industry on the board. According to the annual reports of the 34 CRCs established after the first two selection rounds, 11 centres had company or user representatives chairing their controlling bodies and 14 centres had appointed independent chairpersons. The CRC Committee 'has placed considerable emphasis on the appointment of an independent Chair' in CRCs (DIST 1995, p. 17).

CRCs can also utilise various advisory panels for research and training policy development. For example, the CRC for Soil and Land Management — established by the University of Adelaide, CSIRO and the South Australian Department of Agriculture (now SARDI) — has an advisory panel of 15 representing major community interests including fertiliser, biotechnology and consulting businesses, and farmers and conservation groups.

### *Funding flexibility*

CRC program funds offer greater flexibility in use than most other research grant schemes including ARC and NHMRC grants. CRC program funds can be applied to the full range of costs and do not exclude infrastructure costs. Costs covered include: capital items, although the preferred approach is to pay for the costs of using or occupying major capital facilities such as buildings or larger equipment; salaries for researchers, technical support staff, fellowships and student stipends, and salary on-costs; the direct costs of research; and indirect support costs.

The contributions provided by participants can be either in cash or in kind. In-kind resources include the salaries and related on-costs paid by the participating organisations for the time their staff are engaged in centre activities and the use of buildings and equipment made available for use by CRC personnel. In-kind resources are valued at full cost so that, for example, university participation in a CRC does not entail a subsidy to the program and reduce the ability to continue other university activities (Slatyer 1993, p. 124).

### **CRC resourcing**

Program funding for a centre is contingent upon the core partners providing at least 50 per cent of the establishment and operational costs of the centre for

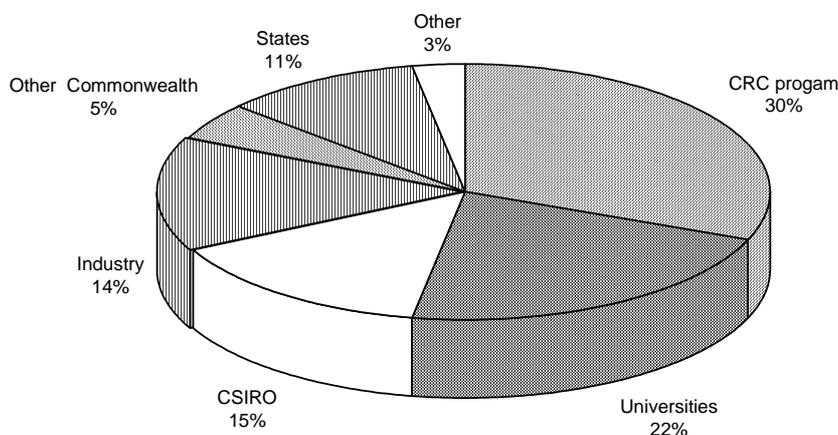
each year of operation. In the event, the Commonwealth's CRC program is estimated to contribute about one-third of total resources.

Data restrictions prevent other than very limited analysis of the resourcing of CRCs. The CRC Committee releases little aggregate data and it relates to intentions at the establishment of each CRC. These data indicate that resources valued at over \$2.7 billion have been committed over the life of the current 61 CRCs. This includes Commonwealth CRC program funding and cash and in-kind contributions from partners. The sources of projected CRC resources are shown in figure F2.2.

At \$844 million, CRC program funding is the major single contributor to the centres, accounting for 31 per cent of all projected resources.

Less directly, the Commonwealth is estimated to contribute at least another \$1 091 million (or 40 per cent) through the universities (\$568 million), CSIRO (\$396 million) and other Commonwealth agencies such as DSTO, AGSO, ANSTO and AIMS (\$127 million).

Figure F2.2: **Projected resource commitments to 61 CRCs over the life of the program**



Source: CRC Secretariat data.

The estimated commitment from 'industry' core partners — firms, government instrumentalities and business enterprises, and rural R&D corporations — totals nearly \$390 million. This accounts for 14 per cent of overall resources. Nevertheless, the contribution from industry rose over the first three CRC

selection rounds. Based on initial intentions data, Hill and Turpin (1993, p. 10) report an increase from 17 per cent of participant contributions in the first round to 21 per cent and 28 per cent in the two subsequent selection rounds.

More detailed data on projected resourcing in individual CRCs are not readily available. Data extracted from the annual reports of centres established after the first two selection rounds indicate a lower level of industry contribution than other estimates. For example, business appears to be contributing 8 per cent of total resources for first round CRCs and 12 per cent of total resources for second round CRCs (or alternatively, 12 per cent and 18 per cent respectively of participant contributions).

Data in table F2.1 indicate that in-kind contributions dominate the resources being made available to CRCs. Commonwealth grants under the CRC program are the only major cash contribution.

**Table F2.1: Contributions to first and second round CRCs by source and type**

<i>Contributor</i>	<i>Percentage contribution:</i>		
	<i>in-kind</i>	<i>cash</i>	<i>total</i>
CRC program	0	31	31
Higher education institutions	22	3	25
Business	8	3	11
CSIRO	16	2	18
Other Commonwealth agencies	4	..	5
States	4	1	5
Other contributors	3	3	5
Total	57	43	100

Note: Data relate to projected resourcing levels at the establishment of the first and second round CRCs and were compiled from the annual reports of individual CRCs.

Of course, such aggregate data conceal wide variations. For example, business is projected to contribute 44 per cent of total resources over the life of the CRC for Intelligent Decision Systems. On the other hand, the corporate sector has relatively little involvement in CRCs undertaking environmental research. One way or another, governments are funding 96 per cent of the estimated \$542 million committed to this field of CRC research.

The aim of the third round of CRC grants was for business enterprises to contribute an average of 25 per cent of the total resources available to centres with industrial applications. That target was reiterated for the fourth round.

People from public sector institutions dominate CRC staffing. An analysis of the staffing resources in the first two CRC rounds indicated that 74 per cent of the 533 key research personnel identified in those centres were drawn from the universities or CSIRO, 13 per cent from industry and the balance was drawn from government departments (Hill & Turpin 1993, p. 10).

### **CRC funding contributions and other R&D programs**

The guidelines for the CRC program stipulate that funds from Commonwealth research granting bodies awarded to members of participant organisations for specific research projects are not eligible for claiming as participants' contributions to CRCs. Two exceptions are as follows:

- for those schemes obtaining funding from an industry levy, only the levy and not the Commonwealth contribution is eligible to be claimed as a contribution to the CRC; and
- Research Infrastructure Block Grants and Research Infrastructure Facilities and Equipment Grants may be claimed as a participant contribution to the extent that they are allocated to support a CRC.

Individuals holding Australian Postgraduate Awards or ARC and NHMRC research fellowships can take up their appointments at CRCs but their salaries cannot be claimed as participant contributions.

Research granting bodies also impose their own conditions. For example, the ARC has indicated that there is no intention of winding down either the Special Research Centres program or the Key Centres of Teaching and Research program. However, while institutions can apply to convert their ARC funded centre to a CRC, once CRC funding becomes available the ARC special centre funding ceases. Once the principal researcher of a Special Research Centre or Key Centre becomes a member of a CRC, funding for the Special or Key Centre will be reviewed and will most likely cease.

ARC Research Grants are not offered to full-time members of CRCs but part-time members may gain an award, subject to meeting other eligibility criteria. Postgraduate awards and research fellowships can be taken up in a CRC. Holders of NHMRC grants, program and institute grants and fellowships have, as a general rule, their funding continued if they become a full-time member associated with a CRC and existing grants can be renewed at the same level.

The IR&D Board will not consider awarding a grant to a CRC or its participants where the intended project is for work which is part of the CRC's research program. However, the Board may consider support for projects that are the outcome of, or are complementary to, a CRC's research program. Indeed, part

of the Board's rationale for recently moving away from the pre-competitive, longer term research funded under its generic technology programs to proposals with 'more immediate prospects' has been the development of CRCs (IC New Industrial Materials Inquiry, transcript, p. 182).

Since 1992 industry contributions to CRCs have been eligible for the R&D tax concession without the application of the clawback provisions of Section 73C of the Income Tax Assessment Act which otherwise apply to projects where a government grant or subsidy is also provided.

### **Evaluation and monitoring**

Extensive evaluation processes form an important part of the CRC concept. A centre's board and management are responsible for regular assessment of performance. Program administrators undertake a three stage evaluation process over the life of a CRC:

- a first year review visit to discuss initial experience and issues and to check that a strategic plan is in place;
- a mid-term visit in year three to assess progress against performance indicators and milestones; and
- a major review, to be conducted usually two years before the end of the contracted period and involving overseas assessors, to evaluate performance against criteria 'similar' to CRC selection criteria.

The first 15 CRCs commenced operating in the latter half of 1991 and underwent their mid-term review between February and March 1995. Two CRCs are further advanced than this — the CRCs for Intelligent Decision Systems and Tropical Pest Management both only had a five year grant period. The second round CRCs started between April and June 1992 and the third round CRCs between April and July 1993. The latest 10 centres were announced in December 1994.

In addition to these procedures, each CRC must report annually and publicly on progress against the performance indicators in the agreement signed with the Commonwealth. However, there is no annual reporting yet by the CRC Committee on overall developments within the program.

At the outset, the CRC program as a whole was to be evaluated independently in 1995–96 to determine its appropriateness, effectiveness and efficiency within the framework of Commonwealth Government support for R&D. That review, conducted by an eight person steering committee chaired by Sir Rupert Myers, commenced early in 1995 and is expected to report in July 1995. The terms of

reference are provided in box F2.3. The third year reviews of the first round of CRCs are an input to the current evaluation of the CRC program.

The current review provides the first opportunity to assess the overall performance of CRCs against program objectives and its wider impact on R&D and Australia's innovation system.

### **Box F2.3: CRC Evaluation Steering Committee**

Under its terms of reference, the Committee is to evaluate whether the CRC Program has achieved or has the potential to achieve its program objectives (see box F2.1) and recommend any improvements in the program. Specifically, it is to consider:

1. the efficiency and effectiveness of the program in working to achieve program objectives, including the process of selecting centres
2. the effectiveness of the program in:
  - building links between research institutions and business designed to lead to profitable commercialisation of the research
  - supporting high quality scientific and technological research
  - encouraging active involvement of the users of research in the work and management of centres
  - promoting cooperation in research
  - promoting the active involvement of researchers from outside the higher education system in education activities
  - offering graduate students opportunities to be involved in major cooperative, user oriented research programs
  - transferring knowledge to users
  - providing access to small and medium sized enterprises
  - developing research management skills
  - increasing user contributions to centres
3. the impact of the CRC program on universities, CSIRO and industry
4. the appropriateness of CRC program objectives

## **F2.4 Issues in evaluating the CRC program**

The relatively short operating time of most CRCs and the considerable diversity they exhibit in organisation, research and other activities, precluded a thorough assessment of the program in this inquiry. Nevertheless, the information elicited from participants and from other sources indicates a number of issues for consideration by the CRC Evaluation Steering Committee. Some of the views of inquiry participants on CRCs are included in box F2.4.

## Box F2.4: Some views of participants on CRCs

### *University views*

Experience with Cooperative Research Centres is both positive and negative. On the positive side, the synergistic boost given to university research by the industry interaction is extremely valuable; likewise the appreciation in industry of the potential for university research. The exposure of graduate students to industrial problems is also beneficial. On the negative side, the contribution of the university (the total of in-kind – space, facilities personnel – and cash is usually in excess of the direct fiscal benefit accruing to the university via CRC program funding. Ideally, the university should not have to contribute cash. Management of programs is particularly challenging, since programs often span institutions and since the personnel report directly to their supervisors in their respective institutions. Even the development of a strategic plan of a CRC must be viewed as something of a triumph of persistence, vision, drive and persuasive and coercive powers. Proper handling of intellectual property (IP) is also a daunting challenge. In a situation outside of a CRC in which a company sponsors research in a university, IP is managed easily, by virtue of the bilateral character of the arrangements. In the multi-lateral CRC environment, the additional issue of which industrial partner owns/or has rights to what IP must be addressed. Background IP is also more difficult to handle. Both industry and universities need more experience in IP in order to be able to deal with issues in a routine way. The CRC process has certainly given a boost to the development of IP maturity in both industry and university sectors (University of Technology, Sydney, Sub. 221, p. 3).

... in the CRC model there was a clear indication that industry had to be heavily involved and we don't have any arguments about that at all. However, there is a little bit of a problem starting to emerge in the sense that industry representatives tend to dominate the board, and industry representatives from the position that they come from are really more interested in the applied components of research than the basic components (Professor Entwistle, University of New England, transcript, p. 1457).

### *An inventor's view*

... the Cooperative Research Centres, are actually competing with me now. Their cost of R&D per man year is between \$300 000 and \$600 000 per annum; my cost of R&D ... is \$176 000 per man year. But what's happening is government funding is now competing with me so now I have the public fund contributing to competition against me in a so-called free market to compete for R&D (Mr A. Martin, Martin Communications, transcript, p. 568).

### *Industry views*

The focus, the funds and the teams are inadequate and the commercial relationships are inadequate. We just withdrew from a CRC because we found that the time constraint for making a decision was such that you could guarantee that you would never get to market with a product. It was just impossible. The decision-making process and getting together 7 per cent of someone here, 11 per cent of someone there, 17 per cent of someone there, when you know perfectly well you will need 50 people doing 120 per cent effort, made it absolutely impossible (Mr J. Riedl, Techniche Ltd, transcript, p. 1744).

I sit on a CRC board and am very familiar with how they work, and the essential difference is that the R&D Corporations of the commodity industries are industry driven in their approach, whereas the CRCs are substantially science driven, and that is the fundamental difference. And the additive fact in there is that the industry-driven model has a very high level of accountability to drive a successful commercialisation adoption technology transfer process, and they have a much stronger mandate in that area than the CRCs, I believe (Dr P. Donnelly, Dairy Industry Research Corporation, transcript, p. 1524).

I believe that, even though it may be a major investment for the government, it is definitely bringing researchers and industry together like never before (Mr K. Daniel, Nucleus Group, DR transcript p. 2492).

The CRC program has a number of commendable features in terms of program design. Grants are awarded after a competitive selection process. Extensive monitoring and evaluation processes are in place. The worth of monitoring and evaluation processes for operating CRCs will be demonstrated as the mid-term reviews are completed and the results published. There has, however, been little information published by program administrators on the overall performance of CRCs. To date, reliance has been placed instead on the individual annual reports of the centres.

There is a real prospect that continued funding for an existing CRC would be able to be contested by other applicants after seven years. Continued funding for individual CRCs beyond their current terms is not assured. The CRC Committee stated:

It has been made clear to all CRCs that there can be no expectation of CRC program funding at the end of the agreed funding period, which in most cases is 7 years. All CRCs have therefore been urged to plan for the period when these funds are no longer available ...

If the CRC program is to be continued into the future, the aim should be to use scarce Commonwealth funds to expand the frontiers of the program by providing seed-corn for new projects, rather than by providing indefinite support for existing ones. This is not to say that the Committee would be unwilling to recommend continued support for existing CRCs, or programs within existing projects, in the appropriate cases. However, CRCs would be very unwise to plan on the assumption that their future can be secured on this basis (Sub. 240, pp. 19–20).

Nevertheless, the CRC program raises a range of issues that need addressing. As a participant in one of this inquiry's roundtable discussions noted, the CRCs account for the biggest chunk of new R&D funds he has seen in his lifetime. No other program in the Commonwealth Government's suite of linkage programs compares to the CRC program in terms of the amount of public funding nor the variety of the linkages it seeks to support. As noted in chapter F1, the CRC program accounts for about two-thirds of the Commonwealth's funding for major linkage programs. It therefore has the potential to have a significant impact on the major components of Australia's innovation system.

## **Linkages**

Although not the prime factor in its original conception, the linkage function is a major objective of the CRC program. Linkages facilitate access but are also vital to the continuous interchange of information and ideas between researchers and users. One issue in evaluating the program is the nature and extent of linkages the CRC program has developed between universities, government research agencies and research users.

As noted by the CRC Committee:

One of the most significant effects of the CRC Program is the way CRCs are changing the research culture in Australia. This has been evident right from the early days of the Program, as interested organisations began to approach others with a view to applying for funding. Researchers began to realise that the process of developing the application opened new doors and established relationships, regardless of whether or not the application was eventually successful (Sub. 240, p. 2).

Professor Ron Johnston (1991) has also reported on a ‘CRC effect’: the CRC program had significantly boosted the planning of cooperative research and the mobilisation of interest in research and research linkages even before the first funds were disbursed. The South Australian Government reported that unsuccessful applicants ‘have pursued significant components of CRC applications through other avenues’ (Sub. 289, p. 21).

Importantly, CRCs have created opportunities for research relationships that had not previously existed. For example, the CRC for Aerospace Structures brought together four universities that had never before worked together (Mr Bob Jeal, transcript, p. 1576). The CRC for Cellular Growth Factors (1992, p. 7) reported that the creation of a single management entity would increase the speed and quality of Australian research in this field. Initiatives such as those by the CRC for Plant Science have created new linkage mechanisms: its Associated Laboratories arrangement allows other Australian universities or other research groups to contribute to Centre research projects and, for an annual fee of \$100, its Industry Associate Scheme provides companies with early information on research results, access to scientific advice and an input into setting its research agenda and education programs. The CRC for the Antarctic and Southern Ocean Environment is involved with a number of international Arctic and Antarctic institutions. CRCs are also forming links with one another.

**An overall assessment of the linkage function of the CRC program would need to take into account the evidence of extensive, and sometimes longstanding, relationships that existed before individual CRCs were established.**

Previous collaborations are evident in industries where there is an effective industry association or body. One notable example is the long relationship between AMIRA and the Julius Kruttschnitt Mineral Research Centre — the latter receives 84 per cent of its funding from industry (Sub. 153, p. 2). Both are partners in the CRC for Mining Technology and Equipment.

Dr Ballard from the CRC for Tissue Growth and Repair reported that:

Our CRC grew out of a collaboration between three groups which had been going for at least 5 years before the CRC started. We knew each other. We knew our weaknesses and strengths and what we did was right from the beginning say, if we’re going to apply

for a CRC – we wanted to make sure that we wouldn't be disadvantaged over where we were at present. Indeed that was quite close for us in the biomedical area because it meant excluding ourselves from the NHMRC's funding support which was very considerable (transcript, p. 239).

Professor Hamilton from the University of Tasmania said:

The CRC in Temperate Hardwood Forestry, which is a marvellous collaboration between the university and ... all of the forestry firms in Tasmania and others across the country, I reckon that it's as good a CRC as is functioning anywhere. The reason it's good is that it just put the icing on some collaboration that had been running for about 20 years (transcript, p. 1838).

Very many of the CRCs for which information is available also report prior linkages between people, institutions and/or firms (table F2.2).

In responding to the Commission's draft report, Professor Michael Pitman, Chair of the Cooperative Research Centres Committee, argued that:

There is no doubt that most, and probably all, CRCs have grown from some pre-existing collaboration amongst some of the participating researchers (Sub. 387, p. 1)

However, he sees CRC linkages as qualitatively and quantitatively different to prior linkages. Whereas previous linkages or linkages outside CRCs 'tend to be either project specific, informal, shorter term, involving only a limited number of organisations, or combination of these characteristics', CRC linkages are viewed as being long term and having a strategic direction, involve many organisations, are bound by formal legal commitments to collaborate in a broad research endeavour and are supported by a formal management, planning and budgeting framework (Sub. 387, p. 1). Other participants (for example, the Australian Academy of Technological Sciences and Engineering, Sub 337) urged that there be no discounting of the value of the CRC program where there were prior linkages.

Any evaluation of the impact of the CRC program on domestic and international linkages would need to assess the extent to which CRC funding has generated new linkages and strengthened existing links. Like many of the other linkage programs reviewed in chapter F1 though, much CRC funding appears to be flowing to parties with prior collaborative experience. In that regard, the CRC program is not targeted at overcoming information deficiencies in collaborative linkages between universities, government research agencies, firms and other users of research.

An important issue therefore is the extent to which the CRC program has induced research that the parties themselves would not otherwise have undertaken individually or in alternative collaborative arrangements.

Table F2.2: **Some of the CRCs reporting prior linkages**

CRC for Polymer Blends	A J Parker CRC for Hydrometallurgy
CRC for Molecular Engineering and Technology	CRC for Plant Science
CRC for Industrial Plant Biopolymers	CRC for Tropical Pest Management
CRC for Intelligent Decision Systems	CRC for Temperate Hardwood Forestry
CRC for Intelligent Manufacturing Systems and Technologies	CRC for Legumes in Mediterranean Agriculture
CRC for Distributed Systems Technology	CRC for Viticulture
Australian Photonics CRC	CRC for Biopharmaceutical Research
CRC for Advanced Computational Systems	CRC for Cochlear Implant, Speech and Hearing
CRC for Mining Technology and Equipment	CRC for Tissue Growth and Repair
G K Williams CRC for Extractive Metallurgy	CRC for Cellular Growth Factors
CRC for Australian Mineral Exploration Technologies	CRC for Biological Control of Vertebrate Pest Populations

*Sources:* Annual reports of the CRCs.

## Research performed in CRCs

CRCs were originally intended to be able to undertake a range of research activities: from long-term strategic research to more applied research tasks. Since its inception, however, there has been an increasing emphasis on near-to-market research and commercialisation activities. The effect of orientating CRC activity in this way undermines the public good rationale for government funding of CRCs. Assessing the nature of CRC research activities and the appropriateness of public funding of them is another task for the current CRC evaluation.

Research on environmental matters is, *prima facie*, an area where governments should provide finance because spillover benefits are likely to be pervasive. It is not surprising that participants in the environmental CRCs — such as the CRCs for Soil and Land Management, the Antarctic and Southern Ocean Environment, Catchment Hydrology, Biological Control of Vertebrate Pest Populations, Freshwater Ecology, Southern Hemisphere Meteorology, Tropical Rainforest Ecology and Management, Conservation and Management of Marsupials and the Sustainable Development of Tropical Savannas — are predominantly from the universities, CSIRO and Commonwealth and State government departments and agencies.

There is also a strong case for government support for industrial research which is generic in nature. The extent to which public funds are being used to support this type of research across CRCs with industry links is not clear. The main research function of the G K Williams CRC for Extractive Metallurgy (1992, p. 1) is:

... to undertake longer term, more basic and strategic research in support of the Australian metallurgical industry. This does not mean that we will not do any short term work; consulting and tactical research has always been an important activity of the group at the University and for CSIRO researchers as it enables them to apply the expertise developed in longer term research projects to practical problems. What it does mean is that in the portfolio of projects in the Centre, the majority of projects will be of a strategic or basic nature. That is the role our industrial supporters see us best performing.

However, in many CRCs with a single firm as an industry partner, or even a number of firms as contributing partners, it needs to be determined whether research of general application is being undertaken or is of a type whose benefits are readily appropriated by the firm or firms. The CRC model is further complicated with other arrangements that CRCs have developed such as joint venture partnerships and consultancy services.

For example, during 1992–93 the CRC for Eye Research and Technology entered into a collaborative agreement with Ciba-Geigy for one of its core research programs. As a consequence, much of the research on its artificial cornea project is commercially confidential and can only be reported in broad terms. Consultancy research activities for individual firms seem to be a significant and growing source of revenue in some CRCs involving both core industry partners and others.

Dr Sceats from the Australian Photonics CRC stated:

We use the Commonwealth funds for two purposes. We use them for the operating costs of what we call centre projects. These are what we would call the strategic basic research for our centre that feeds the development-type projects. We also use the Commonwealth money for infrastructure costs, major equipment that is really essential and is used for all of the activities of the centre. So we keep Commonwealth money away from the operating costs of the projects funded by industry. We have been able to ensure that industry funds its projects really at full cost recovery, even though they're partners in the CRC.

... in many CRCs I'm aware that the Commonwealth funds are used basically to do the work for the industry partners directly and it's basically a cheap or cost-effective way for industry to get some of their tactical R&D done in a centre. We don't adopt that policy at all (transcript, p. 1676).

In its submission on the draft report, the CRC for Aquaculture noted that:

... [research] results could be exclusive, but if so should be fully paid for by the beneficiaries. We also have projects which, while they will be crucial to the future health of the well-established sectors, have a substantial public good element (for example environmental effects and their control) and would not be exclusive to the participant companies ... we have a coherent philosophy which leads to a series of different strategies for different cases, even within one CRC (Sub. 389, p. 1).

A problem identified by a number of participants in the Industry Commission's inquiry on New and Advanced Materials related to the difficulty of access to the research output of CRCs experienced by firms, particularly, but not exclusively, by small and medium sized enterprises (IC 1995d, p. 105).

**Assessing the extent to which CRCs are using their resources to cross-subsidise the performance of firm-specific research will be an important task for the current review of CRCs. Unless there are significant benefits for the more generic research activities and training functions of CRCs, the Commission considers that cross-subsidisation of firm-specific research should be avoided. In undertaking contracted research, CRCs should aim for full cost recovery.**

Another issue in evaluating the research activities of CRCs will be the extent to which CRC structures accommodate the changing research links users may wish to pursue over a centre's seven year life. The CRC model entails supposedly 'binding' commitments from core participants. For some industry partners, exiting a CRC may allow them to concentrate on potentially more productive links with other researchers. Early indications are that commitments from industry participants are more flexible than CRC program guidelines appear. For example, the Australian Computing and Communications Institute Ltd withdrew as a funding member of the CRC for Intelligent Decision Systems after 18 months but the centre continued. In the CRC for Temperate Hardwood Forestry, APM Forests and Bunnings Treefarms joined after the CRC had been established. A number of CRCs have arrangements which facilitate changing industry participation in their activities.

Collaborative research programs such as the CRC program have a role to play in focusing the research activities of public institutions on the needs of industry and other users of research. However, as observed by the Commonwealth Treasury (Sub. 236, p. 51), 'getting industry too involved in the selection of projects may result in firms reducing their own research efforts'.

Submissions to the current evaluation of the CRC program have commented that 'commercialisation may be overshadowing broader application of research as a goal of the Program' (DIST 1995, p. 11). Another indicator of the difficulties CRCs are experiencing in determining the appropriateness of their

research programs is the call by the newly-formed Cooperative Research Centres Association for guidelines to ‘allow CRCs to differentiate an enthusiastic involvement of industry in the fashioning of a CRC program from an inappropriate cross-subsidy’ (Sub. 376, p. 5).

**A key consideration in determining whether public funding for CRCs should continue is the way in which CRCs are managing the tension between generic-type research — to which governments should contribute — and merely subsidising research for firms or industries without wider benefits to the community.**

### Assistance levels

The CRC program can deliver high levels of assistance where the research undertaken is largely for the benefit of a firm or a few firms. Industry participants can benefit from both:

- government funding of the CRC — through the direct Commonwealth payments to CRCs and government funding of universities and public sector research agencies, and State Government contributions; and
- the eligibility of firms to claim the 150 per cent R&D tax concession on their contributions to CRCs.

**The CRC program can potentially generate substantial levels of assistance for participating companies because of the extent of resources provided by governments and public sector institutions and agencies and the interplay with other R&D assistance measures.**

Table F2.3 provides a range of estimates to indicate the *maximum* levels of assistance that could be obtained. The smaller the industry contribution to CRC research the greater the potential level of assistance.

**Table F2.3: Potential maximum nominal levels of assistance in CRCs**

<i>Industry contribution to total CRC resources</i>	<i>Maximum nominal subsidy (cents per dollar)</i>
14 per cent (projected average across all 61 CRCs)	88.5
20 per cent	83.6
25 per cent (target for CRCs with industrial applications)	79.5

Note: The maximum subsidy provided by the CRC program is given by  $S = [g + (1 - g)(c)(t)]$ , where:  $g$  = direct and indirect government contribution;  $c$  = concessional rate of tax deduction (50 per cent); and  $t$  = company tax rate (36 per cent, as announced in the 1995–96 Budget).

The CRC Committee argued that only CRC program funds should be included in any assessment of the potential assistance to companies participating in CRCs. In its view, a company providing 15 per cent of all participants' resources would obtain a benefit equivalent to 15 per cent of the overall benefit. It went on to clarify the position:

In some cases this may be dealt with in terms of exclusive rights to certain areas of applications for specific companies rather than a financial sharing. In all cases, however, there would be financial return to the CRC or to its public sector participants from commercialisation by participating companies. ... The advantage of being a participant rather than a third party buyer of IP [intellectual property] lies in the fact that as a participant the company will be better informed of developments, has a direct input into research direction and management and generally is given a first right of refusal to CRC IP in its area of interest (Sub. 387, p. 2).

However, the overall benefits in which participants may share are generated by employing both their contributions and CRC program funds. The effect of private firms' input into the research direction of a CRC may therefore orient the use of all funds, including program funds, towards the needs of particular firms. The 'exclusive rights' mentioned by the Committee provide the means through which firms can readily appropriate the benefits of research funded directly and indirectly by governments.

Some CRCs have mechanisms to avoid this happening, as instanced by Professor Stephen Hunyor, Director of the CRC for Cardiac Technology:

... we have a nominee company which holds all the intellectual property and profits which come into the CRC... That profit will then be distributed according to the ratio of equity, according to in-kind and cash inputs by the various participants. Now, if for argument's sake, \$1 million comes into the nominee company, the board of directors, which is the same for the nominee company as for our CRC, determines how that is to be distributed (DR transcript p. 3545).

Even then, the efficacy of this mechanism depends on how the difficulties in valuing participants' in-kind contributions are resolved. But at least it avoids the potential high levels of assistance inherent in granting specific firms exclusive rights to CRC research outputs.

Of course, high levels of support would only be realisable where there were no or few spillovers from CRC research outside its industry partner(s). The training and skill enhancement functions of CRC research would need to be taken into account in any assessment. Further, the possibilities for a few firms capturing the benefits of CRC funded research are likely to be reduced if CRCs actively diffuse the results of their research.

**The potential for CRC funding to generate exclusive advantages for participating firms indicates the importance of ensuring that CRC funding**

**serves wider user and community interests other than just those of the individual companies participating in CRCs.**

### **Building 'critical mass' in research activities**

Building centres of research concentration was the principal rationale for the CRC program as originally conceived and it remains one of the CRC program objectives. Large integrated research teams were to be built by co-locating researchers from universities, government research agencies, firms and others.

As discussed in section F2.3, co-location of participants in CRCs has become less of a feature of the program through the first three selection rounds. Co-location was virtually abandoned in the fourth selection (see Cook 1994b). Even where participants are located in the one city, participants sometimes appear to specialise in working on particular projects so the extent of collaboration within a CRC is not obvious.

The CRC Committee suggested the change in the co-location pattern as evidence of the program catalysing new collaborations beyond the immediate and geographically close research community. It also pointed to the likely prohibitive cost of relocating existing research efforts to a single site and the easier accessibility of CRC expertise for industry of dispersed but networked research facilities (Sub. 387, p. 3).

In a submission to this inquiry, Professor Ralph Slatyer commented:

Co-location was a goal of the program, because it is so much easier to benefit from interaction with colleagues who are close enough for frequent contact. The reality has been that to link many of the best groups in Australia, it is necessary to go beyond individual locations and even particular cities. A challenge to the Program is to develop the whole field of distance cooperation in research which, apart from being of direct benefit to researchers in CRCs, is a field from which Australian researchers, perhaps more than in any other country, can benefit (Sub. 341, p. 4).

Professor Sue Serjeantson of the IAS also commented:

It will be interesting when the CRCs are reviewed, I believe, to see whether it's more successful for the participants in a CRC to be co-located or whether it really can work across the system. In theory, with improved telecommunication, e-mail and all the other links, it should be possible to do this. But I think the jury is still to come in in the Australian scene (DR transcript, p. 3303).

Whether or not participants in individual CRCs are geographically dispersed, CRCs can be costly to run. In selected CRCs, administration costs have accounted for over 20 per cent of resource use (table F2.4). As suggested by the CRC Committee, only a detailed analysis of the organisational and geographical

interactions would allow a conclusive comment on the benefits and costs of various collaborative arrangements adopted by CRCs (Sub. 387, p. 4).

**The success of CRCs in building integrated research teams needs to be assessed in view of the increasing tendency to fund widely dispersed research groups. Supporting a concentration of research in some CRCs appears relatively costly.**

**Table F2.4: Resources devoted to administration in selected CRCs**

CRC	No. of cities in which participants are located	Share of resources allocated to administration (%)		
		Year 1	Year 2	Year 3
Polymer Blends	1	29	14	
Materials Welding and Joining	2	21	11	
Waste Management and Control	5	na	20	<16
Australian Maritime Engineering	4	19	22	
Plant Science	1	na	15	10
Mining Technology and Equipment	1	18	14	10
A J Parker CRC for Hydrometallurgy	1	14	10	

Source: CRC Committee, Sub. 387.

Though not funded on the same scale as CRCs, programs such as the Special Research Centres and Key Centres for Teaching and Research also have establishing ‘critical mass’ as an objective and have increasingly developed linkages with industry and other users of research (see appendix G). The Collaborative Research Grants Scheme supports cooperative undertakings smaller in scale and timeframe than CRCs and does not require permanent centres to be established.

Mr Ray Block submitted:

I am particularly concerned about the fractionalising of Australia’s public sector R&D efforts in the CRC program. Fifty two Cooperative Research Centres, now to be topped up by a further 10 ... is far too excessive for a R&D community badly in need of greater priority setting. Granted the concept of the CRCs, in bringing together the CSIRO, university researchers and private sector firms was admirable, particularly in seeking to bring researchers working on the same technology together, and further impose market demands on what would otherwise have been supply driven R&D. There is already

evidence that the CRCs are under management stresses, with the failure of parent institutions to remain strongly committed to the CRCs. There is also some evidence of duplication of effort between CRCs in the same industry area (Sub. 45, p. 8).

The notion that large research teams are especially productive is, however, under challenge. Lowe (1993, p. 243) argues that studies of departments of physics and chemistry show no significant correlations between the size of departments and any output measures. A NBEET commissioned study of the effects of resource concentration on research performance in Australia and the United Kingdom concluded that there is a threshold level in many fields of the natural sciences below which research performance is reduced but there are no economies of scale beyond this threshold (NBEET 1993c, p. xiii). The threshold was variously estimated to be from three to five academic researchers (plus postdoctoral fellows, postgraduate students and technical staff).

In a personal submission, the Chief of CSIRO's Division of Water Resources, which participates in three CRCs, commended the development of the linkages between R&D providers and client organisations but cautioned:

A negative feature however, is the tendency for each CRC to become an entity within itself, with its own bureaucracy, administration, and set of contacts with client agencies. These client agencies are often the same as those of the parent R&D organisations. Without great care this may lead to duplication of research and considerable confusion within the management agencies (Sub. 425, pp. 3–4).

The CRC review will need to evaluate the success of the program in realising its objective of building centres of research concentration and the productivity of those centres. It is important to assess the extent to which the CRC model is a cost-effective way of creating and sustaining linkages, between researchers and between them and users, given the range of alternative linkage programs that government began to fund in the 1990s.

There is also a need to consider whether the CRC and other linkage programs are fragmenting research resources or are providing an appropriate degree of diversity. For example, there are now Key Centres of Teaching and Research *and* CRCs for both aquaculture and for the Antarctic and Southern Ocean studies. However, the CRC for Aquaculture submitted that it and the Key Centre were 'quite distinct and complementary organisations, with effective communications between them': the CRC's educational objective focuses entirely on a PhD program and its research program has a wider spectrum of time frames with generic technology and basic investigations an important component (Sub. 389, p. 2).

AMIRA pointed to the overlap between the CRCs and other government funded schemes (DR transcript, p. 2987).

**The scope of overlap and duplication with other linkage programs in all areas the CRCs operate needs to be assessed.**

In a response to this proposition advanced in the Commission's draft report, the CRC Evaluation Steering Committee has signalled that while 'it recognises the importance of considering alternative approaches, given resource and time constraints, it will have limited ability to do this' (DIST 1995, p. 3)

**Who drives the CRCs?**

Widely differing views were reported to the Commission on who is driving the research and other activities of the CRCs. Box F2.4 provides some examples.

Reporting on CSIRO's involvement as a potential participant in the CRC for Aerospace Structures, Mr Bob Jeal stated:

In all the initial discussions, CSIRO was a major player and wanted to become part of this whole thing. But because they couldn't accept that industry was going to set the long-term targets, in fact, in the end, they dropped out of the whole thing and we have never used CSIRO in any of this sort of work because they can't accept the approach that we are taking ... there was a reluctance to accept that people in industry might know better than them as to what the industry would need (transcript, p. 1577).

AMIRA also pointed to difficulties with CSIRO involvement in CRCs:

If there's a conflict between what they see as being best for CSIRO and what's best for the CRC then understandably CSIRO interests prevail ... most of the CRCs are not incorporated and so people are employed by the participating institutions. The director doesn't have line management control of the program managers and there have been instances where people have been employed by CSIRO as part of a CRC and moved fairly arbitrarily in the view of the other participants in the CRC (DR transcript, p. 2984).

While recognising some very desirable attributes of the CRC program, one experienced insider referred to the 'non-trivial task' of trying to hold a CRC together and summed up the situation thus:

Unfortunately there remain a number of problems with the program that are due to the residual effects of these projects not being sovereign entities but rather partnerships between the end-user and staff from the major research institutions in the form of the universities and the other government-funded bodies such as CSIRO, ANSTO, DSTO etc.

This link back to the major institutions has been a source of uncertainty and conflict from the start of the CRC program. This arises in the first instance from these institutions seeing the CRC programs as a competitor for their own funding and even worse as a Trojan horse that may ultimately destabilise them politically. On the other side the CRCs create bands of renegades within the major institutions who for seven years are out of their control and essentially operating their own programs. Many

disputes arise over questions such as whether claimed contributions are valid, whether overhead claims are valid and whether projects which evolve beyond the institution's perceived interests, but nevertheless retain end-user support, should be continued. As a CRC Director employed by CSIRO I have been frequently placed in the awkward position of needing to pursue a course of action considered contrary to CSIRO's Divisional interests because I believed it in the best interests of the CRC. Similarly the outcome focus of the CRC has resulted in my being in conflict with the more general research ambitions of some of the CRC's university-based researchers (Personal submission from Dr Bruce Cornell, Sub. 311, p. 4).

Problems experienced by industry with CRCs once they were established were identified in the NBEET (1993b) study of linkages as encompassing:

- an inability to influence research objectives;
- the focus and time-scale of these objectives;
- on-going difficulties in dealing with the central administrations of several institutions at once;
- inter-institutional rivalries;
- intellectual property confusions; and
- cumbersome management arrangements (p. xx).

As noted above in section F2.3, firms and users are heavily involved as contributing partners in some CRCs. In the light of this, and the extensive range of mechanisms some CRCs have set up to involve business and other users of research in their decision-making processes, it is not easy to generalise about who drives the CRCs. The apparent scope for CRC funding to be used for research that exclusively benefits only a few firms indicates that some firms may have been 'too successful' in influencing some CRCs.

**A task for the current CRC review is to assess how effectively CRCs have drawn on firms and users in fashioning CRC research and education programs. In particular, the success of CRCs in orienting public sector research priorities for the benefit of the wider community, not just participating firms, should be investigated.**

### **Impact on universities**

Universities have committed themselves to provide \$590 million, of mostly in-kind resources, over the life of the current 61 CRCs. As the CRC Committee noted in its submission, this commitment affects the internal allocation of institutional resources and can create a number of tensions:

- the shift of resources from traditional departmental and discipline boundaries to multidisciplinary, collaborative areas;

- CRC selection processes establish preferred areas for research, putting pressure on other areas;
- business requirements conflict with traditional academic performance measures such as publication output; and
- the educational programs of CRCs have a potential impact on student load in universities and the involvement of researchers outside the university system can challenge traditional supervisory and examination practices (Sub. 240, p. 17).

Hill and Turpin (1993) point to a possible tension between seven year commitments by universities to CRCs as against their own triennial funding and the implications this has for non-CRC research as university funding becomes constrained. NBEET (1993) has provided a report on the infrastructure implications of CRC commitments.

Such effects are not confined solely to the CRC program but are to be expected from any attempt to re-prioritise the research being undertaken in Australian universities and government research agencies. The impact of CRCs on priority setting is, however, more pronounced given the rapid growth of funding under the program. An important issue is the extent to which the priorities being established reflect broad industry and community needs.

**The CRC program should be evaluated in the wider context of government support of the innovation system as it involves implicit tradeoffs with other potential uses for CRC funds, such as increased infrastructure funding for universities and alternative R&D linkage programs.**

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**PART G**

**NATIONAL PRIORITIES**

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## **PART G NATIONAL PRIORITIES**

### **G NATIONAL PRIORITIES**

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## **PART G NATIONAL PRIORITIES**

Part G commences with a discussion of the importance of decisions about what research is done and the implications of proposals in earlier chapters for priority setting. It notes that such decisions are more difficult in the public sector than in the private sector, where they are driven by market needs. The different levels at which priorities can be set are discussed.

It goes on to examine participants' views about the way priorities are currently determined and about whether there is a need for a national system of priority setting.

This is followed by a brief review of recent policy developments in Australia, and of the effectiveness of the priorities identified for Australian R&D in the 1992 White Paper. There is also some discussion of the way overseas countries have developed their priority-setting processes.

The next section is devoted to participants' views on a number of issues related to how a system of national priority setting might be further developed and implemented.

Part G concludes with a discussion of the merits of national priority setting and the scope for its use in Australia.

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## **G NATIONAL PRIORITIES**

The setting of science and technology priorities is essentially a complex political process involving many people who interact with one another ... All countries can of course benefit from the experience of others, but there is no single universal model and the most successful experiences cannot be transposed without adjustment to local circumstances (OECD 1991, pp. 7, 10).

### **G.1 Importance of priority-setting processes**

Research, while important, is not an end in itself. It warrants government support only to the extent that it yields national benefits that would not otherwise be achieved. It is also the case, as noted early in this report, that those benefits can be diffuse and difficult to measure. They include non-material as well as material components of national welfare.

Decisions about what research is done are critical in determining the potential national benefits from R&D. Priority setting is thus a central issue in government R&D policy.

In the case of private firms, their own needs — and the market disciplines placed upon them — will generally ensure that the R&D they initiate is appropriate to their individual circumstances. At the same time, for reasons discussed at length in this report, they may not do enough, or the most appropriate, R&D from a national perspective in the absence of government support.

For research conducted within the public sector, the task of determining what research should be done is much more difficult, largely because, apart from research needs closely related to policy development, the sort of research that needs to be done is that which brings widespread benefits to the community but for which the social pay-offs are hard to measure.

In examining various public institutions involved in research funding and provision, the Commission found that there was scope to improve the processes of resource allocation and priority setting. In particular, while acknowledging the importance of allowing latitude to researchers and research agencies to follow their own leads, the Commission considered that decisions about priorities were not driven enough by those outside the research community and that decisions were sometimes ad hoc and lacking in transparency. The ongoing controversy about the relevance of and payoff from public sector research in

general, and from CSIRO's research in particular, can be seen as one manifestation of this.

Over the past two decades there has been a growing awareness that science and technology should not be seen as ends in themselves, but that science and technology policy should be designed to serve national needs and objectives. There should be 'science in policy' rather than a 'policy for science' (Rubenstein 1994, p. 9).

A number of government research agencies have been following CSIRO's lead in establishing more systematic processes for setting (national) priorities, in the absence of explicit external guidance. These represent an advance over previous arrangements, but despite some involvement of users, remain largely in-house exercises. And while external earnings requirements for government research agencies have served to make them more responsive to direct user needs, they are a blunt instrument and have had some undesirable effects.

The Commission's proposals for CSIRO and other government research agencies are intended to allow government to play a more active role in directing and monitoring their work. It has recommended that CSIRO's research priorities be established by its Board in closer conjunction with government. Priorities would then be influenced more directly by government on the community's behalf.

In the case of university research, the Commission has recognised the importance of the complementarities between research and teaching. The 'relevance' of much university research comes through the enhanced skills of the people who pass through the higher education system, and some research priorities should be driven directly by the numbers of students choosing different disciplines. The Commission has in addition argued that funding for research that is not directly related to student numbers is best provided on a competitive basis through bodies such as the ARC. Within disciplines, the allocation of government funds among projects is also best decided on the basis of academic merit.

There is an issue as to how funds should be allocated *among* disciplines and program areas. Current decision rules are unclear, but the outcome inevitably establishes some implicit priorities. The Commission has proposed that the Council of the ARC should make its allocation decisions in the light of explicit priorities established with broader community involvement.

There is also the question of how the priorities of other funders of public sector research, such as the NHMRC, the IR&D Board, and government departments, can best be formulated. Such bodies are moving more and more towards conducting their own priority-setting exercises.

There is a view that an explicit set of national priorities could be helpful in guiding broader allocation decisions. While the allocation of funding between various funding areas is essentially a political decision, the decision-making process would be assisted by the knowledge that the community considers certain areas more important than others. With a set of national priorities in place it might also be easier to make the trade-offs which have to be made, for instance in allocating funding between university research and other public good research.

The concept of priority setting is, of course, not new. It is done implicitly — and at many levels — each time funding is allocated to a specific area — such as health, or land degradation — or to an individual research program or project (see box G.1). But, as noted by Rubenstein, there has been a long standing debate about the relative merits of having a more centrally-driven and formalised system of setting national priorities, or a more decentralised and iterative process. He said:

While there is agreement at a broad level that science and technology should be better integrated into the policy process and assist in the pursuit of national objectives, consideration of how this is to be accomplished highlights fundamentally different responses. Views range from the frequent and seemingly sensible calls for clear national policies ... to positions arguing for maximum diversity and autonomy in scientific performance as likely to provide the most effective and accountable responses to society's real needs (Rubenstein 1994, p. 5).

#### **Box G.1: Levels of priority setting**

Research priorities could be set at several levels:

- Government could set broad national guidelines for research, linked to perceived community problems and needs.
- Government could influence the allocation of funding between basic, strategic and applied research, through its allocation of funding to universities and public sector research agencies.
- At the next level down, bodies like the ARC, CSIRO, ANSTO and DSTO could make decisions on how much funding to allocate to specific areas, either guided by the framework of community priorities as identified by government, or by direct input of key stakeholders.
- At the operational level, government departments, divisions within CSIRO, and university researchers make decisions about programs and projects, based on user needs as well as their own judgment (depending on where the funding originates).

Rubenstein distinguishes between ‘rational’ — centralist — and ‘incremental’ — diffuse — models of decision making. He says the rational model:

... endorses informed, analytical choice through coordinated, integrated or centralised decision-making mechanisms,

while the incremental model:

... emphasises the fragmented, complex and diffuse character of the policy process (pp. 6–7).

He said the usefulness of the rational model has been questioned as being, amongst other things, politically unrealistic. On the other hand, the incremental model reflects more closely the working of the policy process. However, the danger is that it:

... may be a recipe for conservatism and inaction, neglecting difficult, intractable far-reaching problems ... (Rubenstein 1994, p. 8).

Clearly, national priorities need to be flexible and responsive to community needs. The process of identifying them needs to draw on local knowledge as well as the knowledge of those who can see the bigger picture. Wide consultation among stakeholders is important to balance the often subjective nature of those close to the decision-making process.

## **G.2 Participants' views**

In the lead up to the draft report, many participants said they considered that the existing arrangements did not convey to the research community a sense of where Australia's greatest needs and opportunities lie. They considered that national priorities should spell out more clearly a framework within which research decisions can be made.

Some participants, for instance the Australian Vice-Chancellors' Committee, said there was a lack of coherence and continuity in the current government science and technology policy. It said policy is hampered by the lack of effective coordination between government departments and instrumentalities (Sub. 118, pp. 1–2). The University of Melbourne said:

Australia currently lacks a national S&T policy with a coherent, focussed vision and long-term implementation plans. This vacuum was not filled by the Government's 1992 S&T White Paper ... (Sub. 51, p. 7).

Professor Aitkin said research decisions in Australia are still made in the 'old tradition', which holds, amongst other things, that scientists are the best judges of what is good research. Because research is unpredictable and final outcomes unknown, it is thought that governments cannot sensibly prioritise such research. He said:

Australia still lacks a mechanism for deciding between alternative proposals for spending large sums of public money on R&D ... (Sub. 119, p. 2).

In many cases, the system allows scientists to pursue research topics of interest to them, but not necessarily of benefit to Australian taxpayers who have funded the research. As stated by Professor Jevons:

The simple fact is that the interests of a nation do not coincide with the interests of research performers within that nation (Sub. 5, p. 4).

The Public Sector Union (now the CPSU) submitted that while Australia has developed national strategies for a number of areas of concern to the government, no national science strategy has been advanced. As a result, it had been left to the major players in the field, such as government research organisations, industry, and the higher education sector, to set their own priorities and develop their own processes to guide policy. It said:

The government must express national directives and priorities, providing a framework to direct the science view, and providing an update mechanism which includes regular consultation with community stakeholders (Sub. 178, p. 12).

Several other participants agreed on the need for an explicit science and technology policy. The Australian Industrial Research Group said that if national priorities were not developed, they would come about by default, with individual interests and pressure groups achieving priority for their research programs (Sub. 184).

While the views expressed often concentrated on different aspects of R&D, most were in agreement that national R&D policy should focus on areas of national advantage and importance, while taking into account likely future developments in technology. The Australian Academy of Science said:

The Government should enunciate an overall policy for R&D and set national priorities for Government-funded R&D over the next decade. ... An important criterion to be considered in setting the priorities is the ability of Australia to capture the benefit from the research (Sub. 160, p. 9).

The University of Melbourne, in commenting on Australia's lack of a national science and technology policy, said:

Important elements of a national industry R&D strategy, one of the components of a national S&T policy, would focus on: a policy position on the desirable level of industrial R&D expenditure by industry sector ... (Sub. 51, p. 7).

The Institution of Engineers and the Australian Academy of Technological Sciences and Engineering (IE and AATSE) said:

A national technology policy cannot be developed in isolation from other national policies — on industry restructuring, social security, environment, defence or health, for example — which are subjects of political debate (IE and AATSE 1992, p. 2).

Not many participants commented on the processes which should be used to develop a national R&D priority-setting system. CRA Corporate Services

referred to the need for a clear delineation of the different interests and goals of the nation. It said market mechanisms should identify those areas of research, development and technology transfer that would be most beneficial for Australian firms and improve international competitiveness, but that first:

... government [should state] its vision for Australia and, using a broadly based industry consultative process, establish an appropriate balance between resource, agriculture, manufacturing and service industries. The budget process should then be linked with this balance and priorities derived from it (Sub. 44, p. 35).

Because of the long-term nature of a national technology policy, the IE and AATSE also pointed to the need for it to transcend partisan politics. They said:

The major political parties should establish joint groups to expand areas of bipartisan agreement on technology policy (IE and AATSE 1992, p. 15).

In response to the draft report, some participants said they had reservations about the usefulness of national priorities. For instance, AMIRA expressed concern about whether the outcomes could be meaningful. It said:

In setting national priorities, it is often difficult to get beyond the anodyne in articulating a statement which is meaningful to many interests. Concentration should perhaps be on establishing mechanisms for dealing with issues as they arise rather than attempting to second guess future developments which will inevitably be wide of the mark (Sub. 348, p. 5).

The Rural Industries RDC saw the task as too large:

The difficulty and enormity of the task is such that few countries are able to generate such a master plan ... (Sub. 367, p. 14).

Others saw national priorities as an attempt to impose central planning of research. Dr John Hamblin said:

The idea that central planning separate from supply will lead to an effective use of resources died, I thought, with the demise of the USSR. The needs of politicians (for quick results) and those of science are not necessarily compatible for the national good ... The most likely outcome of changing the support system for public good research is that technical criteria for funding will be replaced with political criteria with almost certainly reduced efficiency in the use of resources (Sub. 398, section 5).

The IR&D Board said governments control the processes of generating and using science and technology but should not control the science and technology itself:

Government does not centrally plan the type of research conducted, this is done and best done by individual researchers and companies. S&T policy makers control the **processes** by which effective decisions are made, they do not make the decisions themselves (Sub. 363, p. 62, emphasis in original).

Others, however, while saying that so far there has been a notable lack of success in attempts to develop a priority-setting system, emphasized their in-principle support for a more strategic national approach to R&D policy. The Australian Academy of Technological Sciences and Engineering said:

The Academy believes the question is not whether there should be a national policy and priorities or not, but what should be the form and process (Sub. 337, p. 6).

The Australian Vic-Chancellors' Committee said:

There is a need for a national framework for broad priority setting so researchers know where they should be focussing their effort. There are too many layers of priority setting at present and no strategic framework to draw it together (Sub. 358, p. 11).

### **G.3 Recent developments in setting national priorities**

As noted, priorities are set implicitly every time funding is allocated to specific disciplinary areas or institutions. However, several attempts have been made in Australia to set priorities more formally.

In 1981, ASTEC conducted a National Objectives and Research Priorities Workshop (also known as the UNESCO study). This study was a:

... methodologically sophisticated attempt to identify priorities for Australian research to the end of the decade (ASTEC 1990b, p. 17).

In 1983, the then Department of Science and Technology commenced a three-phase process, involving a conference in September 1983, a discussion draft published in 1984, and a revised discussion draft published in May 1985. It was:

... an attempt to set directions in a very broad context, while allowing industry the opportunity to make its own decisions within that context (ASTEC 1990b, p. 18).

In 1987 the then Department of Industry, Technology and Commerce undertook the Selecting Technologies Workshop. This covered a range of technologies but could not strictly be termed a national priority-setting exercise.

None of these exercises had much effect in terms of government policy or funding decisions.

In 1989 the Commonwealth Government, in its statement entitled *Science and Technology for Australia*, emphasised the need for a change in attitudes towards science and technology, and for major research institutions to be more conscious of and responsive to society's needs and aspirations. It commissioned ASTEC to undertake a study into research priority setting.

In that study, entitled *Setting Directions for Australian Research*, ASTEC argued that there was a need for priority setting for R&D:

... both because research and development are now seen as directly contributing to the national interest and because funds are no longer available ... to pursue at the same time, all the research activities which might be deemed worthwhile or excellent (ASTEC 1990b, p. 54).

ASTEC's recommendations are reproduced in box G.2. They involve a four-year cycle, commencing with a consultative process, followed by the production of a White Paper and culminating in its implementation.

**Box G.2: ASTEC's 1990 recommendations for a national priority setting process**

- The objective for national direction setting should be to set broad and coordinated government guidelines for research and development policy in Australia, within which departments, agencies and researchers can set more specific strategic and operational priorities.
- The process should take place every four years, include a longer-term perspective of eight to twelve years and relate to annual reviews of research priorities at the strategic and operational level within agencies as part of the triennial rolling budget process.
- The mechanism should be a White Paper tabled by the Prime Minister, endorsed by the Prime Minister's Science Council [now PMSEC], drafted by the Coordination Committee on Science and Technology (CCST), and based on a issues and options paper prepared by the Australian Science and Technology Council following wide consultation with government, the research community, industry and other users of research (ASTEC 1990b, p. xiii).

ASTEC stressed the importance of consultation and suggested the following model:

- The process to commence with a year of information gathering, analysis and consultation, including major studies of, for instance, science and engineering workforce issues, or the need for major facilities; towards the end of the year ASTEC to prepare a draft issues paper.
- Early in the next year a conference to be held to consider the draft issues paper; ASTEC then to revise the issues paper and submit it to the CCST which drafts the White Paper; towards the end of the year the CCST to submit the White Paper to the PMSEC for endorsement and for the Prime Minister to table in Parliament.
- The White Paper to be implemented over the next two years, after which the process recommences.

While the above description makes the process look well defined with set times for each component, ASTEC stresses that the process should be a continuous one. While there would be times of peak activity as well as 'relatively subdued periods', some activities, particularly the liaison between ASTEC and the various research agencies, should be continuous.

Source: ASTEC 1990b.

In accordance with those recommendations, the Prime Minister asked ASTEC to prepare an issues and options report to prepare the way for a Government White Paper on Science and Technology to be tabled in May 1992.

After an extensive program of community consultation, the report produced in response to this request, entitled *Research and Technology — Future Directions*, identified a number of broad priorities (box G.3). Within each of these broad priorities a number of issues were suggested for consideration (see box G.4 for one example).

**Box G.3: Broad national priorities identified by ASTEC in 1991**

- Research, technology and international competitiveness;
- Energy and the environment;
- Quality of Australian life;
- Management of Australia's research resources; and
- Commonwealth — State issues.

*Source:* ASTEC 1991b.

In the subsequently produced White Paper *Developing Australian Ideas*, the Government reaffirmed its commitment to science and technology. It said that:

... science and technology priorities should be set according to the contribution they can make to society's goals' (Free 1992a, p. 8);

and declared its support for innovation; public awareness and understanding of the importance of science, technology and innovation; skill creation in science and engineering; and research infrastructure development.

In setting such broad objectives, the Government appeared to reject ASTEC's recommendations. Instead it said it favoured a decentralised decision-making system and that:

It is the Government's role to identify the overall national goals and objectives, and establish the principles, mechanisms and incentives necessary for researchers and users to determine their own priorities. Individual institutions and agencies must establish their own priorities and strategies within that overall framework (Free 1992a, p. 8).

The national goals and the 'overall framework' developed in the White Paper, while in themselves desirable, have been seen as too broad to fulfil the guiding role of national priorities that many participants saw as necessary. Monash University said the Commonwealth Government appears to lack commitment to priority setting:

... the promising process set in train by ASTEC in *Setting Directions for Australian Research* (1990), followed by *Research and Technology: Future Directions* (1991), eventually came to virtually nothing. The White Paper which eventuated contained little of substance ... (Sub. 330, pp. 12–3).

**Box G.4: Issues identified by ASTEC within the broader priority area of research, technology and international competitiveness**

- Better links need to be developed between the research and technology system and industry. The research and technology system needs to contribute more effectively to the international competitiveness of Australian industries.
- Expenditure on research and technology by Australian business remains low compared to countries with economies of similar size.
- Internationally available research and technical information which is important to competitiveness is not readily available throughout Australian industry.
- The transfer of the results of public sector research and development into commercial products and processes needs to be improved.
- Australian industry needs to improve its image and become more effective at marketing its products and services internationally.
- Management, researchers and the work force need to become more aware of the role of research, development and technology.

*Source:* ASTEC 1991b.

Professor Greg Tegart said that:

... the ensuing White Paper ‘Developing Australian Ideas’ in 1992 did not follow through with the major priorities raised in the ASTEC Report and thus there is still a problem with national priority setting in Australia (Sub. 417, p. 6).

Some participants said this made it necessary for CSIRO to develop its own set of national priorities in order to allocate its block funding between different areas. Mr J.F. Stephens said:

Government reluctance or inability to set national R&D priorities ... has resulted in CSIRO establishing its own version of national R&D priorities ... (Sub. 303, p. 9)

ASTEC is currently undertaking a new study, entitled *Matching Science and Technology to Future Needs*, and the objective is to provide a process which identifies current and likely future national problems and needs for science and technology to the year 2010.

An extensive program of community consultation has been developed, with background papers prepared to ensure participants are as fully informed as possible (ASTECC 1994a, 1994b, 1994d). The study is concentrating on the longer term and there is to be emphasis on consensus and commitment. ASTEC reports widespread support for the study.

Since the Commission's draft report was released, ASTEC has released a paper setting out a set of key issues (see box G.5) it believes will be of particular importance for Australia to the year 2010 (ASTECC 1995a).

#### **Box G.5: ASTEC's key issues for Australia to 2010**

ASTECC identified the following needs:

- innovation and entrepreneurship,
- a technologically literate society,
- to capture opportunities from globalisation,
- to sustain our natural environment,
- continuous improvements in community well-being, and
- to build a forward-looking science and technology system.

*Source:* ASTEC 1995a

In introducing the issues paper, ASTEC said:

Over the coming months ASTEC will again be seeking input. Our focus will be to identify underlying science and technology requirements, including skills and technologies, required to match these needs. ASTEC will then develop strategies to address gaps in current arrangements that may impede Australia's ability to meet the challenges of 2010 (ASTECC 1995a, p. 1).

'Partnerships' are a feature of the current study. Partnerships are 'in-depth foresight studies in a specific sector' (ASTECC 1995b). Five are in progress: an environment partnership, an information and communications technology partnership, a health partnership, a shipping partnership and a youth partnership. The results will be used as input into ASTEC's final report, to be presented to the Government later this year.

### **G.4 Is there a better way?**

Governments do not have unlimited resources at their disposal, and clearly cannot fund all R&D proposed to them as worthwhile. Not only do they have to decide whether to fund R&D or spend the community's resources in other ways, but R&D resources have to be allocated among competing areas and proposals.

The question is not whether choices have to be made, but how those choices are to be made, by whom and at what level?

A number of countries around the world have, in recent years, recognised the need to develop a system of national priority setting for R&D. The term 'foresight' has recently come to denote these processes. It has been defined as:

... the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits (Martin 1994, pp. 1–2).

Foresight is not the same as forecasting. According to ASTEC:

[Foresight] does not attempt to estimate or predict the future. Foresight implies an active approach to the future. It reflects the belief that the future can be created through actions we choose to take today (ASTEC 1994b, p. 7).

The following sections look briefly at how Australia might be able to learn from the way other countries have managed national priority-setting processes, and then discusses whether it is desirable for Australia to develop its own national priority-setting process.

### **Experience in other countries**

While Japan has been undertaking foresight studies since the early 1970s, in the last few years a number of other countries have developed their own system of priority setting. Box G.6 provides a brief summary of the processes employed in some key countries.<sup>1</sup>

While each country has adapted the process to its own unique social and economic environment and culture, most seem to adopt a narrow focus, identifying 'generic' or 'critical' technologies rather than areas of community problems and needs. The United States, after taking the same route for some years, now appears to be adopting national priorities which are so broad as to have little value for funding decisions.

However, in most cases the processes have not been in place long enough to enable adequate evaluation, and there are few clear indications on how the outcomes are to link into funding processes.

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<sup>1</sup> More information is available in a paper produced by ASTEC as part of its current foresight exercise, entitled *Matching Science and Technology to Future Needs: An International Perspective* (ASTEC 1994b).

**Box G.6: Priority setting as practised in some overseas countries****Japan**

The Science and Technology Agency (STA) has been conducting foresight studies on a five-yearly basis since 1970. In these studies respondents, by means of a questionnaire, are asked to rate a list of topics, first identified by working groups. The results of the survey are aggregated and returned to the respondents together with the same survey questionnaire to be filled out again, bearing in mind the results from the first survey. This approach is termed a 'Delphi survey'. The outcome of the process is an analysis of trends in key fields and predictions about future developments and needs.

The process used in Japan is an exercise in forecasting which identifies which topics within each field are likely to become important research tasks. The outcomes of the survey are used as one of the inputs for formulating government science and technology policy. It is not clear to what extent the process is linked to R&D funding.

**United Kingdom**

The Technology Foresight Programme in the UK was launched in 1993 and has not yet been completed. There are three stages. During the first phase a number of seminars were held in different regions to bring the program to the attention of potentially interested parties and generate discussion on possible approaches. Expert panels were established. The next stage, the actual foresight exercise, involves panel discussions, wide consultation, a Delphi survey, regional workshops, wider discussion of panel findings and the production and consideration of panel reports to identify priorities, and finally a report to the Government, to be completed early in 1995. The third stage will involve the implementation of the results of the foresight exercise, and also an analysis of its effectiveness. However, little is yet known about this phase. As in Japan, it is intended that the exercise be carried out at five-yearly intervals.

One of the objectives of the exercise will be to assist government priority setting and research funding decisions. However, it is not yet clear whether the results are intended to guide total government support for science and technology, or only government support for strategic research and development. While the results are intended to be widely disseminated, the mechanism whereby the guidance for government policy is to be achieved has not yet been decided.

**New Zealand**

The New Zealand Government is required by law to set priorities for public good science and must issue a priority statement at least once every three years. For the second statement (for 1995–2000) the first step, currently under way, is the preparation of a strategic statement on New Zealand science by the Strategic Consultative Group on Research. After this statement has been agreed to by the Government it will be submitted to a New Priorities Panel, which, using a consultative process as well as panel members' judgment, will develop the new Priorities Statement. This statement will contain recommendations for specific amounts of funding for each of 17 output classes (fisheries, agriculture etc). The Foundation for Research, Science and Technology will then develop a research strategy for each of the output classes.

A key element in the New Zealand system is the organisational separation of the Government's involvement in science and technology policy, science funding and the carrying out of R&D.

Cont'd

**Box G.5: (Cont'd)****United States**

In the United States lists of 'critical technologies' have been compiled by a number of government and business organisations. There has been little community consultation associated with these studies and they appear to have had little or no impact on government funding of R&D.

In July 1994, the Clinton Administration released a formal statement on science policy: *Science in the National Interest*. In this statement, five broad goals were announced for US science and technology. These were maintaining leadership across frontiers of scientific knowledge; enhancing connections between fundamental research and national goals; stimulating partnerships that promote investment in fundamental science and engineering and effective use of physical, human, and financial resources; producing the finest scientists and engineers for the twenty-first century; and raising the scientific and technological literacy of all Americans. The extent to which there was public consultation in the development of these goals is not clear. A National Science and Technology Council was created to consider science and technology policy making, and the Government Performance and Results Act of 1993 requires agencies to develop strategic plans consistent with the national goals as well as performance reports.

**Netherlands**

In the Netherlands two separate priority-setting exercises have been undertaken by two separate government departments. In each case specific topics were selected for the process. The first exercise, undertaken by the Ministry of Economic Affairs, with the principal objective of obtaining information which will allow decisions to be made on proposals for government funding, was launched in 1988, and involved three phases: the pre-foresight phase involving interviews with stakeholders to assess the usefulness of the exercise as well as possible approaches. The second and main foresight phase involved more interviews with R&D managers and scientists and resulted in a list of 15 emerging technologies, which were then assessed by a Steering Committee. Next came three strategy conferences, which had the objective of informing interested parties of progress so far, and more consultation. Pilot projects were launched and the results of the foresight exercise disseminated. Evaluation took place through interviews with participants and a questionnaire survey.

The second exercise was undertaken by the Ministry of Education and Science, with the objective of providing input to government policy. This exercise involves a four-stage process overseen by an independent Foresight Steering Committee established in 1992. The four stages consist of the preparation of an overview of the strengths and weaknesses of a particular discipline, a scenario analysis of the social environment of the area of research, the development of options for research policy, and action. The process is flexible, and adapted to the particular discipline under study. This second process is more long term in nature than the first and has not yet been completed for any of the disciplines covered.

Cont'd

**Box G.5: (Cont'd)****Germany**

In Germany three different foresight exercises have been held. One for basic research involved the setting up of a committee which held a series of brainstorming sessions at which experts in various fields were asked what they considered to be the most important new areas, and their reasons for saying so. The committee then selected fourteen research topics as high priority areas. Another (uncompleted) exercise, entitled *Technology at the Threshold of the 21st Century* involved the drawing up of a list of 86 technologies with potential economic or social utility over the next ten to fifteen years, and experts from various research agencies then evaluating each technology. The third exercise was based on the Japanese system, a Delphi survey being conducted amongst a sample of experts drawn from industry, universities and government.

The move towards foresight in Germany was primarily motivated by the fact that, since unification, it can no longer afford to spend as freely on R&D as it did in the past. It is not clear how the foresight studies are to be linked to funding.

*Sources:* ASTEC 1994b, Martin 1994, McLoughlin 1994, New Zealand Ministry of Research, Science and Technology 1993.

**Participants' views**

As well as learning from the overseas' exercises, Australia now has some experience of its own to draw on. In the draft report, the Commission sought participants' comments on the ASTEC exercises, and also listed some specific questions it suggested participants might address.

*Participants' views on the ASTEC exercises*

A number of participants endorsed the ASTEC approach to national priority setting early in the inquiry. One was the Australian Academy of Science. Another was the Australian Industrial Research Group, which said:

[Priority setting is] not about technology or information highways or that sort of thing, it's at the very broad level of which industries we're really going to coalesce around, which cultures we're going to build on, which style the government programs are going to reinforce (transcript, p. 1908).

After the release of the draft report, those commenting favourably on the ASTEC processes, generally did so in a qualified way. For instance, the University of Tasmania favoured a mechanism along the lines of the ASTEC proposal. However, it said:

... the mechanisms for 'wide consultation with government, the research community, industry and other users of research' need further development (Sub. 273, p. 4).

The University of Adelaide (Sub. 287) also supported the establishment of a national priority-setting process along the lines of the ASTEC plan. However, it considered more attention should be given to the social sciences and ethical/moral issues, and global trends and predictions should be taken into account. The Queensland Government (Sub. 442) said ASTEC could make greater use of working parties to examine particular issues.

The Warren Centre for Advanced Engineering (Sub. 266) was more critical. It said the current ASTEC exercise leaves a lot to be desired. Amongst other things it said the Background Report is weak in its understanding of the innovation process, it neglects the role of engineers, focuses yet again on science push, and comparison with foresight exercises in some other countries is inappropriate given their massive established industry base.

The Meat RC was also critical, and said:

Two previous attempts by ASTEC to develop national research priorities have produced inconsequential results. By their nature such exercises have been dominated by researchers (Sub. 360, p. 9).

### *Who should be involved in the process?*

There are two aspects to this question. One is about who should manage the process. The other one is about who should provide the input.

There appeared to be consensus among participants that those managing the process should have credibility and be at a sufficiently high level to have the support of all stakeholders. The Victorian Government said:

... any process to establish national priorities should be resolved at a national level ... (Sub. 454, p. 22).

Some thought the organisations involved in the ASTEC processes lacked credibility. For instance, the University of Tasmania said:

... the credibility of the CCST as a body to have a major role in this is low in the general research community ... We suggest that the lack of success [of past priority-setting exercises] is partly the result of the credibility of the bodies concerned ... (Sub. 273, p. 4).

The Department of Commerce and Trade WA, on the other hand, favoured the CCST but not PMSEC:

The PMSEC is not considered the appropriate body to coordinate this process. Instead the Coordination Committee on Science and Technology could be expanded to include high level state representation (Sub. 283, p. 3).

The Electricity Supply Association of Australia (ESAA) said there would be important advantages in allocating the task of major resetting of priorities to an

independent inquiry rather than to an existing institution. For the more routine reviews it recommended on a triennial basis:

... a body such as Economic Planning Advisory Commission, suitably charged to obtain broadly-based input, could review and recommend changes. ESAA has reservations about giving this responsibility to [the] Australian Science and Technology Council, because research is not only about science and engineering technology (Sub. 437, p. 7).

With regard to input, there also was general agreement that all stakeholders should be involved. Particular emphasis was given to the need for the States to be consulted. Both the Victorian Government (Sub. 454) and the Queensland Government (Sub. 442) said State involvement was essential. The Department of Commerce and Trade WA said:

State representation on ... a priority setting body is essential to ensure a truly national approach and to take account of regional differences (Sub. 283, p. 3).

Some participants said industry involvement was also critical. The Australian Industrial Research Group said:

At all stages of setting national priorities there needs to be a strong input from industry which is completely lacking in the ASTEC proposal. One of the objectives of setting national priorities would be to improve Australia's economy and this is unlikely to be achieved without industry's input (Sub. 329, p. 7).

Professor Greg Tegart noted the importance of interaction between those involved. He said:

... effective direction setting requires the linking of 'bottom-up' and 'top-down' procedures. The process needs to be driven by interaction between the collective micro-decisions of the research community (the research providers) and the macro-level analysis of industry committees, teams of experts or Ministers (the research users) (Sub. 417, p. 6).

While extensive consultation with stakeholders is seen to be important, participants said pressure groups should not be permitted to dominate the process if there is to be commitment to the outcomes. The Department of Commerce and Trade WA said:

The repetitive failures that we have seen as a cycle in the federal government system to try and set a series of national priorities has always come to grief on the basis of competition and lobbying from vested interest groups (DR transcript, p. 2025).

### *How broad should national priorities be?*

In a report commissioned for this inquiry, Rubenstein said the issues identified by ASTEC were:

... key structural weaknesses in the research and technology system and areas of significant national need, rather than a prescriptive list of national priorities (Rubenstein 1994, p. 39).

However, he said there would be difficulties in implementing them as R&D priorities because:

... [they are] couched in the more general language of establishing a vision, broad directions, guidelines and goals, rather than specifying explicit priorities (Rubenstein 1994, p. 41).

Most participants agree national priorities should be reasonably broad, with decisions on strategies, programs and specific projects left to research institutions and individual researchers. The Australian Vice-Chancellors' Committee said:

The AVCC believes that the Government should identify a broad framework of national research priorities, but it is the individual institutions and their researchers who are best placed to select the actual topics and projects to undertake the research within this framework (Sub. 358, p. 11).

Some said there could be danger in being too specific. For instance, the University of Tasmania said:

... we urge caution in attempting to be too specific, particularly in early years while experience is limited (Sub. 273, p. 4).

#### *What fields of research should be covered?*

In 1990 ASTEC said it believed that the humanities and social sciences should be included in a consideration of broad national directions for Australian research, because they have social and cultural value, can directly address Australia's needs, and also because they come within public funding ambits. The University of Adelaide, however, said those areas were lacking from the ASTEC exercise:

The plan as it stands gives a sense of science and technology in isolation from other major areas of research (eg social sciences and humanities) and concern (eg ethical/moral issues) (Sub. 287, p. 3).

#### *What should be the time frame for a system of national priorities?*

Participants generally agreed that time frames should be long enough to 'strike a balance between providing a degree of certainty in funding and reassessing priorities arising from the rate of change within the economy' (Queensland Government, Sub. 442, p. 45). The University of Tasmania said:

The time frames of one year, four years and eight to twelve years for reviews ... would be suitable (Sub. 373, p. 4).

The ESAA said:

... a review of national research priorities should be undertaken reasonably frequently, probably triennially, but this does not have to be an exhausting or highly formalised

process each time round. A major resetting of priorities should be undertaken each decade (Sub. 437, p. 7).

The Queensland Government said that taking into account the period necessary for consultation and refining of priorities, it would be reasonable to expect the process itself to take between one and two years. Based on that:

... a rolling program with publication of priorities every five years would seem the most administratively feasible (Sub. 442, p. 45).

### *How should the process be linked to funding processes?*

A priority-setting exercise would be of limited value without a link to funding processes. At the time of its first exercise ASTEC said:

In order to ensure the best use of information, and an environment in which it can be used, long-term planning, or direction-setting, needs to be undertaken at arm's length from the actual allocation of money; yet it must link into the budget process to ensure implementation (ASTEC 1990b, p. 57).

It suggested it was possible, indeed preferable, to retain the current decentralised approach to funding through budget processes, but that additional consultation should take place. It said:

Departments and agencies will provide advice in the light of their budget planning as the White Paper is developed. After analysis and discussion, the White Paper will set the framework and broad allocations for funding within which specific directions are set and allocations made, and then carried by the responsible departments and agencies through the normal budget process (ASTEC 1990b, p. 67).

The National Fishing Industry Council said:

It is pointless to go through the exercise of setting priorities unless these priorities then substantially drive the funding process (Sub. 366, p. 7).

The Australian Academy of Technological Sciences and Engineering said:

Given the ongoing and adaptive nature of policy and strategic direction formulation, the Academy supports the ASTEC view that linkages to funding through budget processes should be maintained ... (Sub. 348, p. 7).

The Queensland Government said linking funding to priorities would provide clear signals for subsequent resource planning by Government agencies, however:

... there must be some flexibility to allow unforeseen projects to be funded. ... the tax concession system should not be affected ... it would seem logical to retain the grants scheme to provide a mechanism for the Government to give effect to the priorities as they have been determined (Sub. 442, p. 46).

## The Commission's view

A process of setting national priorities has costs as well as benefits. The costs can be considerable. To make the process comprehensive, the government agency charged with the process might have to be devoted full time to such a task. Participants in the process would have to give of their time and resources to prepare papers, take part in discussions and workshops, and attend conferences. This applies to participants from industry, the research community, policy makers and policy advisers.

The benefits to be derived from such a process would have to be carefully weighed against the costs. However, those benefits would come from a better allocation of resources to R&D and would be extremely difficult to measure.

Some of the benefits may come from the process itself. Martin said, in the case of Japan:

... it is clear that the main benefit is not the specific forecasts that they yield, but the **process** by which the forecasts are generated (Martin 1994, p. 6, emphasis in the original).

Some participants agreed. They said the process itself can be beneficial in that it promotes communication and cooperation between the various groups — researchers as well as users of research — as well as encouraging the community to think about what it expects from R&D and the resources invested in it. The ESAA agreed. It said;

... the value may be as much in the process as in the outcome. That is to say, a 'collective view of problems, needs and opportunities' is unlikely to do more than signal the extent to which there is a shared vision of the future and a sense of mission for research in achieving it, but the process itself will help participants to form and crystallise their views (Sub. 437, p. 6).

Professor Greg Tegart said:

There needs to be recognition that the process is as important as the outcome with the development of a consensus between researchers, users and policymakers (Sub. 417, p. 6).

Consultation is crucial for the process itself to be of benefit, but also for the outcomes to be useful. This is for two reasons: to ensure the best flow of information into decision making, and to ensure dissemination, commitment and implementation. Consultation should involve both users and performers of research because that brings in both the science push and the demand pull dimensions. It should also include those who provide policy advice and those who manage research programs.

Dissemination of the results is vital. Both Martin and the Advisory Council on Science and Technology (ACOST) in the United Kingdom emphasise that

dissemination of the results to a variety of audiences is important. Martin said many foresight exercises fail to devote sufficient attention to diffusing the results (Martin 1994, p. 25). ACOST said significant effort should be devoted to communicating the results to a variety of audiences, and

... [those involved in conducting the foresight exercise] should also elicit a response ... as a guide to the implementation of the results and to the development of further rounds of foresight (ACOST 1994, p. 18).

Another lesson from overseas experience is that the process needs to be continuous — or repeated regularly — as well as be sufficiently flexible to allow for changes in social and economic conditions, and for unexpected scientific discoveries. The process may also have to be modified if it is not seen to work satisfactorily. As Martin said:

... foresight rarely works well when first attempted. A long learning process is generally involved, with advances being made largely on the basis of 'trial and error' (Martin 1994, p. 28).

For a system of national priorities to be beneficial it is also important that the priorities themselves be sufficiently well defined so as to provide sufficient guidance to decision makers. But they should not be so narrow as to direct R&D into specific areas of technology, or industries. Apart from the difficulty of picking national winners in a changing yet interdependent global environment, such narrowly defined areas would not leave sufficient scope for changes in direction when changes in economic or social conditions, or unexpected discoveries, required it.

Another important point is that a system of national priorities for R&D should not be concerned solely with identifying problems and opportunities which require scientific or technological solutions. Research in areas covered by the social sciences and the humanities can be just as valuable when it comes to addressing community needs.

It is unclear, at this stage, whether the current ASTEC exercise, or indeed any such exercise, will result in net benefits to Australia. Certainly not all participants consider this will be the case. The IR&D Board said:

The ASTEC foresighting exercise will be useful to the extent that it stays a process for Australians to find out about each others technological capacities and intentions. It will have become counterproductive if it moves beyond this into using the scraps of information it acquires to second guess the better informed decisions of researchers and companies working in concert (Sub. 363, p. 63).

However, while this is a valid point to make for industrial research, wider research needs cannot be left to researchers and companies to determine, and it is these wider needs that a national priority-setting process is intended to illuminate.

The lack of progress with national priority setting may have been because Australians are not ready for such a process, or it may be because the processes themselves have been inadequate for the task. A detailed evaluation of the outcomes of the current ASTEC exercise may reveal whether the concept should be developed further.

Meanwhile Australia is left with a system of setting broad research priorities with the following characteristics:

- A diverse range of research funding approaches are financed by governments through their budget processes. In some cases funds are budgeted for several years.
- Decisions about the relative magnitudes of the various research funds are essentially determined politically.
- Several government research agencies have been encouraged to diversify their sources of funds, through external earnings requirements. This was also intended to have some influence on their research priorities.
- From time to time, governments have identified high profile priorities, and usually have provided additional funds to pursue them.
- There have been some limited attempts at priority setting *within* some sectors, for example the National Strategy for Agricultural Research, and the Tasmanian symposium for rural research.
- In general, however, governments have not played a major role in determining priorities.

Essentially the only attempts at identifying broad priorities have been the ASTEC exercises referred to above, which have been of limited influence thus far. It has been left to the funded agencies to determine their own priorities. Until recently such priorities have essentially been set in-house via informal processes and without sufficient consultation with potential users. That is, priorities were seen as being largely set by research providers rather than the users of the ensuing research.

That situation is now changing. More formal processes are being adopted, or at least canvassed, by research bodies at both the Commonwealth and State levels, which involve wider consultation, explicit priority setting, and publication of agreed priorities. The Commission has welcomed this development and recommended in the relevant parts of this report that such formalised priority-setting processes should be followed by all government funded research agencies, as for example in its recommendations for CSIRO, the ARC, and rural research undertaken by State governments.

This improvement in priority setting at the agency level will not only enhance the value to Australia of their research programs, but constitutes an important building block for a broader national priority-setting process, should sufficient support emerge for such an approach.