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Investments in Intangible Assets and Australia's Productivity Growth

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The views expressed in this paper are those of the staff involved and do not reflect those of the Productivity Commission.

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Contents

Tables

Preface

This staff working paper examines investment in intangible assets in Australia and highlights some significant issues relating to the measurement of intangibles and their contribution to productivity.

Helpful comments on the paper were received from Elizabeth Webster (Melbourne Institute of Applied Economic and Social Research), Derick Cullen (Australian Bureau of Statistics) and Myriam van Rooijen-Horsten (Statistics Netherlands). The Australian Bureau of Statistics provided vital assistance through the provision of unpublished data. Paul Roberts and Bertram Antioch of the Australian Bureau of Statistics and Ben Dolman of the Productivity Commission provided helpful advice on data issues and productivity measurement. Tracey Horsfall from the Productivity Commission assisted in the preparation of the paper.

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Abbreviations and explanations

Abbreviations

ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
ASCO	Australian Standard Classification of Occupations
ASIC	Australian Standard Industrial Classification
BERD	Business expenditure on research and development
BEA	Bureau of Economic Analysis (US)
BLS	Bureau of Labor Statistics (US)
CCLO	Classification and Classified List of Occupations
CEASA	Commercial Economic Advisory Service of Australia
CEO	Chief Executive Officer
CHS	Corrado, Hulten and Sichel
COE	compensation of employees
CPI	consumer price index
CVM	chain volume measure
EEBTUM	Employee Earnings, Benefits and Trade Union Membership survey
GDP	gross domestic product
GFCF	gross fixed capital formation
GMI	gross mixed income
GOS	gross operating surplus
GPI	Genuine Progress Indicator
GVA	gross value added
ICT	information and communication technology
IO	input-output

IPD	implicit price deflator
IRR	internal rate of return
IT	information technology
JAA	Jalava, Aulin-Ahmavaara and Alanen
JIP	Japanese Industry Productivity database
LP	labour productivity
MFP	multifactor productivity
MH	Marrano and Haskel
MHW	Marrano, Haskel and Wallis
NCETS	National Centre for Education and Training Statistics
NIPA	National Income and Product Accounts (US)
OECD	Organisation for Economic Cooperation and Development
ONS	Office of National Statistics (UK)
PC	Productivity Commission
PIM	perpetual inventory method
PKS	productive capital stock
QALI	quality adjusted labour input
R&D	research and development
RBT	van Rooijen-Horsten, van den Bergen and Tanriseven
SNA	System of National Accounts
SOG	sources of growth
STAN	Structural Analysis
SU	supply-use
SUIC	supply-use industry code
SUPC	supply-use product code
VA	value added

Explanations

Billion	The convention used for a billion is a thousand million (10^9).

OVERVIEW

Key points

- Investment in capital is important for economic growth. But capital is not just physical assets; firms also invest in 'soft' capital such as knowledge, firm-specific skills, and better ways of doing business. This investment results in accumulation of 'intangible assets'.
- Intangible assets have been categorised as computerised information, innovative property (including R&D) and economic competencies (including firm-specific human capital and organisational capital), and most are difficult to measure. These assets can depreciate more rapidly than physical capital, but they are investments nonetheless, delivering benefits over time, not just in the period the expenditure was made.
- Many elements of spending on intangibles are treated as a current expense in the national accounts rather than as an investment. This leads to an understatement of investment in the economy. It also may affect measures of multifactor productivity (MFP) growth.
- Applying the methodology of Corrado, Hulten and Sichel (2006) found that intangible investment currently is almost half the size of tangible investment in the market sector of the Australian economy. While experimental in nature, the estimates suggest that:
  - market sector investment in intangibles was $57 billion in 2005-06, 80 per cent of which is currently not treated as investment in the national accounts
  - average annual growth in intangible investment has been about 1.3 times that of tangibles since 1974-75
  - including intangible investment in total investment largely removes the past downward trend in the market sector ratio of investment to output (gross value added)
  - investments in organisational capital (strategic planning, adaptation and reorganisation) and computerised information have grown at relatively high rates — making up 27 and 13 per cent of intangible investment in 2005-06.
- Treating investment in intangible assets as capital raises measured final output *and* measured capital inputs *and* alters the capital-labour ratio, hence the effect on measured MFP growth is complex. However, in Australia, adjusting for intangible investment not currently included in the national accounts does not have a large direct effect on the level or pattern of conventionally-measured MFP growth.
  - The contribution of these intangibles was 8 per cent of conventionally-measured MFP growth (0.09 of a percentage point) in the last productivity cycle (1998-99 to 2003-04) and 5 per cent (0.13 of a percentage point) in the period of the productivity surge (1993-94 to 1998-99). (This does not include any indirect effects, such as those arising from complementarities between intangibles and other inputs.)
  - This contrasts with the United States, where intangibles accounted for a large share of the productivity acceleration from the mid-1990s, and the United Kingdom, where a slowdown in MFP growth in the 1990s became an acceleration after adjusting for intangible investment.

Overview

Investment in capital is important for economic growth. But capital is not just physical assets — firms also invest in 'intangible assets', such as knowledge, firm-specific skills and better ways of doing business. Some commentators have suggested that structural and technological changes in economies have increased the importance of investment in intangibles as a source of economic growth. It has also been suggested that the observed diversity in productivity improvements (across firms, industries and countries) is linked to investment in intangibles and its complementarities with other assets, such as information and communication technologies (ICTs).

Despite this increase in prominence, intangibles are relatively poorly measured and understood. Focus has been on a small number of intangibles, such as computer software and scientific R&D. And only a few intangibles are measured as investment in national accounts. Excluding investment in intangibles means investment is underreported, and this may distort measures of growth in capital services and consequently productivity.

Measuring intangibles is not easy. However, Corrado, Hulten and Sichel (CHS 2005, 2006) developed an experimental methodology for measuring investment in a wide range of intangibles. They then used this in a growth accounting framework to explicitly identify the contribution of intangibles to conventional productivity measures. Originally applied to US data, it has now been applied to a number of countries with a range of results.

This paper continues this work by applying the approach to Australia. The paper addresses two questions. Has the composition of investment (including intangibles) changed over time? And does excluding intangible investment result in a distorted view of the dynamic changes in economic growth and productivity? The paper applies the CHS methodology to data for the market sector of the Australian economy to estimate the level and growth of investment in a range of intangibles. It also examines the direct contribution to conventionally-measured productivity growth of those intangibles not currently treated as investment.

Given the experimental nature of the methodology, the assumptions required, measurement challenges and data limitations, the estimates should be interpreted as only indicative. With this caveat, the paper finds that Australia has large and

growing levels of investment in intangibles. Notably, the inclusion of intangibles investment largely flattens the declining trend in the ratio of investment to gross value added for the market sector, and is a growing share of total investment. Nevertheless, only a small amount of conventionally-measured multifactor productivity (MFP) growth in recent periods is accounted for by the direct contribution of services from intangible assets. And unlike the results for some other countries, accounting for intangibles does not have a large effect on the pattern of productivity growth in Australia.

Measuring intangibles is not easy

'Intangible assets' have been variously defined but the common thread of the definitions is that these assets provide future benefits but do not have a physical embodiment. This lack of 'visibility' makes many intangibles difficult to measure. This is part of the reason for the treatment of many elements of spending on intangibles as current expenses, rather than investments, in conventional measures of output and productivity.

There are two main ways in which researchers have tried to quantify intangibles — financial market valuation (the difference between market values of firms and the value of tangible assets of firms) and direct expenditure-based measures of individual types of intangibles. CHS take the latter approach, defining and quantifying three main categories of intangibles (made up of a variety of specific intangibles).

- *Computerised information* is the knowledge embedded in computer programs and databases.
- *Innovative property* includes the relatively familiar scientific R&D (reflecting scientific knowledge embedded in patents, licences and general know-how) but is much broader — including non-scientific R&D or creative property (innovative and artistic content in commercial copyrights, licences and designs).
- *Economic competencies* include brand equity (for example, investment to retain or gain market share and investment in brand names), firm-specific human capital (employee skill building) and organisational capital (investments in strategic planning, adaptation and reorganisation).

The research used the CHS categorisation, to collate a range of data to create a set of experimental estimates for intangibles in Australia (box 1). For some intangibles, such as firm-specific human capital, it has been very difficult to construct reliable measures over time. It has also been necessary to make a number of assumptions based on limited available information. There is much scope for improvement and

refinement of the measures. However, these estimates provide a starting point and the first attempt (as far as can be ascertained) to apply the CHS methodology to measure the range of intangibles for Australia.

Box 1 **Measurement of intangibles**

CHS (2006) identified 3 main groups of intangibles, covering 13 individual intangibles. The measures and data sources used for the Australian estimates are listed below. The percentages of expenditure assumed to be investment are based on CHS (2006) — the extent to which some of these assumptions are somewhat arbitrary, given limited available evidence, is discussed in chapter 3 and appendix A.

Type of intangible	Investment measure and main data source
Computerised information	
Computer software; Computer databases	Investment from ABS national accounts
Innovative property	
Scientific R&D; Social sciences R&D (Business R&D)	Expenditure on R&D from ABS business R&D survey
Mineral exploration	Investment from ABS national accounts
Copyright and licence costs (Artistic originals)	Investment from ABS national accounts
Other product development, design and research	
New product development in financial industry	20 per cent of all intermediate purchases by Finance industry — from ABS supply-use tables
New architectural and engineering designs	50 per cent of sales of architectural and consulting engineering services — from ABS industry surveys
Economic competencies	
Brand equity	
Advertising	60 per cent of advertising expenditure — from advertising industry survey
Market research	60 per cent of sales of market research services (doubled to account for own-account research) — from ABS industry survey
Firm-specific human capital	Direct costs and wage costs of employee time in training — from ABS training surveys
Organisational capital	
Purchased	80 per cent of sales of management consulting services — from ABS industry survey
Own account	20 per cent of salaries of Managers & administrators — from ABS Labour Force Survey

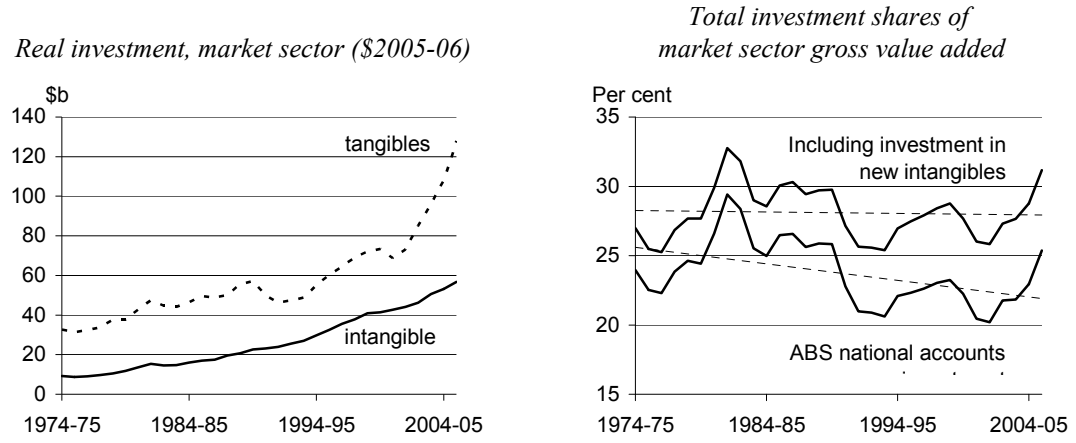
Intangibles are a growing share of total investment

Australian market sector investment in intangibles is large and has grown considerably over time. In 2005-06, market sector nominal investment in intangibles is estimated to have been $57 billion — almost half the size of investment in tangibles (figure 1). Since 1974-75 investment in intangibles as a percentage of market sector gross value added has doubled from about 5 per cent to 10 per cent (in nominal terms).

Investment in intangibles 'flattens' the trend in investment

Including expenditure on 'new' intangibles (that is, those not currently treated as investment in the national accounts) within total investment largely flattens the declining trend in the market sector ratio of total investment to gross value added seen in the Australian national accounts (figure 1).

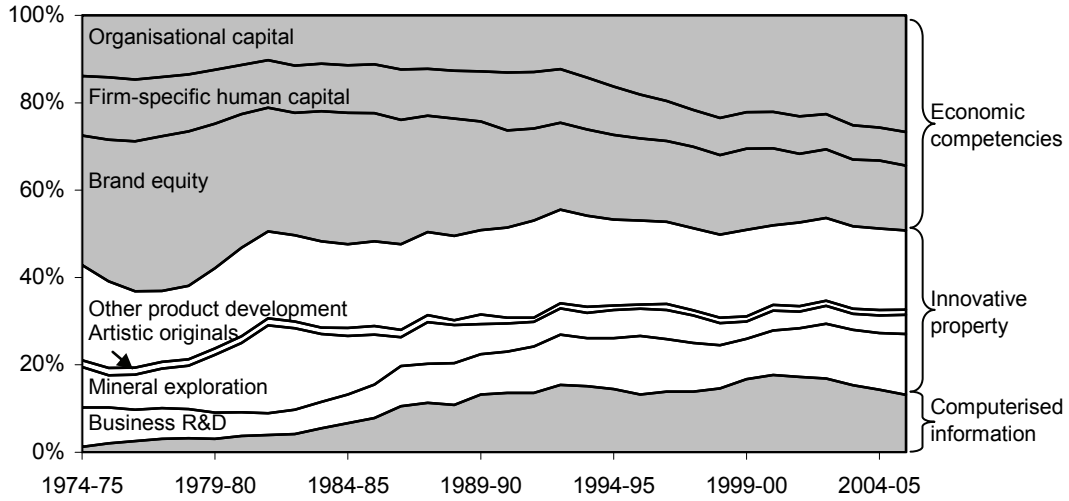
Figure 1 **Market sector investment**



The composition of intangible investment is changing

Over the last thirty years, there has been a shift towards investment in organisational capital and computerised information (figure 2). In 2005-06, around 50 per cent of intangible investment was in economic competencies, 38 per cent in innovative property and 13 per cent in computerised information. Around 80 per cent of total intangible investment was in 'new' intangibles.

Figure 2 **Shares of nominal total intangible investment, by asset type**
Per cent



The intangible capital stock is growing

The intangible capital stock of the market sector has also grown considerably over the last thirty years (despite the assumption that intangibles are relatively short lived compared with most tangible assets).

In 2005-06, the nominal intangible capital stock is estimated to have been $189 billion or around 17 per cent of the tangible capital stock.

- Of this, around 57 per cent was innovative property, 31 per cent economic competencies and 12 per cent computerised information. Seventy per cent of the intangibles stock was 'new' intangibles not already treated as capital in the national accounts.
- Some individual 'new' intangibles are now as large as more traditional intangibles — organisational capital is larger than computerised information and around the same size as each of mineral exploration and business R&D.

Growth in the real intangible capital stock is estimated to have averaged almost 5.5 per cent a year since 1974-75. In capital services terms, the flow of services from intangibles grew at an average of almost 6 per cent a year, around twice the rate for tangible capital services.

Box 2 **Standard growth accounting framework**

This paper uses the growth accounting (or sources of growth) framework, the theoretical foundations of which were first laid out in Solow (1957). This framework is an accounting exercise that breaks down output growth into input growth and attributes the residual to technological change. It examines *growth* in output rather than the *level* of output. It only accounts for the *direct* effect of inputs, not any indirect or spillover effects, such as from complementarities between different types of capital.

When output is measured as gross valued added (total production less intermediate inputs), the growth accounting framework says that value added growth is equal to a weighted average of capital growth and labour growth plus a residual not explained by growth in combined inputs. The residual is commonly referred to as multifactor productivity (MFP) growth, rather than technological change.* As MFP growth is calculated as the residual, it will not only include pure technological change but will also include the effect of any approximations in measurement of output and inputs and violations of underlying assumptions.

The assumptions of the growth accounting framework include:

- constant returns to scale in the underlying production function
- output markets are competitive
- inputs markets are competitive (that is, factor inputs are paid their marginal products)
- inputs are fully divisible
- inputs are fully utilised
- the economy is in long-run equilibrium.

In the ABS official estimates of MFP growth for Australia, output is measured as gross value added (total production less intermediate inputs). Whether expenditure on intangibles is treated as an intermediate input or as an investment will have an effect on both value added and the total capital input, affecting growth accounting estimates (see box 3).

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*Growth accounting can also be done in terms of labour productivity growth (growth in output per hour worked) rather than output growth, in which case labour productivity growth is equal to income share weighted growth in the capital labour ratio (capital deepening) plus MFP growth.

Accounting for intangibles as investment affects the sources of measured growth

Ignoring intangible assets as a source of capital services can result in bias in the estimates of MFP growth. For example, a slowdown in MFP growth in the 1990s in the United Kingdom became an acceleration after adjusting for intangible investment (Marrano, Haskel and Wallis 2007). For the United States, an important part of the productivity acceleration since the mid-1990s has been attributed to intangible assets (CHS 2006). The second half of this paper uses growth accounting to estimate the effect of treating intangible assets as capital on Australian MFP measures.

Growth accounting shows the direct contribution of inputs to output growth

Growth accounting is used to show what proportion of output growth is attributable to increases in labour and capital inputs, with the residual growth explained by other factors (such as technological progress). It is this residual that is considered a measure of MFP. Conventional growth accounting (box 2) treats expenditure on intangibles as current expenses, rather than as investments. This can result in biased measures of MFP (box 3).

Box 3 **Growth accounting with intangibles treated as capital**

Treating intangibles as capital within the growth accounting framework can have a number of effects on both the output and input sides of the accounting exercise, with a consequent effect on measured MFP growth as the residual that depends on the relative changes in output and input growth.

Measured output — treating expenditure on intangibles as an investment, instead of an intermediate input, increases the level of measured output (gross value added) by the amount of intangible investment. But the change in *growth* in measured total output depends on growth in investment in intangibles relative to growth in other outputs. For total output growth to be higher, growth in investment in intangibles must be higher than growth in other outputs.

Measured capital inputs — intangibles investment increases the level of the capital stock and the services from that capital stock. This is the direct effect and does not measure any indirect or spillover effects from that investment. But whether *growth* in total capital services is higher (lower) depends on whether intangible capital services is growing faster (slower) than tangible capital services.

(continued on next page)

Box 3 **(continued)**

Capital and labour shares of total inputs — the increase in measured capital increases the capital *share* and decreases the labour *share* of total inputs, although the return to labour and volume of labour do not change. Combined input *growth* (the weighted average of capital growth and labour growth) will rise (fall) if capital growth is higher (lower) than labour growth.

Measured MFP growth — the effect on measured MFP growth can be positive or negative depending on the relative size of the effects on output and input growth, that is, the difference caused by intangible investment (part of output not previously measured) and by intangible capital inputs (the services of the stock of capital not previously measured). This effect on MFP growth depends not just on the relative growth rates of outputs and capital inputs, but also the combined input growth rate which changes as the capital and labour shares of total inputs change.

The effect on productivity growth for Australia is small

Intangible assets *directly* account for a small but notable amount of conventionally-measured MFP growth for the Australian market sector. (This does not account for any *indirect* spillovers captured in MFP growth from, for example, complementarities between ICTs and particular types of intangible capital.)

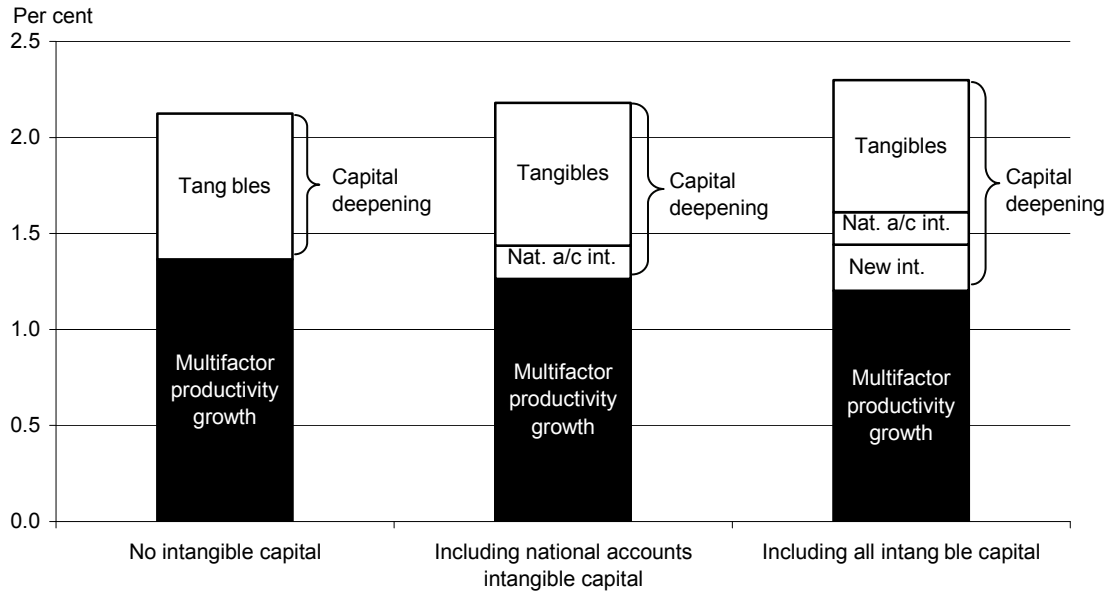
Growth accounting estimates for the Australian market sector are presented for three definitions of capital — including all intangibles, only the national accounts intangibles and no intangibles.[1] Labour productivity (LP) growth (growth in gross value added per hour worked in the market sector) is decomposed into the contributions of capital deepening and MFP growth (figure 3).

The effect of treating intangibles as capital is to raise measured labour productivity growth and to shift the relative importance of the sources of growth — towards capital deepening and away from MFP growth (the residual). When all intangibles are capitalised, on average they contribute 37 per cent of total capital deepening and 17 per cent of LP growth between 1974-75 and 2005-06.

[1] The estimates in this paper for the 'national accounts' case are slightly different from the ABS official estimates due to differences in methodology necessitated by limited intangibles data. The national accounts case was re-estimated for comparability with the other estimates in this paper.

Figure 3 **Decomposition of average annual labour productivity growth, 1974-75 to 2005-06**

Per cent per year



Compared with the case of no intangibles

- LP growth is 0.16 of a percentage point (or 8 per cent) higher
- capital deepening is 0.32 of a percentage point (or 41 per cent) higher
- MFP growth is 0.16 of a percentage point (or 12 per cent) lower (this is the amount of MFP growth under the no intangibles case that is actually attributable to unaccounted for intangible capital).

These results are based on experimental estimates for investment in intangibles and a range of assumptions related to the growth accounting parameters (such as depreciation rates and rates of return). However, sensitivity testing suggests that the finding that capitalising intangibles increases the importance of capital deepening relative to MFP growth as a source of growth is robust to a range of changes in the underlying estimates and assumptions within the reasonable bounds tested.

Accounting for the 'new' intangibles does not change the pattern of MFP growth in Australia

Some intangibles (software, mineral exploration and artistic originals) are already capitalised in the ABS national accounts. Not capitalising the 'new' intangibles affects the national accounts estimates of MFP growth.

- On average, 0.06 of a percentage point or 5 per cent of conventionally-measured annual average MFP growth is attributable to the new intangibles between 1974-75 and 2005-06.
- However, looking at the MFP peak-to-peak periods (which control for influences of the business cycle), the amount attributable to new intangibles ranges from -1 per cent to 8 per cent of conventionally-measured MFP growth. In the most recent cycle, 1998-99 to 2003-04, it is 8 per cent (0.09 of a percentage point).

National accounts intangibles have a larger effect on MFP growth than the new intangibles. While the new intangibles have a larger effect than national accounts intangibles on capital deepening and LP growth, these are largely offsetting so the effect on MFP growth is limited.

Overall, capitalising the new intangibles does not change the length of the MFP growth cycles or the periods in which acceleration/deceleration occurs (although the extent of the change is affected). And only a small proportion of Australia's MFP growth is directly attributable to intangibles.

International comparisons

Comparing measures across countries always raises issues of the extent to which the comparisons are legitimate. Even using measures based on the same methodology, as is the case in this paper, many differences remain because of variations in underlying data and data limitations. The extent to which differences between the estimates in this paper and those in the other country studies represent real differences rather than measurement differences is not known. Any real differences between countries should also be interpreted carefully. Country-specific circumstances will affect their appropriate level and type of intangible investment — the country with the highest ratio of intangibles to output should not be regarded as a benchmark. And the growth accounting approach does not provide information about the causal links between intangible investment and productivity growth.

Australian rates of investment in intangibles are mid-range

Although it is not possible to draw strong conclusions from these international comparisons, there are a number of notable features about the estimates. Experimental estimates based on the CHS methodology suggest that Australia has a ratio of intangible investment to output that is around mid-range of the estimates for other countries (table 1). Australia has a lower ratio than Finland, the United States, the United Kingdom, France, Japan and Germany but a higher ratio than Canada, the Netherlands, Italy and Spain.

Table 1 **Intangible investment as a share of adjusted output**

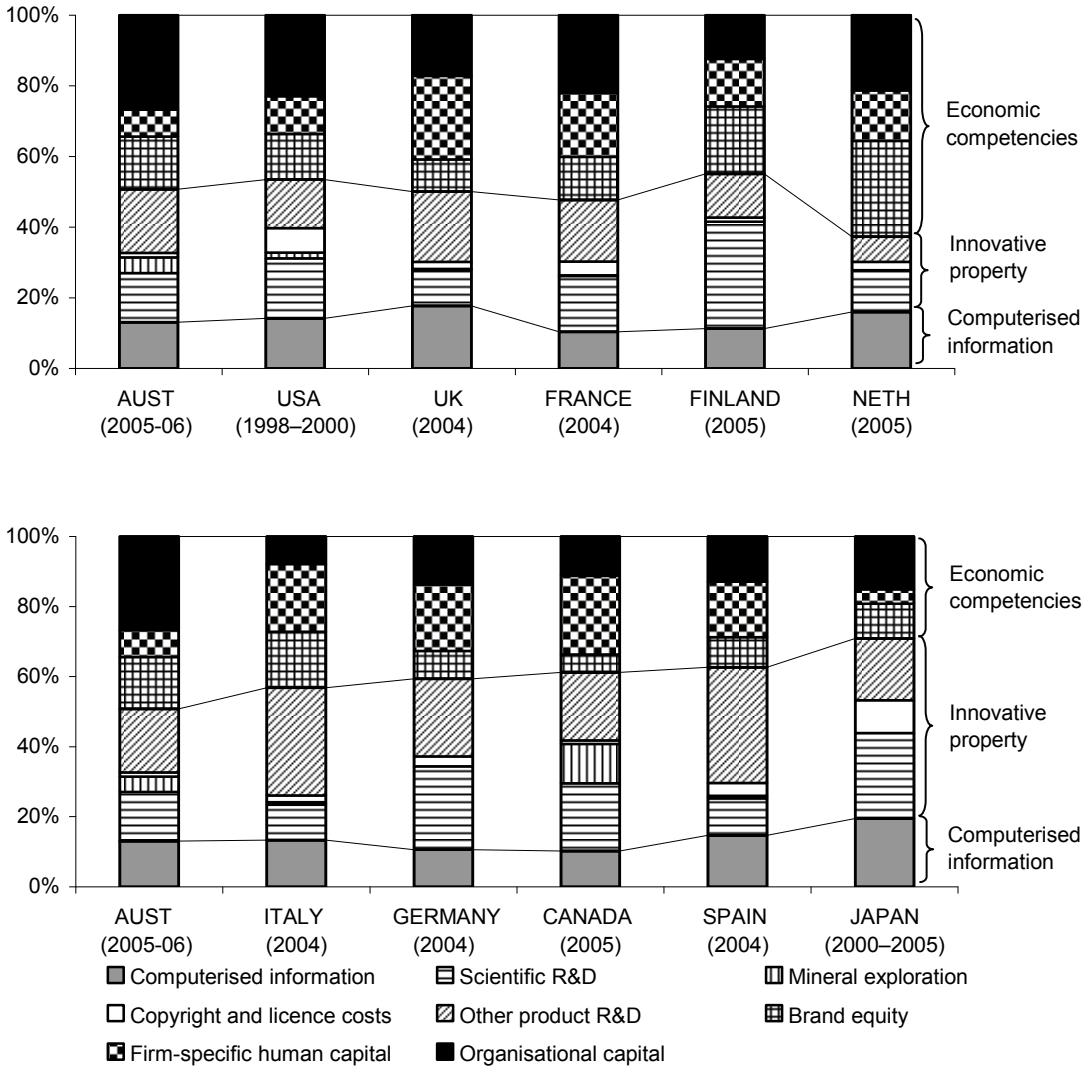
Percentage of output (including intangible investment) for the sector for which intangibles were measured

	Australia - market sector (2005-06)	*USA - non-farm business (1998–00)*	*UK - market sector (2004)*	*Japan - total economy (2000–05)*	*Neth. - total economy (2005)*	*Finland - non-fin. business (2005)*
Computerised information	1.3	2.0	2.3	2.0	1.3	1.6
Innovative property	3.6	5.3	4.2	5.4	1.7	6.4
Scientific R&D	1.3	2.3	1.3	2.6	0.9	4.3
Mineral exploration	0.4	0.2	0.0	0.0	0.0	0.0
Copyright and licence costs	0.1	0.9	0.3	1.0	0.2	0.2
Other product development, design and research	1.7	1.8	2.6	1.8	0.6	1.8
Economic competencies	4.7	6.2	6.5	3.1	4.9	6.6
Brand equity	1.4	1.7	1.2	1.0	2.2	2.7
Firm-specific human capital	0.7	1.4	3.1	0.4	1.1	1.9
Organisational capital	2.6	3.1	2.2	1.6	1.7	1.8
Total	**9.6**	**13.5**	**13.0**	**10.5**	**7.9**	**14.6**
Intangible to tangible investment ratio	0.44	1.2	1.1	0.6	0.5	1.2

	Australia - market sector (2005-06)	*France - market sector (2004)*	*Germany - market sector (2004)*	*Italy - market sector (2004)*	*Spain - market sector (2004)*	*Canada - total economy (2005)*
Computerised information	1.3	1.3	1.1	1.0	1.1	0.9
Innovative property	3.6	4.7	4.9	3.2	3.5	4.6
Scientific R&D	1.3	2.0	2.4	0.8	0.8	1.8
Mineral exploration	0.4	0.0	0.0	0.1	0.1	1.0
Copyright and licence costs	0.1	0.5	0.3	0.1	0.3	0.1
Other product development, design and research	1.7	2.2	2.2	2.3	2.4	1.8
Economic competencies	4.7	6.6	4.1	3.2	2.7	3.5
Brand equity	1.4	1.5	0.8	1.2	0.6	0.5
Firm-specific human capital	0.7	2.3	1.9	1.4	1.2	2.0
Organisational capital	2.6	2.8	1.4	0.6	0.9	1.0
Total	**9.6**	**12.6**	**10.1**	**7.4**	**7.3**	**9.1**
Intangible to tangible investment ratio	0.44	0.9	0.8	0.3	0.4	0.9

Australia has a very similar composition of intangible investment (in terms of the three main categories) to the United States and United Kingdom and France — with economic competencies the dominant type of intangible (figure 4). Actual levels of Australian investment are less in each of these categories of intangibles by similar amounts, rather than investment in any one type being relatively low.

Figure 4 **Composition of intangible investment**
Percentage share



Adjusting for intangibles affects the pattern of MFP for some other countries

The nature of the effect of capitalising intangibles in the growth accounting is the same across most countries for which estimates are available — an increase in LP growth and capital deepening and a decrease in MFP growth. However, the size of the effect varied across countries. For the period of the mid-1990s to the early 2000s, including all intangible capital (compared with the case of no intangible capital) lowered average annual MFP growth by 0.3 of a percentage point in the United States and Australia, 0.2 for France, and 0.1 for Germany, Finland (for new intangibles only) and the United Kingdom. The exceptions were the Netherlands

and Italy, for which there was no change in MFP growth, and Japan and Spain, for which MFP growth rose after capitalising intangibles.

Treating intangibles as capital does not have a large effect on the pattern of growth over productivity cycles for Australia. This contrasts with the United Kingdom, for which a deceleration in MFP growth between the early and late 1990s cycles became an acceleration after capitalising intangibles (Marrano, Haskel and Wallis 2007). For the Netherlands, the reverse was found — an acceleration in average MFP growth between 1996–2000 and 2001–2005 became a deceleration after capitalising intangibles (van Rooijen-Horsten et al. 2008).

While this paper does not explore or provide any measures of the indirect effects, it does add to the scope for international comparisons of the size of intangibles with potential complementarities. Fukao et al. (2008b) note that differences in the accumulation of intangible assets that play a complementary role to ICT capital might explain differences in productivity growth — and the results for Japan, particularly in terms of lower organisational capital, provide some support to this as a potential explanation. It is also the case that Australia (like the United States) has higher levels of organisational capital and higher levels of productivity growth than Japan.

Further research

Estimates in this paper are exploratory and, as is acknowledged by the authors of the other country studies, much work could be done to improve them. There are also alternative methodologies for the measurement of intangibles that could be explored. The development of improved measures (and data collections to support them), in conjunction with national statistics agencies, would be required before such intangibles could be considered for formal identification into the national accounts or even inclusion in a separate dataset focused on growth accounting.

However, beyond these direct measurement issues there is a range of other possible areas for further research.

- *Organisational capital*. The experimental estimates suggest that investment in organisational capital in Australia is now larger than business R&D, which the ABS intends to capitalise in the Australian national accounts. There are currently no plans to capitalise organisational capital — and this would be difficult since it is relatively poorly measured. However, the size of the estimates indicate that the measurement and effects of organisational capital (including complementarities with ICTs) warrant further investigation.

- *Industry level estimates*. Intangibles are likely to be relatively more important in some industries than others. For example, a relatively high rate of intangible investment was found in the financial services industry in the Netherlands (van Rooijen-Horsten et al. 2008). For Japan, the services sector had a lower rate of intangible investment relative to the manufacturing sector (Fukao et al. 2008b). Subject to data limitations, estimates for selected Australian industries or sectors would enable a closer examination of the links between intangibles and growth.
- *Econometric analysis of intangibles*. As the number of country studies using the CHS methodology increases it may be possible to undertake some econometric analysis of intangibles by pooling the data. This may enable the indirect spillovers from intangible assets to be examined.

1 Background

The rise of the 'knowledge economy' has brought productivity gains. But the extent of diversity in performance improvement across firms, industries and some countries has increased attention on the role of investments in certain intangible assets — such as computerised information (for example, databases), innovative property (for example, patents and designs) and economic competencies (for example, 'organisational capital'). Most of the focus on intangibles has been on computer software and R&D. But the other intangibles also warrant investigation — for example, it has been suggested that organisational capital facilitates adaptation to change and has complementarities with ICT capital.

Lev (2001) suggests that intangibles, while not new[1], have come to prominence because of intensified competition, due to globalisation of trade and deregulation in key economic sectors, and ICTs. These factors have changed the structure of firms and elevated the role of intangibles. However, despite this elevated role, intangibles are not well understood.

- Lev (2001, p. v) suggests that, despite their importance, intangibles are poorly measured, if at all, and their implications for public policy are not understood.
- Corrado, Hulten and Sichel (2005, p. 37) suggest that the conventional framework and current data used in growth analysis are "not telling us all we need to know about the role of knowledge capital in economic growth."
- Nakamura (1999, p. 13) traces the exclusion of intangibles from the capital stock in the national accounts to long-standing statistical conventions that assets had to be material and states that "… we need to recognize the increasing importance of intangible investment for our economy. Otherwise, statistical conventions can cause us to misread the fundamental forces propelling economic activity."

It has been argued that there are several areas of potential distortion of resource allocation and policy that arise from the fact that intangibles are only incompletely revealed in available statistical data and company accounting and reporting. There

[1] There is also a considerable history of research into intangibles — see Webster (1999) for an overview of the earlier roots of this literature.

are four main issues (see Mortenson 2000, Vickery 2000 and Lev 2001 for further details):

- capital markets, partly due to regulation, emphasise tangible rather than intangible capital, with an effect on access to and cost of capital
- mandatory expensing of intangibles leads to asymmetric information available to managers and shareholders and potentially distorts market transactions
- within companies, insufficient information about intangibles may distort management decisions and the formulation of business strategies
- within public policy, insufficient information about intangibles may distort particular policies (for example, industry policy, taxation, R&D and intellectual property protection).

There is an important measurement issue — treating expenditure on intangibles as a current expense, rather than as an investment, has an impact on the magnitude of measured value added and hence also on productivity measured. More fundamentally, intangible assets can be seen as a necessary pre-condition for optimising productivity gains. Specifically, investment in intangibles, such as new organisational structures, is needed in order to tap fully the productivity potential that information and communications technology presents.

Conventionally-measured GDP treats much of intangible expenditure as an intermediate input rather than an investment. This means that expenditure on intangibles is not included as investment in GDP and the flow of services from intangible capital is not included as an input. This will affect the measurement of multifactor productivity (MFP) and can affect the pattern of growth.

The rationale for treating intangibles as capital, put forward by Corrado, Hulten and Sichel (2006), is that any use of resources that reduces current consumption in order to increase it in the future qualifies as an investment. While computer software is now treated as capital in the national accounts of many countries, many other intangibles, including R&D, are currently not.

Recent studies have investigated the puzzle as to why knowledge activities are not as ‘visible’ in the economic statistics as expected. These studies have attributed:

- an important part of the US productivity acceleration since the mid-1990s to growth in intangible assets (Corrado, Hulten and Sichel 2006)
- a lack of productivity uplift in the United Kingdom to mismeasurement (a period of seemingly-low growth was actually a period of more rapid build-up of intangible assets) (Marrano, Haskel and Wallis 2007)

- a lack of productivity uplift in Japan to the lack of investment in intangibles (Fukao et al. 2007).

1.1 Definition of intangibles

Intangible capital — as well as being known by different names, such as knowledge assets and intellectual capital — is variously defined:

- a nonphysical claim to future benefits

  Assets are claims to future benefits, such as the rents generated by commercial property, interest payments derived from a bond, and cash flows from a production facility. An intangible asset is a claim to future benefits that does not have a physical or financial (a stock or a bond) embodiment. (Lev 2001, p. 5)

- private expenditure on assets that are not tangible but are necessary to the creation and sale of new or improved products and processes (Nakamura 2001)
- the 'glue' that creates value from the usual factor inputs (Cummins 2005)
- all assets that are neither natural or produced — a very broad measure that includes raw labour, human capital, social capital and institutional infrastructure, such as the judicial system (World Bank 2006).

The focus of this paper is narrower than that used by the World Bank, concentrating on intangibles invested in by businesses. Intangibles have been categorised (and quantified) by Corrado, Hulten and Sichel (2006) as:

- *computerised information* (software and computerised databases)
- *innovative property* (scientific and non-scientific R&D and design)
- *economic competencies* (brand equity, firm-specific human capital and organisational capital).

This paper uses this categorisation of intangibles.

1.2 Objectives and scope of the paper

The overall objective of this study is to gain a better understanding of the nature, role and importance of intangible assets in Australia's productivity performance.

More specifically the objectives are to:

- develop quantitative measures of intangible assets and provide time series estimates of intangible asset investment and stocks

- assess the contribution to conventionally-measured MFP growth in Australia
- provide an international perspective on the types and magnitudes of intangible assets in Australia compared with other countries.

Measuring intangibles contributes to:

- a better understanding of the importance of intangibles for Australian productivity growth
- a better understanding of the international differences in the mix of drivers of productivity growth (for example, does Australia have lower R&D but higher organisational capital than other countries?)
- a better understanding of the potential for interactions between intangible and other capital (for example, complementarities between ICT and organisational capital).

This study is a continuation of the Commission's stream of research that has 'parcelled out' elements of MFP growth and also builds on previous Commission research on some aspects of intangible assets, such as R&D.

1.3 The rest of the paper

The remainder of this paper is organised as follows.

- Chapter 2 outlines the methodology for identifying the contribution of intangibles in the measurement of MFP — covering previous studies and the current treatment of intangibles in the Australian national accounts. Appendix B provides details of the model specification.
- Chapter 3 outlines the way in which investment in each of the intangibles has been measured. Appendix A provides details of the data sources and method of construction of these estimates.
- Chapter 4 describes the construction of the capital stocks for each of the intangibles. Appendix A provides details of the assumptions used in their construction.
- Chapter 5 reports the results of explicitly identifying the contribution of intangibles in growth accounting in the Australian context. Related appendixes provide details of the construction of the capital services indexes for intangibles and the steps taken to adjust the growth accounting framework to treat intangibles as capital (appendix C) and the sensitivity testing of results (appendix D).
- Chapter 6 compares the Australian results with those from other country studies.

2 Methodology

This chapter outlines the methodology used to estimate the effect on multifactor productivity (MFP) of capitalising intangibles. A brief summary of related studies is provided, followed by the model and the classification of intangibles used in this paper.

2.1 Previous studies

There is an extensive literature on some elements of intangible investment/capital (for example, R&D capital), while other elements (for example, organisational capital) have received less attention.[1] This section provides a few examples of recent approaches to measuring intangibles in the economics literature.

Sichel (2008) identifies three broad approaches to measuring intangible capital in general — financial market valuation; other performance measures; and direct expenditure data.

The first approach, financial market valuation, infers the value of intangible capital as the difference between the market value of firms and the value of tangible assets.

- Brynjolfsson, Hitt and Yang used this approach in a number of papers examining the link between intangible investments and investment in computers in the United States (Brynjolfsson and Yang 1999, Brynjolfsson, Hitt and Yang 2000 and 2002). These papers used firm-level data and found that each dollar of installed computer capital in a firm was associated with between five and ten dollars of market value. They interpreted this difference as revealing the existence of a large stock of intangible assets that are complementary with computer investment. They also identified particular organisational practices at the firm level that represent at least part of these intangible assets (related to the types of decision making authority, use of self-managing teams and the breadth of job responsibilities).
- Webster (2000) used a similar approach with Australian data, assuming that any residual market value of the firm (stock market value plus liabilities) not explained by the balance sheet value of tangible assets must be due to intangible

[1] A review of this literature is beyond the scope of this paper.

assets. The results implied that the ratio of intangible to all enterprise capital rose by 1.25 per cent a year over the 50 years to 1998.

- World Bank (2006) measured intangible capital at the country rather than firm level. The value of intangible capital was derived as the residual after deducting natural capital and produced capital from total wealth (measured as the net present value of future sustainable consumption). For Australia this measure was US$288 686 of intangible capital per person or around US$5600 billion in total in 2000.

The second approach uses other performance measures, such as productivity or earnings, to estimate the value of intangible capital.

- McGrattan and Prescott (2005) inferred the value of intangible capital from corporate profits, the returns to tangible assets, and the assumption of equal after-tax returns to tangible and intangible assets. They estimated the value of intangible capital at 31 to 76 per cent of US GDP.
- Cummins (2005) defined intangible capital in terms of adjustment costs and estimated these costs econometrically from US firm-level panel data. His estimates were based on creating a proxy for the intrinsic value of the firm from discounted value of expected profits from analysts' forecasts (which he suggested reflect the analysts' valuation of intangibles) and estimating the return on each type of capital (tangible and intangible). He found no appreciable intangibles associated with R&D and advertising but sizable intangibles (organisational capital) created by IT.
- Webster (2000) measured growth in the rate of intangible investment using the proportion of the labour force in jobs that produce intangible capital. For Australia, growth in the ratio of intangible investment to all production was estimated to be around 2.8 per cent per year for the 25 years to 1996.
- Lev and Radhakrishnan (2005) developed a firm-specific measure of organisational capital, modelling the effect on sales of organisational capital (proxied by reported 'sales, general and administrative expenses', as this includes expenditures that generate organisational capital). They estimated the marginal productivity of organisational capital to be between 0.4 and 0.6, and mean organisational capital of 4 per cent of average sales of their sample of US firms.

It has been suggested that the first two approaches may be subject to considerable measurement error — for example, stock market values may reflect a mismeasurement to the extent that asset prices depart from their intrinsic values and analysts' measures of earnings can be subject to mistakes and biases (Cummins 2005).

The third approach uses expenditure data to develop more direct measures of intangible capital. This approach is not without measurement error and data limitations — including whether the list of measures of intangibles is comprehensive and able to capture changes in the nature of intangibles over time.

- Nakamura (1999, 2001) was the first to employ this approach. He measured gross investment in intangible assets using a range of measures including R&D expenditure, software, advertising and marketing expenditure, and wages and salaries of managers and creative professionals. He estimated that in 2000 US investment in intangibles was US$1 trillion (roughly equal to that in non-residential tangible assets), with an intangible capital stock of at least US$5 trillion.
- Corrado, Hulten and Sichel (CHS) (2005) expanded Nakamura's work to develop expenditure-based measures of a larger range of intangibles for the United States (see section 2.3). They estimated investment in intangibles averaged US$1.1 trillion between 1998 and 2000 (1.2 times tangible capital investment) or 12 per cent of GDP.
- CHS (2006) built on this work to develop a methodology for explicitly identifying the contribution of intangibles in the national accounts and growth accounting. They estimated that previously unmeasured intangible capital contributed 0.24 of a percentage point (18 per cent) to conventionally-measured MFP growth in the United States between the mid-1990s and early 2000s. The CHS methodology has been applied in a number of other country studies — with estimates of the contribution of previously unmeasured intangible capital to MFP growth of 14 per cent (United Kingdom in Marrano, Haskel and Wallis 2007), 3 per cent (Finland in Jalava, Aulin-Ahmavaara and Alanen 2007) and 0 per cent (the Netherlands in van Rooijen-Horsten et al. 2008), over a similar period. Other country studies estimated only the contribution of *all* intangibles to MFP growth — -19 per cent in Japan (Fukao et al. 2008b), 19 per cent in France, 18 per cent in Germany, 9 per cent in Spain and 0 per cent in Italy (Hao, Manole and van Ark 2008).[2]
- Hulten and Hao (2008) applied a methodology similar to CHS to the financial data of a group of US R&D intensive companies to construct estimates of R&D and organisational capital. They found that this explained a significant portion of the difference between market value and book value.

[2] Belhocine (2008) estimated intangible investment for Canada but did not estimate the effect on MFP growth. The findings of all these studies are discussed in more detail, and compared with Australian estimates derived in this paper, in chapter 6.

Schreyer (2007, p. 79) notes that the CHS approach appears more practical for regular measurement of intangibles.

> The Corrado-Hulten-Sichel approach does not require explicit econometric techniques and would appear more practical from the perspective of monitoring intangibles as part of a periodic measurement program carried out by a statistical office.

This quote highlights one of the reasons for the considerable ongoing debate about appropriate measures of intangibles in the broader literature — the desirability of a particular measure depends on the perspective taken and the use to which the measure is to be put. The literature on intangibles is from economic, accounting, legal and management perspectives (Bosworth and Webster 2006 provides a useful discussion of intangibles from each of these perspectives). One particular issue of debate is whether the measurement should be expenditure-based or value-based. The characteristics of a measure to be included in the accounts of an individual firm for accounting purposes may be different to those used for internal business management purposes (for example, past objective expenditures may be preferred for accounting purposes rather than estimates of future profits that may be useful for management purposes). An examination and assessment of this debate is beyond the scope of this paper and has been well canvassed elsewhere (see, for example, Lev 2001, Hunter, Webster and Wyatt 2005 and Bosworth and Webster 2006).

It is the CHS (expenditure-based) methodology that has been applied in this paper because it focuses on the examination of the relationship between intangibles and MFP growth and data for international comparisons are available. The CHS approach embeds intangibles in the standard growth accounting framework used to examine productivity growth, and it has already been applied to several OECD countries. This paper is an (exploratory) step in examining intangibles in Australia in an international context, using a method for which there are readily available international estimates on a comparable basis. (No previous applications of this methodology to Australian data have been identified). The remainder of this chapter focuses on the CHS methodology.

Justification for capitalisation of intangibles

The adjusted growth accounting in the expenditure-based approach to intangible measurement is based on capitalising intangibles.[3] CHS (2006) suggest that the justification for capitalising intangibles from the standpoint of consumption is that any use of resources that reduces current consumption in order to increase it in the

[3] 'Capitalising' refers to the treatment of expenditure as investment and the accumulation of a capital stock according to the perpetual inventory method.

future qualifies as an investment. And symmetry of all types of capital should therefore require that intangibles are treated in the same way as tangibles.[4]

However, from the production side, the principle of symmetrical treatment has been used as an argument against the capitalisation of intangibles. CHS (2006, pp. 10–4) list the characteristics that have been identified as disqualifying intangibles from being treated as capital and go on to counter these arguments. In brief, the characteristics and counter arguments are as follows.[5]

- *Lack of verifiability* of the quantity of intangibles not purchased through market transactions.
  - However, this does not automatically make intangibles intermediate inputs. Some tangibles lack verifiability (for example, internal construction projects) and some intangibles do not (for example, purchased management consulting services). CHS (2006) suggest that the economic character of the good not the ease of measurement should determine the classification of the good.
- *Lack of visibility* (or intangibility) after their acquisition, which complicates efforts to track past vintages. The lack of a physical embodiment means that in terms of national income methodology this creates difficulty in measuring depreciation rates and obtaining stocks.
  - Again, CHS (2006) suggest this measurement concern is not a valid conceptual reason for not capitalising intangibles.
- *Non-rivalness* (for example, knowledge being able to be employed by many users simultaneously without decreasing the quantity available to any single user) and *lack of appropriability of returns* from some intangibles (such as intellectual property).
  - CHS (2006, p. 13) argue that the capitalisation issue pivots on whether the provision of the intangible increases future output and consumption, not whether it is partly non-appropriable or non-rival. Therefore these two characteristics do not invalidate the need to capitalise intangibles that have these characteristics (and not all do).

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4 The justification for capitalising intangibles is further explored in Webster and Jensen (2006). Also, van Rooijen-Horsten et al. (2008, pp. 5–9) provides a useful discussion of the extent to which different intangibles satisfy the definition of capital from the perspective of the 1993 System of National Accounts (which sets out the international statistical standards for the measurement of the market economy). These criteria include: having an economic and legal owner; providing possible economic benefits from being held or used; and being used repeatedly or continuously in production processes for more than one year.

5 These characteristics are also of concern to accountants. For a detailed discussion of the recognition and definition rules for intangibles, from an accounting perspective, see Wyatt (2006).

2.2 Model

CHS (2006) set out the effect on national account measures of treating intangibles expenditure as investment rather than as an intermediate input (see appendix B for a fuller derivation). Their model, outlined below, is based on three goods — a consumption good with real output volume in period t of C_t with price P_{C_t}; a tangible investment good I_t with price P_{I_t}; and an intangible good N_t with price P_{N_t}.

Intangibles treated as intermediate inputs

When intangibles are regarded as being intermediate inputs, labour L and tangible capital K are allocated to the production of all three goods, and N is an input to C and I. The production function and flow account for each of the three sectors is then

Intangible sector $\quad N_t = F_N(L_{N_t}, K_{N_t}, t) \qquad P_{N_t}N_t \equiv P_{L_t}L_{N_t} + P_{K_t}K_{N_t}$ (2.1)

Tangible sector $\quad I_t = F_I(L_{I_t}, K_{I_t}, N_{I_t}, t) \qquad P_{I_t}I_t \equiv P_{L_t}L_{I_t} + P_{K_t}K_{I_t} + P_{N_t}N_{I_t}$ (2.2)

Consumption sector $\quad C_t = F_C(L_{C_t}, K_{C_t}, N_{C_t}, t) \qquad P_{C_t}C_t \equiv P_{L_t}L_{C_t} + P_{K_t}K_{C_t} + P_{N_t}N_{C_t}$ (2.3)

where tangible capital accumulates according to the perpetual inventory model $K_t \equiv I_t + (1-\delta_k)K_{t-1}$ with depreciation rate δ_k. The production functions in each equation are linked to the accounting identities by the assumption that each input is paid the value of its marginal product. For intangibles, the left-hand side of equation (2.1) says that the output of intangibles is produced by labour and tangible capital in that sector. The right-hand side says that the value of the intangibles produced is identically equal to the returns to labour and tangible capital used in that sector (assuming factors are paid their marginal products).

The assumption in this model that intangibles N_t $(= N_{I_t} + N_{C_t})$ are an intermediate input means that, as both an output and an intermediate input to the production of the other products, intangibles net out in the aggregate.[6] Intangibles therefore do not appear separately in the total output (Q'_t) identity

$$P_{Q'_t}Q'_t \equiv P_{C_t}C_t + P_{I_t}I_t \equiv P_{L_t}L_t + P_{K_t}K_t \quad (2.4)$$

where $L \equiv L_N + L_I + L_C$, and $K \equiv K_N + K_I + K_C$

6 CHS (2006) adopts the convention that intermediates used by the industry that produced them are netted out of final output. N_N is therefore omitted from the production function of the intangible sector.

Intangibles treated as capital

If intangibles are treated as capital, a different model applies. The intangible capital stock accumulates according to $R_t \equiv N_t + (1-\delta_R)R_{t-1}$, in the same way as tangible capital. The production function and flow account for each of the three sectors become

Intangible sector $N_t = F_N(L_{N_t}, K_{N_t}, R_{N_t}, t)$ $P_{N_t}N_t \equiv P_{L_t}L_{N_t} + P_{K_t}K_{N_t} + P_{R_t}R_{N_t}$ (2.5)

Tangible sector $I_t = F_I(L_{I_t}, K_{I_t}, R_{I_t}, t)$ $P_{I_t}I_t \equiv P_{L_t}L_{I_t} + P_{K_t}K_{I_t} + P_{R_t}R_{I_t}$ (2.6)

Consumption sector $C_t = F_C(L_{C_t}, K_{C_t}, R_{C_t}, t)$ $P_{C_t}C_t \equiv P_{L_t}L_{C_t} + P_{K_t}K_{C_t} + P_{R_t}R_{C_t}$ (2.7)

where P_{R_t} is the rental price associated with the services of the intangible stock.[7]

Intangibles now appear on the left-hand side, in the production functions, as a cumulative stock (R_t) not as an intermediate input (N_t) as above. On the right-hand side payments to that stock ($P_{R_t}R_t$) appear rather than payment for the entire intermediate input ($P_{N_t}N_t$).

Again, the production functions in each equation are linked to the accounting identities by the assumption of marginal productivity pricing. The total output (Q_t) identity is expanded to include the value of output of the intangibles on the production side[8] and the payments to the stock of intangibles on the income side:

$$P_{Q_t}Q_t \equiv P_{C_t}C_t + P_{I_t}I_t + P_{N_t}N_t \equiv P_{L_t}L_t + P_{K_t}K_t + P_{R_t}R_t \quad (2.8)$$

where $N \equiv N_N + N_I + N_C$ and $R \equiv R_N + R_I + R_C$

Comparing MFP growth under the two approaches

To see the implications for MFP growth, the following growth accounting equations can be derived from the production functions above (see appendix B).

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7 The rental price of tangible capital (P_{K_t}) will also change when intangibles are capitalised because of the change in the equalising rate of return. However, the same notation 'P_{K_t}' is maintained in both cases for simplicity (see appendix B).

8 This is the case whether intangibles are purchased intermediate inputs or own account production. When intangibles are produced on own account, some of the currently measured primary inputs of that industry are being used to create the additional intangible output. The expenditure-based approach values this additional output using the primary input costs (see chapter 3).

As an intermediate input, intangibles expenditure is netted out and does not appear in the MFP growth equation ($\dot{x}$ denotes the growth rate of x)

$$\dot{MFP}' = \dot{Q}' - s'_L \dot{L} - s'_K \dot{K} \quad (2.9)$$

where $s'_L \equiv [P_L L]/[P_L L + P_K K]$ and $s'_K \equiv [P_K K]/[P_L L + P_K K]$

As capital, intangibles appear as an input in the MFP equation, which becomes

$$\dot{MFP} = \dot{Q} - s_L \dot{L} - s_K \dot{K} - s_R \dot{R} \quad (2.10)$$

where $s_L \equiv [P_L L]/[P_L L + P_K K + P_R R]$, $s_K \equiv [P_K K]/[P_L L + P_K K + P_R R]$ and $s_R \equiv [P_R R]/[P_L L + P_K K + P_R R]$.

Equation (2.10) differs from (2.9) in a number of ways.

- The level of aggregate output increases because it includes the value of output of the intangible goods. But whether output growth rises depends on whether the growth rate of real intangible investment is higher or lower than the growth rate of other output.
- The payment to an additional factor of production, the stock of intangibles, is also included.
- All the factor income shares are different because both output and the total payments to capital differ. Output has increased because of the inclusion of intangible output. And there is a corresponding increase in total factor payments. Income payments to the additional factor, intangible capital stock, increase total payments to capital. The labour income *share* therefore falls (the level of labour income is unchanged).
- The effect on MFP growth is ambiguous — it may rise or fall depending on the change in output growth relative to the change in input growth. For example, MFP growth will fall if the inclusion of intangibles raises the output growth rate by less than it raises the growth in inputs.

Implementation of the model

The methodology for explicitly identifying the contribution of intangible assets in growth accounting is discussed in detail in the following chapters, together with the results. Implementation requires a number of steps, many of which involve difficult measurement issues.

- Estimate investment in each intangible asset (see chapter 3)

  - find relevant data sources for expenditure on each intangible
  - compile a time series of nominal expenditure
  - determine the share of expenditure that is to be treated as investment
  - select appropriate deflator and deflate to get a real investment series.
- Build a real capital stock for intangible assets (see chapter 4)
  - determine the appropriate rate of depreciation for each intangible asset
  - use the perpetual inventory method to construct a real capital stock from the real investment series and assumed depreciation rates.
- Adjust output and income to include intangibles as per equation (2.8) (see chapter 5)
  - recalculate output (measured as market sector gross value added for Australia) to include intangibles output
  - adjust the operating surplus for market sector gross value added by adding intangibles investment.
- Construct a volume index of capital services measures of all capital inputs (tangible and intangible) using capital stocks and rental prices (see chapters 4 and 5)
  - determine the appropriate rental price parameters for each intangible asset
  - rental prices for each asset (tangible and intangible) are derived from the adjusted operating surplus by solving for an equalising rate of return across all assets.
- Undertake growth accounting as per equation (2.10) (see chapter 5)
  - using the data for intangibles estimated as outlined above, together with the published and unpublished Australian Bureau of Statistics (ABS) national accounts data used in standard growth accounting.

2.3 Classification of intangibles

As noted in chapter 1, CHS (2006) classify intangibles into three main categories — computerised information, innovative property and economic competencies. This classification is followed in this paper.

The three main categories of intangibles are made up of a variety of specific intangibles (as defined in CHS 2006).

- *Computerised information* is the knowledge embedded in computer programs and databases.

- *Innovative property* includes the relatively familiar scientific R&D (reflecting scientific knowledge embedded in patents, licences and general know-how) but is much broader — including non-scientific R&D or creative property (innovative and artistic content in commercial copyrights, licences and designs).
- *Economic competencies* include brand equity (for example, investment to retain or gain market share and investment in brand names), firm-specific human capital (employee skill building) and organisational capital (investments in strategic planning, adaptation and reorganisation).

Of these intangibles, organisational capital is perhaps the least well known. It is variously defined as:

- the body of knowledge in a firm enabling it to combine conventional factors of production in the production process (for example, business processes built around computer systems) (Brynjolfsson and Yang 1999)
- business processes, management structures and organisational systems specifically designed to maximise the value of output given available physical and human capital (quality management systems, supply chain management solutions and innovation processes for product development) (De and Dutta 2007)
- the organisational architecture and the systems for monitoring activity and communicating within the firm (Webster and Jensen 2006)
- the inherent values, relationships and practices of an organisation which contribute to performance (internal and external networks based on partnership and trust) (Healy 2005).

The individual types of intangible assets are discussed further in chapter 3 and appendix A.

Current treatment of intangible assets in Australian National Accounts

Intangibles are not easily measured and work has mainly focused on elements such as human capital and R&D. However, the identification of intangible assets in official national accounts, under the UN System of National Accounts (SNA), has been even more limited.[9]

[9] The treatment of intangibles is, of course, only one of a number of national accounting issues under consideration. However, a discussion of these broader issues is beyond the scope of this paper.

- The decision to capitalise software and databases, mineral exploration and entertainment, literary or artistic originals was taken under SNA93 and has been implemented in many countries.[10]
- The decision to capitalise R&D was taken in 2007. According to Pilat (2007) there are no current plans for brand equity, firm-specific human capital and organisational capital to be capitalised in the SNA.[11]

The ABS *Australian System of National Accounts*[12] includes the following intangibles in investment and capital stock series.

- computer software (purchase of software, and software developed in-house if expenditure is large, and large expenditures on the purchase, development or extension of databases)
- entertainment, literary or artistic originals (the originals of films, sound recordings, manuscripts, tapes etc on which drama performances, radio and television programming, musical performances, sporting events, literary and artistic output etc., are recorded or embodied)
- mineral and petroleum exploration (capitalised value of expenditures on exploration for petroleum, natural gas and mineral deposits).

The measurement of these 'national accounts' intangibles and the 'new' intangibles (the other intangibles in the CHS classification) is discussed in chapter 3.

10 Although this has been done in different ways, particularly for software, which affects international comparability (Aspden 2007).

11 The OECD plans to release a handbook on measuring intellectual property to provide guidance on how to introduce various intangible fixed assets into national accounts (Pilat 2007).

12 See ABS (2000, chapter 15) for details. Spectrum licences appear as experimental estimates in the national balance sheet but not the gross fixed capital formation or capital stock estimates (ABS 2000, para. 15.4).

3 Measurement of investment in intangibles

This chapter outlines the data sources and development of Australian estimates of investment in the range of intangibles described in chapter 2. The estimates are for the market sector of the Australian economy, the sector of the economy for which Australian multifactor productivity (MFP) estimates are available.[1]

As outlined in chapter 2, a number of steps and measurement challenges are involved in estimating investment in each intangible:

- find relevant data sources for expenditure on each intangible
- compile a time series of nominal expenditure
- determine the share of expenditure that is to be treated as investment
- select appropriate deflator and deflate to get a real investment series.

These steps, and the difficulties encountered in implementing them, are discussed in the following sections and the estimated real investment series presented. (A more detailed description of the method, data limitations and the comparability with other studies is provided in appendix A. The sensitivity of the real investment estimates to some of the assumptions is discussed in appendix D.)

Table 3.1 summarises the data sources and assumptions used to construct the real investment estimates for each of the intangibles. In most cases, the measures follow Corrado, Hulten and Sichel (CHS 2005) in order to facilitate international comparisons, with some improvements as incorporated in Marrano, Haskel and Wallis (MHW 2007). The exceptions are where Australian Bureau of Statistics (ABS) measures are available — computer software, artistic originals and mineral exploration.

[1] See table A.1 for a list of the twelve industry Australian and New Zealand Standard Industrial Classification (ANZSIC) divisions that make up the market sector. The industries excluded are Property & business services, Government administration & defence, Education, Health & community services, and Personal & other services. These industries are excluded because of the difficulties of measuring outputs in some service industries. The sector of the economy for which intangibles and MFP have been estimated varies across countries — this is discussed in chapter 6.

Table 3.1 **Summary of data sources and assumptions used to construct investment of intangibles**

Type of intangible	*Expenditure measure and main data sources*[a]	*Proportion of expenditure treated as investment*[b]	*Deflator*
Computerised information			
Computer software	Software investment by market sector industries ABS national accounts (Cat. no. 5204.0)	1	ABS computer software implicit price deflator (IPD)
Computer databases	Included in software estimates		
Innovative property			
Business expenditure on R&D (BERD)	Business R&D expenditure by market sector industries ABS BERD survey (Cat. no. 8104.0)	1	Implied market sector gross value added (GVA) deflator
Mineral exploration	ABS national accounts (Cat. no. 5204.0)	1	ABS mineral exploration IPD
Artistic originals	ABS national accounts (Cat. no. 5204.0)	1	ABS artistic originals IPD
Other product development, design and research			
New product development in financial industry	20 per cent of all intermediate purchases by Finance industry ABS Input-Output/Supply-Use (IO/SU) tables (Cat. no. 5215.0/unpublished)	1	Implied Finance & insurance industry GVA deflator
New architectural and engineering designs	50 per cent of sales of architectural and consulting engineering services to market sector industries ABS Industry survey (Cat. no. 8155.0) and ABS IO/SU tables (Cat. no. 5215.0/ unpublished)	1	Implied market sector GVA deflator
R&D in social sciences and humanities	Included in BERD estimates		
Economic competencies			
Brand equity			
Advertising	Market sector share of total advertising expenditure less expenditure on classifieds and directories. Doubled to account for production costs. Commercial Economic Advisory Service of Australia advertising expenditure survey and ABS IO/SU tables (Cat. no. 5215.0/unpublished)	0.6	Implied market sector GVA deflator

(continued on next page)

Table 3.1 **(continued)**

Type of intangible	*Expenditure measure and main data sources*[a]	*Proportion of expenditure treated as investment*	*Deflator*
Market research	Sales of market research services to market sector industries. Doubled to account for own-account market research. ABS Industry surveys (Cat. nos 8155.0, 8677.0) and ABS IO/SU tables (Cat. no. 5215.0/unpublished)	0.6	Implied market sector GVA deflator
Firm-specific human capital	Direct costs and wage costs of employee time in training for market sector industries (excluding Agriculture). ABS Training surveys (Cat. nos 6353.0, 6278.0)	1	Average weekly full-time ordinary earnings deflator
Organisational capital			
Purchased	Sales of management consulting services to market sector industries. Assumed to be 77 per cent of sales of all business management services to market sector industries. ABS Industry survey (Cat. no. 8155.0) and ABS IO/SU tables (Cat. no. 5215.0/ unpublished)	0.8	Implied market sector GVA deflator
Own account	20 per cent of salaries of Managers & administrators (excluding farm managers and IT managers) in market sector industries. ABS Labour Force Survey (Cat. no. 6310.0)	1	Implied market sector GVA deflator

[a] Full details of data sources are provided in appendix A. [b] As used in CHS (2005, 2006). Basis for assumptions discussed in appendix A and sensitivity testing of some of these assumptions reported in appendix D.

3.1 Nominal expenditure series

For each of the intangibles an expenditure series was compiled for 1974-75 to 2005-06 — which in most cases required backcasting based on related data.

Computerised information

As noted in chapter 2, computer software is already treated as investment in the Australian national accounts. This covers both purchased and own-account software and database development — although databases and own-account software

development are only included if the expenditure is 'large' (ABS 2000, p. 452). The ABS estimates for this intangible asset are used in this paper — time series for gross fixed capital formation and capital stock are available for the full period 1974-75 to 2005-06.

This is broadly similar to the combination of the measures of computer software and computerised databases used in CHS (2005), although the ABS measure may understate this intangible through the exclusion of some database and own-account software development (see appendix A).

Innovative property

CHS include six types of innovative property — scientific R&D, mineral exploration, copyright and licence costs, new product development costs in the financial industry, new architectural and engineering designs, and R&D in social sciences and humanities. Differences in the collection and capitalisation of some of these expenditures by the ABS means there are some differences in the categorisation of these intangibles in this paper.

Business expenditure on R&D

Australian business expenditure on R&D (BERD) is available from ABS *Research and Experimental Development, Businesses* (Cat. no. 8104.0). A consistent series for the *market sector* (excluding Agriculture, forestry & fishing[2]) was compiled for 1968-69 to 2002-03 by Shanks and Zheng (2006). For this paper it was updated and extended to 2005-06 using revised and updated data from the ABS Cat. no. 8104.0.[3]

R&D activity is defined by the ABS as

> Creative work undertaken on a systematic basis, in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (ABS Cat. no. 8104.0, 2005-06, p. 30)

Unlike the US survey of industrial R&D, the ABS survey of BERD includes R&D in fields classed as social sciences and humanities (identified as a separate category of intangible in CHS 2005). A separate consistent time series for this subset of R&D was not readily available for Australia. Therefore, in this paper, the intangible

[2] The ABS did not directly survey farms and other businesses in this industry until 2005-06. Agriculture has been excluded from the 2005-06 data to maintain comparability over time.

[3] The series used is total expenditure on R&D, not just current expenditure. This means that there is some double counting of capital expenditure, as was also the case in the UK study. However, capital expenditure was only 6 per cent of total Australian BERD in 2005-06.

category ‘business expenditure on R&D’ includes ‘R&D in social sciences and humanities’ as well as scientific R&D undertaken by market sector industries.

It should also be noted that the ABS BERD data include some R&D related to financial services and architectural/engineering services. It appears that the scope of these types of R&D as discussed in CHS (2005) is broader than those activities that may be covered by the BERD survey (although few details are given in CHS 2005). For comparability, the CHS method was used to estimate these separate types of R&D and the ABS-based BERD estimates were reduced to avoid double counting, where possible.[4] The extent of any remaining duplication is discussed below.

Mineral exploration

Mineral exploration (the use of existing exploration techniques) is already capitalised in the Australian national accounts. The ABS estimates for this intangible asset are used in this paper — time series for gross fixed capital formation and capital stock are available for the full period 1974-75 to 2005-06.

This measure does not include mining R&D (the development of new exploration techniques and associated research) and therefore differs from that used in CHS (2005). In this paper, mining R&D is included in BERD because a separate consistent time series for mining R&D was not readily available.

Artistic originals

Artistic originals are already capitalised in the Australian national accounts. The ABS defines entertainment, literary or artistic originals as:

> … originals of films, sound recordings, manuscripts, tapes, models, etc., on which drama performances, radio and television programming, musical performances, sporting events, literary and artistic output, etc., are recorded or embodied. (ABS 2000, p. 454)

This appears to be similar coverage to copyright and licence costs in CHS (2005). The ABS estimates are based on the present value of expected future income flows generated from the originals. The ABS uses a range of valuation techniques including the market transactions approach (for example, payment of advances to composers and authors) and the production cost approach (for example, the production costs of recorded music).[5]

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[4] An adjustment was made for financial services R&D but no adjustment was possible for architectural and engineering designs (see appendix A for details).

[5] See ABS (2000, p. 38) for further details.

The ABS estimates for this intangible asset are used in this paper — time series for gross fixed capital formation and capital stock are available for the full period 1974-75 to 2005-06.

Other product development, design and research

CHS include 'non-scientific' R&D in the areas of new product development in the financial industry, new architectural and engineering designs and social sciences and humanities in this category of intangibles. As already discussed, R&D in social sciences is included in BERD in this paper.

New product development in the financial industry

CHS use a crude proxy for spending on new product development by the financial services industry of 20 per cent of total intermediate purchases by that industry.

The financial services industries of interest in the Australian context are a subset of ANZSIC Division K Finance & insurance — that is, Finance (ANZSIC 73) and a share of Services to finance and insurance (ANZSIC 75).

For this paper, a series for 20 per cent of total intermediate purchases[6] by the financial services industries has been constructed from ABS data from input-output (IO) and supply-use (SU) tables. The share of Services to finance, investment and insurance is based on the output share of Finance in the combined output of Finance & insurance. This series covers the full period 1974-75 to 2005-06 — IO/SU data were not available for every year and missing years were interpolated/extrapolated (see appendix A for details).

This approach is taken for comparability with overseas studies, but the alternative of using only financial R&D expenditure as collected in the ABS BERD survey is examined as part of sensitivity testing (see appendix D).

6 No attempt has been made to specifically deduct purchases of intermediate inputs counted elsewhere in intangibles (particularly computer software). In line with CHS (2005), the percentage of intermediate purchases assumed to be product development (20 per cent) is conservative to account for this overlap.

New architectural and engineering designs

CHS estimate this intangible as half of the revenue of the architectural and engineering industries.

A time series for 50 per cent of the revenue of architectural and engineering industries was constructed for this paper using a number of data sources. The relevant industries for new designs are ANZSIC 7821 Architectural services and ANZSIC 7823 Consulting engineering. Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0) for the period 1998-99 to 2004-05.[7]

To backcast the aggregate series of architectural and engineering services to 1974-75, the growth rates for a related group of services from the product details of the ABS *Australian National Accounts: Input-Output Tables* (Cat. no. 5215.0) and unpublished SU tables were used — Architectural services, surveying and consulting engineering and Architectural services, surveying, consulting engineering and quantity surveying, respectively.

The resulting series for sales income for architectural and engineering design services was for the total economy. It was necessary to scale it down to the share relevant to the market sector. This was done using the market sector intermediate usage share of Australian production of Architectural, surveying, consulting engineering and quantity surveying services from the SU tables from 1994-95 to 2002-03. This share was backcast to 1974-75 (and forecast to 2005-06) using growth in the market sector share of gross value added.

On the issue of possible double counting with ABS BERD estimates, engineering and architectural R&D are amongst the fields covered by the ABS BERD survey. There are few details given in CHS (2005) as to the nature of the new architectural and engineering designs that make up this intangible asset in their study. However, it appears clear that the activities the authors have in mind fall outside what would 'normally' be considered architectural and engineering R&D — an example may be new designs using existing technology and methods — since their data source for 'scientific R&D' already includes engineering R&D in its scope.[8] It is therefore assumed there is no issue of double counting between a CHS-type measure for Australia and activities covered above under the ABS BERD survey.

Some architectural and engineering services expenditure is already capitalised by the ABS — appearing as part of the tangible capital stock. However, these data are

[7] The 2005-06 estimate was made assuming that growth rate for sales was the same as in 2004-05.

[8] A similar conclusion was drawn in the UK study (see MH 2006, p. 4 for further discussion).

not available so it is not possible to compare this with the CHS-type estimate for Australia or make any adjustment for double counting (see appendix A for further discussion). The alternative of assuming that all relevant expenditure is already capitalised (that is, no additional architectural/engineering services expenditure is treated as investment) is examined as part of sensitivity testing (see appendix D).

Economic competencies

Economic competencies are defined by CHS (2005, p. 28) as the value of brand names and other knowledge-embedded firm-specific human and structural resources.

Brand equity

Spending on brand development is proxied by spending on advertising and market research. CHS suggest this includes the costs of launching new products, developing customer lists and maintaining brand equity and note that

> Although advertising and market research are generally aimed at building a firm's market share at the expense of its competitors, such spending is necessary for developing new brands and maintaining the value of existing brands. (2005, p. 28)

Various rationales have been put forward for capitalising advertising and marketing expenditure — it may result in a positive image of the firm in the market and help to secure future orders (De and Dutta 2007); and it may establish a reputation for quality or educate consumers about the existence of new goods (Nakamura 1999, p. 6). A reputation for reliability may persuade shoppers to try a new item for the first time.

Advertising

CHS estimate this intangible using expenditure data published by a US advertising association.

Australian advertising expenditure for 1975 to 2006 is available from an annual survey of the industry conducted by Commercial Economic Advisory Service of Australia (CEASA 2003, 2006, 2007). This is a similar type of data source to that used in CHS (2005), except that it includes only media costs for time and space and excludes production costs. Based on data for the United States and United Kingdom about the proportion of production costs in total advertising costs (see appendix A), the CEASA series has been doubled to account for production costs.

These estimates for the total Australian economy have been scaled down to market sector estimates using market sector intermediate usage as a share of Australian production of advertising services from the ABS SU tables for 1994-95 to 2003-04. This share was backcast to 1974-75 (and forecast to 2005-06) using growth in the market sector share of gross value added.

Market research

CHS estimate this intangible as twice the revenue of the market and consumer research industry. Industry revenue is doubled to allow for firm's own account spending on market research.

A time series of twice the revenue[9] of the market research industry was constructed for this paper using a number of data sources. The relevant industry is ANZSIC 7853 Market research services. Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0) for 1998-99 to 2004-05.[10] An irregular survey, *Selected Business Services, 1992-93* (ABS Cat. no. 8677.0) provided similar data for 1992-93. The estimates for the missing years were interpolated by simple averages.

This series of market research services was backcast from 1992-93 to 1974-75 using the growth in Market and business consultancy services from the product details of the ABS IO tables (Cat. no. 5215.0).

The resulting series was for the total economy. It was necessary to scale it down to the share relevant to market sector intermediate usage using data on the closest available group of services (Other business services) from SU tables for 1994-95 to 2003-04. This share was backcast to 1974-75 (and forecast to 2005-06) using growth in the market sector share of gross value added.

Firm-specific human capital

CHS (2005, p. 29) suggest that spending on firm-specific human capital can be measured by the costs of employer-provided workforce training. Spending on workforce training consists of two types of expenses:

- direct firm expenses (outlays on inhouse and external training courses)
- wage and salary costs of employee time spent in informal and formal training.

9 The CHS approach was followed for comparability purposes and in the absence of readily available alternative estimates of inhouse market research.

10 The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05.

There are two aspects of the scope of the measure of firm-specific human capital used in this paper that should be noted.

- All employer-provided structured training is included.
  - There is a question as to how much of this training is firm-specific and not transferable.[11] Richardson (2004, p. 29) notes that it is standard to argue that in a competitive labour market there will be no benefit to firms from providing general training so firms will only provide firm-specific training.[12] On that basis it could be assumed that all employer-provided training is firm specific. However, in practice most training is neither wholly general nor firm specific. It has not been possible to examine this issue in detail in this paper or adjust the measure of firm-specific human capital.
- This is not a measure of total human capital.
  - It does not include education and unstructured on-the-job training. However, to some extent these broader elements of human capital are incorporated into the growth accounting exercise in chapters 5 and 6 through use of the ABS experimental quality-adjusted labour input series.[13]
  - Related to this is an issue of double counting. Fukao et al. (2008a) note

    > If workers gain non-firm-specific skills from [employer provided] off-the-job training, such accumulation of human capital will be reflected in their wage rates. Since in standard growth accounting wage increases by age are already taken into account as improvements in labor quality, there is a risk of double counting [in capitalising off-the-job training costs incurred by employers]

    Again, it has not been possible to make any adjustment for this potential double counting.

It has been acknowledged by a number of researchers in this area that employer-provided training in Australia is poorly measured (see, for example, Cully 2005 and Richardson 2004), particularly prior to 1990 (Smith 1999). No single data source provides a time series of Australian employer-provided training expenditure. To construct a series, several different sources were used, together with a number of

11 ABS Cat. no. 6278.0 (2005, p. 48) defines skills gained through the completion of a training course as transferable if they could be used in a similar job with another employer. It estimated that 90 per cent of reported work-related training courses completed by employees were considered by the employees as providing skills that were transferable. However, it was also the case that employees considered that 93 per cent of this training had not helped them gain a pay rise or promotion.

12 For a discussion of the economics of general versus firm-specific training see Borland (1990).

13 For ABS estimates of the human capital stock based on education and work experience see Wei (2008).

assumptions. The resulting series is therefore only broadly indicative and trends in it should be interpreted with caution.

The ABS *Employer Training Expenditure, Australia* (Cat. no. 6353.0), an employer survey, measured both direct costs and wage and salary costs for the total economy (excluding agriculture) for 1989, 1990, 1993 and 1996. The ABS also estimated this measure for 2001-02 based on data from *Employer Training Expenditure and Practices* (Cat. no. 6362.0) and *Education and Training Experience* (Cat. no. 6278.0) (NCETS 2004). Specifically the measure includes

> The sum of employers' expenditure for employees gross wages and salaries for time receiving and providing structured training, fees paid to consultants and institutions and other expenditure on structured training. (ABS Cat. no. 6353.0, 1996, p. 46)

where structured training is defined as

> all training activities which have a predetermined plan and format designed to develop employment-related skills and competencies. It consists of periods of instruction, or a combination of instruction and monitored practical work. (ABS Cat. no. 6353.0, 1996, p. 45)

For 1993-94 and 1996-97 the expenditure data were available by industry, enabling the construction of a market sector (excluding Agriculture) estimate. For 1989-90 and 1990-91, the market sector estimate was derived by using growth in expenditure for the whole economy. For 2001-02 the market sector estimate was derived by using total economy growth in expenditure between 1996-97 and 2001-02, adjusted for the fall in market sector share of total hours of training from ABS *Education and Training Experience, Australia* (Cat. no. 6278.0).

To backcast the expenditure series to 1974-75 it was necessary to use growth in a related series. No ideal series was available. However, it was possible to construct an approximate series for total training hours for the market sector (excluding Agriculture).[14] This was combined with an approximate series for real expenditure per training hour[15] to derive total training expenditure for the market sector.

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[14] This was based on data for training hours per employee from ABS Cat. nos 6353.0 and 6278.0 and the number of employees from the Labour Force Survey (see appendix A). A constant number of training hours per employee was assumed from 1974-75 to 1989-90. This is a very crude assumption. However, this assumption is made for transparency in the absence of sufficient data to fit a trendline. (During the period for which there are data available there are breaks in series created by the introduction of the Training Guarantee in 1990-91, its suspension in 1994-95 and abolition in 1996-97.)

[15] Expenditure per training hour was available for 1989-90, 1990-91, 1993-94, 1996-97 from ABS Cat. no. 6353.0 and derived for 2001-02 from NCETS (2004) and ABS Cat. no. 6278.0. These data were deflated by growth in average weekly earnings to obtain a real cost series. In the absence of any specific information on changes in real costs, real cost per hour was interpolated

No adjustment was made to account for training in the agriculture industry, which would lead to an understatement of expenditure by the market sector on firm-specific human capital. However, in general, the firm-specific human capital series should be viewed as being affected by a number of measurement errors that could lead to understatement or overstatement of the true level. (For example, the use of constant training hours per employee at either end of the series may have biased the estimates). Additional data and/or more sophisticated estimation techniques would be required to make more definitive statements about the size and direction of change in firm-specific human capital investment. This exercise was beyond the scope of this paper.

Organisational capital

This intangible, along with firm-specific human capital, is particularly difficult to estimate. However, CHS note that the importance of organisational capital requires its treatment as an investment for consistency with other assets. They also cite micro data evidence that firm level differences in organisational practices are strongly related to productivity (CHS 2006, pp. 18–9).

Marrano and Haskel (MH 2006, p. 11) liken the measurement problem of establishing a volume of organisational capital from observed expenditure to that of establishing the volume of R&D knowledge capital from observed expenditure on R&D. An additional problem is that expenditure on organisational capital can be unobserved.

CHS (2005, p. 29) suggest that investment in organisational capital is made up of two components

- purchased — such as management consultant fees
- own account — measured in terms of the value of executive time spent on improving the effectiveness of business organisations (that is, time spent on developing business models and corporate cultures).

CHS note that there is some overlap between these measures of organisational capital and some other intangibles

> Consulting expenditure and the estimated value of executive time conceptually overlap by a small amount (the value of executive time in the management consulting industry). In addition, some portion of management time arguably overlaps with R&D, so that, for some industries, the line between industry-specific process innovation and organizational change more generally may not be easily drawn. But, whatever uncertainty the amount induces in our estimates, it is dwarfed by the use of an arbitrary

between the actual data points and an exponential trend was fitted to estimate growth before 1989-90 and from 2001-02 (see appendix A).

> fraction for the amount of executive time devoted to organizational change and development. (2005, pp. 29–30)

MH (2006, p. 12) also suggest some overlap with IT consulting and software investment. They also note that some expenditure on management consultants is to deal with short term problems (for example, closing down businesses and discharging employees).

Purchased

CHS estimate this intangible from the revenue of the management consulting industry. Data for the revenue of the Australian management consulting industry is very limited. A time series was constructed for this paper from the few available data sources for the closest relevant industry, ANZSIC 7855 Business management services. This is broader than just management consultancy — for example, it includes public relations consultancies (which are excluded from the UK and US studies). Therefore only 77 per cent of this industry revenue was included, as a crude adjustment for some of this difference in scope.[16]

Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0) for 1998-99 to 2004-05.[17] The series for business management services was backcast from 1998-99 to 1974-75 using the growth in Market and business consultancy services from the product details of the ABS IO tables (Cat. no. 5215.0).

The resulting series for sales income for business management services was for the total economy. It was necessary to scale it down to the share relevant to market sector intermediate usage using data on the closest available group of services (Other business services) from SU tables from 1994-95 to 2003-04. This share was backcast to 1974-75 (and forecast to 2005-06) using growth in the market sector share of gross value added.

16 There is very limited information about the size of the public relations segment of this industry in 1992-93 and it is assumed that the public relation share is constant over the full time series. It has not been possible to adjust for other differences in scope, such as the inclusion in Australian estimates of environmental consultancies, and this may lead to an overstatement of organisational capital compared with the studies of other countries (see appendix A for further details). This is examined as part of sensitivity testing in appendix D.

17 The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05.

Own account

CHS estimate the own-account component of organisational capital as 20 per cent of the value of executive time using BLS data on employment and wages in executive occupations. MH (2006, p. 13) use a similar approach but excludes ICT managers (to avoid double counting with capitalised software) and the self-employed (who they indicate do not build organisational capital in the same way as in other industries). The definition of managers appears to be relatively broad (not just, for example, CEOs).

The own account portion of organisational capital for Australia was estimated from average earnings of managers and the number of managers in the market sector. The specific occupation group used is Managers & administrators[18] excluding, where possible, both IT managers and Farmers & farm managers. The exclusion of IT managers is based on the reasoning used by MH (2006) — avoiding double counting with IT capital. Farmers & farm managers are excluded because this subgroup is considerably different from other managers and would not be expected to build organisational capital in the same way. The self-employed (owner-managers of unincorporated enterprises) are also excluded, as in MH (2006), because the relevant ABS survey did not cover this group.

Data on average weekly earnings and number of Managers & administrators were available from the *Employee Earnings, Benefits and Trade Union Membership* (EEBTUM) survey (ABS Cat. no. 6310.0). The average earnings are calculated excluding those employees who did not draw a wage or salary, that is, people working in their own incorporated enterprises.

Annual unpublished data on earnings and employee numbers from the EEBTUM survey are available for Managers & administrators, excluding IT managers and farmers, in the market sector from August 1997 to August 2006. The number of employees obtained includes persons who receive a wage or salary or persons who operate their own incorporated enterprises. Using this number of employees to obtain the wages bill implicitly assumes the value for own account organisational capital investment for owner-managers is equal to the average earnings of Managers & administrators drawing a wage or salary.

Prior to 1997 data are only available from the annual publication of the EEBTUM survey. This included the number of Managers & administrators for the total economy back to 1986 and average weekly earnings back to 1988. Prior to this, data

[18] *Australian Standard Classification of Occupations*, *Second edition*, 1997 (ABS Cat. no. 1222.0) has been used or the closest available occupation from earlier occupational classifications (see appendix A).

for full-time Managers & administrators in the total economy were available back to August 1975. Growth in average weekly earnings for these groups of Managers & administrators were used to backcast the market sector series from 1997 to 1975. For employee numbers the series for Managers & administrators excluding IT managers and farmers was backcast from 1997 to 1975 using growth in a market sector series constructed from Labour Force Survey data for employed Managers and administrators by industry.

The total wages bill was calculated as the number of employees multiplied by average weekly earnings multiplied by 52 weeks. As noted above, this number of employees excludes owner-managers of unincorporated enterprises. This may lead to an underestimate of own-account organisational capital if this group does invest in this intangible in the same way as other Managers & administrators.

Twenty per cent of this wages bill was counted as expenditure on own account organisational capital. CHS (2005, p. 30) note that the assumption that managers spend 20 per cent of their time investing in organisational development is arbitrary. However, for the purposes of comparability, and in the absence of alternative estimates of time spent, the same percentage is used in this paper.

3.2 How much of expenditure is investment

Column 3 of table 3.1 shows the proportion of current expenditure that is assumed to be investment, in line with CHS (2005). This approach is followed for international comparability and in the absence of estimates of the proportion of expenditure that should be treated as investment.[19] For most intangibles 100 per cent of the expenditure estimate is included. There are two exceptions — brand equity and purchased organisational capital.

Brand equity

CHS (2005) exclude certain categories of advertising that are not considered to be reputation building and then assume 60 per cent of the remaining advertising expenditure and 60 per cent of market research expenditure is investment. This approach is followed in this paper.

There are two issues — does this expenditure build an asset and how long lived is it?

[19] Sensitivity testing of the growth accounting results to investment size is reported in appendix D.

- As already noted, the extent to which expenditure on advertising is building an asset rather than being consumed is a difficult question, which is not examined in detail in this paper. However, some types of ads are excluded altogether from other studies because they are not considered to be asset building at all.
  - The US study includes only national ads — the 'local' ads are considered to be promoting sales at specific stores rather than being aimed at selling specific products (CHS 2005, p. 33).
  - The UK study excludes classified ads — small personal ads by individuals or recruiting advertisements for vacancies to be filled in a relatively short time period (MH 2006, p. 8).
  - It was possible to exclude 'Classifieds and directories' from the Australian advertising expenditure series — a similar adjustment to the UK study.
- Advertising or market research expenditures with a service life of less than one year are excluded as they are an expense not an investment.
  - CHS (2005, p. 32) note that, while the literature finds that the effects of advertising are generally short-lived, more than half has a service life of at least one year. From this they assume that 60 per cent of advertising and market research expenditures should be counted as investment.

Purchased organisational capital

CHS assume 80 per cent of spending on management consulting services relate to building organisational capital. The remainder is assumed to be related to be day-to-day advising on, for example, short-term personnel problems, which is assumed not to build organisational capital. This approach is followed in this paper, given the very limited available data about the Australian management consulting industry.

3.3 Deflators

Column 4 of table 3.1 shows the deflators used to convert nominal values for investment in intangibles into their real counterparts. As noted by CHS (2005, p. 36), this conversion is difficult because intangibles are often owner constructed or difficult to measure services with no available or reliable price deflator. In CHS (2006), the authors settle on the use of a pure output deflator (non-farm business output) as a proxy for the price of intangibles, while noting that this proxy is a 'placeholder' until further research develops deflators for specific intangibles.[20]

[20] For a discussion of the relative merits of an output versus a wage deflator for this purpose see CHS (2006, pp. 14–5).

The equivalent deflator in the Australian context is the implied market sector gross value added (GVA) deflator, derived from the Australian national accounts.[21] This deflator is used for all categories of intangible except for:

- computer software, mineral exploration and artistic originals — ABS real gross fixed capital formation series are available for these intangible assets (based on asset-specific implicit price deflators)[22]
- financial product development — an implied Finance & insurance GVA deflator (derived from the Australian national accounts) was used. As discussed by MHW (2007, p. 15), the most relevant output deflator is the one for the output that presumably embodies the knowledge that the R&D is generating
- firm-specific human capital — in order to compile this series a wage deflator (derived from average weekly ordinary time earnings for full-time adults) was used to estimate real cost per hour of training. As this intangible mainly comprises wage costs the resulting estimates of firm-specific human capital in real terms were used as the real investment series.

3.4 Real investment series

Current intangible investment

Applying the measurement assumptions discussed above, it is estimated that market sector investment in intangibles was $57 billion in 2005-06 (table 3.2). This was almost half the size of market sector investment in tangibles and nearly 10 per cent of adjusted market sector gross value added (including the investment in the intangibles).[23] Around 80 per cent of this investment was in the newer intangibles (that is, those not already treated as investment in the national accounts).

[21] Australian MFP is measured for the market sector rather than the non-farm business sector used in the United States. The implied market sector GVA deflator is derived from the current price and chain volume series in the Australian national accounts.

[22] See ABS (*Australian System of National Accounts*, Cat. no. 5204.0) for further details. MHW (2007) similarly use the software deflator from the UK Office of National Statistics.

[23] This is equivalent to about 6 per cent of conventionally-measured GDP (for the total economy not just the market sector), which includes software, mineral exploration and artistic originals but not the new intangibles.

Table 3.2 **Nominal intangible investment, market sector, 2005-06**

	2005-06	*Share of investment*	*Share of adjusted market sector GVA*[a]
	$m	%	%
Computerised information	*7 435*	*13.1*	*1.3*
Innovative property	*21 346*	*37.6*	3.6
BERD	7 904	13.9	1.3
Mineral exploration	2 503	4.4	0.4
Artistic originals	698	1.2	0.1
Other product development, design and research	10 241	18.1	1.7
Financial product development	5 591	9.9	0.9
New arch./eng. designs	4 650	8.2	0.8
Economic competencies	*27 942*	*49.3*	4.7
Brand equity	8 444	14.9	1.4
Advertising	7 337	12.9	1.2
Market research	1 107	2.0	0.2
Firm-specific human capital	4 353	7.7	0.7
Organisational capital	15 146	26.7	2.6
Purchased org. capital	10 208	18.0	1.7
Own account org. capital	4 938	8.7	0.8
Total intangibles investment	**56 724**	**100.0**	**9.6**
New intangibles	46 088	25.0	7.8
National accounts intangibles	10 636	5.8	1.8
Tangibles	127 935	69.3	21.6
Total investment	**184 659**	**100.0**	**31.2**
Ratio intangible to tangible investment	0.44		
Ratio of existing to adjusted market GVA			0.92

[a] Adjusted market sector gross value added is existing market sector GVA at basic prices plus market sector investment in new intangibles.

Source: Authors' estimates.

Total investment in intangibles in 2005-06 was made up as follows.

- The largest component was economic competencies (49 per cent).
  - Of this, more than half was organisational capital, about a third brand equity and about a sixth firm-specific human capital.

- Innovative property was the second largest group (38 per cent).
  - This was fairly evenly split between non-scientific R&D (other product development and artistic originals) and other R&D (BERD and mineral exploration).[24]
- Investment in computerised information (13 per cent) was around a third the size of that in innovative property.

Therefore investment in some of the newer intangibles was as large or larger than the more traditional intangibles:

- organisational capital was the largest individual component of investment in intangibles and twice the size of investment in computerised information
- investment in brand equity was similar in size to investment in computerised information and to BERD.

Growth in intangible investment

In real terms, total intangible investment in the market sector grew from just over $9 billion in 1974-75 to $57 billion in 2005-06 — an average annual growth rate of 6 per cent (figure 3.1). Real tangible investment increased from $33 billion to $128 billion over the same period — an average annual growth rate of 4.5 per cent.

Intangible investment increased in importance relative to tangible investment over this period — the ratio of intangible to tangible investment rising from 0.20 to 0.44 (in nominal terms)[25], having reached 0.54 in 2001-02 prior to the recent period of rapid growth in tangibles.

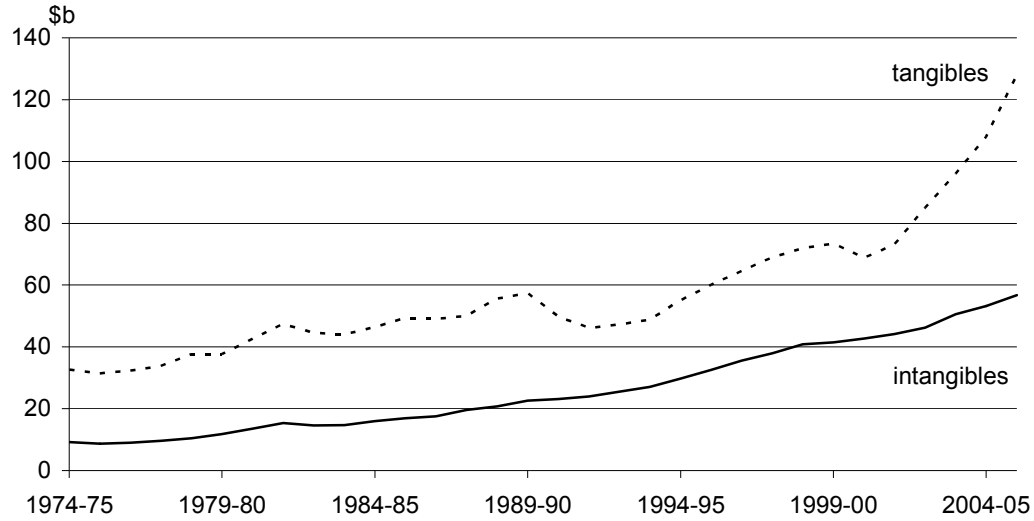
Capitalising all intangibles investment virtually removes the declining trend in the ratio of total investment to gross value added shown by ABS national accounts data (figure 3.2). ABS national accounts data (which include only a subset of intangibles as investment) show a declining trend in nominal total investment as share of market sector gross value added (bottom line). However, after including the 'new' intangibles as investment the trend is almost flat (top line). This trend is obviously sensitive to the assumptions used in estimating investment in the new intangibles (see appendix D for the variability of investment to these assumptions).

[24] However, due to data limitations BERD does include R&D in social sciences and humanities.

[25] In nominal terms, because of the non-additivity of real (chain volume) measures.

Figure 3.1 **Real investment, tangibles and intangibles[a], market sector, 1974-75 to 2005-06**

2005-06 dollars, chain volume measures

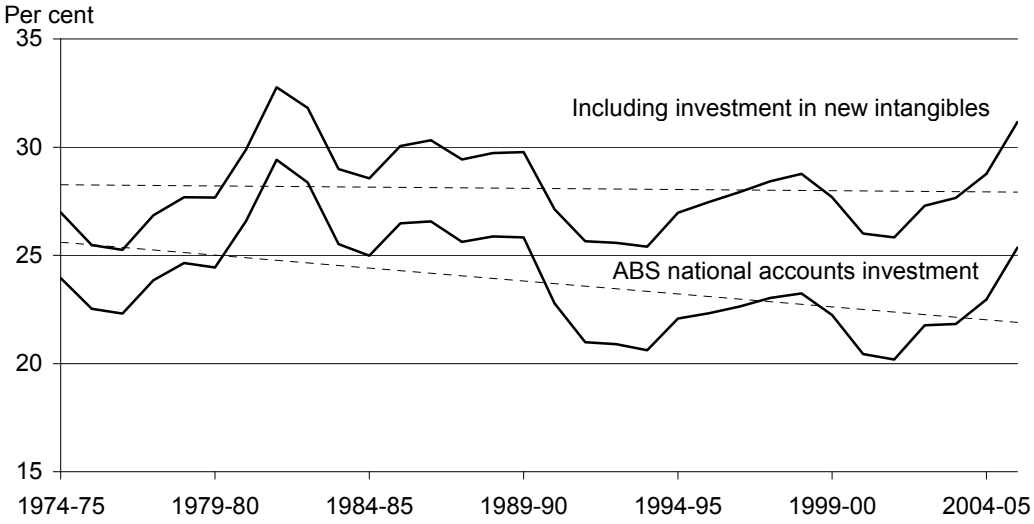


a For sensitivity of intangibles investment to some of the assumptions in its compilation, see appendix D.

Data sources: Based on ABS national accounts data and authors' estimates.

Figure 3.2 **Total investment shares of gross value added, 1974-75 to 2005-06**

Percentage of market sector gross value added[a]



a For the top line, investment in all assets including 'new' intangibles as a share of adjusted market sector gross value added (existing market sector gross value added at basic prices plus market sector investment in new intangibles). For the bottom line, investment in all assets included in the ABS national accounts (only includes the intangibles software, mineral exploration and artistic originals) as a share of existing market sector gross value added at basic prices derived from the ABS national accounts. Both in nominal terms.

Data sources: Based on ABS national accounts data and authors' estimates.

Total investment in intangibles as a share of adjusted market sector gross value added is estimated to have risen from 4.5 per cent in 1974-75 to 9.6 per cent in 2005-06. This is an average growth rate in this share of 2.4 per cent a year — which is similar to the Webster (2000) estimate (derived using different methodology), although the share is quite different.

- Webster (2000) estimated that enterprise intangible investment as a ratio of all production rose by 2.8 per cent a year in the 25 years to 1996. Growth in the investment series in this paper over the closest comparable period (1974-75 to 1995-96) is very similar to this at 2.9 per cent a year.
- Webster (2000) proxied this investment ratio with the share of the labour force in occupations producing intangible capital — which was 11 per cent in 1971 and 22.1 per cent in 1996. The expenditure-based measures in this paper are less than half the size — about 5 per cent in 1974-75 and 8.5 per cent in 1995-96.

Growth in the level of intangibles investment has been fairly steady on average over the last three decades — 1974-75 to 1984-85, 1984-85 to 1994-95 and 1994-95 to 2005-06 — at 5.6, 6.4 and 6.0 per cent a year, respectively (table 3.3). This contrasts with tangible assets, for which average growth was around 4, 2, and 8 per cent a year in successive decades.

While average growth in total investment in intangibles has been fairly steady over the three decades, the trends across different types of intangibles have varied (table 3.3). Overall, the average rate of growth of investment in the national accounts intangibles has declined over successive periods (although the computerised information growth rate has remained the highest), while that of the new intangibles as a group rose between the first period and latter periods.

The fastest growing group within economic competencies shifted from brand equity in the first decade to organisational capital in subsequent periods. Growth in firm-specific human capital fluctuated but was relatively low in most periods. The growth rate of investment in BERD fluctuated but reached higher levels in the last decade than the first. The opposite was the case for other product development. Average growth in each of the components of innovative property was lower than that of organisational capital in the last period.

Table 3.3 **Growth in real intangible investment[a], market sector**

	1974-75 – 1984-85	*1984-85 – 1994-95*	*1994-95 – 2005-06*	*1974-75 – 2005-06*
	% per year	% per year	% per year	% per year
Computerised information	*28.3*	*21.4*	*11.6*	*20.0*
Innovative property	*5.4*	*4.9*	*4.3*	*4.9*
BERD	2.0	12.3	7.1	7.1
Mineral exploration	9.0	-1.2	1.2	2.8
Artistic originals	11.1	-3.1	6.4	4.7
Other product development, design and research	4.3	5.4	3.3	4.3
Financial product development	4.6	3.9	0.8	3.0
New arch./eng. designs	3.5	8.6	7.4	6.5
Economic competencies	*4.4*	*4.4*	*5.5*	*4.8*
Brand equity	5.6	1.5	2.9	3.3
Advertising	5.4	1.1	2.1	2.8
Market research	15.8	12.5	11.3	13.1
Firm-specific human capital	2.8	4.5	0.0	2.3
Organisational capital	3.4	9.9	10.2	7.9
Purchased org. capital	15.8	19.3	13.4	16.1
Own account org. capital	1.6	5.1	5.9	4.3
Total intangibles investment	**5.6**	**6.4**	**6.0**	**6.0**
New intangibles	4.2	5.5	5.3	5.0
National accounts intangibles	12.8	9.9	8.8	10.4
Tangibles	3.6	1.7	8.0	4.5
Total investment	**4.0**	**2.9**	**7.3**	**4.8**
		Average nominal ratio		
	1974-75 – 1984-85	*1985-86 – 1994-95*	*1995-96 – 2005-06*	*1974-85 – 2005-06*
Ratio intangible to tangible investment	0.23	0.34	0.48	0.35
Ratio of existing to adjusted market GVA	0.96	0.94	0.93	0.94

a Growth rates are based on chain volume measures (CVMs) — ABS CVMs have been used for mineral exploration and artistic originals; an aggregate market sector CVM has been calculated for computerised information using ABS industry data; and CVMs have been calculated for all subtotals and totals.

Source: Authors' estimates.

For some intangibles growth in real investment was relatively volatile from year to year — particularly innovative property intangibles, such as mineral exploration, artistic originals and financial product development (figure 3.3).

Figure 3.3 **Real investment, by asset type, market sector, 1974-75 to 2005-06**

Index 2005-06 = 100

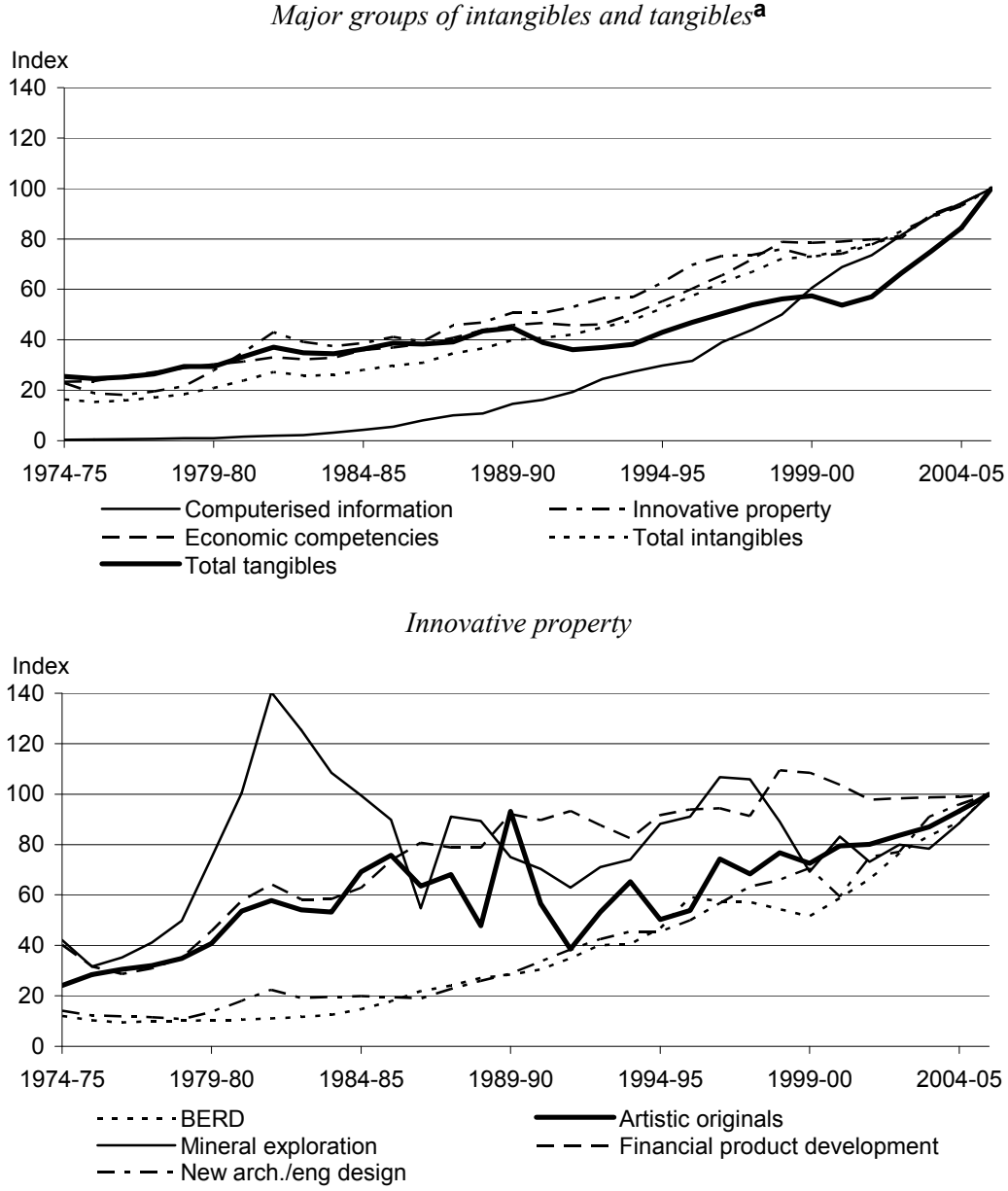


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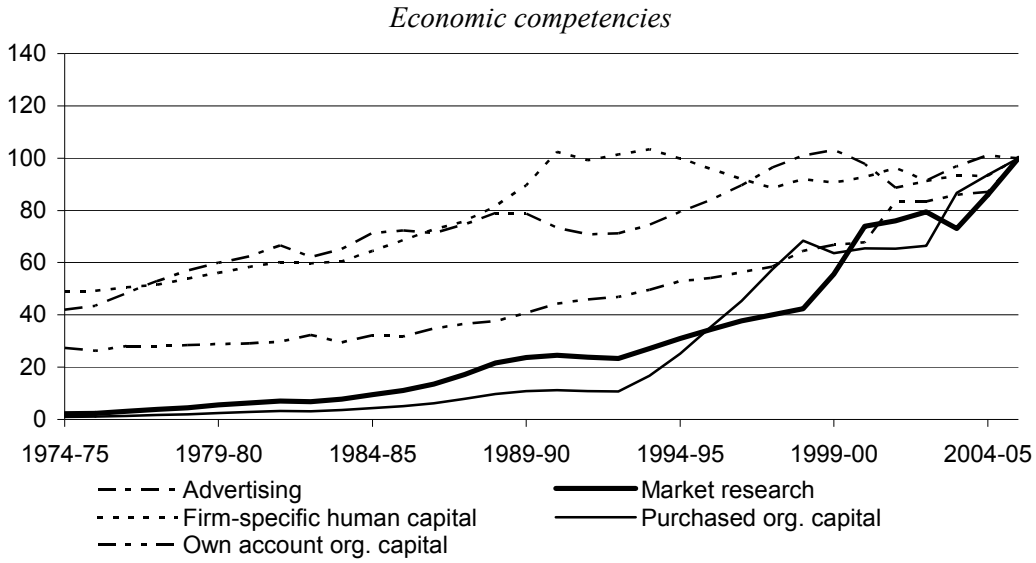
Figure 3.3 **(continued)**

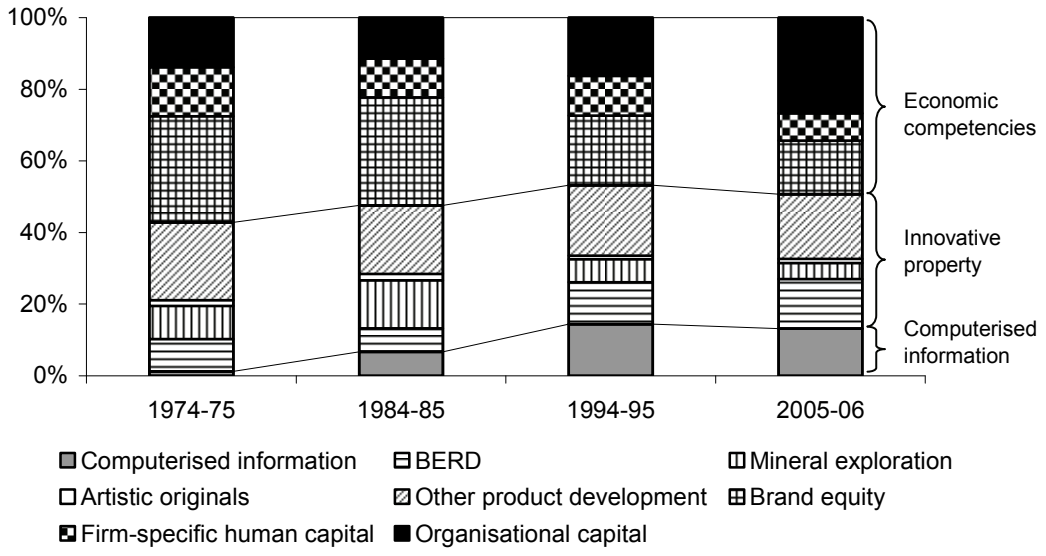


a ABS CVMs have been used for mineral exploration and artistic originals; an aggregate market sector CVM has been calculated for computerised information using ABS industry data; and CVMs have been calculated for all subtotals and totals.

Data sources: Authors' estimates; ABS national accounts data.

The varying growth rates across intangibles have obviously led to a change in the composition of total intangible investment over time. Figure 3.4 highlights the growing importance of organisational capital, computerised information and BERD relative to the other intangibles.

Figure 3.4 **Shares of nominal total intangible investment[a], by asset type**
Per cent



a For sensitivity of the composition of intangibles investment to some of the assumptions in its compilation, see appendix D.

Data source: Authors' estimates.

4 Services from intangible capital

For the purposes of examining the contribution of intangibles to productivity growth, it is the capital services flowing from the stocks that is the most relevant measure. Capital services are estimated by combining data on the size of the capital stocks and the rental prices of that capital.

As outlined in chapter 2, the estimation of capital services from intangibles involves a number of steps and measurement challenges:

- build a real capital stock for intangible assets
  - determine the appropriate rate of depreciation for each intangible asset
  - use the perpetual inventory method to construct a real capital stock from the real investment series and assumed depreciation rates
- construct a volume index of capital services of all capital inputs (tangible and intangible) using capital stocks and rental prices
  - determine the appropriate rental price parameters for each intangible asset
  - rental prices for each asset (tangible and intangible) are derived from the adjusted operating surplus by solving for an equalising rate of return across all assets.

This chapter presents the estimates of both the stocks and services measures of intangible capital, together with an outline of the methodology used to derive them and the measurement challenges involved. (The methodology is described in more detail in appendix C. The sensitivity of the capital estimates to some of the underlying assumptions is discussed in appendix D.)

4.1 Intangible capital stocks

Perpetual inventory method

The Australian Bureau of Statistics (ABS) estimates the stock of software, mineral exploration and artistic originals and these national accounts data are used in this paper. The measurement framework used to derive estimates of the stock of each

the 'new' intangible is the perpetual inventory method (PIM).[1] PIM can be represented by

$$R_{t+1} = (1-\delta)R_t + N_t$$

where δ is the geometric constant depreciation rate of the asset[2], R_t is the intangible stock and N_t is the flow of investment (expenditure in constant prices) at time t.[3]

Assuming that preceding the initial observation (the first available data point), there was a long period of real investment growth at a constant rate of g, the initial stock of intangible capital in period $t = 0$ (R_o) can be calculated using

$$R_o = N_o /(g + \delta)$$

where N_o is the investment in the intangible (in constant prices) during the first year for which data are available; and g is approximated by the average annual logarithmic growth of investment in the intangible (in constant prices) over the full period for which data on the intangible are available.

This application of the PIM differs from that used in the United States, United Kingdom and Japanese studies in the assumptions related to the initial stock. Corrado, Hulten and Sichel (CHS 2006) assumed an initial stock of zero in a specific year for each asset (for example, 1928 for advertising). Marrano, Haskel and Wallis (MHW 2007) assumed an initial stock of zero for all intangible assets in 1970. Fukao et al. (2008b) constructed their initial stocks as they had investment data back to 1973 and began their stock estimates in 1980. The method used in this paper, as described above, does not set an initial stock equal to zero but can be used to calculated the initial stock in any year (1974-75 in this case) for which investment flow data are available. It does assume a constant rate of investment growth for the period prior to the first data point for investment. However, this does not make a large difference to the initial stock estimates because of the high depreciation rates.

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1 The ABS also uses the perpetual inventory method to estimate the stocks for the national accounts intangibles. However, the ABS method is more complex than the method used in this paper (see ABS 2000, chapter 16).

2 In the capital measurement literature, this form of PIM corresponds to the geometric age-efficiency profile for the productive capital stock. This differs from the hyperbolic function used by the ABS for tangibles and the national accounts intangibles, where the decline in efficiency of the asset increases as the asset ages (ABS 2000, para. 16.19–16.21).

3 CHS (2006, p. 23) note that the use of this identity assumes that investment becomes productive as soon as it is put in place. This assumption, which avoids the complication of different gestation lags for different assets, is in line with much of the growth accounting literature.

The investment flows (N_t) for each intangible were described in chapter 3. The depreciation rates (δ) used for each new intangible in the PIM are those used in CHS (2006) to enable comparability (table 4.1).[4] These assumed rates are based on the interpretation by CHS of the empirical literature for R&D and brand equity and their view that firm-specific human capital and organisational capital lie between R&D and brand equity in terms of longevity (further details are provided in appendix A). The average ABS depreciation rates for software, mineral exploration and artistic originals are included for comparison.[5]

Table 4.1 **Depreciation rate assumptions**[a]

Category of intangible	*Rate*
	%
Computer software	20
Innovative property	
Business R&D	20
Mineral exploration	10
Artistic originals	60
Other product development, design and research	20
Economic competencies	
Brand equity	60
Firm-specific human capital	40
Organisational capital	40

a For the new intangibles the depreciation rate is assumed to be constant over time. For the intangibles already included in the national accounts (software, mineral exploration and artistic originals) the ABS varies the rate over time — the rate shown is the average for the period 1974-75 to 2005-06.

Sources: Corrado, Hulten and Sichel (2006, p. 23); ABS unpublished national accounts data.

4 It should be noted that the United States, United Kingdom and Japanese studies appear to use the simple PIM for estimating the capital stocks for the existing national accounts intangibles. As noted above, the Australian ABS estimates for these assets that have been used in this paper are based on a more complex approach.

5 These depreciation rates differ from those in the US study, which used 33 per cent for software and 20 per cent for mineral exploration and artistic originals (CHS 2006, p. 23). Some sensitivity testing of the growth accounting results to depreciation rate assumptions for the new intangibles is presented in appendix D.

Capital stock estimates

Current capital stock

The value of the total intangible capital stock of the market sector is estimated to have been around $189 billion in 2005-06 (or 14 per cent of the total capital stock) (table 4.2).[6] Just over 70 per cent of the total intangible stock was the newer intangibles (that is, those not already treated as capital in the national accounts). And several of the new intangibles were as large or larger than computerised information (which is capitalised in the national accounts) and business R&D (for which treatment as capital in the national accounts is planned).

The composition of the total intangible stock was as follows (table 4.2).

- Innovative property was more than half of this total stock (57 per cent).
  - Of this, around two-thirds was intangibles not currently in the national accounts (40 per cent of the total intangible stock). The largest individual component was other product development (24 per cent), followed by business R&D and mineral exploration (each around 16 per cent). Artistic originals was the smallest share of total intangibles (less than 1 per cent).
- Economic competencies made up nearly a third of the total intangible stock (30 per cent).
  - Organisational capital was the largest component of this group (18 per cent) and of similar size to business R&D and mineral exploration. Firm-specific human capital and brand equity were both relatively small at around 6 per cent of total intangible assets.
- The remainder was computerised information (12 per cent of the total stock of intangibles).
  - The computerised information stock was smaller than some of the new intangibles, including non-scientific R&D and organisational capital.

6 World Bank (2006) estimated that Australia's intangible capital stock was $5624 billion in 2000. However, as discussed in chapter 1, that estimate is based on a much broader definition of intangibles (including raw labour, social capital and institutional infrastructure) than the CHS methodology.

Table 4.2 **Value of intangible capital stock[a], market sector, 2005-06**

	Value	*Share of total*
	$m	%
Computerised information	*22 619*	*12.0*
Innovative property	*108 240*	*57.3*
Business R&D	29 490	15.6
Mineral exploration	31 737	16.8
Artistic originals	1 102	0.6
Other product development, design and research	45 911	24.3
Financial product development	27 507	14.6
New architectural and engineering designs	18 405	9.7
Economic competencies	*58 032*	*30.7*
Brand equity	13 867	7.3
Advertising	12 160	6.4
Market research	1 707	0.9
Firm-specific human capital	10 429	5.5
Organisational capital	33 737	17.9
Purchased organisational capital	22 650	12.0
Own account organisational capital	11 086	5.9
Total intangibles	**188 891**	**100.0**
New intangibles	133 433	10.2
National accounts intangibles	55 458	4.2
Tangibles	1 124 783	85.6
Total capital	**1 313 674**	**100.0**
Ratio of intangibles to tangibles stock	0.17	

a Net capital stock.

Sources: Authors' estimates; ABS national accounts data.

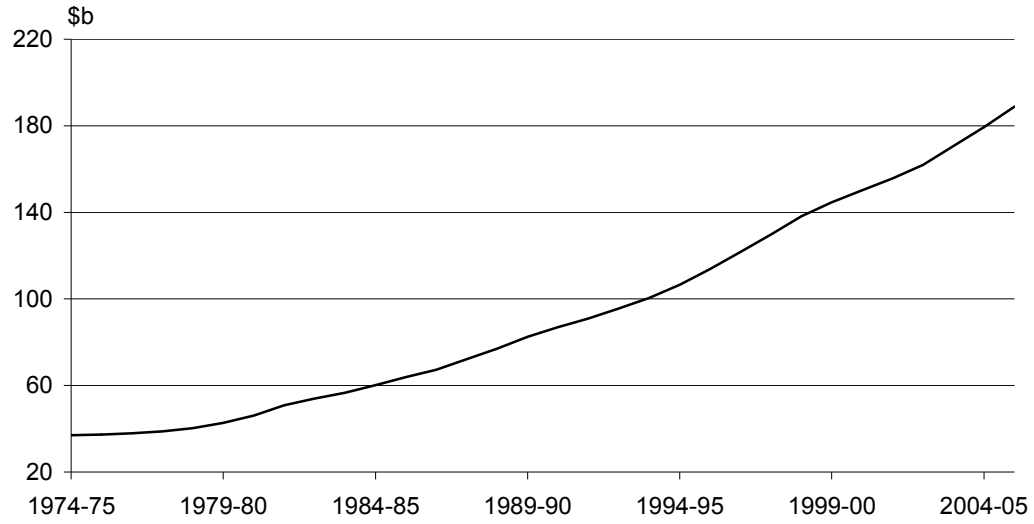
Growth in the capital stock

Between 1974-75 and 2005-06, the total stock of intangibles grew from $37 billion to $189 billion (in real terms) — an average rate of 5.4 per cent a year (figure 4.1).

The share of intangible capital in total capital (in nominal terms) grew from 7.3 per cent in 1974-75 to 14 per cent in 2005-06, a growth rate of 2.1 per cent a year. This is a higher growth rate than found by Webster (2000), who estimated growth of 1.25 per cent a year over the 50 years to 1998 (on a trend basis). However, this difference is likely to be partly due to the longer time period (with intangibles growth likely to have been slower in the pre-1975 period). Also, Webster's intangibles estimates, which were based on the difference between the stock market value and balance sheet value of publicly-listed companies, were adjusted to exclude a series of negative estimates of intangible capital.

Figure 4.1 **Total intangibles capital stock[a], market sector, 1974-75 to 2005-06**

2005-06 dollars, chain volume measure



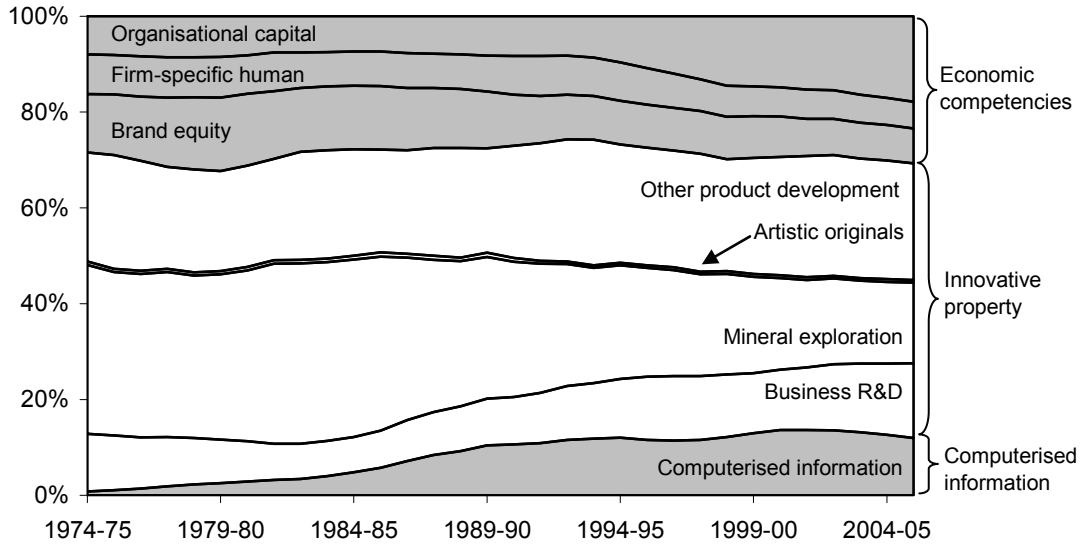
a For sensitivity of the intangible capital stock to some of the assumptions in its compilation, see appendix D.

Data source: Authors' estimates.

The composition of the intangible capital stock changed considerably between 1974-75 and 2005-06 (figure 4.2). The share of computerised information capital has increased, while that of innovative property as a group has decreased. The share of economic competencies also increased slightly. However, there was also change in the composition within economic competencies and innovative property. Organisational capital gained share, while the shares of brand equity and firm-specific human capital fell. Within innovative property, mineral exploration lost share, while business R&D and other product development gained share.

Figure 4.2 **Composition of total nominal intangible stock, 1974-75 to 2005-06**

Per cent



Data source: Authors' estimates.

4.2 Capital services

For the purposes of calculating multifactor productivity (MFP), it is real capital services that is the relevant input measure not the capital stock. Aggregate capital services indexes are created using the volume index of the capital stock of each asset weighted by its rental price weight (see appendix C).

Rental prices

Rental prices are the user cost of capital — their use as weights assumes that the rental price reflects the marginal product of an asset. Therefore more productive assets are given a higher weight in forming the capital services measure.

Rental prices include the opportunity cost of investing elsewhere, the loss in market value of the good due to ageing; and the capital gains or losses due to asset price inflation/deflation; and adjustments for differential tax treatment across assets. They are derived from the rate of return on assets (which is common to all assets[7]), asset

[7] This assumes that businesses invest in each type of capital until the rate of return is equal across assets, as is the case in standard growth accounting (see CHS 2006, p. 26 for further discussion).

price deflators, the depreciation rate and income and non-income tax parameters[8] (see appendix C for a discussion of these rental price components).

As noted in chapter 2, the capitalisation of intangibles requires the equalising rate of return on all assets to be recalculated. By capitalising intangibles, total value added, total capital income and the pool of assets over which this income is distributed are all changed. The equalising rate of return across all assets therefore changes and this affects the rental prices for *all* assets, not just the intangibles (see section C.1 for a full derivation).[9]

Differences in rental prices across assets mean that the growth in aggregate capital services will differ from growth in the aggregate capital stock. Figure 4.3 shows the rental prices used for the new intangibles — there are considerable differences in the level of and trends across assets. The growth in the capital stock of an asset with a higher rental price will carry a higher weight in the aggregate capital services index.

One factor that has a large effect on the spread of the rental prices across assets is the depreciation rate — the larger the depreciation rate, the higher the rental price. Brand equity has the highest depreciation rate (60 per cent) and rental price, followed by organisational capital and firm-specific human capital (40 per cent). The remainder of the assets (business R&D, financial product development, and new architectural and engineering designs) have a depreciation rate of 20 per cent and lower rental prices.

There are additional parameter differences that explain some of the variation in rental prices between assets with the same depreciation rate. Different price deflators explain this variation between financial product development and new architectural and engineering designs, and between organisational capital and firm-specific human capital. Additional tax concessions lower the rental price of business R&D compared with the other forms of R&D.

The major factors affecting the trend over time are changes in the price deflators and tax parameters. The depreciation rate for these assets is assumed to be constant.

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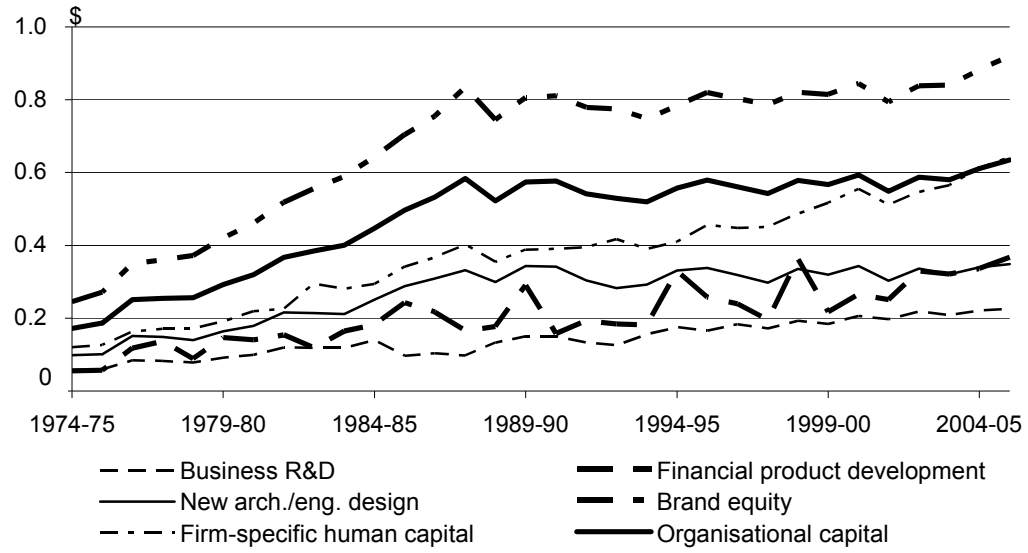
8 The inclusion of the tax parameters in the rental price removes some of the distortions to the rental price due to different tax allowances for different capital items and industries over time (ABS 2000, para. 27.61).

9 In line with the ABS approach to deriving the rate of return, an exogenous floor rate of return (equal to consumer price index growth plus 4 per cent) has been applied. This differs from CHS (2006), which uses an endogenous rate. The effects of this difference and the sensitivity of the results to the rate of return assumption are discussed in appendix D.

Figure 4.3 **Rental prices by intangible asset type, 1974-75 to 2005-06**
Dollars



Data source: Authors' estimates.

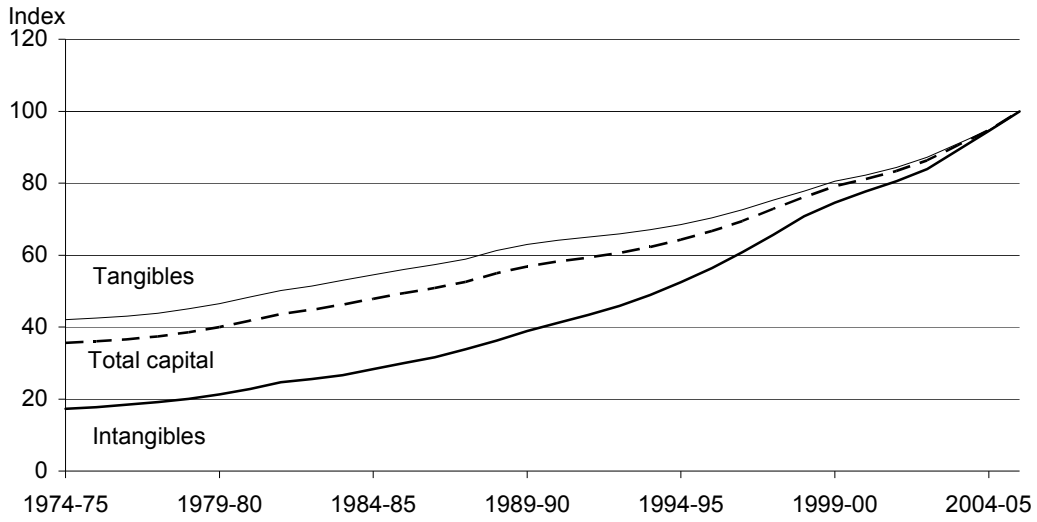
Capital services indexes

Capital services from intangible assets grew at a relatively high rate compared with tangible assets over the last thirty years (figure 4.4). On average, capital services from total intangible assets grew at almost 6 per cent a year compared with less than 3 per cent a year for tangible capital services (table 4.3). The average contribution of intangibles to growth in total capital services was 33 per cent — of which 13 percentage points was national account intangibles and 20 percentage points was the new intangibles.

Of the three major groups of intangibles, computerised information had the fastest average growth (nearly 20 per cent a year), while innovative property and economic competencies grew at similar rates (around 4.5 per cent a year). However, given the smaller initial level of capital services from computerised information, the contribution of each group to total capital services growth was fairly similar — 11, 9 and 14 per cent, respectively.

Figure 4.4 **Capital services index, tangibles and intangibles, market sector, 1974-75 to 2005-06**

Index 2005-06 = 100



Data source: Authors' estimates.

There were considerable differences in growth rates amongst the components of innovative property and economic competencies. Average growth in business R&D (6 per cent a year) was higher than other product development (5 per cent), artistic originals (4 per cent) and mineral exploration (3 per cent) — the contributions to total capital services growth were 2, 5, 0.1 and 2 per cent, respectively. Growth in organisational capital (8 per cent a year) far exceeded brand equity (3 per cent) and firm-specific human capital (2 per cent) — the contributions to total capital services growth were 7, 5 and 2 per cent, respectively.

Examining average growth in each of the last three decades (table 4.3), there was relatively little variation over time for total intangibles — average growth was around 5 per cent a year in the decade to 1984-85, and around 6 per cent in the following two periods (1984-85 to 1994-95 and 1994-95 to 2005-06). However, because growth in intangibles was faster than that for tangibles, the contribution of intangibles to total capital services growth increased considerably — from around a quarter in the first period to around a third in the subsequent periods.

Table 4.3 **Growth rate of intangible capital services, market sector**

Per cent per year (percentage contribution to total growth)

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Computerised information	19.8	27.3	21.9	11.5
	(32)	(16)	(42)	(35)
Innovative property	4.2	4.3	4.5	3.9
	(27)	(34)	(27)	(22)
Business R&D	5.7	-0.4	10.4	7.1
	(5)	(-1)	(6)	(8)
Mineral exploration	2.7	5.5	1.6	1.2
	(6)	(16)	(5)	(1)
Artistic originals	3.7	8.7	-1.7	4.1
	(0.4)	(1)	(-0.3)	(1)
Other product development, design and research	4.5	4.5	5.6	3.6
	(15)	(18)	(17)	(12)
Financial product development	3.4	4.2	4.7	1.5
	(8)	(12)	(11)	(3)
New arch./eng. designs	6.5	5.0	7.3	7.2
	(7)	(5)	(7)	(8)
Economic competencies	4.7	4.4	4.0	5.5
	(41)	(51)	(31)	(43)
Brand equity	3.3	5.4	1.5	3.0
	(15)	(34)	(6)	(9)
Advertising	2.8	5.3	1.1	2.2
	(13)	(32)	(5)	(7)
Market research	12.4	15.4	11.8	10.4
	(2)	(1)	(2)	(2)
Firm-specific human capital	2.3	2.8	4.8	-0.4
	(5)	(7)	(9)	(-0.6)
Organisational capital	7.5	3.8	8.0	10.4
	(21)	(10)	(16)	(35)
Purchased org. capital	15.3	16.1	15.7	14.2
	(15)	(5)	(10)	(28)
Own account org. capital	4.1	2.2	4.6	5.5
	(6)	(5)	(6)	(7)
Total intangibles	**5.8**	**5.1**	**6.3**	**6.0**
	(100)	(100)	(100)	(100)
New intangibles	4.7	4.2	4.8	5.1
	(20)	(18)	(19)	(22)
National accounts intangibles	9.2	8.9	10.3	8.6
	(13)	(9)	(16)	(13)
Tangibles	2.8	2.6	2.3	3.5
	(67)	(74)	(64)	(65)
Total capital services	**3.4**	**3.0**	**3.0**	**4.1**
	(100)	(100)	(100)	(100)
		Average ratio		
Intangibles to tangibles[a]	0.2	0.2	0.2	0.3

[a] Share of capital income.

Source: Authors' estimates.

The fairly constant average growth rate for total intangibles masks different patterns of growth in individual intangibles over time.

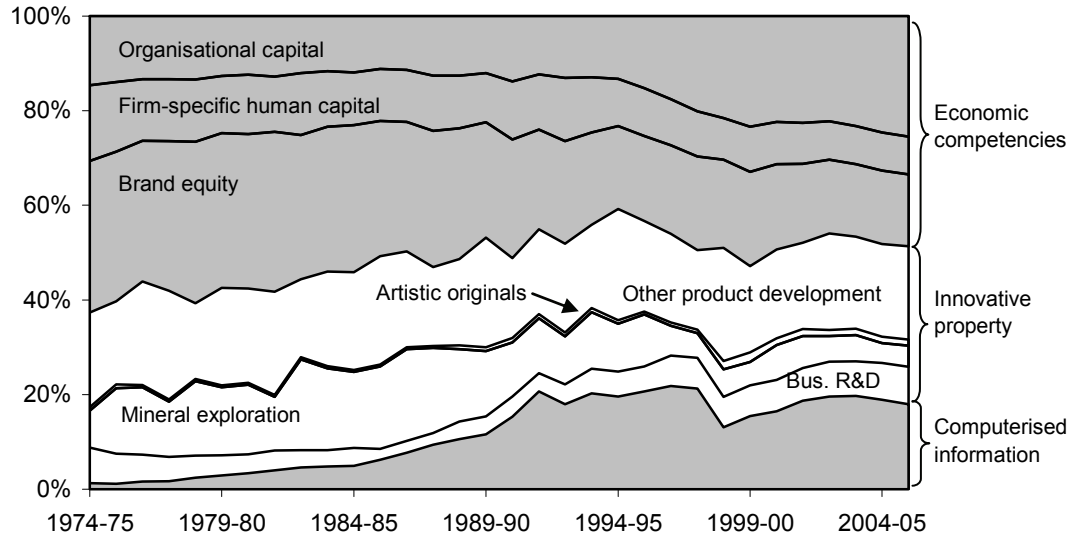
- Computerised information had the fastest growth rate in each period (except for purchased organisational capital in the third period) and, although the rate declined in each successive period, the contribution to total capital services growth increased (from 4 to 15 per cent between the first two periods before declining to 12 per cent in the third period).
- The growth in innovative property accelerated in the second period before dropping back to a rate lower than in the first period (the contribution to total capital services growth similarly rose from 9 to 9.5 per cent before dropping back to 8 per cent).
  - Business R&D was a large contributor to this acceleration in the second period. Other product development was the largest contributor to the decline in the third period.
- Economic competencies growth fell between the first and second periods before rising to its highest rate in the third period (the contribution to total capital services growth was 14, 11 and 15 per cent, respectively).
  - Growth in organisational capital increased in successive periods (its contribution rising from 3 to 6 and then 12 per cent of total capital services growth) but in the second period this was offset by a large decline in growth in brand equity (its contribution dropping from 9 to 2 per cent).

Figure 4.5 highlights the changing composition of the service flow from intangible capital. Services from computerised information have clearly increased in importance over time. While economic competencies as a group has accounted for a falling share of total capital services, the contribution of organisational capital has grown strongly. High growth in purchased organisational capital is behind this trend. There was a smaller shift in the composition of innovative property capital services to non-scientific R&D from other R&D (business R&D and mineral exploration). This was largely because of relatively slow growth in mineral exploration investment combined with relatively low and stable rental prices.

Comparing figures 4.5 and 4.2 highlights the effect of using a capital services measure rather than a capital stock measure — for a given size capital stock, those assets with shorter asset lives (that is, higher depreciation rates) have a higher capital services flow in a given period than those with longer asset lives. For example, for economic competencies the share of capital services is higher than the share of the capital stock, while the opposite is the case for innovative property.

Figure 4.5 **Composition of total intangible capital services[a], 1974-75 to 2005-06**

Per cent



a The composition is based on the share of capital services (capital stock weighted by rental prices as described in appendix C). For sensitivity of the composition of intangibles capital services to some of the assumptions in its compilation, see appendix D.

Data source: Authors' estimates.

5 Growth accounting results

This chapter presents the results of growth accounting including intangible assets. Three different definitions of capital have been used to analyse the impact of intangibles on measured productivity growth in the market sector:

- all intangible and tangible assets
- all Australian Bureau of Statistics (ABS) national accounts assets (which includes all tangible assets and a subset of the intangible assets[1])
- tangible assets only.

A comparison of the results for the three definitions of capital provides a picture of the impact of intangibles on measured productivity growth and the extent to which the national accounts are affected by not capitalising some intangible assets.

The data for national accounts tangible and intangible assets are sourced from ABS national accounts data.[2] The other intangible investment and intangible capital services have been estimated as described in chapters 3 and 4.

5.1 Growth accounting components

The general aim of growth accounting is to understand the drivers of output growth in the economy. It is used to show how much output growth is attributable to increases in measured input — usually labour and capital inputs. The residual growth not explained by changes in these inputs is due to other factors, and is called multifactor productivity (MFP) growth.

Most of the growth accounting results presented in this chapter are for labour productivity growth, that is, growth in the level of output per unit of labour input. This controls for any output growth attributable to changes in the work force, such as higher population growth, changes in the unemployment rate or changes in the

[1] The ABS definition of capital includes only three intangible assets: software, mineral exploration and artistic originals (ABS 2000, paras 16.47 - 16.56).

[2] All published and unpublished national accounts data used in the growth accounting in this paper are from the dataset underlying ABS *Australian System of National Accounts, 2006-07* (Cat. no. 5204.0).

participation rate. Labour productivity growth can be decomposed into capital deepening, which is the capital income share weighted growth in capital inputs relative to labour, and MFP growth.

The first question is what portion of LP growth normally attributed to MFP growth is actually due to an increase in capital deepening in unaccounted intangible assets. The second question is how much are growth measures affected by not including intangible investments as outputs.

As discussed in chapter 2 and appendix B, in the case where no intangibles are treated as capital, growth in output can be expressed as

$$\dot{Q}' = \dot{MFP}' + s'_L \dot{L} + s'_K \dot{K} \qquad (5.1)$$

where Q' is output excluding investment in all intangible assets; L and K are labour and capital inputs; s'_L and s'_K are labour and capital income shares before the inclusion of intangibles; and $\dot{MFP}'$ is residual MFP growth.

Re-expressing this in per unit of labour terms gives labour productivity growth (see appendix B)

$$\dot{LP}' = \left(\frac{\dot{Q}'}{L}\right) = \dot{KD}' + \dot{MFP}' \qquad (5.2)$$

where capital deepening $\dot{KD}'$ is $s'_K \left(\frac{\dot{K}}{L}\right)$ (5.3)

Capital deepening is the growth of capital inputs relative to labour. It is derived by multiplying the rate of change of the capital/labour ratio by the average capital income share.

Treating intangibles as capital changes output growth, total capital input growth, the capital and labour income shares and MFP growth.

Output growth becomes

$$\dot{Q} = \dot{MFP} + s_L \dot{L} + s_K \dot{K} + s_R \dot{R} \qquad (5.4)$$

where $Q = Q' + N$, that is, output including intangible investment (N), and R is the intangible capital stock.

And therefore in labour productivity terms

$$\dot{LP} = \left(\frac{\dot{Q}}{L}\right) = \dot{KD} + \dot{MFP} \qquad (5.5)$$

where $\dot{MFP}$ is MFP growth adjusted for capitalising intangibles and capital deepening $\dot{KD}$ is combined tangible and intangible capital deepening.

On the output side, the size of the effect on labour productivity growth from capitalising intangibles will depend on the size of intangibles investment relative to total output and the growth rate of intangibles relative to other output.

$$\dot{LP} = \left(\frac{\dot{Q}}{L}\right) = \frac{N}{Q} \bullet \left(\frac{\dot{N}}{L}\right) + \frac{Q'}{Q} \bullet \left(\frac{\dot{Q}'}{L}\right) \qquad (5.6)$$

Intangible investment as a share of total output	Growth in intangible investment relative to labour	Other output as a share of total output	Growth in other output relative to labour

If growth in intangible investment is higher (lower) than growth in other output, then total output growth, and therefore labour productivity growth, will increase (decrease) with the inclusion of intangibles.[3] The magnitude of this effect will depend on the size of intangibles investment as a share of total output.

On the input side, treating intangibles as capital affects capital deepening and MFP growth as the residual.

Total capital deepening including intangible capital becomes

$$\dot{KD} = s_K\left(\frac{\dot{K}}{L}\right) + s_R\left(\frac{\dot{R}}{L}\right) \qquad (5.7)$$

where $\dot{KD}$ is the tangible capital income share weighted growth in tangible capital relative to labour plus the intangible capital income share weighted growth in intangibles relative to labour.

[3] Growth in labour inputs will not change with the treatment of intangibles as capital, so labour productivity growth will only change if output growth is affected.

The income shares s_R and s_K are

$$s_K \equiv P_K K/(P_K K + P_R R + P_L L) \text{ and} \tag{5.8}$$

$$s_R \equiv P_R R/(P_K K + P_R R + P_L L) \qquad (P_i \text{ is the price of input } i) \tag{5.9}$$

With the inclusion of intangible capital, the total capital income share increases ($s_K + s_R > s'_K$).

The effect of including intangible capital on the rate of capital deepening depends on both the increase in the total capital income share and the growth in intangible capital inputs relative to the growth in tangible assets.

MFP growth as the residual is derived as

$$\dot{MFP} = \dot{LP} - \dot{KD} \tag{5.10}$$

The treatment of intangibles as capital affects both inputs and output, so the direction of the effect on MFP growth depends on the relative size of the output and input effects. If the inclusion of intangible capital increases the rate of capital deepening by more (less) than it increases the rate of labour productivity growth, MFP growth will fall (rise).

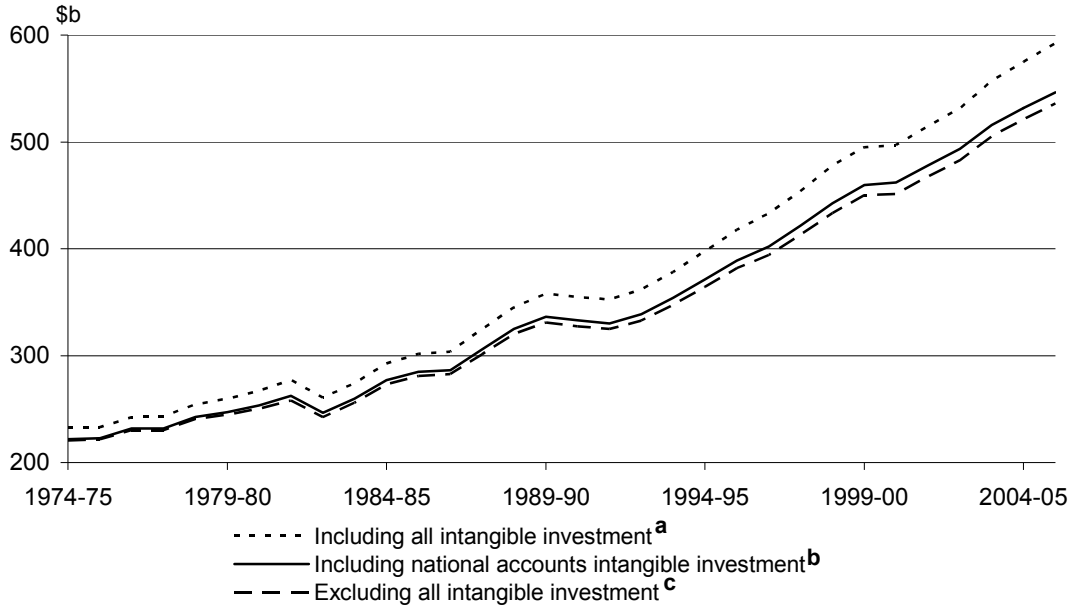
Impact of intangibles on growth accounting components

This section shows the relative changes to the components of the production function due to capitalising intangibles. As explained above, capitalising intangible assets will affect several components of the production function and each of these will affect the productivity results. The components are examined in turn for the period 1974-75 to 2005-06 (and three sub-periods covering decades ending 1984-85, 1994-95 and 2005-06.)

Output

Market sector gross value added (GVA) is the output measure used for the growth accounting. Figure 5.1 compares market sector GVA for each of the three definitions of capital — including investment in all intangible assets, including national accounts intangibles and excluding all intangibles. As reported in chapter 3 (table 3.2), investment in the new intangible assets is larger than investment in the national accounts intangible assets (software, mineral exploration and artistic originals). Therefore the new intangible assets represent a much larger proportion of total GVA (including all intangible investment) than the national accounts intangibles. And intangibles in total have grown as a percentage of GVA.

Figure 5.1 **Market sector gross value added, 1974-75 to 2005-06**
2005-06 dollars, chain volume measures



a Market sector GVA including national accounts intangibles is existing market sector GVA supplied by the ABS national accounts. **b** Market sector GVA including all intangibles is existing market sector GVA plus investment in new intangibles. **c** Market sector GVA excluding all intangibles is existing market sector GVA minus gross fixed capital formation (GFCF) in the national accounts intangible assets. For details see appendix C.

Data sources: Authors' estimates; published and unpublished ABS national accounts data.

Because investment in intangible assets grew at a faster rate than GVA excluding all intangibles, growth in GVA once all intangibles were included was higher in each period (table 5.1). However, over the full period the gap between growth in GVA excluding all intangible investment and growth in intangibles investment narrowed, especially in the final period 1994-95 to 2005-06. Over the full period, GVA growth was 0.16 of a percentage point (5 per cent) higher with the inclusion of all intangible investment compared with the no intangibles case. This slowed from an average of 8 per cent higher between 1974-75 and 1984-85 to 3 per cent higher between 1994-95 and 2005-06. Of this growth in GVA including all intangible investment, the new intangible assets contributed more than the national accounts intangible assets.

Table 5.1 **Growth in market sector gross value added**

Per cent per year[a]

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Including all intangible investment	3.06	2.33	3.11	3.69
	(5)	(8)	(6)	(3)
Including national accounts intangible investment	2.95	2.25	2.97	3.57
	(2)	(4)	(2)	(0)
Excluding all intangible investment	2.90	2.16	2.93	3.57

a Bracketed figure is the increase in growth rate (compared with excluding all intangible case) as a percentage of the growth rate when all intangible investment is excluded.

Sources: Authors' estimates; published and unpublished ABS national accounts data.

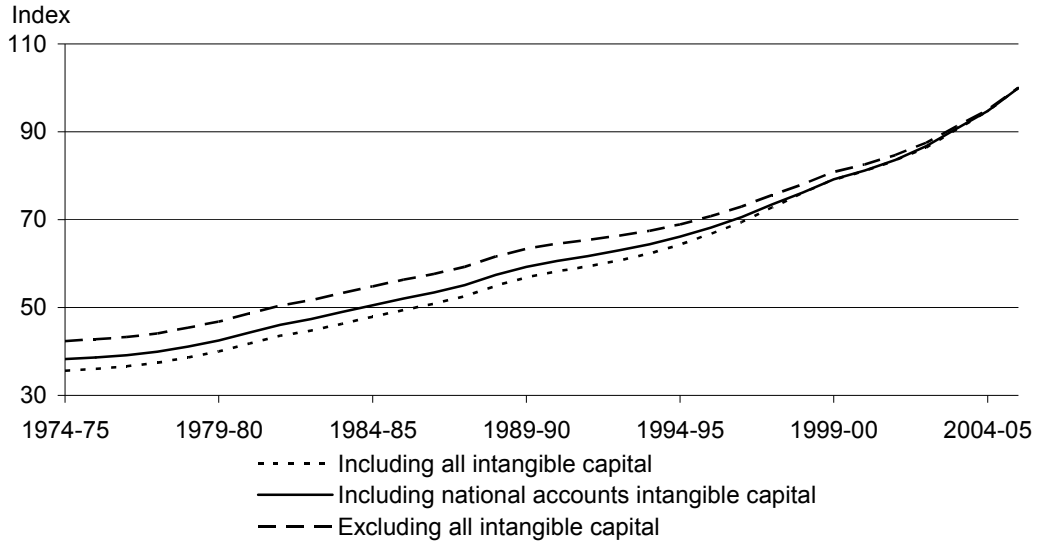
Capital services

As discussed in chapter 4, aggregate capital services indexes are created using the volume index of the productive capital stock for each asset weighted using rental prices as weights.[4] The treatment of intangibles as capital will only increase the growth rate of the aggregate capital services index if the growth of intangibles is higher than the growth of tangibles.

Figure 5.2 shows the total capital services indexes for each of the three definitions of capital. Growth in capital services before the treatment of any intangibles as capital averaged 2.7 per cent a year over the full period. With the treatment of all intangibles as capital this increased to 3.4 per cent a year, an increase of 19 per cent. This shows that growth in capital services from intangibles was faster than growth in capital services from tangible assets.

4 For the new intangible assets, it has been assumed the productive capital stock is equal to the net capital stock. This is likely to slightly understate the size and growth of intangible capital services. More detail on the methodology used to build the capital services indexes is contained in appendix C, section C.1.

Figure 5.2 **Capital services, market sector, 1974-75 to 2005-06**
Index 2005-06 = 100



Data sources: Authors' estimates; published and unpublished ABS national accounts data.

As shown in figure 5.2, including the national accounts intangible assets has a larger impact on capital services *growth* than the new intangible assets. Growth in capital services increased by 11 per cent with the treatment of the national accounts intangibles as capital and a further 10 per cent with the treatment of the new intangibles as capital. Although the national accounts intangibles are a smaller share of the total capital stock than the new intangibles, the national accounts intangible assets had a larger impact on capital services *growth* because of the combination of higher growth in both rental prices and investment than the new intangibles.[5]

Factor income shares

Table 5.2 shows the contribution of intangible assets to changes in the factor income shares. There is an upward trend in the capital share of total factor income over the period 1974-75 to 2005-06 even before the treatment of intangibles as capital. However, capitalising all intangibles has increased the average capital income share over the period from 37 per cent to 41 per cent, with a corresponding fall in the labour income share.[6]

[5] Investment growth in the national accounts intangibles averaged 12.8 per cent a year for the period 1974-75 to 1984-85, compared with 4.2 per cent for the new intangible assets. More detail on the construction of rental prices is contained in appendix C, section C.1.

[6] Total capital income when capitalising all intangibles is equal to investment in new intangible assets added to the existing capital income estimate supplied by the ABS.

Because investment in the new intangibles is much larger than investment in the national accounts intangibles, the investment in the new intangible assets increases the capital income share by a greater percentage than the national accounts intangible assets.

Table 5.2 **Capital[a] and labour income shares, market sector**

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Including all intangible assets				
New intangible assets	0.06	0.05	0.05	0.08
National accounts intangible assets	0.02	0.01	0.02	0.03
Tangible assets	0.34	0.31	0.35	0.34
Total capital	0.41	0.37	0.42	0.45
Labour	0.59	0.63	0.58	0.55
Including national accounts intangible assets				
National accounts intangible assets	0.02	0.02	0.02	0.03
Tangible assets	0.36	0.32	0.37	0.38
Total capital	0.38	0.35	0.39	0.41
Labour	0.62	0.65	0.61	0.59
Excluding all intangible assets				
Capital	0.37	0.34	0.38	0.40
Labour	0.63	0.66	0.62	0.60

a When intangibles are not capitalised, all capital income is attributed to tangibles, including the return on intangibles. When intangibles are capitalised, total capital income is allocated across both tangibles and intangibles. See appendix B for details.

Sources: Authors' estimates; published and unpublished ABS national accounts data.

5.2 Growth accounting results

This section presents the growth accounting results using the three different definitions of capital described above. The effect of capitalising intangibles on labour productivity growth, MFP growth and capital deepening are examined. These estimates are also decomposed to examine the relative effect of capitalising the new intangibles and the national accounts intangibles on each estimate.

Contribution of intangibles to labour productivity growth

Table 5.3 shows the relative contributions of MFP growth and capital deepening to overall labour productivity growth (as specified in equation 5.5). Labour productivity for the case where all intangibles are treated as capital grew at a rate of 2.28 per cent a year between 1974-75 and 2005-06, compared with 2.12 per cent a year for the case where no intangibles are treated as capital — an increase of 0.16 of a percentage point, or around 8 per cent.

The relative contributions of capital deepening and MFP growth to labour productivity growth shifted after all intangibles were treated as capital, with the rate of capital deepening increasing while the contribution of MFP growth decreased.

Capital deepening after the inclusion of all intangible capital increased from 0.76 per cent a year to 1.08 per cent a year, or a 42 per cent increase (table 5.3). The contribution of MFP growth decreased from 1.36 per cent a year to 1.20 per cent, or a 12 per cent fall. The fall in the rate of MFP growth indicates that some labour productivity growth that was attributed to MFP growth before the capitalisation of intangibles was actually driven by capital deepening due to intangibles. This capital deepening was attributable largely to an increase in the capital income share from the inclusion of intangibles investment. An increase in the growth rate of the capital services index due to intangibles had a smaller, though still positive, effect on capital deepening.

Although on average over the full period MFP growth was lower and capital deepening higher after capitalising intangibles, the relative contributions of MFP growth and capital deepening to labour productivity growth shifted considerably across decades. For the first period, 1974-75 to 1984-85, MFP growth was virtually unchanged with the treatment of the national accounts intangibles as capital — including investment in these intangibles increased labour productivity growth by about the same amount as the increase in capital deepening.

Growth in labour productivity was at its lowest between 1984-85 and 1994-95, with most of the fall attributable to a decline in the rate of capital deepening, although MFP growth was also lower during this period. However, growth in investment in intangibles was still strong, so the inclusion of intangible capital almost doubled the rate of capital deepening when compared with the case where no intangible capital was included.

Table 5.3 **Contributions to labour productivity growth[a], market sector**

Per cent per year (Percentage share of total growth)

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Including all intangible assets				
Capital deepening	1.08	1.12	0.63	1.43
	(47)	(47)	(39)	(51)
MFP growth	1.20	1.25	1.00	1.35
	(53)	(53)	(61)	(48)
Labour composition[b]	na	na	0.27	0.19
			(17)	(7)
MFP growth adjusted for labour composition	na	na	0.73	1.16
			(45)	(42)
Labour productivity growth	2.28	2.37	1.63	2.78
	(100)	(100)	(100)	(100)
Including national accounts intangible assets				
Capital deepening	0.91	0.99	0.48	1.20
	(42)	(43)	(32)	(45)
MFP growth	1.26	1.30	1.02	1.45
	(58)	(57)	(68)	(54)
Labour composition[b]	na	na	0.28	0.21
			(19)	(8)
MFP growth adjusted for labour composition	na	na	0.74	1.25
			(49)	(47)
Labour productivity growth	2.17	2.29	1.50	2.67
	(100)	(100)	(100)	(100)
Excluding all intangible assets				
Capital deepening	0.76	0.90	0.32	1.02
	(36)	(41)	(22)	(38)
MFP growth	1.36	1.31	1.13	1.63
	(64)	(59)	(78)	(61)
Labour composition[b]	na	na	0.28	0.22
			(19)	(8)
MFP growth adjusted for labour composition	na	na	0.85	1.43
			(59)	(54)
Labour productivity growth	2.12	2.20	1.45	2.66
	(100)	(100)	(100)	(100)

a Shares of labour productivity growth may not add to total due to rounding. **b** Labour productivity growth attributable to change in the quality adjusted labour inputs index. See appendixes B and C for more information.

Source: Authors' estimates.

Table 5.4 shows the breakdown of capital deepening by asset type. The rate of capital deepening was considerably higher after the treatment of intangibles as capital. The contribution of intangibles capital deepening to labour productivity growth has increased over time, from 0.29 per cent a year from 1974-75 to 1984-85 to 0.57 per cent a year from 1994-95 to 2005-06.

Table 5.4 **Contributions to capital deepening[a], market sector**
Per cent per year (Percentage share of total capital deepening)

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Including all intangible assets				
National accounts intangible assets	0.17	0.10	0.19	0.22
	(15)	(9)	(28)	(15)
New intangible assets	0.24	0.19	0.16	0.35
	(22)	(17)	(25)	(24)
Tangible assets	0.69	0.84	0.31	0.89
	(63)	(74)	(47)	(61)
Total capital deepening	1.08	1.12	0.63	1.43
	(100)	(100)	(100)	(100)
Including national accounts intangible assets				
National accounts intangible assets	0.17	0.10	0.18	0.23
	(19)	(11)	(37)	(19)
Tangible assets	0.74	0.89	0.32	1.00
	(81)	(89)	(63)	(81)
Total capital deepening	0.91	0.99	0.48	1.20
	(100)	(100)	(100)	(100)
Excluding all intangible assets				
Total capital deepening	0.76	0.90	0.32	1.02

a Percentage contributions shown in brackets, numbers may not add to total due to rounding.

Source: Authors' estimates.

The average percentage contribution of all intangibles to total capital deepening increased from 26 per cent between 1974-75 and 1984-85 to 39 per cent between 1994-95 and 2005-06. The contribution of intangibles to total capital deepening peaked in the period 1984-85 to 1994-95 at 53 per cent (a period in which capital deepening attributable to tangibles was low). When all intangible assets were treated as capital, they contributed an average of 37 per cent of all capital deepening over the full period.

Including intangible capital increased the total rate of capital deepening and decreased the contribution to capital deepening of tangible assets. The contribution of tangible assets decreased, as a result of treating intangibles as capital, for several reasons: existing capital income fell as a share of total income (including intangible

investment); a portion of existing capital income (previously attributed to tangibles) was redistributed to intangibles as a result of the reweighting of capital income shares for each asset[7]; and the rental prices for tangibles also changed.[8]

The justification for the redistribution of a portion of existing capital income from tangibles to intangibles is that some capital income that is currently attributed to tangible assets is actually a return on unmeasured intangible capital.

Comparing the impact of the new and existing intangibles

The new intangible assets and the national accounts intangible assets had different effects on the rate of capital deepening and MFP growth.

Growth in total investment in the national accounts intangible assets is higher than growth in investment in the new intangible assets. However, the level of investment in the new intangibles is much higher than that of the national accounts intangibles. The new intangibles have a greater effect on adjusted GVA growth because they represent a higher share of total investment, even though growth in investment in the new intangibles is lower than that of the national accounts intangibles.

Capitalising the new intangibles also has a bigger impact on the rate of capital deepening than that of the national accounts intangibles. Most of this difference is caused by the new intangibles increasing the rate of capital deepening through a larger increase in the capital income share.[9]

The rate of MFP growth is determined by the ratio of capital deepening to growth in labour productivity. The new intangible assets had a similar impact on the rate of capital deepening and labour productivity growth, meaning the impact on MFP growth was limited. However, including the national accounts intangibles as capital increased the rate of capital deepening by more than it increased the rate of labour productivity growth, leading to a larger relative impact on MFP growth.

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7 Capital income is split between assets based on the rental price weight of each asset. The treatment of intangibles as capital reduced the rental price weight of the tangible assets. Therefore tangible assets had a lower share of total capital income attributed to them.

8 There are several components of the rental price equation, including the equalising rate of return across all assets, that will change for national accounts tangible assets after capitalising intangibles. More detail on these changes are included in appendix C.

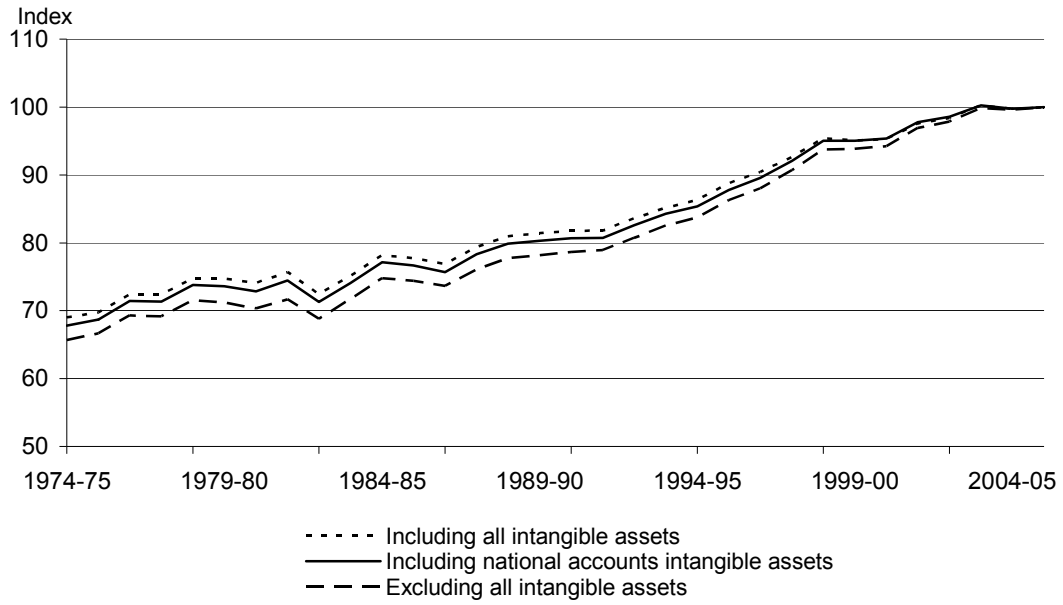
9 The rate of capital deepening can also be increased by an increase in the growth of the aggregate capital services, but this change is usually smaller than that caused by the increased capital income share.

Growth accounting periods

This section analyses the impact of intangible investment on the growth in MFP, specifically concentrating on the impact of intangibles on the timing and magnitude of the MFP growth cycles. The growth cycles are the trend periods in MFP growth identified by the ABS in the national accounts. Marrano, Hulten and Wallis (MHW 2007) identified that for the United Kingdom capitalising intangibles changed the pattern of the MFP cycles in that country. This section tests whether this is also the case in Australia.

Figure 5.3 shows that capitalising intangibles expenditure has changed the average rate of MFP growth, but the pattern of MFP growth, including all of the turning points, is virtually unchanged.

Figure 5.3 **Multifactor productivity, market sector, 1974-75 to 2005-06**
Index 2005-06 = 100



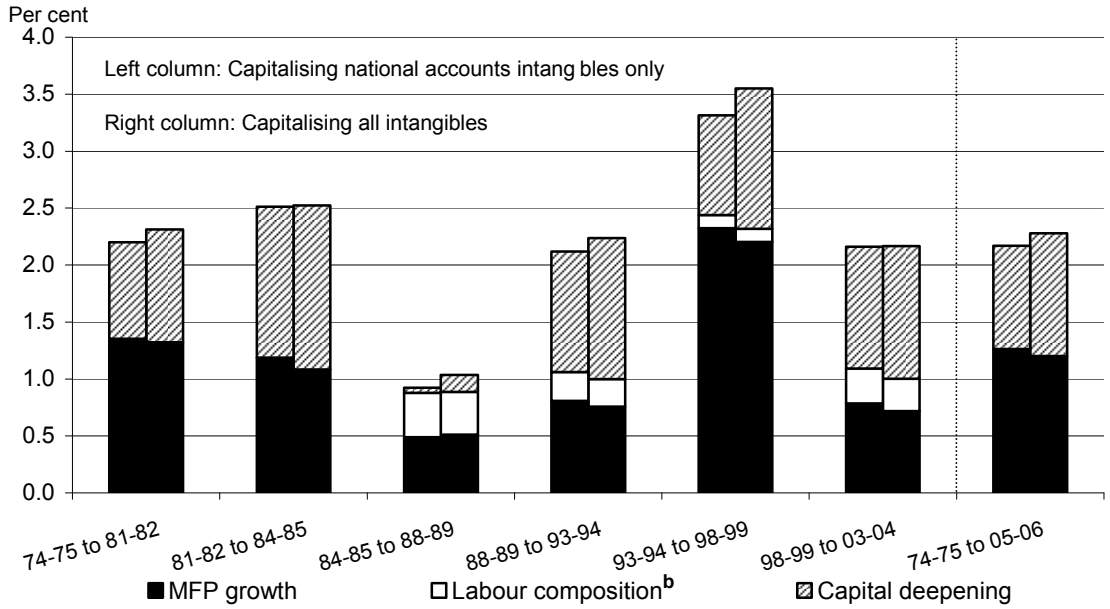
Data source: Authors' estimates.

For most periods MFP growth does not change as much as the rate of capital deepening and labour productivity growth (figure 5.4). Broadly speaking, the timing and magnitude of the MFP growth cycles remain similar after the treatment of intangibles expenditure as investment. Each period consistently shows that treatment of the new intangibles as capital increases the rate of capital deepening, while in general only reducing the rate of MFP growth by a relatively small amount (table 5.5).

The productivity surge from 1993-94 to 1998-99 is still present after capitalising intangibles. MFP grew at a rate of 2.30 per cent a year during this period (table 5.5), much higher than the average 1.20 per cent a year over the full period. MFP growth was only 0.13 of a percentage point lower than the existing market sector estimates after capitalising the new intangibles. New intangibles therefore accounted for only a small portion of conventionally-measured MFP growth during this period (figure 5.4).

Figure 5.4 **Contributions to labour productivity growth over MFP growth cycles[a], market sector**

Per cent per year



a The estimates for the national accounts definition of assets are different to the ABS national accounts estimates due to differences in the level of aggregation at which the estimates are constructed. The reasons for this are discussed in detail in appendix C. **b** Labour composition data are not available for the periods prior to 1984-85 to 1988-89 and therefore the full period 1974-75 to 2005-06. Labour composition change is captured in MFP growth where not separately identified.

Data source: Authors' estimates.

Table 5.5 **Productivity growth cycle analysis[a], market sector**

Per cent per year

	1974-75 –1981-82	*1981-82 –1984-85*	*1984-85 –1988-89*	*1988-89 –1993-94*	*1993-94 –1998-99*	*1998-99 –2003-04*	*1974-75 –2005-06*
Labour productivity							
Including all intangible assets	2.31	2.50	1.04	2.24	3.55	2.17	2.28
Including national accounts intangible assets	2.20	2.48	0.92	2.12	3.31	2.16	2.17
Excluding all intangible assets	2.03	2.59	0.91	2.03	3.27	2.16	2.12
Multifactor productivity[b]							
Including all intangible assets	1.32	1.08	0.89	1.01	2.30	0.98	1.20
Including national accounts intangible assets	1.35	1.19	0.88	1.07	2.43	1.07	1.26
Excluding all intangible assets	1.25	1.43	0.98	1.19	2.59	1.26	1.36
Capital deepening							
Including all intangible assets	0.99	1.44	0.15	1.24	1.23	1.16	1.08
Including national accounts intangible assets	0.85	1.32	0.05	1.06	0.87	1.07	0.91
Excluding all intangible assets	0.78	1.19	-0.06	0.85	0.68	0.89	0.76

a MFP growth cycles. **b** Includes labour composition change for comparability across periods.

Source: Authors' estimates.

Sensitivity testing results

The estimates for investment in the new intangible assets used in this paper are experimental, as are the depreciation rates, deflators, and tax rates used for calculating capital stock estimates and capital services indexes. Therefore, the results presented above have been tested for their sensitivity to changes in the investment estimates for the new intangibles and changes to selected parameters used in the growth accounting. The tests include higher and lower estimates of investment in intangibles, changes to parameters within the rental price equation and increasing the depreciation rate on intangible assets. See appendix D for full details of the sensitivity tests undertaken.

The tests show that the main results of the growth accounting are robust to most of the changes trialled. This is consistent with the results of similar sensitivity tests undertaken by MHW (2007) and Fukao et al. (2008b). The only test to produce a large change in the estimates was the use of a purely endogenous rate of return rather than using the ABS methodology (which has been used for comparability with ABS results).[10] The change in results was consistent across each of the three capital definitions. Therefore the effect is not important when measuring the relative impact of capitalising different groups of intangible assets. However, because some overseas studies use endogenous rates of return, the international comparability is affected by the use of the exogenous floor rate of return. The use of the endogenous rate returns a change in Australian growth accounting results as a result of capitalising all intangibles that is closer to that estimated for the United States by Corrado, Hulten and Sichel (CHS 2006).

10 The ABS methodology uses an endogenous rate of return unless the endogenous rate falls below the level of consumer price index (CPI) growth plus 4 per cent. If the rate falls below this level, CPI growth plus 4 per cent is used as the rate of return. In practice the rate of return, which was constrained to be the same across all assets, rarely fell below this mark and can therefore be considered to be an exogenous rate of return for most years. This differs from the CHS (2006) methodology, which used a purely endogenous rate of return.

6 International comparisons

This chapter examines the estimates of Australian intangibles in an international context. As noted in earlier chapters, the Corrado, Hulten and Sichel (CHS) methodology has also been used to measure intangible investment and its effect on productivity for the United States, the United Kingdom, Japan, Finland, the Netherlands, France, Germany, Italy and Spain, and intangible investment only for Canada.[1]

Estimates based on the same methodology provide a reasonable basis for making international comparisons. However, there are a few points to note about the comparisons in this chapter.

- National statistical systems differ from country to country and this affects comparability of the underlying data. (Differences in data sources are discussed in appendix A.)
- Although the basic methodology for measuring intangibles is quite similar, data limitations have led to some differences in its application across countries. (These are noted in the comparisons below.)
- The implementation of the growth accounting differs across countries. For example, the US and UK results use capital services indexes based on endogenous rates of return, while the results for the Netherlands are based on an exogenous rate of return. Results for Australia have been estimated using an endogenous rate of return with a exogenous floor rate of return (which in practice leads to an exogenous rate in the majority of years) and sensitivity tested using a purely endogenous rate.
- The proportion of the total economy for which intangibles is measured is different in each country — the market sector for Australia (62 per cent of the total economy); the market economy for France (65 per cent), Germany (70 per cent), Italy (72 per cent) and Spain (75 per cent); the non-financial business

[1] The United States in CHS (2005, 2006), the United Kingdom in Marrano and Haskel (MH 2006) and Marrano, Haskel and Wallis (MHW 2007), Japan in Fukao et al. (2007) and Fukao et al. (2008b), Finland in Jalava, Aulin-Ahmavaara and Alanen (JAA 2007), the Netherlands in van Rooijen-Horsten, van den Bergen and Tanriseven (RBT 2008) and van Rooijen-Horsten et al. (2008), France, Germany, Italy and Spain in Hao, Manole and van Ark (2008) and Canada in Belhocine (2008).

sector for Finland (72 per cent); the non-farm business sector for the United States (77 per cent); the market sector for the United Kingdom (89 per cent); and the whole economy for the Netherlands[2], Canada and Japan (100 per cent).[3] Data availability is one reason for this. The other reason is that the focus of the studies is on identifying the contribution of intangibles in measured MFP, and MFP is measured for different sectors of the economy in each country.

- The estimates do not cover the same time period for each country. This limits the comparability and the ability to examine differences between sub-periods.
- The periods for which data are available do not necessarily coincide with the peak-to-peak growth periods[4] that provide the most accurate view of growth.

There are also a number of other points to note about the interpretation of the international comparisons in this chapter.

- In addition to the differences in application of the methodology across countries, the limitations of the underlying methodology also mean that the relativities between countries are only indicative. (For example, the proportions of intangible expenditure that are treated as investment are assumed because of limited information and are uniform across countries.)
- Country-specific circumstances will affect the appropriate level and type of intangible investment for a particular country — the country with the highest ratio of intangibles to output should not be regarded as a benchmark. As with any other investment, it is allocative efficiency that counts for maximising its benefits for productivity and living standards. More is not necessarily better.
- The growth accounting approach does not provide information about the *causal* links between intangible investment and productivity growth.

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2 In some cases, data are available for the commercial sector as well as the total economy for the Netherlands. However, the estimates reported in van Rooijen-Horsten et al. (2008) for the commercial sector are less disaggregated by intangible type than those for the total economy. Therefore section 6.1 focuses on the total economy results, while the growth accounting results in section 6.2 are for the commercial sector.

3 Australian market sector share of gross value added (GVA) at basic prices in 2005-06 (ABS Cat. no. 5204.0); US non-farm business GVA as a share GDP in 1998–2000 (BEA 2008); UK market sector share of GVA at basic prices in 2004 (ONS 2006); Finnish non-financial business sector share of GVA at basic prices in 2005 (Statistics Finland 2008); and France, Germany, Italy and Spain market economy share of value added at basic prices in 2004 (EU KLEMS 2008). These shares are only indicative as they are measured on varying bases and use recent national accounts data — due to revisions this data may differ from that which underlies the intangibles estimates in the individual country studies.

4 Calculating productivity trends from 'peak to peak' is one way of overcoming the spurious influences of business cycles in estimates of productivity growth. Business cycles will affect the utilisation of existing capital stocks but because of insufficient information, productivity estimates are based on the assumption of constant utilisation of capital.

6.1 Intangible investment as a share of output

To compare the importance of intangible investment across countries, it is necessary to scale this investment to a common measure, for example, output. Intangible investment as a percentage of GDP was reported in each of the country studies and has therefore been estimated for Australia (table 6.1). Based on this measure, Australia has a relatively low proportion of intangible investment to output — about half that of the United States and Japan, 56 per cent of the United Kingdom, 60 per cent of Canada, 65 per cent of Finland, 70 per cent of the Netherlands[5], 71 per cent of France and 83 per cent of Germany. Australia has a higher proportion than Spain and Italy (by 13 per cent).

This provides one perspective on the relativities between countries. However, it is distorted to some extent because, as noted above, the proportion of the total economy for which investment has been measured differs across countries. An alternative perspective is to consider intangible investment as a percentage of output of the sector for which the investment is estimated — that is, intangible investment as a percentage of the output it is used to produce. From this perspective, Australia's relative position rises.

Table 6.2 shows intangible investment as a share of the adjusted output (including investment in intangibles) of the sector for which intangibles are measured[6] — the market sector for Australia, the United Kingdom, France, Germany, Italy and Spain, non-farm business sector for the United States, the non-financial business sector for Finland, and the total economy for Japan, the Netherlands and Canada. The intangible investment share for Australia increases to 66 per cent of that for Finland, 71 per cent of the United States, 74 per cent of the United Kingdom, 76 per cent of France, 91 per cent of Japan, and 95 per cent of Germany. Australia also has a higher share than Canada (by 5 per cent), the Netherlands (by 22 per cent)[7], Italy (by 30 per cent) and Spain (by 32 per cent).

5 This percentage rises to 82 per cent if the results for the commercial sector of the Netherlands are used for comparison.

6 Estimates have been derived using a number of sources with some variation in measures remaining (see notes to table 6.2) and may therefore be only indicative.

7 This percentage falls to 3 per cent higher if the result for the commercial sector of the Netherlands is used for comparison.

Table 6.1 **Intangible investment as a share of GDP, by country**

Percentage of existing GDP

	Australia - market sector (2005-06)	*USA - non-farm business (1998–00)*	*UK - market sector (2004)*	*Japan - total economy (2000–05)*	*Netherlands[a] - total economy [commercial] (2005)*	*Finland - non-fin. business (2005)*	*France - market sector (2004)*	*Germany - market sector (2004)*	*Italy - market sector (2004)*	*Spain - market sector (2004)*	*Canada - total economy (2005)*
Computerised information	0.8	1.7	1.9	2.2	1.4 [1.2]	1.0	0.9	0.8	0.7	0.8	1.0
Innovative property	2.2	4.6	3.4	5.9	1.8 [1.4]	4.0	3.1	3.5	2.3	2.5	5.0
Scientific R&D[b]	0.8	2.0	1.1	2.8	1.0	2.7	1.3	1.7	0.5	0.6	1.9
Mineral exploration	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Copyright and licence costs	0.1	0.8	0.2	1.1	0.2	0.1	0.3	0.2	0.1	0.2	0.1
Other product development, design and research	1.1	1.6	2.1	2.0[c]	0.6[d]	1.1[e]	1.5	1.6	1.6	1.7	1.9
Economic competencies	2.9	5.4	5.2	3.4	5.2 [4.6]	4.1	4.4	2.9	2.2	2.0	3.8
Brand equity	0.9	1.5	1.0	1.1	2.3	1.7	1.0	0.6	0.8	0.4	0.5
Firm-specific human capital	0.4	1.2	2.5	0.5[c]	1.2	1.2	1.5	1.3	1.0	0.8	2.2
Organisational capital[f]	1.6	2.7	1.8	1.7[c]	1.8	1.1	1.8	1.0	0.4	0.7	1.1
Total	**5.9**	**11.7**	**10.5**	**11.5**	**8.4 [7.2]**	**9.1**	**8.3**	**7.1**	**5.2**	**5.2**	**9.8**

Components may not add to total due to rounding. [a] Results for the Netherlands are available for the total economy and the commercial sector, although the data for the latter are less disaggregated. [b] Includes R&D in social sciences for Australia, Finland, the Netherlands, France, Germany, Italy and Spain. R&D in social sciences is included in Other product development, design and research for the USA, UK, Japan and Canada. [c] Fukao et al. (2008b, p. 14) note that this is likely to be an underestimation due to lack of reliable data. [d] Includes a narrower scope of financial services R&D. [e] Relates to the non-financial business sector so does not include financial services R&D. [f] Differences in scope and data sources across countries (see table A.3).

Sources: UK from MHW (2007) and MH (2006); USA from CHS (2005, table 3; 2006, table 1); Japan from Fukao et al. (2008b, tables 2, 4); Finland from JAA (2007, table 2); Netherlands from van Rooijen-Horsten et al. (2008, tables A2, A4); Canada from Belhocine (2008, table 1); France, Germany, Italy and Spain from Hao, Manole and van Ark (2008, table 1); authors' estimates for Australia.

Table 6.2 **Intangible investment as a share of adjusted output, by country**

Percentage of adjusted output[a]

	Australia - market sector (2005-06)	*USA - non-farm business (1998–00)*	*UK - market sector (2004)*	*Japan - total economy (2000–05)*	*Netherlands[b] - total economy [commercial] (2005)*	*Finland - non-fin. business (2005)*	*France - market sector (2004)*	*Germany - market sector (2004)*	*Italy - market sector (2004)*	*Spain - market sector (2004)*	*Canada - total economy (2005)*
Computerised information	1.3	2.0	2.3	2.0	1.3 [1.6]	1.6	1.3	1.1	1.0	1.1	0.9
Innovative property	3.6	5.3	4.2	5.4	1.7 [1.8]	6.4	4.7	4.9	3.2	3.5	4.6
Scientific R&D[c]	1.3	2.3	1.3	2.6	0.9	4.3	2.0	2.4	0.8	0.8	1.8
Mineral exploration	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.0
Copyright and licence costs	0.1	0.9	0.3	1.0	0.2	0.2	0.5	0.3	0.1	0.3	0.1
Other product development, design and research[c]	1.7	1.8	2.6	1.8	0.6	1.8	2.2	2.2	2.3	2.4	1.8
Economic competencies	4.7	6.2	6.5	3.1	4.9 [6.0]	6.6	6.6	4.1	3.2	2.7	3.5
Brand equity	1.4	1.7	1.2	1.0	2.2	2.7	1.5	0.8	1.2	0.6	0.5
Firm-specific human capital	0.7	1.4	3.1	0.4	1.1	1.9	2.3	1.9	1.4	1.2	2.0
Organisational capital[c]	2.6	3.1	2.2	1.6	1.7	1.8	2.8	1.4	0.6	0.9	1.0
Total	**9.6**	**13.5**	**13.0**	**10.5**	**7.9 [9.3]**	**14.6**	**12.6**	**10.1**	**7.4**	**7.3**	**9.1**
Intangible to tangible investment ratio	0.44	1.2	1.1	0.6	0.5 [1.0]	1.2	0.9	0.8	0.3	0.4	0.9

Components may not add to total due to rounding. [a] Percentages from table 6.1 scaled by reported ratios of total investment in intangibles to relevant output adjusted to include intangibles not already included in output: adjusted non-farm business sector output for USA (CHS 2006, fig. 2); adjusted market sector GVA for UK (MHW 2007, p. 11); adjusted non-financial business sector GVA for Finland (JAA 2007, p. 12); adjusted total economy VA for Japan (Fukao et al. 2008b, tbl. 2). Where adjusted ratios not reported, derived using data from additional sources: adjusted GDP and adjusted commercial sector VA for the Netherlands (derived from value of intangible investments on pp. 27 and tables A2; and percentage of unrevised GDP in tables A3 and A4 of van Rooijen-Horsten et al. 2008); adjusted market economy VA for France, Germany, Italy and Spain (derived from market economy VA at basic prices from EU KLEMS 2008 and value of intangible investment from Hao, Manole and van Ark 2008, tbl. 2); and adjusted total economy GDP (derived from percentage of unadjusted GDP in Belhocine 2008, tbl. 1 and value of GDP from Statistics Canada 2008). The Australian estimate is total intangible investment as percentage of adjusted market sector GVA (market sector GVA at basic prices plus investment in new intangibles). [b] Results for the Netherlands are available for the total economy and the commercial sector, although the data for the latter are less disaggregated. [c] Comparisons affected by lack of data for some intangibles or differences in scope. See notes to table 6.1 and table A.3.

Sources: Derived from MHW (2007) and MH (2006); CHS (2006); Fukao et al. (2008b); JAA (2007); van Rooijen-Horsten et al. (2008); Belhocine (2008); Hao, Manole and van Ark (2008); authors' estimates for Australia.

The ratio of intangible investment to tangible investment is around one for the United States, the United Kingdom, Canada, Finland, France and Germany but is around 0.5 for Japan, the Netherlands[8], Italy, Spain and Australia. Fukao et al. (2008b) note that while this ratio is low for Japan, intangible investment as a share of GDP in Japan is not that far behind the United States. The lower ratio is attributed to considerably higher tangible investment in Japan, which has been explained as a consequence of their financial system.

> In Japan, financial institutions such as banks play a major role in the provision of corporate funds and they typically require tangible assets as collateral to provide financing. As a result, Japanese firms have preferred to accumulate tangible assets which can be used as collateral. In addition, small firms have been hampered in their growth because they often possess insufficient tangible assets to increase borrowing. These mechanisms as a result of Japan's financial system are likely to be important reasons why the ratio of intangible to tangible investment is low in Japan. (p. 7)

Australia's lower ratio reflects both a lower rate of intangible investment *and* a relatively high rate of tangible investment to output (26 per cent). For example, the rate of tangible investment was lower in Japan and Italy (22 per cent); Netherlands and Finland (20 per cent); United States and Germany (18 per cent); and United Kingdom (17 per cent).[9]

There are remaining distortions in the international comparability of these estimates related to industry coverage and measurement issues for specific intangibles (see appendix A for details). The studies do not measure intangibles for the same group of industries in each case. If the rates of investment in intangibles differ across industries, the average rate will be affected by the differences in industry coverage across countries. And differences in the scope of the measures for individual intangibles, particularly computerised information, R&D in social sciences, other product development and purchased organisational capital, may partly explain differences between the rates of intangible investment in Australia compared with other countries. It has not been possible to determine the extent of any relative underestimation or overestimation.[10]

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8 This is for the total Netherlands economy — for the commercial sector the ratio rises to one.

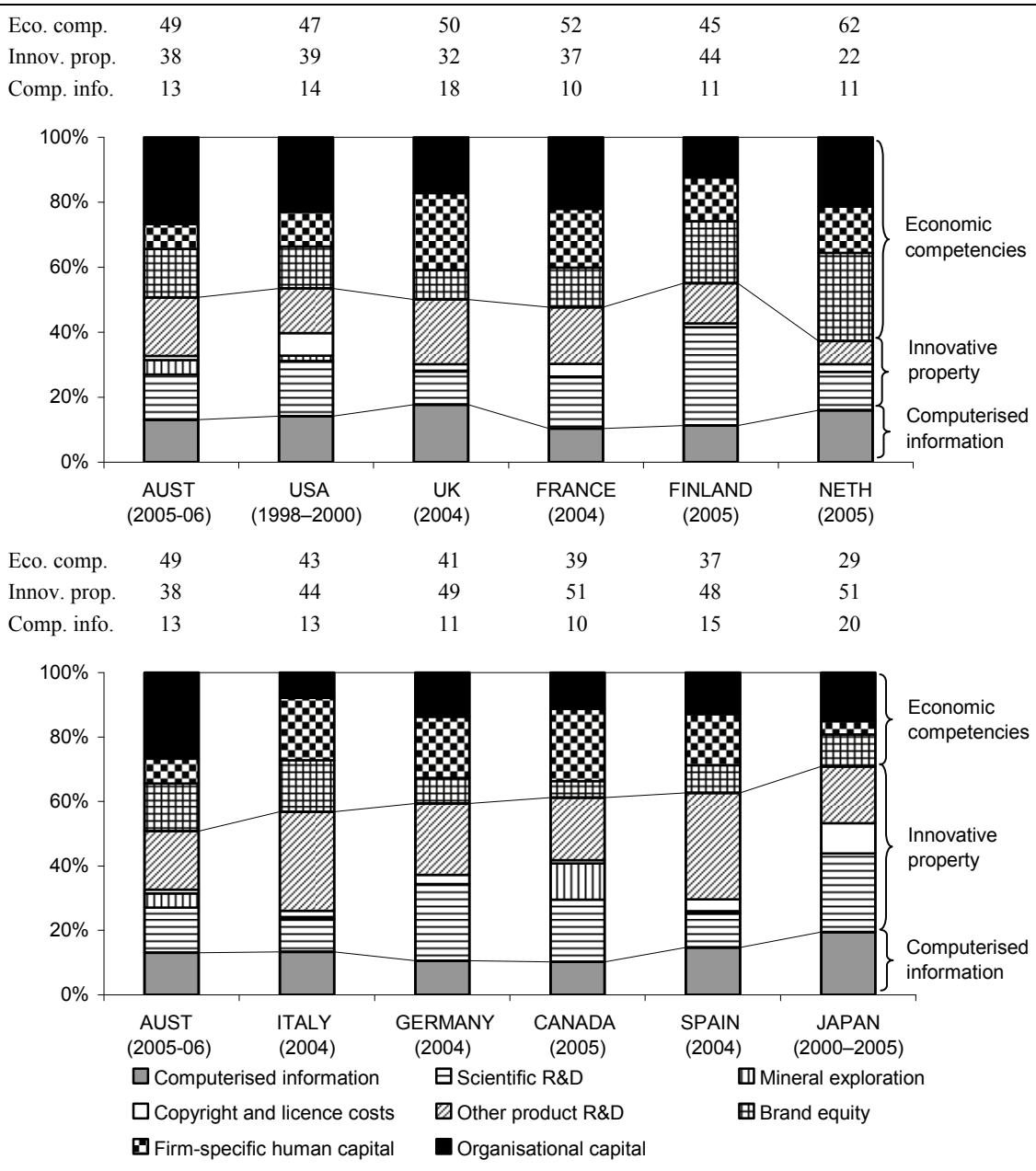
9 Gross fixed capital formation excluding software for the total economy as a share of total value added (at basic prices) (EU KLEMS 2008) for the years in table 6.2. Equivalent data for Canada and Spain are not available from the EU KLEMS database.

10 The estimates for some of the other countries do not include the same coverage of intangibles (see notes to table 6.1 and appendix A). Sensitivity testing of the Australian results to the size of investment in particular intangibles is reported in appendix D.

While the overall rate of intangible investment differs considerably across countries, there is less variation in the composition of that investment (figure 6.1). On the basis of the broad types of intangibles (computerised information, innovative property and economic competencies) the United States, United Kingdom, France and Australia are fairly similar.

Figure 6.1 **Composition of intangible investment, by country**

Percentage share



a Organisational capital and firm-specific human capital for the United States have been derived from information in CHS (2005, 2006). **b** Total economy, not commercial sector, estimates for the Netherlands.

Data sources: CHS (2005, 2006); Fukao et al. (2008b); MH (2006), MHW (2007); JAA (2007); van Rooijen-Horsten et al. (2008); Hao, Manole and van Ark (2008); Belhocine (2008); authors' estimates.

- Australia has a very similar composition of intangible investment to the United States in terms of the three main categories of intangibles.
  - Australia's lower rate of investment in intangibles relative to the United States reflects a lower rate in each of the main groups of intangibles, rather than a concentration of investment in any one of these groups.
- The United Kingdom is also fairly similar but with a lower proportion in innovative property than the United States.
  - The UK's lower rate of investment in total intangibles relative to the United States is virtually all attributable to a lower rate of investment in innovative property.
- By comparison, the other countries have quite different compositions of investment to Australia.
  - For most of these countries, investment is more heavily concentrated in innovative property and less concentrated in economic competencies than Australia. The exception is the Netherlands for which the opposite is the case — with the highest share in economic competencies and the lowest share in innovative property.

At a more disaggregated level of intangibles there is more variation in composition.

- Within innovative property, there is considerable variation in the investment shares of most individual intangibles.
  - The scientific R&D investment share ranges from 10 per cent (United Kingdom and Italy) to 30 per cent (Finland) — Australia is mid-range (15 per cent), along with the United States and France.[11]
  - Mineral exploration is negligible for most countries — for Australia the share is 4 per cent, putting it between the United States (2 per cent) and Canada (11 per cent).
  - Copyright costs are around 2-3 per cent for most countries — the exceptions are Japan (9 per cent) and the United States (7 per cent).
  - The other product development share ranges from 7 per cent (Netherlands) to 33 per cent (Spain) — Australia is mid-range (18 per cent), along with most of the other countries.

[11] This comparison is affected by scientific R&D also including R&D in social sciences, except in the case of the United States, United Kingdom, Japan and Canada (where it is included in other product development). This measure of scientific R&D for each country also takes no account of any spillovers from R&D done in other countries.

- It is a similarly varied picture for economic competencies.
  - The brand equity share of total intangible investment ranges from 5 per cent (Canada) to 28 per cent (Netherlands) — Australia lies mid-range at 15 per cent.
  - For firm-specific human capital the range is 4 per cent (Japan) to 24 per cent (United Kingdom). For Australia it is 8 per cent, with the United States at around 10 per cent. Fukao et al. (2008b) suggest that Japan's particularly low share is partly due to the CHS method not including on-the-job training, which is often utilised in Japan.[12]
  - Australia has the highest organisational capital share (27 per cent), while the United States, the Netherlands and France have shares around 20 per cent. The United Kingdom[13], Japan and Germany have a share of around 15 per cent, just ahead of Canada, Finland and Spain (around 12 per cent). Italy has the lowest share (8 per cent). However, there is considerable variation across countries in the data sources used to measure organisational capital.

Some of the differences in composition between Australia and the other countries are to be expected or are already documented.

- Differences in industrial composition will lead to different types of intangible investment.
  - For example, the mining industry is a larger share of GDP in Australia than in most of the other countries.[14] Therefore Australia might be expected to have a higher share of its intangible investment in mineral exploration.
- Differences in business expenditure on R&D (BERD) between countries are already documented (see, for example, PC 2007), with Finland, Japan, the United States, Germany, France and Canada having a higher rate of investment in BERD than Australia and the United Kingdom.[15]

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12 Fukao et al. (2008b, p. 11) cite a 2007 survey estimating that Japanese workers spend about 9.9 per cent of their time on on-the-job training.

13 MH (2006, p. 13) note this is consistent with the UK's poorer investment (compared with the United States) in organisational capital suggested by micro-comparisons of management and findings of higher firm-specific training based on other datasets.

14 Mining value added averaged 1 per cent of US GDP over the period 1998 to 2000 (BEA 2008). The comparable figure for Australia for 2005-06 was 7 per cent (and around 4 per cent in 1998-2000). In 2005, the equivalent measure was 2.3 per cent in the UK, 3 per cent in the Netherlands, 0.3 per cent in Finland and 0.1 per cent in Japan (EU KLEMS 2008). In Canada, mining was 5 per cent of GDP at basic prices in 2005 (Statistics Canada 2007).

15 In 2002, BERD intensity (business expenditure on R&D as a percentage of total value added) was 0.8 per cent in Italy and Spain, 1.2 per cent in Australia, 1.5 per cent in the Netherlands and 1.8 per cent in the United Kingdom compared with 3.6 per cent in Finland, 3.0 per cent in Japan, 2.6 per cent in the United States and Germany, 2.2 per cent in France and 1.6 per cent in Canada

- Differences in the level of executive remuneration between countries will affect own account organisational capital.
  - Fukao et al. (2008b) found that remuneration of Japanese executives is lower than in the United States. Australian managers are also paid less on average than those in the United States.[16]

Growth in investment

Figure 6.2 shows the growth in investment in intangibles relative to output (and the composition of that growth) by country.[17] These are cumulative charts so that the top line shows the share of total intangible investment in output. The gap between the lines is the share of each category of investment (in these figures mineral exploration is included in Scientific R&D). The total line shows the rising importance of nominal intangible investment in each case. In general, brand equity has been relatively constant, while computerised information and firm-specific resources (firm-specific human capital plus organisational capital) have shown the most marked increases. The exceptions are Finland and Japan, where scientific R&D has increased its share more than firm-specific resources, and Canada, where all shares have been relatively constant (for a relatively short period for which data are available).

The rate of growth of intangible investment relative to output has varied over time and across countries. However, most countries had a period of relatively high growth in the latter half of the 1980s and the latter half of the 1990s.

In the latter half of the 1980s, firm-specific resources and computerised information were the main contributors to growth in this ratio in the United Kingdom and the United States. Non-scientific R&D and computerised information were the largest contributors in Japan. This was also the case in Australia in the first half of the 1980s (a period of higher growth for Australia than the latter half of the 1980s). This period was also the one of highest growth in the 1980s in Finland — with scientific R&D contributing around half of total growth.

(PC 2007, p. 575). (The first group of countries is that with a relatively low share of intangible investment in scientific R&D compared with the second group of countries.) These differences have also been attributed, in part, to differences in industry structure (see PC 2007, appendix C).

16 For example, average annual earnings for Managers and administrators in Australia was A$67 704 in 2006 (ABS Cat. no. 6310.0) compared with Management occupation annual earnings of A$121 347 for the United States (US$91 930 from BLS 2008 at an average exchange rate of US$0.757 to A$1).

17 Equivalent time series for France, Germany, Italy and Spain were not reported in Hao, Manole and van Ark (2008).

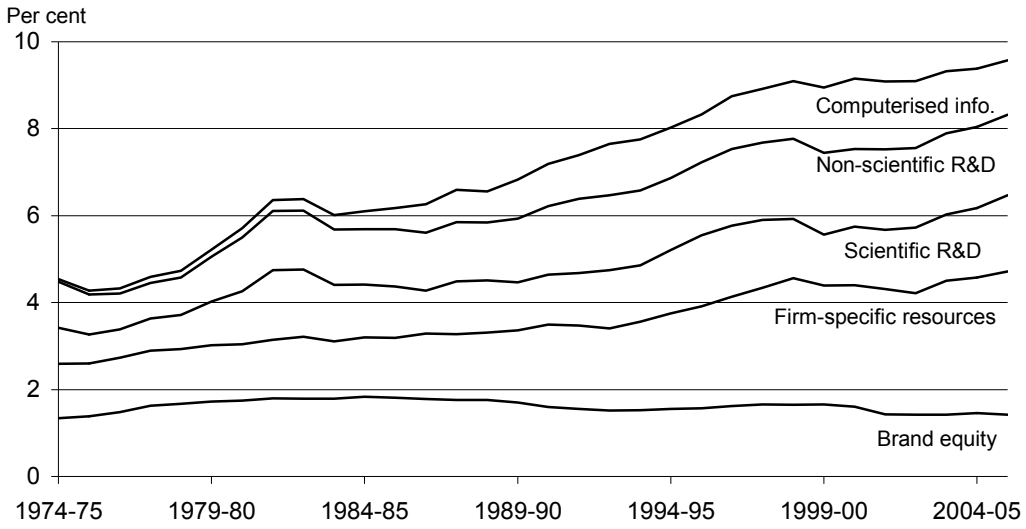
In the latter half of the 1990s, firm-specific resources and computerised software were again the main contributors to growth in the ratio of intangible investment to output in the United Kingdom and the United States. These intangibles were also the largest contributors in the Netherlands. Finland was an exception, with scientific R&D accounting for around two-thirds of growth. For Australia, the first half of the 1990s was a higher growth period than the second half, with firm-specific resources contributing almost half of this growth.

Hao, Manole and van Ark (2008, pp. 6–7) examined France, Germany, Italy and Spain between 1991 and 2004. The share of intangible investment in GDP was relatively stable in Germany and France, while it grew faster in Spain and Italy (from a lower base). The growth in Italy was across the three main categories of intangible, with little change in the composition of intangible investment. For Spain, the growth was in computerised information and innovative property, with the share of economic competencies falling. The share of economic competencies also fell in France and Germany, with growth in the share of investment in computerised information in France and Germany and in innovative property in Germany.

Figure 6.2 **Intangible investment shares of output[a], by country**

Per cent

Australian investment in intangibles as a share of adjusted market sector gross value added



United Kingdom investment in intangibles as a share of adjusted market sector gross value added

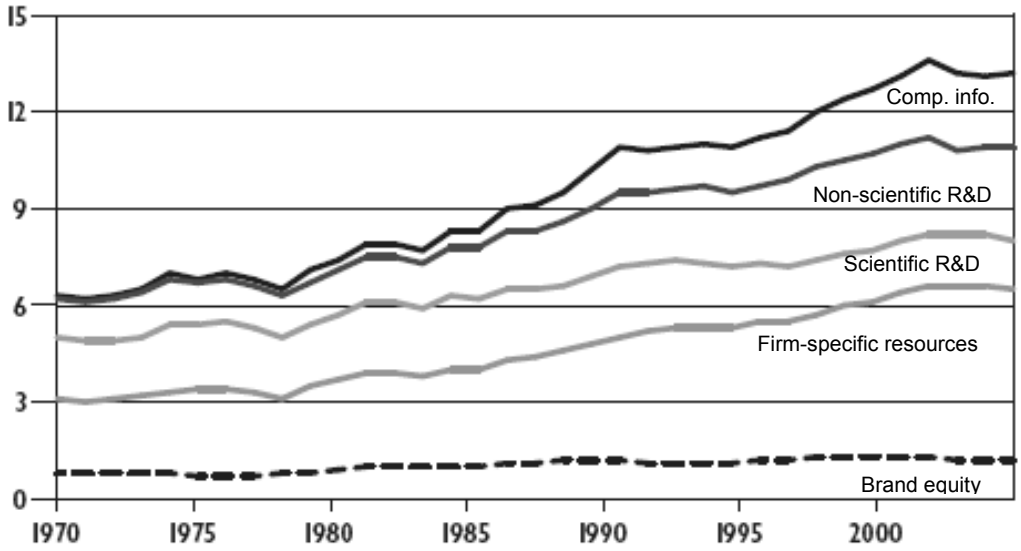


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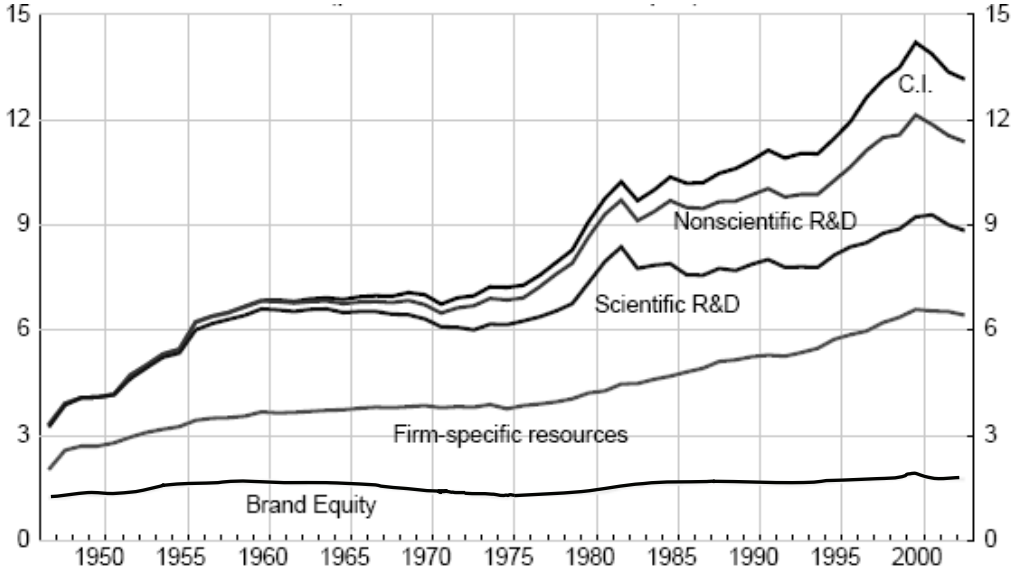
Figure 6.2 **(continued)**

United States investment in intangibles as a share of adjusted non-farm output



Note: C.I. = Computerized information

Finnish investment in intangibles as a share of adjusted business gross value added

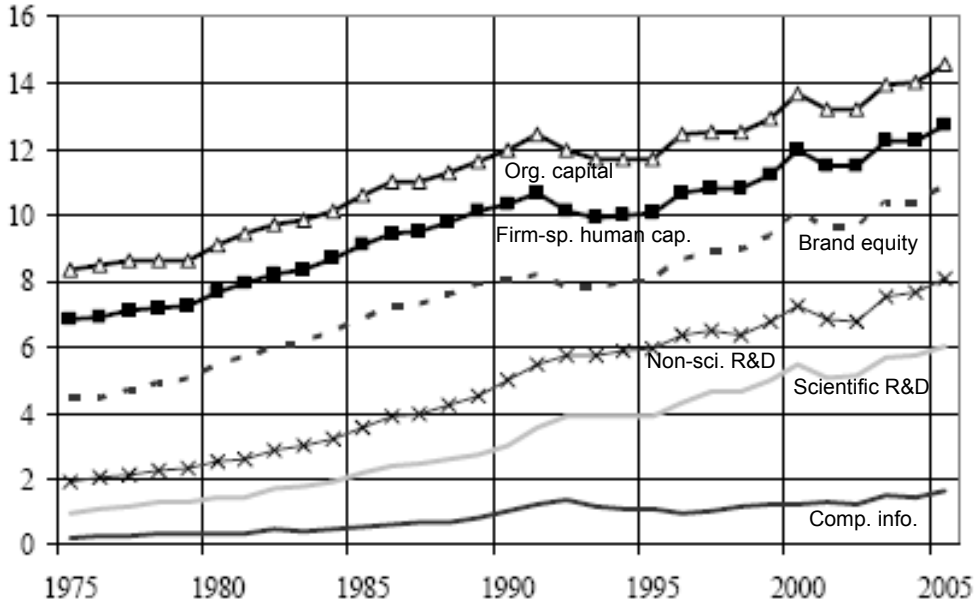


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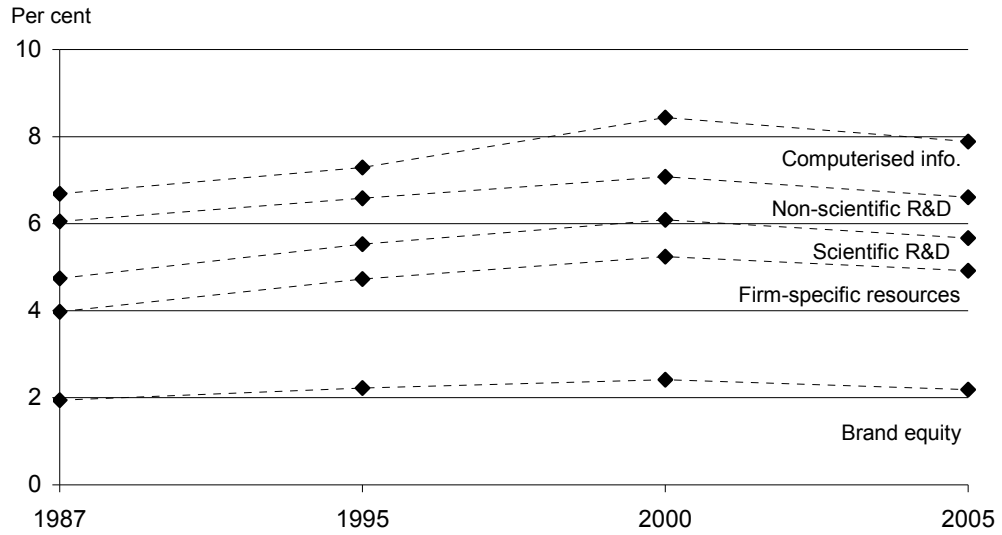
Figure 6.2 **(continued)**

Netherlands investment in intangibles as a share of adjusted GDP



Japanese investment in intangibles as a share of unadjusted value added[b]

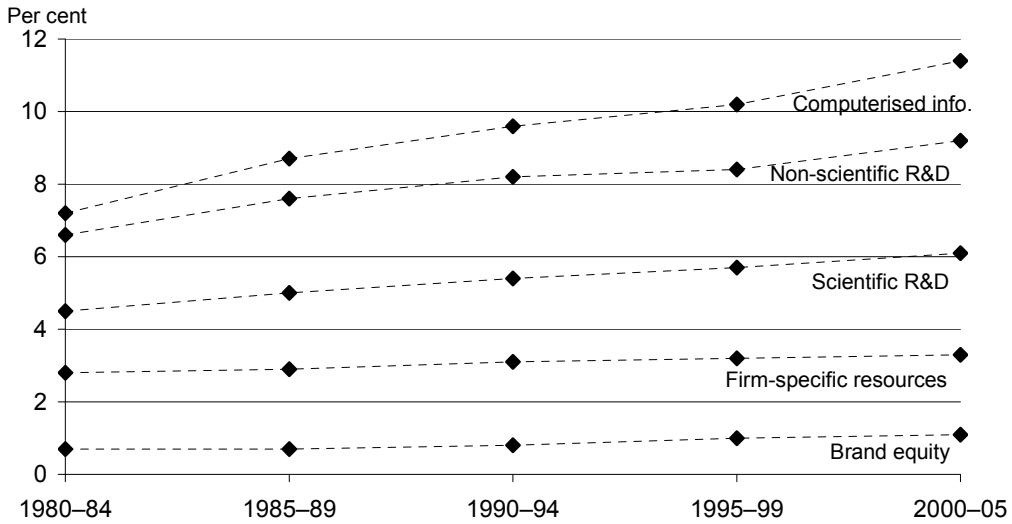


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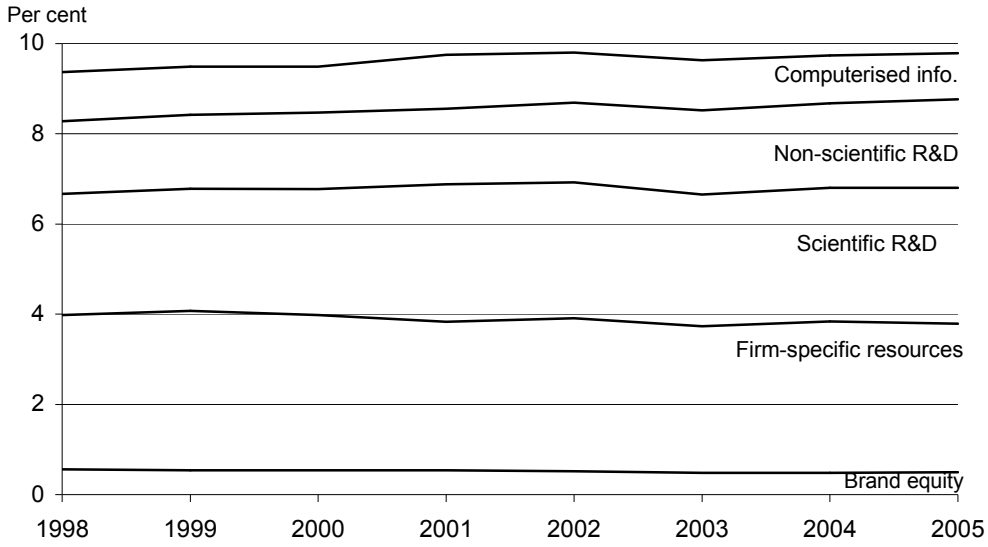
Figure 6.2 **(continued)**

Canadian investment in intangibles as a share of unadjusted GDP[c]



[a] Investment for sector of the economy listed in table 6.1 (total economy not commercial sector for the Netherlands). Output differs across countries: adjusted market sector gross value added (market sector GVA at basic prices plus market sector investment in new intangibles) for Australia; adjusted market sector GVA for United Kingdom; adjusted non-farm business output for the United States; adjusted business GVA for Finland; adjusted GDP for the Netherlands; unadjusted VA for the total economy for Japan; and unadjusted GDP for Canada. Mineral exploration is included in Scientific R&D for all countries. It also includes R&D in social sciences for Australia, Finland, the Netherlands, France, Germany, Italy and Spain. [b] Japanese estimates are based on the share of unadjusted VA and will therefore be larger than if calculated using adjusted VA (which includes intangible investment), as used for the other countries. Data are averages for five periods. [c] Canadian estimates are based on the share of unadjusted GDP and will therefore be larger than if calculated using adjusted GDP (which includes intangible investment), as used for the other countries.

Sources: Data sources are authors' estimates for Australia; derived from van Rooijen-Horsten et al. (2008, table A2) for the Netherlands; derived from Fukao et al. (2008b, table 4) for Japan; and derived from Belhocine (2008, table 1) for Canada. Figures are reproduced (with additional labels added) from Corrado, Hulten and Sichel (2006, figure 2) for the United States; Giorgio Marrano, Haskel and Wallis (2007, chart 3.1) for the United Kingdom; and JAA (2007, figure 4) for Finland.

6.2 Growth accounting results compared

As noted above, the periods for which data are available differ across countries. For this reason, only a single period is discussed in this section — the mid-1990s to the early 2000s. Estimates for this period are available from all the country studies that have identified intangibles in growth accounting analysis.[18] The MFP growth

[18] For the Netherlands the full decomposition of labour productivity growth is not available, but MFP growth results are reported for the commercial sector. Growth accounting results for earlier periods are reported in the country studies for the United States, the United Kingdom and Japan. Results for later periods are reported in the country studies for Japan, the Netherlands, Finland, France, Germany, Italy and Spain.

estimates presented in this chapter have been adjusted for labour composition change for all countries except the Netherlands.

It should also be noted that the results for Australia presented in this chapter are for a different time period to those in chapter 5. The series has been truncated to 2003 to match the majority of other countries. The period 1994-95 to 2002-03 is not a peak-to-peak period for Australia and may be affected by the influences of business cycles. This caveat also applies to the periods reported from the other country studies.[19]

Comparison of the importance of intangibles

Intangibles capital deepening, and capital deepening in total, made a relatively small contribution to Australian labour productivity (LP) growth compared with most of the other countries — the largest contribution was from multifactor productivity (MFP) growth (table 6.3).

- The contribution of intangibles capital deepening to LP growth was 5-10 percentage points lower in Australia than most of the other countries.
  - The contribution in Finland (16 per cent) was lower than Australia (19 per cent). Most of the other countries had a contribution in the range of 20-27 per cent. For Spain it was 38 per cent, while for Italy intangible capital deepening was greater than LP growth (which was negative).

19 The closest peaks for Australia are 1993-94 and 2004-05. The MFP index for 1994-95 is higher than 1993-94 and 2002-03 is slightly lower than 2003-04. So while not ideal the periods examined are at least not distorted by being peak to trough. JAA (2007, p. 14) note that the Finnish data for 1995–2000 are affected by the cyclical effects from exiting the early 1990s recession. For the United States, the cycle period is 1995–2003 (Dolman, Parham and Zheng 2007, p. 63). MHW (2007, p. 23) note that for the United Kingdom 1990–2000 is a full peak-to-peak cycle period (Kneller and Young 2001). Fukao et al. (2003) note that Japan's official business cycle peaks are May 1997 and October 2000.

Table 6.3 **Productivity growth after accounting for all intangibles[a], by country**

Per cent per year (percentage contribution to LP growth)

	Australia	*USA*	*UK*	*Neth.*	*Finland*	*Japan*	*France*	*Germany*	*Italy*	*Spain*
	1994-95 –2002-03	*1995 –2003*	*1995 –2003*	*1996 –2000*	*1995 –2003*	*1995 –2000*	*1995 –2003*	*1995 –2003*	*1995 –2003*	*1995 –2003*
	Including all intangible assets[b]									
Labour productivity growth	3.01	3.09	2.93		4.12	1.78	2.34	2.07	-0.10	0.16
	(100)	(100)	(100)		(100)	(100)	(100)	(100)	(100)	(100)
Decomposition:										
Capital deepening	1.36	1.68	2.14		0.13	1.34	1.19	1.42	0.64	0.58
	(45)	(54)	(73)		(3)	(75)	(51)	(69)	(-640)	(363)
Tangible	0.81	0.85	1.54		-0.51	0.86	0.64	0.97	0.45	0.52
	(27)	(28)	(53)		(-12)	(48)	(27)	(47)	(-450)	(325)
Intangible[c]	0.57	0.84	0.60		0.64	0.48	0.55	0.45	0.19	0.06
	(19)	(27)	(20)		(16)	(27)	(24)	(22)	(-190)	(38)
Labour composition	0.24	0.33	0.31		0.06	na	0.29	0.04	0.15	0.49
	(8)	(11)	(11)		(1)		(12)	(2)	(-150)	(306)
MFP growth	1.51	1.08	0.48	0.83	3.93	0.44	0.87	0.60	-0.89	-0.91
	(47)	(35)	(16)		(95)	(25)	(37)	(29)	(890)	(-569)

a Market sector for Australia, United Kingdom, France, Germany, Italy and Spain; non-farm business sector for the United States; commercial sector for the Netherlands; non-financial business sector for Finland; and total economy for Japan. **b** Includes all intangibles as covered in table 6.1. **c** Does not include mineral exploration for the United States, which is included as part of the tangibles.

Sources: MHW (2007, table 5) for the United States and United Kingdom; Fukao et al. (2008b, table 9-1) for Japan; van Rooijen-Horsten et al. (2008, table A8); JAA (2007, table 3) for Finland; Hao, Manole and van Ark (2008, table 5) for France, Germany, Italy and Spain; authors' estimates for Australia.

- Although Australia (and particularly Finland) had lower contributions of *total* capital deepening to LP growth, intangibles were a relatively larger share of total capital deepening than in the United Kingdom, Japan and Germany (which had relatively high existing levels of tangible capital deepening).
  - Intangibles accounted for 42 per cent of total capital deepening in Australia compared with around a quarter in the United Kingdom. Intangibles accounted for around a third of total capital deepening in Japan and half in the United States. Intangibles contributed more than 100 per cent of total capital deepening in Finland because there was tangible capital shallowing.
- MFP growth (as the residual) was a larger share of LP growth in Australia and Finland than the other countries.
  - MFP growth was 47 per cent in Australia and 95 per cent in Finland, compared with around 35 per cent in the United States, France and Germany. For Japan it was around a quarter and for the United Kingdom it was 16 per cent. MFP growth was negative in Spain and Italy.

This comparison across countries is affected to some extent by the use of an exogenous floor rate of return for the Australian capital services estimates.[20] This differs from the US study, in which an endogenous rate of return is used. All of the other country studies also use an endogenous rate of return, except the study of the Netherlands (which uses an exogenous rate of return). As discussed in chapter 5, the Australian results were sensitivity tested to the rate of return assumptions. Using an endogenous rate of return, the effect on the Australian growth accounting estimates of treating all intangibles as capital is larger. The increase in capital deepening is larger and there is a correspondingly larger decrease in MFP growth (see appendix D for details of estimates using endogenous rates of return). In terms of comparisons with the US results:

- the contribution of intangible capital deepening to LP growth increases, to a level more similar to the United States
- the contribution of MFP growth to LP growth falls by about 5 percentage points, to levels more similar to the United States.

[20] This approach is used in this paper because it is used by the ABS in the Australian national accounts (see appendix C for details).

Contribution of each intangible asset

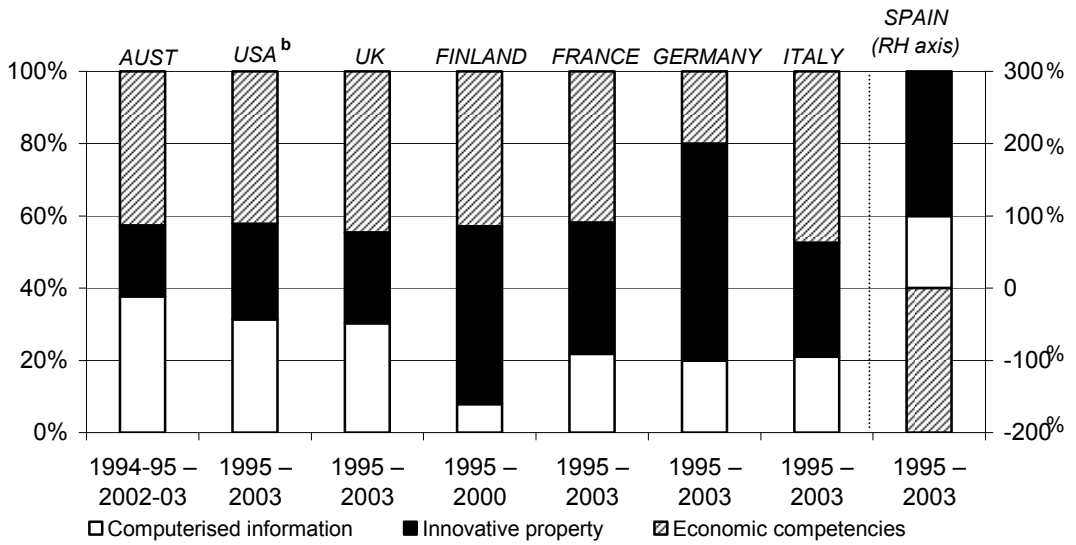
By broad asset type, Australia's pattern of contributions to total intangible capital deepening was most similar to the United States and United Kingdom (figure 6.3). — economic competencies made the largest contribution followed by computerised information and innovative property. Of all the countries shown in figure 6.3, Australia had the lowest contribution from innovative property and the highest contribution from computerised information.

The other countries had quite different patterns of intangible capital deepening. For France and Italy, economic competencies were also the main contributor but for these countries innovative property made a larger contribution than computerised information. For Finland, Germany and Spain, innovative property was the largest contributor. Computerised information was a particularly small share of total intangibles capital deepening in Finland and economic competencies made a negative contribution in Spain.

Figure 6.3 **Contributions of individual intangibles to total intangible capital deepening, by country[a]**

Percentage shares

Eco. comp.	41	42	45	42	42	20	47	-200
Innov. prop.	21	26	25	48	36	60	32	200
Comp. info.	38	31	31	8	22	20	21	100



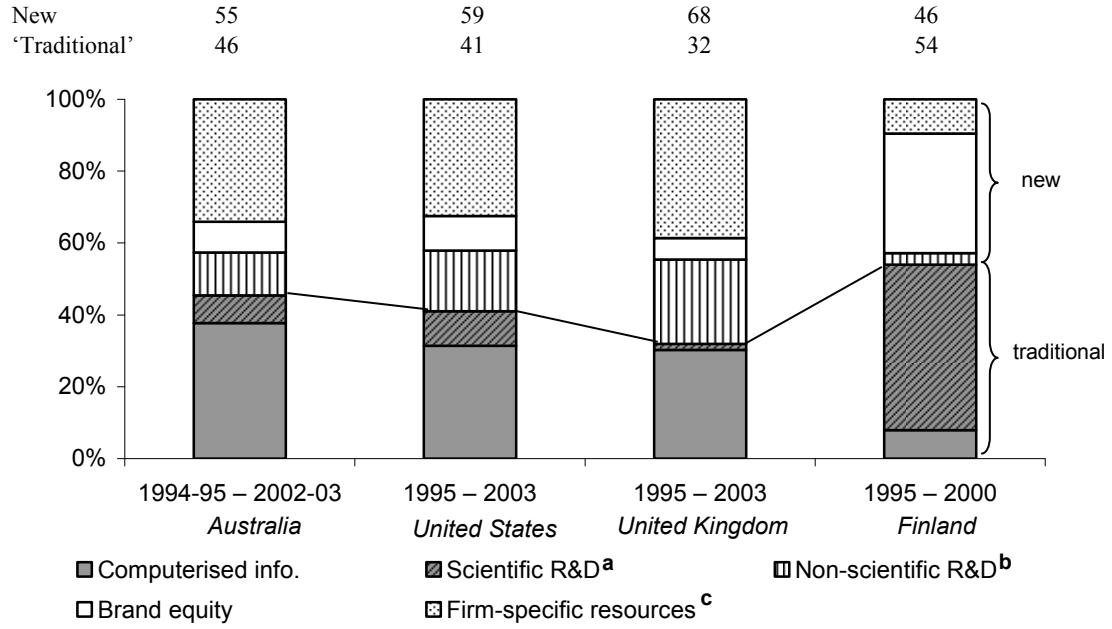
Components may not add to 100 due to rounding. [a] No comparable data were available for Japan or the Netherlands. [b] Does not include mineral exploration for United States — the growth accounting in CHS (2006) treats mineral exploration as a tangible asset.

Data sources: MHW (2007, table 6) for the United States and United Kingdom; JAA (2007, table 4) for Finland; Hao, Manole and van Ark (2008, table 5) for France, Germany, Italy and Spain; authors' estimates for Australia.

Figure 6.4 illustrates the significance in total capital deepening of the 'new' intangibles compared with the 'traditional' intangibles.[21] CHS (2006, p. 31) noted that growth accountants in the United States should not lose sight of the new intangibles that are just as large as the 'traditional' intangibles — computerised information (which is already capitalised) and scientific R&D (which is on the agenda to be capitalised). This point also applies to the United Kingdom, Australia and, to some extent, Finland.

Figure 6.4 **Contributions of new and 'traditional' intangibles to total intangible capital deepening, by country**

Percentage shares



Components may not add to 100 due to rounding. **a** Scientific R&D includes mineral exploration for the United Kingdom, Australia and Finland (it also includes R&D in social sciences for Australia and Finland, which is included in non-scientific R&D for the United Kingdom and the United States). It does not include mineral exploration for United States — the growth accounting in CHS (2006) treats mineral exploration as a tangible asset. **b** Non-scientific R&D includes other product development and copyright and licence costs. **c** Firm-specific resources includes firm-specific human capital and organisational capital.

Data sources: MHW (2007, table 6) for the United States and United Kingdom; JAA (2007, table 4) for Finland; authors' estimates for Australia.

21 Disaggregated data for France, Germany, Italy and Spain were not reported in Hao, Manole and van Ark (2008).

Firm-specific resources made a similar contribution to computerised information (slightly less in Australia and slightly more in the United States, Finland and United Kingdom). Non-scientific R&D contributed more than scientific R&D, except in Finland. The contribution of scientific R&D was 94 per cent of that for total R&D in Finland, compared with 7 per cent in the United Kingdom and 35 to 40 per cent in the United States and Australia.[22]

Comparison of the effect of adding intangibles

As discussed in chapter 5, capitalising rather than expensing intangibles expenditure results in a change to measured MFP growth. MFP growth can rise or fall, depending on the relative growth rates of current intangible investment on the output side and services from accumulated intangible capital on the input side.

Table 6.4 and figure 6.5 show growth accounting estimates for the three definitions of capital — including no intangibles, national accounts intangibles and all intangibles. For most countries examined in this chapter, the direction of effect of including intangible capital was the same — labour productivity growth rose by less than capital deepening, resulting in a fall in MFP growth (which is derived as the residual).[23] Input growth from including intangibles capital services generally outweighed the increase in output growth from including intangible investment. Intangibles therefore raised the importance of capital deepening and lowered the importance of MFP growth as sources of growth.

[22] MHW (2007, p. 21) note that this accords with discussion that in the United Kingdom 'design' is strong but scientific R&D lags behind the United States.

[23] The exceptions are the Netherlands (for which MFP growth was unchanged after capitalising the new intangibles), Japan (for which MFP growth rose after capitalising all intangibles) and Spain (for which MFP growth was unchanged after capitalising all intangibles).

Table 6.4 **Effect of intangibles on productivity growth, by country and intangible group[a]**

Per cent per year (percentage contribution to LP growth)

	Australia	*USA*	*UK*	*Neth.*	*Finland*	*Japan*	*France*	*Germany*	*Italy*	*Spain*
	1994-95 –2002-03	*1995 –2003*	*1995 –2003*	*1996 –2000*	*1995 –2000*	*1995 –2000*	*1995 –2003*	*1995 –2003*	*1995 –2003*	*1995 –2003*
	Excluding most intangible assets[b]									
Labour productivity growth	2.90	2.78	2.59			1.50	2.17	1.93	-0.24	0.10
	(100)	(100)	(100)			(100)	(100)	(100)	(100)	(100)
Decomposition										
Capital deepening	0.92	0.98	1.64			1.13	0.78	1.14	0.49	0.58
	(32)	(35)	(63)			(75)	(36)	(59)	(-204)	(580)
Labour composition	0.27	0.38	0.36			na	0.32	0.05	0.16	0.52
	(9)	(14)	(14)				(15)	(3)	(-67)	(520)
MFP growth	1.71	1.42	0.58			0.37	1.08	0.73	-0.89	-1.00
	(59)	(51)	(22)			(25)	(50)	(38)	(371)	(-1000)
	Including national accounts intangible assets[c]									
Labour productivity growth	2.94	2.95	2.73		3.64					
	(100)	(100)	(100)		(100)					
Decomposition										
Capital deepening	1.12	1.26	1.82		-0.48					
	(38)	(43)	(67)		(-13)					
Tangible	0.90				-0.53					
	(31)				(-14)					
Intangible	0.23				0.05[e]					
	(8)				(1)					
Labour composition	0.26	0.37	0.35		0.07					
	(9)	(13)	(13)		(2)					
MFP growth	1.56	1.32	0.56	0.83	4.05					
	(53)	(45)	(21)		(111)					

(continued on next page)

Table 6.4 **(continued)**

	Australia	*USA*	*UK*	*Neth.*	*Finland*	*Japan*	*France*	*Germany*	*Italy*	*Spain*
	1994-95 –2002-03	*1995 –2003*	*1995 –2003*	*1996 –2000*	*1995 –2000*	*1995 –2000*	*1995 –2003*	*1995 –2003*	*1995 –2003*	*1995 –2003*
	Including most intangible assets[d]									
Labour productivity growth	3.01	3.09	2.93		4.12	1.78	2.34	2.07	-0.10	0.16
	(100)	(100)	(100)		(100)	(100)	(100)	(100)	(100)	(100)
Decomposition:										
Capital deepening	1.36	1.68	2.14		0.13	1.34	1.19	1.42	0.64	0.58
	(45)	(54)	(73)		(3)	(75)	(51)	(69)	(640)	(363)
Tangible	0.81	0.85	1.54		-0.51	0.86	0.64	0.97	0.45	0.52
	(27)	(28)	(53)		(-12)	(48)	(27)	(47)	(450)	(325)
Intangible[f]	0.57	0.84	0.60		0.64	0.48	0.55	0.45	0.19	0.06
	(19)	(27)	(20)		(16)	(27)	(24)	(22)	(190)	(38)
Labour composition	0.24	0.33	0.31		0.06	na	0.29	0.04	0.15	0.49
	(8)	(11)	(11)		(1)		(12)	(2)	(150)	(306)
MFP growth	1.41	1.08	0.48	0.83	3.93	0.44	0.87	0.60	-0.89	-0.91
	(47)	(35)	(16)		(95)	(25)	(37)	(29)	(890)	(569)

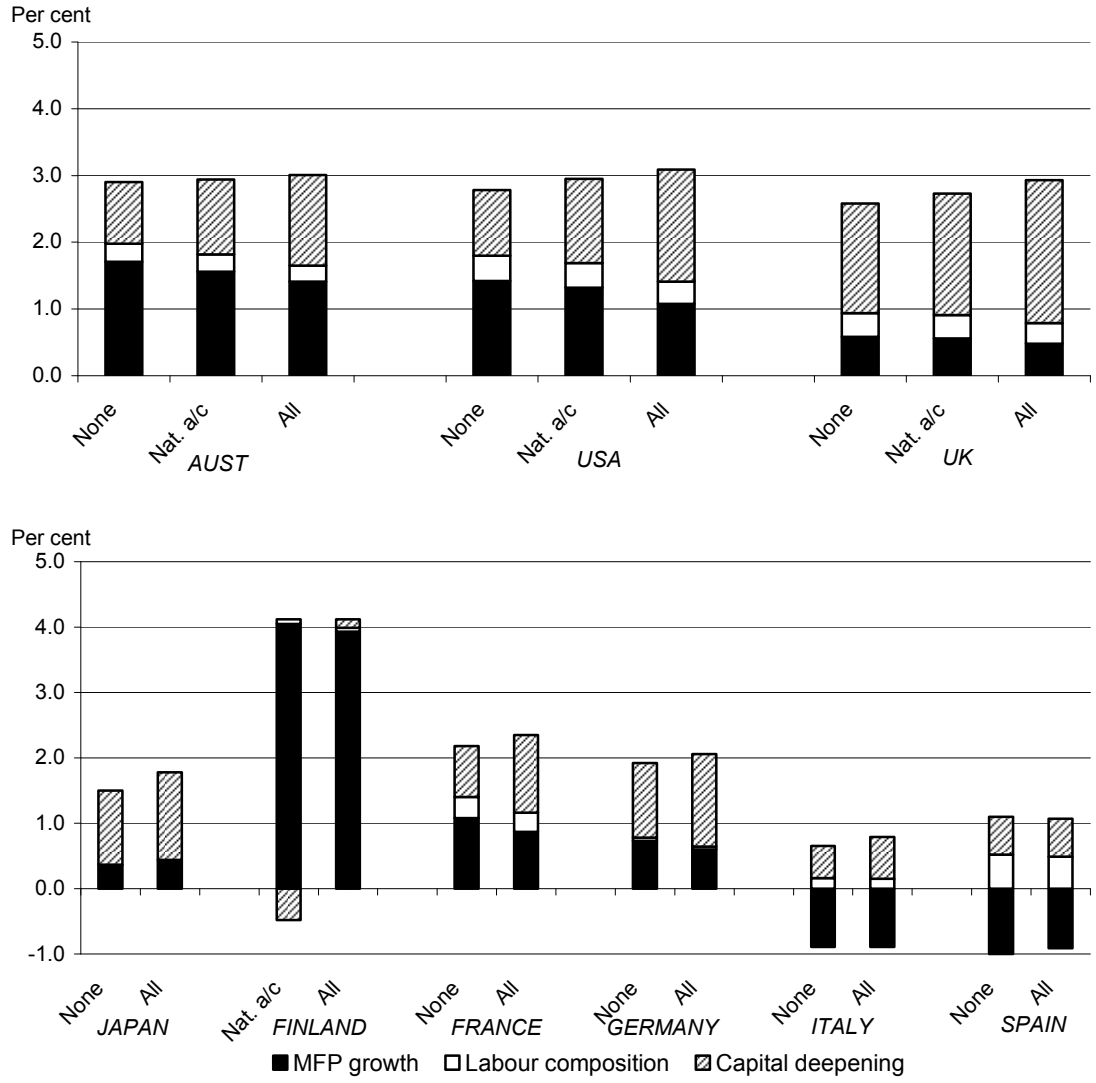
[a] Market sector for Australia, United Kingdom, France, Germany, Italy and Spain; non-farm business sector for the United States; commercial sector for the Netherlands; non-financial business sector for Finland; and total economy for Japan. [b] Computerised information excluded in all cases. The intangibles of mineral exploration and the architectural and design services embedded in equipment purchases are included for the United States. [c] For the United States, includes computerised information, mineral exploration and the architectural and design services embedded in equipment purchases. For the United Kingdom, includes computerised information. For Australia includes computerised information, mineral exploration and artistic originals — calculated using aggregate methodology rather than aggregating from industry estimates and will differ from ABS published estimates. [d] Includes all intangibles as covered in table 6.1. [e] Computerised information only. [f] Does not include mineral exploration for the United States, which is included as part of the tangibles.

Sources: MHW (2007, table 5) for the United States and United Kingdom; Fukao et al. (2008b, table 9-1) for Japan; van Rooijen-Horsten et al. (2008, table A8); JAA (2007, tables 3, 5) for Finland; Hao, Manole and van Ark (2008, table 5) for France, Germany, Italy and Spain; authors' estimates for Australia.

Figure 6.5 illustrates the differences between the three panels in table 6.4, that is the change in the decomposition of LP growth as different groups of intangibles are treated as capital.

Figure 6.5 **Decomposition of labour productivity growth, by country, by definition of capital[a], mid-1990s to early 2000s[b]**

Per cent per year



a 'None' is no intangibles treated as capital; 'National accounts' is national accounts intangibles treated as capital; and 'All' is all intangibles treated as capital. For Japan any labour composition effect is not separately identified. **b** 1994-95 to 2002-03 for Australia; 1995 to 2003 for the United States and the United Kingdom; 1995 to 2000 for Japan; 1995 to 2000 for Finland; and 1995 to 2003 for France, Germany, Italy and Spain.

Data sources: MHW (2007, table 5) for the United States and United Kingdom; Fukao et al. (2008b, table 9-1) for Japan; JAA (2007, tables 3, 5) for Finland; Hao, Manole and van Ark (2008, table 5) for France, Germany, Italy and Spain; authors' estimates for Australia.

Examining the effect of capitalising all intangibles (compared with the no intangibles case):

- labour productivity growth was higher in all countries
  - but in percentage terms, LP growth increased by less in Australia because of the relatively smaller contribution of intangible investment to output growth and/or a higher LP growth in the no intangibles case than the other countries
- the contribution of capital deepening to LP growth was higher in all countries (except Spain where there was no change)
  - the contribution of capital deepening to LP growth rose more (in percentage terms) in the United States, France and Australia than the United Kingdom and Japan (which already had high rates of capital deepening)[24]
- in most countries, the increase in capital deepening was greater than the increase in LP growth, so the contribution of MFP growth (as the residual) fell
  - the contribution of MFP growth to LP growth fell less (in percentage terms) in Australia (18 per cent) than the United States (24 per cent) and France (19 per cent), the same as in Germany (18 per cent) but more than the United Kingdom (17 per cent) and Spain (9 per cent). There was no change in Italy and in Japan the contribution rose 19 per cent.

Overall, capitalising all intangibles in the growth accounting (compared with capitalising none) generally shifted the sources of growth towards capital deepening and away from MFP growth. However, this shift was less pronounced in percentage terms for Australia than some of the other countries because of lower investment in intangibles and/or relatively high MFP growth. For Australia, even after the capitalising all intangibles, MFP growth remained a larger contributor to LP growth than capital deepening — this was not the case for most of the other countries.

Relative importance of 'new' and 'old' intangibles

As noted above, the national accounts already include some intangibles (mainly computerised information). This raises two questions:

- How do the contributions of the new intangibles compare with those of the existing intangibles?
- To what extent are the national accounts estimates affected by not treating the new intangibles as capital?

[24] MHW (2007, p. 22) noted that the effect in the United Kingdom is less than the United States because capital deepening is already quite high in the United Kingdom.

Figure 6.5 illustrates the progressive effect of capitalising the national accounts and the new intangibles for Australia, the United States and the United Kingdom (and the new intangibles for Finland). The answer to the first question is that over the period examined the 'new' intangibles affect the MFP results more than the 'old' intangibles[25], highlighting the importance of attempting to capitalise the new intangibles in the national accounts. For Australia, however, the difference between the 'new' and 'old' intangibles is small.

The answer to the second question varies across countries. Overall, in percentage terms, not treating the new intangibles as capital affects MFP growth in the Australian national accounts[26] less than it affects the national accounts of most of the other countries for which data are available (figure 6.5).[27] Australian MFP growth is overstated by 10 per cent (0.15 of a percentage point), compared with 18 per cent (0.24 of a percentage point) in the United States, 14 per cent (0.08) in the United Kingdom and 3 per cent (0.12) in Finland (table 6.4).

Overall, not capitalising all intangibles in the national accounts affects the picture of the relative importance of the sources of growth. Capital deepening is relatively more important and MFP growth relatively less important when the new intangibles are measured.

Effect on growth accounting results over shorter periods

The above results cover only one period but data for various shorter periods were examined in most of the country studies and the growth cycle periods were examined for Australia in chapter 5. While in many cases treating intangibles as capital altered the extent of any acceleration/deceleration in MFP growth between periods, in only two countries is it reported to have reversed the pattern of MFP growth.

- For the United Kingdom, the inclusion of the 'new' intangibles changed a deceleration in LP growth and MFP growth between the early and late 1990s to an acceleration in LP growth and MFP growth (MHW 2007, table 3).

25 The change in MFP growth from moving from a capital definition that includes no intangibles to one that includes the national accounts intangibles is less than the change in MFP growth from moving from a capital definition that includes national accounts intangibles to one that includes all intangibles.

26 The estimates for the national accounts definition of capital are not the same as ABS published estimates for Australia because of differences in methodology (see appendix C).

27 There are some differences across countries as to which intangibles are already treated as capital in the national accounts — the US estimates do not include artistic originals, which are included in the Australian and UK national accounts.

  - MHW (2007) suggest that the 'mystery' of the LP growth slowdown in the conventionally measured statistics was in fact a 'statistical illusion' caused by not accounting for investment in intangibles.
  - This was a period of rapid investment in intangibles that raised output growth more than input growth was raised by including intangible capital services as an input.
- For the Netherlands, capitalising intangibles resulted in a deceleration rather than an acceleration in MFP growth between 1996-2000 and 2001-05.
  - Capitalising intangibles left MFP growth unchanged in 1996-2000 but lowered it in 2001-05. The MFP growth rate therefore became higher in 1996-2000 than 2001-05, the reverse of the pattern before capitalising intangibles (van Rooijen-Horsten et al. 2008, p. 30).
- For Australia, as shown in chapter 5, there has been no change in the pattern of growth across the cycles (in terms of a switch from acceleration to deceleration).
  - In general, the lower levels of investment in intangibles means that treating intangibles as capital has a lesser effect on the growth accounting results than in some of the other countries. This also makes it less likely that the effect of treating intangibles as capital will be large enough to change the periods of acceleration and deceleration between cycles.

6.3 Summary

The estimates for Australia (and the other countries) are exploratory and have a number of identified deficiencies. And the international comparisons are further hampered by differences in coverage and underlying data used in the estimates. Even comparable estimates should be interpreted carefully — the country with the highest ratio of intangibles to output should not be seen as a benchmark. Country-specific circumstances will affect the appropriate level and type of intangible investment for a particular country. However, with these caveats in mind, there are a number of broad similarities and differences between Australia and the other countries that are of interest.

- Australia has a lower rate of intangible investment than the United States, United Kingdom, Japan, France, Germany and Finland but greater than the Netherlands, Canada, Italy and Spain (when measured as a share of adjusted output for the sector for which intangibles were measured).
  - But Australian investment in intangibles is still large — $57 billion or around 10 per cent of adjusted market sector gross value added in 2005-06.

  - And the pattern of growth has been similar to most of the other countries examined, including the United States and United Kingdom.

- Even though Australia (like Japan, Italy and Spain) has a relatively low ratio of intangibles to tangibles investment, compared with the United States, it is still around half the size of tangible investment.
  - And with higher growth in intangible investment than tangible investment over the longer term, this changes the trend in the Australian ratio of investment to output from a declining to relatively stable one.
- The composition of Australia's intangible investment is more similar to the United States than most of the other countries examined (particularly Japan).
  - The lower ratio of intangible investment to output is due to lower levels across the three main groups of intangibles rather than particularly low investment in any one group.
- While further analysis is required, the international comparisons suggest that the type of intangible investment may be important for growth performance.
  - For example, Japan has a higher share of its intangibles investment in computerised information than the United States or Australia but a lower share of investment in economic competencies. Fukao et al. (2008b) note that differences in the accumulation of intangible assets that play a complementary role to ICT capital (for example, organisational capital) might explain differences in productivity growth compared with the United States.
  - Other studies have suggested that Australian productivity performance has benefited from links between ICTs and organisational capital. Gretton et al. (2003) found significant interactions between ICT use and complementary organisational variables (including human capital, history of innovation, the use of advanced business practices and the intensity of organisational change) using an Australian firm-based longitudinal dataset. And Australia is one of the few countries to show evidence of MFP gains related to ICT use (OECD 2003). The differences between Australia and Japan in organisational capital investment (as measured using the CHS-methodology) also suggest that this is a potential explanation for some of the difference in MFP growth.[28]

[28] It should be noted that comparability of organisational capital measures across countries is affected by data limitations — the Japanese estimate is likely to be an underestimate (Fukao et al. 2008b) and the Australian estimate may be an overestimate (see chapter 3).

- In most countries, when intangibles are capitalised LP growth and capital deepening rise and MFP growth falls — that is, part of conventionally-measured MFP growth was actually attributable to previously unmeasured intangible assets.
  - The percentage contribution of 'new' intangibles to conventionally-measured MFP growth is relatively low in Australia compared with the United States and United Kingdom. This reflects a lower level of intangible investment and relatively high MFP growth in Australia. (However, it also reflects the use of an exogenous floor rate of return rather than endogenous rate of return, under which the contribution of intangibles to conventionally-measured MFP growth in Australia is larger.)
- Only a small proportion of Australia's relatively high MFP growth is *directly* attributable to intangibles and capitalising intangibles does not appreciably change the pattern of growth over the productivity cycles (unlike in the United Kingdom).
  - This does not rule out *indirect* effects from intangibles, such as complementarities with ICTs, contributing to MFP growth.

A Data sources for investment in intangibles

This appendix describes the Australian data sources used in this study and presents the capital series estimates. While the intent has been to follow the Corrado, Hulten and Sichel (CHS) methodology used in the studies of the United States (CHS 2005, CHS 2006), the United Kingdom (Marrano and Haskel 2006, Marrano, Haskel and Wallis 2007) and Japan (Fukao et al. 2008b), to allow comparability, data availability has led to some differences. A discussion of how the data sources compare with those used in the other studies is included.[1]

The estimates of intangibles have been constructed for the market sector (the industries that make up the market sector are listed in table A.1). All references to ABS ANZSIC (Australian Bureau of Statistics Australian and New Zealand Standard Industrial Classification) are to the ANZSIC 1993 edition. The closest available ASIC (Australian Standard Industrial Classification) industry division/subdivision has been used for early years in the absence of sufficient data to use a more precise concordance.

Table A.1 **Industries included in the market sector[a]**

Agriculture, forestry & fishing	Retail trade
Mining	Accommodation, cafes & restaurants
Manufacturing	Transport & storage
Electricity, gas & water	Communication services
Construction	Finance & insurance
Wholesale trade	Cultural & recreational services

a The industries excluded are Property & business services, Government administration & defence, Education, Health & community services, and Personal & other services.

1 The Corrado, Hulten and Sichel methodology (CHS 2006) has also been used to measure intangibles for Finland (Jalava, Aulin-Ahmavaara and Alanen 2007), the Netherlands (RBT 2008, van Rooijen-Horsten et al. 2008), France, Germany, Italy and Spain (Hao, Manole and van Ark 2008) and Canada (Belhocine 2008). Any major measurement differences in these studies are noted in table A.3 and the international comparisons in chapter 6.

Table A.2 summarises the measures, data sources, deflators and depreciation rates used to construct the Australian capital stock for each of the intangibles. The following sections explain these factors, and the rationale for them, in more detail. Table A.3 at the end of the chapter compares data sources across studies.

A.1 Expenditure on computerised information

As noted above, computer software is already capitalised into the national accounts by the ABS and these data are used in this paper.

The ABS defines computer software as:

> … computer programs, program descriptions and supporting materials for both systems and applications software. Included are purchased software, and, if the expenditure is large, software developed on own-account. Large expenditure on the purchase, development or extension of computer databases that are expected to be used for more than one year, whether marketed or not, are also included. (ABS 2000, p. 452)

CHS (2006) identify computer software and computerised databases separately — taking the computer software data and own account computer databases data from the US National Income and Product Accounts. The purchased component of computer databases is estimated from US Services Annual Survey (based on subscription revenue from database and directory publishing industry).[2]

The ABS measure appears broadly similar to the combined CHS measures. However, the ABS measure may understate this intangible through the exclusion of some database and own-account software development.

It should be noted that the asset lives used for computer software differ across countries. For example, the average depreciation rate is 20 per cent in the Australian national accounts compared with 40 per cent in the United Kingdom. In the US study, CHS (2006) use 33 per cent and this is followed by in the Japanese study.

[2] This was around 2 per cent of software included in the US National Income and Product Accounts in 1998–2000 (CHS 2005, table 3).

Table A.2 **Summary of data sources and assumptions used to construct stocks of intangibles**

Type of intangible	*Main data source*	*Time series (all refer to financial year ended)*	*Proportion of expenditure considered as investment*	*Deflator*	*Dep'n rate*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
Computerised information	ABS national accounts (5204.0)	2006-1975 Gross fixed capital formation (GFCF) and productive capital stock (PKS) for computer software by market sector industries	1	ABS computer software implicit price deflator (IPD)	0.2	7 435	22 619
Business expenditure on R&D	ABS BERD survey (8104.0)	2006-1975 Business expenditure on R&D by market sector industries (excluding R&D by the financial services industry)	1	Implied market sector gross value added (GVA) deflator	0.2	7 904	29 490
Mineral exploration	ABS national accounts (5204.0)	2006-1975 GFCF and PKS for mineral exploration	1	ABS mineral exploration IPD	0.1	2 503	31 737
Artistic originals	ABS national accounts (5204.0)	2006-1975 GFCF and PKS for artistic originals	1	ABS artistic originals IPD	0.6	698	1 102

(continued on next page)

Table A.2 **(continued)**

Type of intangible	*Main data source*	*Time series*	*Proportion of expenditure considered as investment*	*Deflator*	*Dep'n rate*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
New product development in financial industry	ABS IO/SU tables (5215.0/ unpublished)	2006-2005 Forecast at 2004 growth rate 2004-1995 20 per cent of intermediate purchases of SUIC 380 Finance and Finance share of SUIC 400 Services to finance, investment & insurance 1994-1975 Backcast using growth rate in intermediate usage of Financial & insurance	1	Implied Finance & insurance industry GVA deflator	0.2	5 591	27 507
New architectural and engineering designs	ABS Industry survey (8155.0)	2006 Forecast at 2005 growth rate 2005-1999 Half of sales of architectural and consulting engineering services (ANZSIC 7821, 7823). 1998-1995 Backcast using growth in Architectural, surveying, consulting engineering and quantity surveying services SUPC 43020. Assumes growth for broader group is same as for ANZSIC 7821-7823. 1994-1975 Backcast using growth rate in Architectural services, surveying and consulting engineering in IO product tables. Assumes growth for broader group is same as ANZSIC 7821-23. All scaled to market sector using market sector intermediate usage as a share of Australian production of SUPC 43020 from SU tables back to 1994-95 (backcast using market sector share of GVA).	1	Implied market sector GVA deflator	0.2	4 650	18 405

Advertising	CEASA (2003, 2006, 2007)	2006-1975 Total advertising expenditure less expenditure on classifieds and directories. Multiplied by 2 to arrive at estimate including production costs. Scaled to market sector using market sector intermediate usage as a share of Australian production of advertising services (SUPC 43025 from SU tables back to 1994-95, backcast using market sector share of GVA)	0.6	Implied market sector GVA deflator	0.6	7 337	12 160
Market research	ABS Industry surveys (8155.0, 8677.0)	2006 Forecast at 2005 growth rate 2005-1993 Twice sales of market research services (ANZSIC 7853), to impute own account market research. 1992-1975 Backcast using growth rate in Market and business services from IO product tables. Assumes growth rate for this broader group is same as for ANZSIC 7853. Scaled to market sector using market sector intermediate usage as a share of Australian production of Other business services SUPC 43031 from SU tables back to 1994-95 (assumes this share is the same for market research services) (backcast using market sector share of GVA).	0.6	Implied market sector GVA deflator	0.6	1 107	1 707

(continued on next page)

Table A.2 **(continued)**

Type of intangible	*Main data source*	*Time series*	*Proportion of expenditure considered as investment*	*Deflator*	*Dep'n rate*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
Firm-specific human capital	ABS Training surveys (6353.0, 6278.0)	Market sector excluding Agriculture Survey data for training costs (including wages of employees being training) for 2002, 1997, 1994, 1991. Estimates (in real terms) for other years derived from estimated total hours of training and estimated real costs per training hour Total hours of training based on growth in employee numbers and; for years between survey observations (1990, 1991, 1994, 1997, 2001, 2005) an assumed linear growth in hours per employee; or for 1975-89 assumed hours per employee at 1990 levels and for 2006 at 2005 levels. Linear interpolation used to estimated real costs per hour between survey data (2002, 1997, 1994, 1991) and exponential trend growth used for 1975-1990 and 2003-2006.	1	Average weekly full-time ordinary earnings deflator	0.4	4 353	10 429

Purchased organisational capital	ABS Industry survey (8155.0)	2006 Forecast at 2005 growth rate 2005-1999 Sales of business management services (ANZSIC 7855). 1998-1995 Backcast using growth rate in Other business services SUPC 43031. Assumes growth rate for this broader group is same as for ANZSIC 7855. 1994-1975 Backcast using growth rate in Market and business services from IO product tables. Assumes growth rate for this broader group is same as for ANZSIC 7855. All scaled to market sector using market sector intermediate usage as a share of Australian production of Other business services SUPC 43031 from SU tables back to 1994-95 (assumes this share is the same for business management services) (backcast using market sector share of GVA).	0.8	Implied market sector GVA deflator	0.4	10 208	22 650

(continued on next page)

Table A.2 **(continued)**

Type of intangible	*Main data source*	*Time series*	*Proportion of expenditure considered as investment*	*Deflator*	*Dep'n rate*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
Own account organisational capital	ABS Labour survey (6310.0)	2006-1998 20 per cent of earnings of market sector employees classified as Managers & administrators (excluding farm managers and IT managers). 1997-1989 Earnings backcast using growth rate in earnings of employees classified as Managers & administrators for the total economy. Assumes market sector growth rate is the same as for the total economy Employee numbers backcast using growth in total employed Managers & administrators for market sector less Agriculture. 1988-1975 Earnings backcast using growth rate in earnings of full-time employees classified as Administrative, executive and managerial employees for the total economy. Assumes market sector growth rate is the same as for full-time Managers & administrators employees for the total economy. Employee numbers backcast using growth in total employed in Administrative, executive and managerial occupations for approximated market sector less Agriculture.	1	Implied market sector GVA deflator	0.4	4 938	11 086

A.2 Expenditure on innovative property

CHS (2005) include six types of innovative property — scientific R&D, mineral exploration, copyright and licence costs, new product development costs in the financial industry, new architectural and engineering designs, and R&D in social sciences and humanities. The extent to which these types of innovative property are covered by the ABS in the Australian national accounts and the survey of business expenditure on R&D (BERD) (*Research and Experimental Development, Businesses, Australia*, Cat. no. 8104.0) was examined and compared with the US study.

In brief, mineral exploration and copyright and licence costs are already capitalised by the ABS in the national accounts. The ABS survey of BERD clearly covers scientific R&D and R&D in social sciences and humanities. It also covers some aspects of product development costs in the financial industry and new architectural and engineering designs. Whether this coverage is as broad as that envisaged by CHS (2005) is examined in more detail below, together with issues of double counting. Fewer issues of double counting arise in the US and UK studies — the US R&D survey covers only scientific R&D, while the UK R&D survey does not cover the financial services industry.

Business expenditure on R&D

R&D activity is generally defined as

> Creative work undertaken on a systematic basis, in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (ABS Cat. no. 8104.0, 2005-06, p. 30)

More specifically it includes

> Systematic investigation or experimentation involving innovation or technical risk. The outcome of which is new knowledge, with or without a specific practical application, or new or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental. (p. 34)

Data on scientific R&D expenditure are relatively well collected. CHS (2005) use US Census Bureau data, collected for the National Science Foundation, and includes mainly industrial R&D, covering the physical sciences, biological sciences, and engineering and computer science (but excluding geophysical, geological, artificial intelligence, and expert systems research) (CHS 2005, table 1.3).

Expenditure series

A current price series for Australian BERD for the market sector (excluding Agriculture, forestry & fishing[3]) was available from Shanks and Zheng (2006).[4] This series covered 1968-69 to 2002-03. For this paper it was updated and extended to 2005-06 using revised and updated data from the ABS *Research and Experimental Development, Businesses, Australia, 2005-06* (Cat. no. 8104.0).[5]

The Shanks and Zheng dataset is primarily based on ABS Cat. no. 8104.0 and related unpublished data but has been adjusted in several ways. These adjustments are discussed in detail in appendix A of Shanks and Zheng (2006). The main adjustment was to approximate the market sector expenditure by deducting Property & business services (excluding Scientific research).[6]

It should be noted that the ABS BERD data includes R&D in social sciences and humanities (identified as a separate category of intangible in the US study). In this paper, the intangible category of 'scientific R&D' includes 'R&D in social sciences and humanities' The ABS BERD survey uses the Frascati definition of R&D (as described above), which includes R&D in fields classed as social sciences and humanities.

- For R&D undertaken by businesses themselves, the scope of the activity includes social sciences and humanities (for example, fields such economics; commerce, management, tourism and services; journalism, librarianship and curatorial services; language and culture; and the arts). To the extent that R&D in these fields is undertaken by businesses in the market sector, that R&D is included in the market sector BERD estimates discussed above.

3 The ABS did not directly survey farms and other businesses in this industry until 2005-06. Generally R&D related to this industry is performed in government, higher education and private non-profit institutions, as well as by businesses classified to other industries (Shanks and Zheng 2006, p. A.3). Agriculture has been excluded from the 2005-06 data to maintain comparability over time.

4 An electronic dataset is available athttp://www.pc.gov.au/research/staffworkingpaper/economicmodelling [R&D stocks constructions (domestic) Ext Rel.xls: Series - adjusted BERD (less PBS)] (accessed 31 October 2007).

5 The series used is total expenditure on R&D, not just current expenditure. This means that there is some double counting of capital expenditure, as was also the case in the UK study. However, capital expenditure was only 6 per cent of total Australian BERD in 2005-06 ($641 million out of $10 081 million).

6 Some non-market sectors could not be excluded because of lack of disaggregated data. The industry 'Scientific Research' (ANZSIC 781) was not excluded because it undertakes R&D principally for other industries. The R&D of this industry was therefore redistributed to the other industries using a breakdown by socio-economic objective of the R&D, so as to obtain the market sector portion of this research. See Shanks and Zheng (2006, appendix A) for further details.

- In addition, the market sector BERD estimates include a portion of ANZSIC industry 7810 Scientific research. The scope of this industry also includes social sciences as well as agricultural, biological and physical sciences.

van Rooijen-Horsten et al. (2008, p. 12) note that it is possible that an R&D survey based on Frascati definitions of R&D would result in an underestimation of R&D in social sciences and humanities (as well as R&D in financial services). This is because ad hoc R&D is common in social sciences, humanities and financial services industries rather than systematic R&D (as would be required to meet the Frascati definition of R&D). However, in the absence of any measure of the likely understatement, in this paper (as in van Rooijen-Horsten et al. 2008) it is assumed that the BERD survey correctly measures R&D in social sciences and humanities.

While R&D in social sciences and humanities was separately identified in the US and UK studies of intangibles this has not been possible for this paper.[7] A separate consistent time series for this subset of R&D was not readily available for Australia.

It should also be noted that the ABS BERD data does include some R&D related to financial services and architectural/engineering services. It appears that the scope of these types of R&D as discussed in CHS (2005) is broader than those activities that may be covered by the BERD survey. For this reason the CHS method has been used to estimate these components of R&D (as discussed below). The ABS BERD data have therefore been adjusted, where possible, to avoid double counting of these types of R&D under Scientific research. For R&D in financial services it has been possible to construct a series for the financial services industry component of the ABS BERD estimates[8] and reduce BERD by this amount. Insufficient data are available to make any adjustment for 'new architectural and engineering designs' (the extent of any duplication is discussed below under that heading).

Investment series

Marrano and Haskel (MH 2006) exclude expenditure on R&D in the computer industry from its investment series in order to avoid double counting with software. It has not been possible to make this exclusion for this paper. However, much of software R&D would be undertaken by the Computer services industry (part of Property and business services and outside the market sector) and is already excluded from the Shank and Zheng estimates of BERD for the market sector.

[7] R&D in social sciences was also included with Scientific R&D for Finland and the Netherlands. For the Japanese study this category was not included at all due to lack of data.

[8] Data are available for expenditure on R&D by the financial services industry from 1986-87 to 2005-06. Prior to this R&D for the financial services industry was included in 'Other nec' and the growth in this series has been used to backcast the financial services industry series.

In line with CHS (2006) the whole of BERD for the market sector was considered investment. The expenditure series was deflated by the implied market sector GVA deflator (base year 2005-06) to obtain the real investment series.

Capital series

The capital stock series was constructed using the perpetual inventory method (PIM), as described in chapter 4, with an assumed 20 per cent depreciation rate. This was in line with the rate used in CHS (2005, p. 23), which is assumed to be the mid-range of rates reported in the literature. As discussed in chapter 4, instead of selecting a year when the initial stock is equal to zero, the alternative method was used in which the initial stock for the first year of the data series is estimated by dividing that year's investment by the sum of the depreciation rate and the trend growth rate over years for which investment data are available.

Mineral exploration

As noted above, mineral exploration is already capitalised into the national accounts by the ABS and these data are used in this paper. There is no overlap between R&D carried out for Mining, such as the development of new exploration techniques and associated research, which is included in Scientific R&D, and mineral exploration as currently capitalised, which is the use of existing exploration techniques.

CHS (2005, table 1.3) include mining R&D and mineral exploration, having excluded mining R&D from scientific research. The UK study includes mining R&D under scientific R&D, and therefore includes only mineral exploration in its estimate of this intangible.

Artistic originals

As noted above, artistic originals are already capitalised into the national accounts by the ABS and these data are used in this paper. The ABS defines entertainment, literary or artistic originals as:

> … originals of films, sound recordings, manuscripts, tapes, models, etc., on which drama performances, radio and television programming, musical performances, sporting events, literary and artistic output, etc., are recorded or embodied. (ABS 2000, p. 454)

The UK, Finnish and Netherlands studies also use artistic originals as defined under the System of National Accounts (SNA93). This measure appears to have similar coverage to the copyright and licence cost intangible in CHS (2005), which is

proxied by development costs in the motion picture industry plus double new product development costs for motion pictures as crude proxy for development costs in radio, TV, sound recording and book publishing industries. MH (2006, p. 6) note that while the national accounts measure may not cover as wide a definition as envisaged by CHS it probably covers the main expenditures of this type.

Other product development, design and research

Traditional definitions of R&D exclude items such as design and some non-scientific research. However, the Frascati Manual (OECD 2002) in its proposed standard practice for surveys on R&D does include R&D activities beyond the traditional scientific R&D, such as R&D in banking and insurance, other service industries and R&D in social sciences and humanities. This is the classification system used by the ABS in its survey of business R&D. Therefore the estimates of BERD will include some of these 'other product development, design and research' listed in CHS (2005). The scope of the measures used in this paper for each type of other product R&D is discussed below.

New product development costs in the financial industry

CHS (2005) use a crude proxy for spending on new product development by the financial services industry of 20 per cent of total intermediate purchases of that industry. CHS (2006, p. 18) note

> Many new products in the financial services industry involve computerized information; to avoid double-counting (particularly with the own-account portion of computer software), we deliberately were very conservative in our estimates for this component.

MH (2006, p. 7) improve on this crude proxy by deducting purchases of intermediate inputs counted elsewhere in intangibles — that is, advertising, software, consulting services and architectural and engineering activities.

The ABS BERD survey follows the Frascati Manual classification of R&D. Examples of R&D in banking provided in the Frascati Manual (OECD 2002, pp. 49–50) include:

- Mathematical research relating to financial risk analysis.
- Development of risk models for credit policy.
- Experimental development of new software for home banking.
- Development of techniques for investigating consumer behaviour for the purpose of creating new types of accounts and banking services.

- R&D related to electronic banking and insurance, Internet-related services and e-commerce applications.
- R&D related to new or significantly improved financial services (new concepts for accounts, loans, insurance and saving instruments).

Australian BERD would therefore appear to cover at least some of the types of developments envisaged by CHS (2006), although no specific examples were given in their paper. van Rooijen-Horsten et al. (2008, p. 12) note that it is possible that an R&D survey based on Frascati definitions of R&D would result in an underestimation of R&D in financial services industries. They suggest that ad hoc R&D is common in the financial services industries and is excluded from the Frascati definition of R&D since it is not undertaken on a systematic basis.

Estimates based on the CHS method were compared with the financial services industry component of the ABS BERD survey and found to be considerably smaller.[9] For comparability with the US study, the CHS method of estimating financial services R&D has been used in this paper.[10] To avoid double counting, the financial services industry component of total BERD from the ABS R&D survey has been excluded from Scientific research (as noted above).

However, it should be noted that if the ABS estimate of financial services industry R&D does cover all relevant R&D activity in this industry, the CHS-type estimate will represent a considerable overstatement of this intangible.

Expenditure series

The financial services industries of interest in the Australian context are a subset of ANZSIC Division K Finance & insurance — that is, Finance (ANZSIC 73) and a share of Services to finance and insurance (ANZSIC 75).

For this paper, a series for total intermediate purchases by the financial services industries has been constructed from ABS data from input-output (IO) and supply-use (SU) tables. The SU industry codes equivalent to ANZSIC 73 and 75 are 380 Finance and 400 Services to finance, investment and insurance. The share of Services to finance, investment and insurance is based on the output share of Finance in the combined output of Finance and Insurance.

9 In 2005-06 the ABS BERD survey (Cat. no. 8104.0) reported total expenditure on R&D by Finance & insurance of $902 million, which equates to only 16 per cent of the estimate using the CHS methodology. It is estimated that this percentage ranged from 2 to 17 per cent over the full period examined.

10 Both the US and UK surveys of R&D do not include financial services.

An unpublished ABS SU data series was obtained for 1994-95 to 2003-04. To construct a data series covering the period 1974-75 to 2005-06 it was necessary to backcast and forecast sections of the data series. To backcast the period to 1974-75 a series for total intermediate purchases of financial services industries was assembled from ABS published IO tables, in the same manner as for the SU tables. The IO tables were available annually up to 1993-94, except for 1976-77, 1977-78, 1984-85, 1985-86, 1987-88, 1988-89, 1990-91 and 1991-92. The data for the missing years was interpolated and then the year on year growth rates from this series were applied to backcast the actual SU data series.[11] The last two years of the SU series were then forecast on a linear growth path based on the actual SU data series. The resulting series was smoothed using a 3-period moving average.[12]

In line with CHS (2005), 20 per cent of intermediate purchases was counted as expenditure on financial services R&D. The Finance & insurance industry is part of the market sector so all expenditure on this intangible is relevant to a market sector estimate.

Investment series

Deductions of specific intermediate inputs (as suggested by MH 2006) have not been made. The need to combine irregular data from different sources in different classifications would have made any adjustment of this kind very imprecise. Some account of the potential for double counting is made by using the CHS (2006) 'conservative' 20 per cent of total intermediate purchases.

The investment series was deflated by the implied Finance & insurance gross value added (GVA) deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 20 per cent. This is in line with CHS (2006, p. 23) — based on the mid-range of rates for R&D in general (not specifically this type of R&D) reported in the literature.

[11] The IO intermediate usage series is in basic prices while the SU series is in purchaser prices. This backcasting method therefore assumes no major change in the rate of taxes, subsidies and margins (the difference between basic and purchaser prices).

[12] The series was smoothed to remove some volatility caused by changes in classifications. The ABS cautions against interpreting IO data as a time series.

New architectural and engineering designs

CHS (2005) estimate this intangible as half of the revenue of the architectural and engineering industries. MH (2006) use 50 per cent of architectural and engineering activities industry turnover (after deducting industry purchases of advertising, software and consulting to avoid double counting with other intangibles). They also add twice the turnover of another industry, specialty design activities, as an estimate of own account new designs. Fukao et al. (2008b) estimate this intangible using input-output table data for new architectural design and service industry survey data for engineering design.

The Frascati Manual (OECD 2002) includes engineering and architectural R&D amongst the fields covered and these are also included in the ABS BERD survey. There are few details given in CHS (2005) as to the nature of the new architectural and engineering designs that make up this intangible asset in their study. However, it appears clear that the activities the authors have in mind fall outside what would 'normally' be considered architectural and engineering R&D — an example may be new designs using existing technology and methods — since their data source for 'scientific R&D' already includes engineering R&D in its scope. It is therefore assumed there is no issue of double counting between a CHS-type measure for Australia and activities covered above under the ABS BERD survey.

It is also the case that the ABS already capitalises some portion of architectural services (allocated to dwellings capital expenditure) and consulting engineering services (allocated to non-dwelling construction capital expenditure).[13] Sufficient data to make an adjustment for double counting with the CHS-type measure were not available. However, in the case of architectural services there should not be any overlap with an estimate for the market sector since dwellings capital falls outside the market sector.

Expenditure series

A time series of revenue of architectural and engineering industries was constructed for this paper using a number of data sources. The relevant industries for new designs are ANZSIC 7821 Architectural services and ANZSIC 7823 Consulting engineering.

[13] The Dutch and Finnish studies (RBT 2008 and Jalava, Aulin-Ahmavaara and Alanen 2007) both refer to a large part of architectural and engineering design expenditure being registered as investment in the national accounts. In those studies, this investment is deducted from tangible capital and separately identified.

Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0).[14] Sales of goods and services/operating income is available for 1998-99 to 2000-01 and 2002-03 and total income (including other income such as interest income) for 2002-03 to 2004-05. Sales of goods and services is the most relevant measure so the growth rate in total income for the latter period was applied to sales in 2002-03 to estimate this series to 2004-05. The 2005-06 estimate was made assuming that growth rate for sales was the same as in 2004-05.

To estimate data for the missing years and backcast the aggregate series of architectural and engineering services to 1974-75, the growth rates for Australian production in published data for a related group of services from the product details of the ABS *Australian National Accounts: Input-Output Tables* (Cat. no. 5215.0) and unpublished SU tables were used.[15,16]

The SU data were used to backcast from 1998-99 to 1994-95 and derive an estimate for 2001-02. The most recent data in the SU tables (1994-95 to 2002-03) cover Architectural services, surveying, consulting engineering and quantity surveying (SUPC 43020).[17] Surveying (equivalent to ANZSIC 7822) is not included above but accounts for only a small proportion of the combined total of ANZSIC 7821-7823 (for example, 7 per cent in 2004-05) and should not distort the growth rate to any great extent for this purpose.

The IO Australian production data were used to backcast from 1998-99 to 1974-75. The IO tables cover selected years over the period 1974-75 to 2001-02.[18] There has been a variety of classification changes over time but a reasonably consistent series is available for the sum of Architectural services, Surveying and Consulting engineering (including Technical services nec which is not included above) for the period 1974-75 to 1986-87.[19] In 1989-90 and 1992-93 there were classification

[14] Prior to 1998-99 there were some irregular surveys of selected technical services (for example, *Technical Service, 1992-93*, ABS Cat. no. 8676.0 and *Engineering and Technical Services Industry*, *1987-88,* Cat. no. 8666.0) but data from these surveys was not comparable as a result of definitional changes.

[15] Product data included the amount of that product produced by all industries not just the main industry that produces that product. However, in this case most of these services are produced by one industry.

[16] The series was smoothed with a 3-period moving average to remove some volatility due to classification changes.

[17] There is no equivalent group in the SU tables from 2003-04 onwards because of a change in classification.

[18] Annual except for 1975-76, 1976-77, 1984-85, 1985-86, 1987-88, 1988-89, 1990-91, 1991-92, 1995-96, 1997-98, 1999-00 and 2000-01.

[19] Unable to exclude Surveying because of apparent changes in classification over time.

changes that affected the growth rate but there were no readily available data to use to adjust for these changes. The missing years in the IO series were interpolated by simple averages.

The resulting series for sales income for architectural and engineering design services was for the total economy (that is, Australian production of these services[20]). It was necessary to scale it down to the share relevant to market sector intermediate usage. Using the SU tables the market sector intermediate usage share of Australian production of SUPC 43020 Architectural, surveying, consulting engineering and quantity surveying services was calculated for 1994-95 to 2002-03.[21] This share was backcast to 1974-75 and forecast for 2003-04 to 2005-06 using growth in the market sector share of gross value added.[22]

In line with CHS (2005), 50 per cent of the derived sales series was counted as expenditure on new architectural and engineering designs.

Investment series

Deductions of specific intermediate inputs (as suggested by MH 2006) have not been made due to lack of data. Nor has any additional estimate been made of own account design.

The investment series was deflated by the implied market sector GVA deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 20 per cent, in line with CHS (2006, p. 23).

[20] Insufficient data were available to make any adjustment for any difference between exports and imports of these services. The estimates implicitly assume net exports are zero — if net exports are positive (negative) then the estimates will be overstated (understated).

[21] This share was smoothed using a 3-period moving average to remove volatility.

[22] Intermediate usage data from IO tables for a broader group of services (Scientific research, technical and computing services) that includes architectural and engineering services) were examined but the series was quite volatile — partly due to changes in classifications over time. The ABS cautions against using such data as a time series.

A.3 Expenditure on economic competencies

Economic competencies are defined by CHS (2005, p. 28) as the value of brand names and other knowledge embedded in firm-specific human and structural resources.

Brand equity

Spending on brand development is proxied by spending on advertising and market research. CHS (2005, p. 28) suggest this includes the costs of launching new products, developing customer lists and maintaining brand equity and note that

> Although advertising and market research are generally aimed at building a firm's market share at the expense of its competitors, such spending is necessary for developing new brands and maintaining the value of existing brands.

Various rationales have been put forward for capitalising advertising and marketing expenditures — they may result in a positive image of the firm in the market and help to secure future orders (De and Dutta 2007); and they may establish a reputation for quality or educate consumers about the existence of new goods (Nakamura 1999, p. 6). A reputation for reliability may persuade shoppers to try a new item for the first time.

Advertising

CHS (2005) and Marrano, Haskel and Wallis (MHW 2006) estimate this intangible using data on advertising spending as collected by advertising associations. Fukao et al. (2008b) use advertising industry output from the national accounts. In all three studies 60 per cent of the expenditure on advertising was treated as investment.[23]

Expenditure series

Advertising expenditure by media sector is available from an annual survey of the industry conducted by Commercial Economic Advisory Service of Australia (CEASA 2003, 2006, 2007). This expenditure includes only media costs, not advertising agency commission, production costs or any other costs than for time

[23] US data included all commissions as well as the art, mechanical and production expenses that are part of the advertising budget for each medium (Universal McCann 2007). UK data also included production costs (Advertising Association 2005).

and space. This is a similar type of data source to that used in the overseas studies, except for the exclusion of production costs.

Hamilton and Denniss (2000, p. 55), stated that data on Australian production costs of advertisements, such as recording, editing and graphic design, are not available. This still appears to be the case. The production activities undertaken for advertising are also undertaken for other purposes. ABS data is not sufficiently disaggregated to identify the share relevant to advertising.

As the most readily available and complete time series of advertising expenditure for the total Australian economy, the CEASA series has been used. Data were compiled for 1974-2006. An adjustment was then made for production costs.

There are some readily available data on the likely share of production costs in total advertising expenditure in the United States. Data on total advertising expenditure are available from Universal McCann (2007) (as used in CHS 2006) and advertising expenditure excluding production costs from CEASA (2003, 2006, 2007). Production costs averaged 44 per cent of total advertising expenditure between 1993 and 2006. A similar calculation for the United Kingdom for 2004, using data from MHW (2006) and CEASA (2006), puts the UK share at 52 per cent. This assumes the data sources with and without production costs are reasonably comparable, which they appear to be.

Based on these data it is assumed that Australian advertising expenditure excluding production costs is 50 per cent of total advertising expenditure. Therefore the CEASA series, which excludes production costs, has been multiplied by two. The CEASA calendar year data were also averaged to derive a financial year series.

This has been scaled down to a market sector estimate using market sector intermediate usage as a share of Australian production[24] of advertising services from the ABS SU tables for 1994-95 to 2003-04.[25] This share was backcast to 1974-75 and forecast for 2004-05 and 2005-06 using growth in the market sector share of gross value added.[26]

[24] Insufficient data were available to make any adjustment for any difference between exports and imports of these services. The estimates implicitly assumes net exports are zero — if net exports are positive (negative) then the estimates will be overstated (understated).

[25] This share was smoothed using a 3-period moving average to remove volatility.

[26] Intermediate usage data from IO tables for a broader group of services (Legal, accounting, marketing and business management services) were examined but the series was quite volatile — partly due to changes in classifications over time. The ABS cautions against using such data as a time series.

Investment series

The extent to which expenditure on advertising is building an asset rather than being consumed is a separate issue. MH (2006, p. 8) suggest this is a difficult question.

> An advertisement proclaiming the reliability of a good would seem, at least in part, to be expenditure on an asset. An advertisement proclaiming a price reduction for the next two weeks would seem to be better thought of as an intermediate spending, although if it is building a reputation for lower prices that would be an asset.

There are two issues — does the ad build an asset and how long lived is it? Some studies deducted from the expenditure series those types of ads not considered to be asset building at all. The US study only included the national ads as they were considered to be those aimed at selling specific products rather than promoting sales at specific stores (CHS 2005, p. 33). The UK study excluded classified ads (small personal ads by individuals or recruiting advertisements for vacancies to be filled in a relatively short time period) (MH 2006, p. 8). It has been possible to deduct classifieds and directories from the CEASA series for Australia.

Further adjustments were then made to account for ads that had short-lived effects. Those ads with a service life of less than one year would be an expense not an investment. CHS (2005, p. 32) note that while the literature finds that the effects of advertising are generally short-lived, more than half has a service life of at least one year. From this they assumed that 60 per cent of total advertising expenditures should be counted as investment.

In this study it will be assumed that 60 per cent of expenditure is an investment — this will provide comparability with the overseas studies.

The series was deflated by the implied market sector GVA deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 60 per cent. CHS (2006, p. 24) noted that the literature reports a wide range of findings on the longevity of advertising capital — with studies estimating service lives of between 0 and 7 years. They concluded that advertising has a service life of less than 3 years, implying a geometric rate of depreciation of 60 per cent.

Market research

CHS (2005) and MH (2006) estimate this intangible as twice the revenue of the market and consumer research industry. The use of twice industry revenue is to estimate firm's own account spending on market research.

Expenditure series

A time series of revenue of the market research industry was constructed for this paper using a number of data sources. The relevant industry is ANZSIC 7853 Market research services.

Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0). Sales of goods and services/operating income is available for 1998-99 to 2000-01 and 2002-03 and total income (including other income such as interest income) for 2002-03 to 2004-05. Sales of goods and services is the most relevant measure so the growth rate in total income for the latter period was applied to sales in 2002-03 to estimate this series to 2004-05. The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05.

Prior to 1998-99, an irregular survey, *Selected Business Services, 1992-93* (ABS Cat. no. 8677.0) was carried out. From this survey data on sales of goods and services was available.[27]

The estimates for the missing year 2001-02 was interpolated by simple averages.

To backcast the series of market research services from 1992-93 to 1974-75, the growth in published data for a related group of services from the product details of the ABS *Australian National Accounts: Input-Output Tables* (Cat. no. 5215.0) was used.[28] The IO tables cover selected years over the period.[29] There has been a variety of classification changes over time but a reasonably consistent series is

[27] An irregular survey conducted in 2001-02 (*Market Research Services*, ABS Cat. no. 8556.0) but this had a different coverage of business services and was not comparable.

[28] Product data included the amount of that product produced by all industries not just the main industry that produces that product. However, in this case most of these products (or services in this case) are produced by one industry.

[29] Annual except for 1975-76, 1976-77, 1984-85, 1985-86, 1987-88, 1988-89, 1990-91, 1991-92, 1995-96, 1997-98, 1999-00 and 2000-01.

available for the sum of market and business services to 1991-92.[30] Missing years were interpolated by simple averages.

The resulting series for sales income for market research services was for the total economy (that is, Australian production of these services[31]). It was necessary to scale it down to the share relevant to market sector intermediate usage using data on the closest available group of services. Using the SU tables the market sector intermediate usage share of Australian production of SUPC 43031 Other business services (which includes market research services among many other services) was calculated for 1994-95 to 2003-04.[32] This share was backcast to 1974-75 and forecast for 2004-05 and 2005-06 using growth in the market sector share of gross value added.[33]

In line with CHS (2005), this series was doubled to obtain total expenditure on market research including own account market research.

Investment series

The expenditure series was adjusted to account for some market research information having a service life of less than one year. In this study it will be assumed that 60 per cent of expenditure is an investment — this will provide comparability with the overseas studies. The investment series was deflated by the implied market sector GVA deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 60 per cent, in line with CHS (2006, pp. 23–4) and the same as for advertising. This is based on a service life of less than 3 years, the average of the range reported in the advertising literature (see the discussion of advertising above).

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30 The series was smoothed with a 3-period moving average to remove some volatility due to classification changes.

31 Insufficient data were available to make any adjustment for any difference between exports and imports of these services. The estimates implicitly assumes net exports are zero — if net exports are positive (negative) then the estimates will be overstated (understated).

32 This share was smoothed using a 3-period moving average to remove volatility.

33 Intermediate usage data from IO tables for a broader group of services (Legal, accounting, marketing and business management services) were examined but the series was quite volatile — partly due to changes in classifications over time. The ABS cautions against using such data as a time series.

Firm-specific human capital

CHS (2005, p. 29) suggest that spending on firm-specific human capital can be measured by the costs of workforce training and education. Spending on workforce training consists of two types of expenses:

- direct firm expenses (outlays on inhouse and external training)
- wage and salary costs of employee time spent in informal and formal training.

Expenditure series

No single data source provides a time series of employer-provided training expenditure. To construct a series, several different sources were used, together with a number of assumptions. The resulting series is therefore only indicative.

The ABS *Employer Training Expenditure, Australia* (Cat. no. 6353.0), an employer survey, measured both direct costs and wage and salary costs for the total economy (excluding agriculture) for July to September[34] 1989, 1990, 1993 and 1996. The ABS also estimated this measure for 2001-02 based on data from *Employer Training Expenditure and Practices* (Cat. no. 6362.0) and *Education and Training Experience* (Cat. no. 6278.0) (NCETS 2004).[35] Specifically the measure includes

> The sum of employers' expenditure for employees gross wages and salaries for time receiving and providing structured training, fees paid to consultants and institutions and other expenditure on structured training. (ABS Cat. no. 6353.0, 1996, p. 46)

where structured training is defined as

> all training activities which have a predetermined plan and format designed to develop employment-related skills and competencies. It consists of periods of instruction, or a combination of instruction and monitored practical work. (ABS Cat. no. 6353.0, 1996, p. 45)

[34] These were multiplied by four to arrive at financial year estimates for 1989-90, 1990-91, 1993-94 and 1996-97.

[35] It has not been possible to assess the effect of differences between these surveys on the trend in the expenditure data. However, the ABS did make some adjustments for differences in scope to the expenditure data reported in NCETS (2004) for its comparison across surveys.

No adjustment was made to account for Agriculture so the estimates will be an understatement.[36]

For 1993-94 and 1996-97 expenditure data were also available by industry enabling the construction of a market sector (excluding Agriculture) total. For 1990-91, the market sector estimate was derived by using the total economy growth in expenditure between 1990-91 and 1993-94. (This assumes a constant market sector share over this period.) For 1989-90 total expenditure was not available — data were only available for the total economy average of expenditure per training hour and training hours per employee. These data were used with the estimated training hours series for the market sector (discussed below) to derived total training expenditure for the market sector.

For 2001-02 the market sector estimate was derived by using total economy growth in expenditure between 1996-97 and 2001-02, adjusted for the fall in market sector share of total hours of training from ABS *Education and Training Experience, Australia* (Cat. no. 6278.0).

To complete the expenditure series it was necessary to use growth in a related series. No ideal series was available, but it was possible to construct an approximate series for total training hours for the market sector (excluding Agriculture). Hours of training per *market sector* employee was available for 1993-94 and 1996-97 from ABS Cat. no. 6353.0. The same measure for *all* employees was available from the same source for 1989-90, 1990-91, 1993-94 and 1996-97. The growth rate in this series was used to estimate the market sector measure for 1989-90 and 1990-91. It was also possible to derive hours of training per market sector employee from ABS Cat. no. 6278.0 for 1996-97, 2000-01 and 2004-05.[37] Because of differences in survey coverage and methodology between these two surveys[38], the growth rate from Cat. no. 6278.0 was applied to the Cat. no. 6353.0 series to estimate it for 2000-01 and 2004-05. In the absence of any other data, a time series of training hours per market sector employee from 1974-75 to 2006-07 was completed by assuming linear growth in that measure between the data points discussed above

[36] Sufficient data were not available to estimate a time series for training expenditure for Agriculture. However, Richardson (2004, p. 31) notes that Agriculture offers particularly low levels of training (around 60 per cent of the total industries average for training hours per employee in 1996).

[37] Total training hours for the market sector were available from table 26 of the 2005 issue of Cat. no. 6278.0. The market sector employee numbers to which these training hours related were estimated using the market sector share of total employees from *Labour Force, Australia* (ABS Cat. no. 6291.0) and total employees (excluding owner managers) from Cat. no. 6278.0. Training hours per market sector employee was derived from these data.

[38] ABS Cat. no. 6353.0 is an employer survey while Cat. no. 6278.0 is an employee survey that covers the four most recent training courses undertaken by an employee.

and a constant level of hours per employee from 1974-75 to 1989-90 (at the 1989-90 level) and for 2005-06 (at the 2004-05 level).[39] This was used in conjunction with a series for market sector employees[40] to derive a series for market sector total hours of training.

The actual training expenditure data points were deflated using an index of average weekly ordinary time earnings for full-time adult employees in the total economy (excluding Agriculture) from *Average Weekly Earnings* (ABS Cat. no. 6302.0).[41] This provided real expenditure for these years. This was then used to calculate a real expenditure per hour of training. An exponential trend was fitted to this data and used to estimate real cost per hour from 1974-75 to 1988-99 and from 2002-03. Linear growth in cost per hour was assumed between the actual cost data points from 1990-91 to 2001-02. Multiplying real costs per hour and total hours, a market sector total expenditure was derived for the missing years to complete the real training cost series for the market sector.

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39 These assumptions are crude, particularly for the earlier period. However, they are made for transparency in the absence of sufficient data to fit a trendline. There are breaks in series caused by the Training Guarantee, which was introduced in 1990, suspended in 1994 and abolished in 1996 (ABS Cat. no. 6353.0, 1996). The Training Guarantee required employers with an payroll above a set amount to spend a minimum amount on training equivalent to a specific proportion of their gross wages and salaries. Apart from the 1989 ABS data, there are no reliable and comparable measures of training expenditure prior to the introduction of the Training Guarantee. The Business Council of Australia (BCA) survey from the mid-1980s, often cited to suggest that training levels in Australia were lower than other countries (see, for example, Curtain, Krbavac and Stretton 1986), does not provide a measure that is comparable with the ABS data. It has also been suggested that the BCA survey, as a small survey designed to gather data about total labour oncosts, provides highly unreliable estimates of small components of this total, such as training costs (Stromback and Moy 1989).

The ABS data post-1996 are suggestive of a decrease in training hours after the removal of the Training Guarantee. However, as noted by Long (2002, p. 8), decreases in training hours do not necessarily indicate a decrease in training effort because of the possibility of increased efficiency of training delivery.

40 The employee numbers from ABS Cat. no. 6353.0 (from which the cost data are taken) do not correspond to the standard series from the Labour Force Survey (even after excluding Agriculture). For consistency with the training survey data, the growth rate in the LFS employed persons series (ABS Labour Force Timeseries 6291.0.55.003 EO5_nov84 and aug_94 and 6204.0.55.001 Labour Force Historical Timeseries, Australia, 1966 to 1984) was applied to the employee numbers from Cat. no. 6353.0 at either end of the series (pre 1990-91 and post 1996-97). The missing years in between these two years were filled using a linear trend between the actual data points (rather than growth in the employed numbers from the LFS, because of differences in trends over these short time periods).

41 This was available back to 1983-84. This was backcast using the Reserve Bank of Australia historical series for average weekly ordinary time earnings for full-time adult employees to 1980-81 and average weekly total earnings for full-time adult employee to 1974-75 (RBA 2008).

It should be noted that the 2001-02 training expenditure data suggest a large increase in real training costs per hour compared with 1996-97, while training hours per employee appear to have fallen. It has not been possible to determine the extent to which this may reflect differences in the ABS surveys from which these data are derived. However, the ABS data also show a large increase in fees paid to external trainers (NCETS 2004, table 2). This may mean that a change in pattern of training provision has affected costs per hour of training. It may also reflect a change in the composition of those participating in training (for example, those in higher paid employment representing a larger proportion of total participants) or a change in the quality of the training.

Investment series

All such expenditure is counted as investment, in line with overseas studies.

The process of constructing the expenditure series was done in real terms (using the average weekly earnings deflator), so no further deflation was required to get the real investment series.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 40 per cent. This was the rate assumed by CHS (2006, p. 24), an average of the depreciation rates of brand equity and R&D (see discussion under organisational capital).

Organisational capital

This intangible, along with firm specific human capital, is particularly difficult to estimate. However, CHS (2006, p. 18–9) note that importance of organisational capital requires its treatment as an investment for consistency with other assets. They also cite micro data evidence that firm level differences in organisational practices are strongly related to productivity.

MH (2006, p. 11) liken the measurement problem of establishing a volume of organisational capital from observed expenditure to that of establishing the volume of R&D knowledge capital from observed expenditure on R&D. An additional problem is that expenditure on organisational capital is unobserved.

CHS (2005, p. 29) suggest that investment in organisational capital is made up of two components

- purchased — such as management consultant fees
- own account — measured in terms of the value of executive time spent on improving the effectiveness of business organisations (that is, time spent on developing business models and corporate cultures).

CHS (2005, pp. 29–30) note that

> Consulting expenditure and the estimated value of executive time conceptually overlap by a small amount (the value of executive time in the management consulting industry). In addition, some portion of management time arguably overlaps with R&D, so that, for some industries, the line between industry-specific process innovation and organizational change more generally may not be easily drawn. But, whatever uncertainty the amount induces in our estimates, it is dwarfed by the use of an arbitrary fraction for the amount of executive time devoted to organizational change and development.

MH (2006, p. 12) also suggest some overlap with IT consulting and software investment. They also note that some expenditure on management consultants is to deal with short term problems (for example, closing down businesses and discharging employees).

Purchased

CHS (2005) estimate this intangible from the revenue of the management consulting industry. Only 80 per cent of this revenue is included to account for the portion devoted to short term problems.[42] Fukao et al. (2008b) were not able to find data for the consulting industry in Japan, so instead use the output of the closest relevant industry (law and accounting business services) from input-output tables.

Expenditure series

It has been noted in studies of the Australian management consulting industry that there is a paucity of available data (see, for example, Kitay and Wright 1999 and Gowen 1999). The measurement difficulties are compounded by the industry being

[42] CHS (2005, p. 34) note that little is known about the composition of purchased management expertise but they have a strong suspicion that a portion of these costs are current expenses rather than investment. They make an arbitrary deduction of 20 per cent of the spending estimate to arrive at the estimate for investment. There are some anomalies in the treatment of purchased organisational capital across the papers using the CHS method — in some cases the 20 per cent deduction is made to the own-account spending estimate instead. However, it seems clear that the original CHS methodology intended that the deduction be made to purchased component of spending rather than own account spending component (which they note was developed by explicitly considering what was investment).

defined in various ways and changes in the range of activities undertaken by management consultants over time.

For this paper, a time series of revenue of the management consulting industry was therefore constructed using the few data sources available for the business management services industry (ANZSIC 7855). This industry is broader than just management consultancy — for example, it includes public relations consultancies (which are excluded from the UK and US studies). An adjustment for this difference of scope is discussed below.

Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0). Sales of goods and services/operating income is available for 1998-99 to 2000-01 and 2002-03 and total income (including other income such as interest income) for 2002-03 to 2004-05.[43] Sales of goods and services is the most relevant measure so the growth rate in total income for the latter period was applied to sales in 2002-03 to estimate this series to 2004-05. The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05. The estimates for the missing year 2001-02 was interpolated by simple averages.

To backcast the series of business management services from 1998-99 to 1974-75, the growth in published data for a related group of services from the product details of the ABS *Australian National Accounts: Input-Output Tables* (Cat. no. 5215.0) was used.[44] The IO tables cover selected years over the period.[45] There has been a variety of classification changes over time but a reasonably consistent series is available for the sum of market and business services.[46] Missing years were interpolated by simple averages.

[43] Prior to 1998-99, an irregular survey, *Selected Business Services, 1992-93* (ABS Cat. no. 8677.0) was carried out. However, this was not used because of an apparent break in series. Gowen (1999) suggests the 1992-93 figure considerably understates revenue but provides no firm alternative estimate.

[44] Product data included the amount of that product produced by all industries not just the main industry that produces that product. However, in this case most of these products (or services in this case) are produced by one industry.

[45] Annual except for 1975-76, 1976-77, 1984-85, 1985-86, 1987-88, 1988-89, 1990-91, 1991-92, 1995-96, 1997-98, 1999-00 and 2000-01.

[46] The series was smoothed with a 3-period moving average to remove some volatility due to classification changes.

The resulting series for sales income for business management services was for the total economy (that is, Australian production of these services[47]). It was necessary to scale it down to the share relevant to market sector intermediate usage using data on the closest available group of services. Using the SU tables the market sector intermediate usage share of Australian production of SUPC 43031 Other business services (which includes business management services among many other services) was calculated for 1994-95 to 2003-04.[48] This share was backcast to 1974-75 and forecast for 2004-05 and 2005-06 using growth in the market sector share of gross value added.[49]

A final adjustment was made to account for the broader scope of ANZSIC 7855 Business management services compared with the other studies. There is very limited information about the size of the public relations segment of this industry. The ABS in an irregular survey of Business management services in 1992-93 estimated that public relations consulting services accounted for 23 per cent of total income from business management consulting services (*Selected Business Services, 1992-93*, Cat. no. 8677.0, table 14.1). In the absence of additional data, for each year of the series only 77 per cent of the total income from Business management services has been counted as management consulting. The assumption of a constant share may lead to the adjusted estimate in any given year being understated or overstated.

No adjustment has been possible for some differences in the scope of this measure compared with the studies for the United States and United Kingdom.

- ANZSIC 7855 Business management services includes environmental consultancies, which are not included in the US estimate of organisational capital.[50] This means that the Australian estimate is likely to be overstated compared with that of the United States. And this overstatement may have grown over time if environmental consultancies have increased as a share of total business management services. However, it has not been possible to make any adjustment for this overstatement.

47 Insufficient data were available to make any adjustment for any difference between exports and imports of these services. The estimates implicitly assumes net exports are zero — if net exports are positive (negative) then the estimates will be overstated (understated).

48 This share was smoothed using a 3-period moving average to remove volatility.

49 Intermediate usage data from IO tables for a broader group of services (Legal, accounting, marketing and business management services) were examined but the series was quite volatile — partly due to changes in classifications over time. The ABS cautions against using such data as a time series.

50 It is unclear if environmental consultancies are included in the UK estimates.

- MH (2006) adjust the UK estimate to exclude subcontracting of smaller consulting firms to larger consulting firms. Insufficient data are available to make any adjustment to the Australian data and this may result in an overstatement of organisational capital.

The resulting Australian series shows considerable growth in the management consulting industry (around 24 per cent a year between 1974-75 and 2005-06), particularly in the 1980s (30 per cent) and from the mid to late 1990s (around 20 per cent). There are few data sources against which to validate the estimates — however, there are some references to size and growth of the industry in particular years that suggest the estimates in this paper are plausible (putting aside issues of comparability of scope with the overseas estimates).

- It has been generally reported that growth in the management consulting industry has been high globally (see, for example, Wooldridge 1997; Gowen 1999). Kitay and Wright (1999, p. 7) estimated that the number of consulting businesses in Sydney and Melbourne (as listed in the yellow pages) grew nearly four-fold between 1978 and 1998. They also acknowledged that while estimates of the overall size of the Australian consulting market varied wildly, several studies had suggested growth of 25 per cent a year. Wright (2000, p. 99) refers to dramatic growth in the 1980s in the Australian management consulting industry as being fuelled by fundamental economic and technological changes. Kitay and Wright (2003, p. 22) note that the Australian consulting industry grew rapidly in the 1990s as was the case worldwide.
- Gowen (1999, p. 33) estimated the size of the management consulting industry to be $5-$6 billion in 1996, although she acknowledges that it is likely this may include non-consulting revenue. Allen (1990) reported the annual turnover of the Australian market and business consultancy industry as $1.3 billion in 1990. Wright (2000, pp. 100–1) cited data for the leading firms that suggests total turnover was $0.5 billion in 1985.[51] The estimates based on the backcasting method described above are broadly in line with these estimates at $5.1 billion for 1995-96, $1.5 billion for 1989-90 and $0.4 billion for 1984-85.[52]

[51] This is based on the reported turnover of leading firms of $104 million in 1985 and the assumption that the reported share of these firms in the late 1980s (20 per cent) also applied in 1985.

[52] Estimates of business management services after deducting estimated public relations consultancies (and before scaling down to market sector usage).

Investment series

In line with CHS (2005), 80 per cent of the expenditure series is used to represent investment. No adjustment was made for any overlap with own account organisational capital (for the same reasons as noted by CHS above).

The investment series was deflated by the implied market sector GVA deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 40 per cent. This is in line with CHS (2006, pp. 23) — an average of the rates used for brand equity and R&D. CHS (2006, p. 24) justify this as follows

> Investments through strategic planning and reorganization reflect business' need to constantly adapt to changing economic conditions. While such investments undoubtedly have a long-lasting "learning-by-doing" dimension (similar to that in R&D), we believe they also have a short-lived "organizational forgetting" dimension (similar to that in advertising).

Own account

CHS (2005, table 1.3) estimate the own account component of organisational capital as 20 per cent of the value of executive time using US Bureau of Labor Statistics (BLS) data on employment and wages in executive occupations. MH (2006, p. 13) use a similar approach but exclude ICT managers (to avoid double counting with capitalised software) and self-employed (who they indicate they do not believe built organisational capital in the same way as in other industries). The definition of managers appears to be relatively broad (not just, for example, CEOs), although it has not been possible to compare the specific occupational groups used.

It should be noted that percentage of executives' time spent building organisational capital is likely to have changed over time and to vary across countries — the use of a constant 20 per cent of executive time may therefore be a source of mismeasurement. For example, Fukao et al. (2008a) cite a 2006 study that estimated that Japanese CEOs spent only 9 per cent of their time on activities related to building organisational capital. But he also noted that some Japanese firms have divisions specialising in these activities, although there are no data about their expenditure. As Fukao notes, a new survey is probably needed to obtain better measures of organisational capital.

Expenditure series

The own account portion of organisational capital is estimated from average earnings of managers and the number of managers in the market sector.

The specific occupation group used was Managers & administrators (ASCO 1) excluding, where possible, both IT managers (ASCO 1224) and Farmers & farm managers (ASCO 13).[53] The exclusions of IT managers was based on the reasoning used by MH (2006) — avoiding double counting with IT capital. It was possible to exclude the self-employed (owner-managers of unincorporated enterprises[54]), as done by MH (2006), because the ABS survey used excluded this group. The additional exclusion of Farmers & farm managers has been made on the basis that this subgroup is considerably different from the other managers and would not be expected to build organisational capital in the same way.

Data on average weekly earnings and number of Managers & administrators were available from the *Employee Earnings, Benefits and Trade Union Membership* (EEBTUM) survey (ABS Cat. no. 6310.0) (a supplement to the August Labour Force Survey). Weekly earnings are defined in this survey as the amount of 'last total pay' (that is, before taxation and other deductions have been made).[55] The average earnings are calculated excluding those employees who did not draw a wage or salary, that is, people working in their own incorporated enterprises.

Unpublished data on earnings and employee numbers from Cat. no. 6310.0 were available for Managers & administrators excluding IT managers and farmers in the market sector annually for August 1997 to August 2006. These August observations were used for the financial years 1997-98 to 2006-07. The number of employees obtained includes persons who receive a wage or salary or persons who operate their own incorporated enterprises. Using this number of employees to obtain the wages bill, implicitly assumes the value for own account organisational capital

53 *Australian Standard Classification of Occupations (ASCO)*, *Second edition*, 1997 (ABS Cat. no. 1222.0) has been used or the closest available occupation from the earlier occupational classifications, ASCO 1st edition and Classification and Classified List of Occupations (CCLO). It has not been possible to compare the scope of Managers and administrators in this classification with the 'executive' occupations used in the US and UK papers.

54 Owner-managers of incorporated enterprises are included.

55 No adjustment is made for any back payment of wage increases, prepayment of leave, or bonuses, etc. No explicit reference to the treatment of salary sacrifice amounts years is made in the survey questions, and the ABS considers it probable that some respondents are already including amounts salary sacrificed in their responses, depending upon how their pay is reported. (See *Changes to ABS Measures of Employee Remuneration, 2006*, ABS Cat. no. 6313.0, p. 31 for further details).

investment for owner-managers equal to the average earnings of Managers & administrators drawing a wage or salary.

Prior to 1997 data were only available from the annual publication of Cat. no. 6310.0.[56] This provided data for the total economy for Managers & administrators numbers and average weekly earnings but insufficient data to calculate market sector estimates. The EEBTUM Employee numbers were backcast using growth in a series constructed from Labour Force Survey (LFS) data for all Managers and administrators (not just employees) in an approximated market sector (excluding Agriculture).[57]

Average weekly earnings were also backcast using growth in the closest available series to Managers and administrators (or the closest occupational classification) in the market sector (less Agriculture). From 1988 to 1996, the closest series was average weekly earnings of Managers and administrators (ASCO1) for the total economy. Prior to this, it was full-time managers for the total economy (Manager & administrators ASCO1/Administrative, executive and managerial employees CCLO). It was not possible to apply any industry or occupational concordance to these dollar averages. The implicit assumption is therefore that growth in these wages was representative of the ASCO2 Managers & administrators group of interest. The use of full-time average weekly earnings growth for the earlier period also assumes a constant share of part-time workers, that part-time workers work constant hours and that part-time wages are proportional to full-time wages according to hours worked. The share of part-time workers among Managers & administrators increased from 4 per cent in 1975 to 6 per cent in 1985[58] so is unlikely to represent a major distortion. The EEBTUM survey (Cat. no. 6310.0) commenced in 1975, so the August 1974 estimate (used for 1974-75) was derived using growth in Managers & administrators total employed from the Labour Force

56 No survey was conducted in 1996. No publication was produced in 1995 and the electronic data file is no longer available. Data for these years are interpolated on a linear trend between 1994 and 1997 data.

57 Employed Managers & administrators by industry were taken from ABS 6291.0.55.003 EO9_aug 86 back to 1986-87 and from LFS microfiche back to 1974-75 (the ASIC to ANZSIC industry concordance used in Gretton and Fisher 1997 was applied to the latter industry numbers to construct a market sector estimate). Growth in each segment of this series was spliced together as there were also two breaks in the series due to changes in occupational classification — from CCLO to ASCO1 in 1986 and to ASCO2 in 1996. The closest occupational classification to ASCO2 Managers and administrators was used in each case — CCLO Administrative, executive and managerial and ASCO1 Managers and administrators (with ASCO 1st edition having a different definitions of Managers & administrators).

58 From ABS *Labour Force Historical Timeseries, Australia, 1966 to 1984* (Cat. no. 6204.0.55.001).

Survey for the number of employees and average weekly earnings estimated assuming the growth rates between 1975 and 1976.

From these employee number series and average weekly earnings series, the total wages bill was calculated as the number of employees multiplied by average weekly earnings multiplied by 52 weeks. As noted above, this number of employees excludes owner-managers of unincorporated enterprises. This may lead to an underestimate of own-account organisational capital if this group does invest in this intangible in the same way as other Managers & administrators.

Twenty per cent of this wages bill was counted as expenditure on own account organisational capital. CHS (2005, p. 30) note that their assumption that managers spend 20 per cent of their time investing in organisational development is arbitrary. However, for the purposes of comparability and in the absence of alternative estimates of time spent, the same percentage is used in this paper.

Investment series

No further adjustments were made to the nominal expenditure to obtain nominal investment.

The series was deflated by the implied market sector gross value added deflator.

Capital series

The capital stock series was constructed using PIM, as described in chapter 4, with an assumed depreciation rate of 40 per cent. This depreciation rate was selected for the same reasons as described under purchased organisational capital above.

A.4 Comparison of data sources with other studies

As discussed in chapter 6, the various country studies do not measure intangibles for the same group of industries in each case — the market sector for Australia and the United Kingdom (but the UK market sector is much broader than that for Australia); the non-farm business sector for the United States; the non-financial business sector for Finland; and the whole economy for the Netherlands and Japan.

If the rates of investment in intangibles differ across industries, the average rate will be affected by the differences in industry coverage across countries. For example, the Australian market sector is defined more narrowly than the UK market sector, which includes additional industries such as property and business services and

private education and health. Higher than average rates of investment in intangibles in these additional industries would increase the UK market sector average compared with a more narrowly defined market sector. Differences between the rate of intangible investment in the United Kingdom and Australia could therefore be due to differences in industry coverage of the measure, rather than actual differences between the countries at the industry level. However, it has not been possible to adjust for this possible source of bias and determine if this is the case.

Table A.3 summarises details of the proxies and sources used in other studies (for the sector of the economy as listed above) and compares them with the Australian sources used.

Table A.3 **Comparison of data sources across countries**

Category of intangible	*Sources from other studies*	*Australian sources*
Computerised information		
Computer software	*US:* Own use, purchased and custom software from National Income and Product Accounts (NIPA). *UK:* Own use, purchased and custom software from Office for National Statistics (ONS) estimates. *Japan:* Data from Japan Industrial Productivity (JIP) database, compiled from IO tables and other surveys. *Finland:* National accounts computer software series for the non-financial business sector. *Netherlands:* National accounts (purchases and own account). *France:* France National Institute of Statistics and Economic Studies, (purchased from SU tables and annual business surveys on software publishers; own account from labour costs of computer specialists). *Germany, Italy and Spain:* EU KLEMS database software investment. *Canada:* National accounts (purchases and own account).	Purchased and own-account (but only includes software developed in-house if expenditure is large) from ABS national accounts.

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Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
Computer databases	*US:* own use captured in NIPA software measures. Purchased component estimated from Services Annual Survey (subscription revenue from database and directory publishing industry). *UK:* Included in software estimates. *Japan:* Sales data for information service industry. *Finland:* Included in software estimates. *Netherlands:* Included in software estimates. *France, Germany, Italy and Spain:* EU KLEMS database gross output of database activities industry. *Canada:* Purchased from Survey of Software Development and Computer Services. Own account included in software estimates.	Large expenditures on purchase, development or extension of databases from ABS national accounts. Included in computer software estimates.

Innovative property

Scientific R&D	*US:* Mainly R&D in manufacturing, software publishing and telecom industries. National Science Foundation Census. *UK:* current expenditure on R&D from BERD. R&D in computer industry subtracted (to avoid double counting with software; still leaves in possible double counting of tangible capital expenditure on R&D by using current and capital expenditure on R&D). *Japan:* Expenses on materials and labour costs on R&D activities from Survey on R&D. *Finland:* BERD (compiled according to OECD Frascati manual guidelines) adjusted for a number of factors including acquisition of R&D, imports and exports. *Netherlands:* Current expenditure on R&D based on R&D survey (compiled according to the Frascati manual) but translated to R&D use according to national account conventions. Excludes government consumption of R&D and market R&D use in the R&D- and universities industry. *France, Germany, Italy and Spain:* EUROSTAT R&D expenses for natural science and social science, excluding software. Excludes government and higher education sector. *Canada:* BERD survey for manufacturing, utilities, construction and agriculture.	Current expenditure by business on R&D from Shanks and Zheng (2006) R&D database, updated from ABS survey of BERD. R&D by financial services industry deducted.

(continued on next page)

Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
Mineral exploration	*US:* Mineral exploration in Census of Mineral Industries and National Income and Product Accounts; R&D in mining industries from Census of Mineral Industries. *UK:* National accounts. *Japan:* Estimated from Handbook of the Mining Industry and Annual Report on Natural Gas. *Finland:* National accounts. *Netherlands:* National accounts. *France, Germany, Italy and Spain:* Derived from exploration costs in the North Sea. *Canada:* BERD survey for R&D of Mining, oil and gas extraction industry and Annual survey of service industries surveying and mapping for other geophysical and geological exploration.	Mineral exploration from ABS national accounts.

Copyright and licence costs	*US:* Mainly R&D in information sector industries (except software publishing) — proxied by development costs in motion picture industry from industry association plus double new product development costs for motion pictures as crude proxy for development costs in radio, TV, sound recording and book publishing industries. *UK:* National accounts (SNA93). *Japan:* JIP database (nominal output of publishing and newspaper industry and video picture, sound info, character information production and distribution industry). *Finland:* National accounts (SNA93). *Netherlands:* National accounts. *France, Germany, Italy and Spain:* Development costs of motion pictures from Screen Digest plus double these costs to proxy for development costs in radio, TV, sound recording and book publishing. *Canada:* R&D of information and cultural industries.	Artistic originals (SNA93) from ABS national accounts.

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Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
Other product development, design and research		
New product development costs in the financial industry	*US:* 20 per cent of all intermediate purchases by Financial services industry. (US SIC 60-62, 67, includes services to finance but not insurance). *UK:* 20 per cent of all intermediate purchases by Financial services industry (intermediate purchases reduced by purchases of advertising, software, consulting and design). (UK SIC 65, 67, includes services to finance but not insurance). *Japan:* 20 per cent of all intermediate purchases by Financial industry and Insurance industry. *Finland:* Not included because intangibles measured for the non-financial business sector. *Netherlands:* Assumed to be included in Scientific R&D. *France, Germany, Italy and Spain:* 20 per cent of intermediate inputs of financial industry from OECD STAN database, adjusted to avoid double counting of inputs counted elsewhere. *Canada:* BERD survey of finance sector.	20 per cent of total intermediate usage by Finance industry (ANZSIC 380 and share of ANZSIC 400) from ABS Input-output/Supply-use tables.

New architectural and engineering designs	*US*: Half of total turnover of architecture and design industry. *UK*: Half of total turnover of architecture and design industry (turnover reduced by purchases of advertising, software and consulting). *Japan*: Output data of the design, display, and machinery design industries from the input-output tables for new architectural design and data from Survey of Selected Service Industries for investment in engineering design. *Finland*: Already included in tangible investments, so deducted and separately identified. *Netherlands*: National accounts. Intermediate input of these designs in the production of capital goods. Investments are two-thirds of this value. *France, Germany, Italy and Spain:* 50 per cent of gross output of Architectural, engineering and other technical activities industry from EU KLEMS database, excluding inputs counted elsewhere. *Canada:* BERD survey of architectural and engineering services.	Half of revenue from architectural and engineering industries (ANZSIC 7821 and 7823) from ABS industry surveys.

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Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
R&D in social science and humanities	*UK/US:* Twice industry revenues of social science and humanities R&D industry (uses twice as way of estimating own account spending). *Japan:* no suitable data available. *Finland:* Included under Scientific R&D. *Netherlands:* Included under Scientific R&D. *France, Germany, Italy and Spain:* Included under Scientific R&D. *Canada:* .BERD survey of remaining service industries not included elsewhere.	Included under Scientific R&D.

Economic competencies			
Brand equity			
	Advertising expenditure	*US:* 60 per cent of Grand total by type of advertiser as reported by Universal-McCann. *UK:* 60 per cent of total spending on advertising reported by Advertising Association, less expenditure on classified ads. *Japan:* 60 per cent of nominal output of advertising industry purchased by other industries. *Finland:* Included in marketing expenditure. *Netherlands:* Expenditure according to National accounts, on marketing and advertisement, excluding spending by advertising agencies. Further exclusions, based on industry and type of advertisement, to arrive at estimates of capital spending. *France, Germany, Italy and Spain:* 60 per cent of gross output of advertising industry (excluding classified ads) from EU KLEMS database. *Canada:* 60 per cent of revenue from Annual Survey of Advertising and Related Services.	60 per cent of total advertising expenditure, excluding classifieds and directories, from CEASA industry survey association. Doubled to estimate allow for production costs.

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Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
Market research	*US:* Twice revenues of the market and consumer research industry as reported in Services Annual Survey. *UK:* Twice revenues of the market and consumer research industry as reported in Annual Business Inquiry. (Twice as estimate of own account spending). *Japan:* not separately measured. *Finland:* Purchased marketing expenditures from business register data for 1999-2005. *Netherlands:* Purchased market research based on national accounts data series concerning total production and purchases of economic advice as well as more detailed microdata. *France, Germany, Italy and Spain:* Twice turnover of Market research and public opinion polling industry from Structural Business Statistics of EUROSTAT. *Canada:* Twice revenue of market research industry from Datamonitor survey (excluding public sector).	Twice revenue of ANZSIC 7853 Market research services from ABS industry surveys.

Firm-specific human capital	*US:* BLS surveys of employer-provided training in 1994 and 1995. Includes direct firm expenses (inhouse trainers, outside trainers, tuition reimbursement and outside training funds); and wage and salary costs of employee time in formal and informal training. *UK:* National Employer Skills Survey 2005, similar survey of employer-provided training adjusted to consider private sector expenditure and all UK. *Japan:* As for US, using data on vocational education costs per worker from the General Survey of Working Conditions and opportunity cost data from Survey of Personnel Restructuring and Vocational Education/Training Investment in the Age of Performance-based Wage Systems. *Finland:* Direct firm expenses and wage and salary costs from Continuing Vocational Training Survey for 1999. *Netherlands:* Direct firm expenses and wage and salary costs from Continuing Vocational Training Survey for most industries; other survey data and annual reports for missing industries. *France, Germany, Italy and Spain:* Continuing Vocational Training Survey and Labour Cost Survey from EUROSTAT and labour compensations from EU KLEMS database. *Canada:* Direct training expenses per employee from Conference Board of Canada and employment data from Labour Force Survey of Statistics Canada. Doubled to proxy wage and salary costs of employee time.	Cost of employer-provided training and wage and salary costs of employee time undertaking training from ABS training surveys.

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Table A.3 **(continued)**

Category of intangible	*Sources from other studies*	*Australian sources*
Organisational capital		
Purchased	*US:* 80 per cent of estimate using Services Annual Survey data on the revenues of the management consulting industry. *UK:* 80 per cent of revenue of management consulting industry from Management Consulting Association (Private sector expenditure only). *Japan:* Nominal output of law firms and accounting offices from input-output tables. *Finland:* Nominal gross output in business and management consultancy activities. *Netherlands:* Based on National accounts data series concerning total production and purchases of economic advice as well as more detailed microdata. *France, Germany, Italy and Spain:* Revenue of the management consulting industry survey by the European Federation of Management Consultancies Associations (excluding public sector spending). *Canada:* 80 per cent of revenue of Management, scientific and technical consulting services.	80 per cent of revenue of 77 per cent of ANZSIC 7855 business management services from ABS Industry survey.

Own account	*US:* 20 per cent of value of executive time using BLS data on employment and wages in executive occupations. *UK:* 20 per cent of value of executive time using Annual Survey Hours and Earnings data on employment and wages in executive occupations, excluding software occupations. *Japan:* 20 per cent of salaries and bonuses for executives from the Survey of Financial Statements of Business Enterprises. *Finland:* 20 per cent of value of management personnel time from Structure of Earnings statistics. *Netherlands:* 20 per cent of value of executive time using labour force data on wages in managerial occupations (based on German data on the difference between average earnings in management occupations and all occupations). *France, Germany, Italy and Spain:* 80 per cent of 20 per cent of compensation of Legislators, senior officials and managers derived from the EU KLEMS database and Structure of Earnings Survey by EUROSTAT. *Canada:* 20 per cent of wages bill of senior management occupations from the census of population.	20 per cent of value of Managers & administrators (less IT and farm managers) time using data on employment and wages from ABS labour force survey.

Sources: Corrado, Hulten and Sichel (2005); Marrano and Haskel (2006); Fukao et al. (2008b); Jalava, Aulin-Ahmavaara and Alanen (2007); van Rooijen-Horsten et al. (2008); Belhocine (2008); Hao, Manole and van Ark (2008); author's estimates.

B Specification of model

Corrado, Hulten and Sichel (CHS 2006, pp. 4–9) outline the implications of capitalising intangibles expenditures compared with their current treatment as intermediate goods. This appendix outlines the production functions and accounting identities associated with the two approaches as specified by CHS (2006).

B.1 Intangibles treated as intermediate inputs

Suppose there are three goods produced, a consumption good C, a tangible investment good I, and an intangible good N. When the intangible is considered to be an intermediate good, it is an input to the other two goods (C and I), and labour L and tangible capital K are inputs to all three goods.

The production function and flow account for each of the three sectors is then

Intangible sector $N_t = F_N(L_{N_t}, K_{N_t}, t)$ $P_{N_t}N_t \equiv P_{L_t}L_{N_t} + P_{K_t}K_{N_t}$ (B.1)

Tangible sector $I_t = F_I(L_{I_t}, K_{I_t}, N_{I_t}, t)$ $P_{I_t}I_t \equiv P_{L_t}L_{I_t} + P_{K_t}K_{I_t} + P_{N_t}N_{I_t}$ (B.2)

Consumption sector $C_t = F_C(L_{C_t}, K_{C_t}, N_{C_t}, t)$ $P_{C_t}C_t \equiv P_{L_t}L_{C_t} + P_{K_t}K_{C_t} + P_{N_t}N_{C_t}$ (B.3)

where $L \equiv L_N + L_I + L_C$, $K \equiv K_N + K_I + K_C$, $N \equiv N_I + N_C$, and tangible capital accumulates according to $K_t \equiv I_t + (1\text{-}\delta_k)K_{t\text{-}1}$ with depreciation rate δ_k. The production functions are linked to the accounting identities by the assumption that each input is paid the value of its marginal product. In this case, N_t is both an output and an intermediate input to the production of the other products. N_t therefore nets out of the aggregate and does not appear separately in the GDP identity[1]

$$P_{Q'_t}Q'_t \equiv P_{C_t}C_t + P_{I_t}I_t \equiv P_{L_t}L_t + P_{K_t}K_t \quad \text{(B.4)}$$

[1] CHS (2006) adopts the convention that intermediates used by the industry that produced them are netted out of final output. They also omit chain weighting from the equations for simplicity of exposition.

The conventional sources of growth (SOG) framework allocates the output growth to the share-weighted input growth and a residual, multifactor productivity (MFP) growth.[2] The SOG equation is derived by logarithmic differentiation of (B.4):

$$\dot{Q}'_t = s'_{C_t}\dot{C}_t + s'_{I_t}\dot{I}_t \qquad (B.5)$$

$$= s'_{L_t}\dot{L}_t + s'_{K_t}\dot{K}_t + \dot{MFP}'_t$$

where $\dot{x}_t$ denotes the rate of growth of variable x_t.

Rearranging (B.5) MFP growth[3] is therefore

$$\dot{MFP}'_t = \dot{Q}'_t - s'_{L_t}\dot{L}_t - s'_{K_t}\dot{K}'_t$$

The expenditure shares $s'_{C_t} \equiv [P_{C_t}C_t]/[P_{C_t}C_t + P_{I_t}I_t]$ and $s'_{I_t} \equiv [P_{I_t}I_t]/[P_{C_t}C_t + P_{I_t}I_t]$

and income shares $s'_{L_t} \equiv [P_{L_t}L_t]/[P_{L_t}L_t + P_{K_t}K_t]$ and $s'_{K_t} \equiv [P_{K_t}K_t]/[P_{L_t}L_t + P_{K_t}K_t]$

are assumed to be equal to the corresponding output elasticities. Intangible input and output do not appear in this SOG equation.

B.2 Intangibles treated as capital

If the intangible is treated as capital, a different model applies. The output of the intangible, N_t, enters in the production functions of the consumption and tangible investment sectors as a cumulative stock rather than as an intermediate input. The intangible capital stock accumulates according to the perpetual inventory method $R_t \equiv N_t + (1-\delta_R)R_{t-1}$, in the same way as tangible capital. The equations for each of the sectors become

Intangible sector $N_t = F_N(L_{N_t}, K_{N_t}, R_{N_t}, t)$ $\quad P_{N_t}N_t \equiv P_{L_t}L_{N_t} + P_{K_t}K_{N_t} + P_{R_t}R_{N_t}$ (B.6)

Tangible sector $I_t = F_I(L_{I_t}, K_{I_t}, R_{I_t}, t)$ $\quad P_{I_t}I_t \equiv P_{L_t}L_{I_t} + P_{K_t}K_{I_t} + P_{R_t}R_{I_t}$ (B.7)

Consumption sector $C_t = F_C(L_{C_t}, K_{C_t}, R_{C_t}, t)$ $\quad P_{C_t}C_t \equiv P_{L_t}L_{C_t} + P_{K_t}K_{C_t} + P_{R_t}R_{C_t}$ (B.8)

2 This follows Solow (1957).

3 As is common practice, the continuous time variables are approximated with their discrete time counterparts. And a combined input index is computed as a Tornqvist index (a discrete approximation of a continuous Divisia index).

The balance equations are modified with $R \equiv R_I + R_C + R_N$ replacing $N \equiv N_I + N_C$.[4] The production functions are linked to the accounting identities by the assumption of marginal productivity pricing, as in the above case. The GDP identity is expanded to include the flow of new intangibles on the expenditure side and the flow of services from the intangible stock on the income side:

$$P_{Q_t} Q_t \equiv P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t \equiv P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t \quad \text{(B.9)}$$

The price P_{R_t} is the rental price associated with the services of the intangible stock and is a source of income that is not included in the conventional intermediate goods case (B.4).[5]

When intangible capital is treated in the same way as tangibles, the SOG equation becomes

$$\dot{Q}_t = s_{C_t} \dot{C}_t + s_{I_t} \dot{I}_t + s_{N_t} \dot{N}_t \quad \text{(B.10)}$$

$$= s_{L_t} \dot{L}_t + s_{K_t} \dot{K}_t + s_{R_t} \dot{R}_t + \dot{MFP}_t$$

4 In this second case, CHS (2006) expand the technology of the intangible producing sector to use its own stock of accumulated intangibles.

5 The rental price of tangible capital (P_{K_t}) will also change when intangibles are capitalised because of the change in the equalising rate of return (see appendix C). However, the same notation 'P_{K_t}' is maintained in both cases for simplicity.

In practice, total capital income is derived as the difference between total income and labour income, which is

$P_{K_t} K_t \equiv P_{Q'_t} Q'_t - P_{L_t} L_t$ when intangibles are expensed

$P_{K_t} K_t + P_{R_t} R_t \equiv P_{Q_t} Q_t - P_{L_t} L_t$ when intangibles are capitalised.

Since capitalising intangibles increases total income ($P_{Q_t} Q_t > P_{Q'_t} Q'_t$) and labour income is unchanged, total capital income increases. However, after the capitalisation of intangibles the rental price of *tangible* capital changes (as a result of the changed capital income, and the inclusion of intangible assets in the derivation of a new equalising rate of return). (P_{K_t} is derived from total capital income rather than measured directly, so when intangibles are expensed some capital income that is attributed to tangible capital is actually a return on intangibles that have not been counted as part of the capital stock.) Total capital income is split between tangibles and intangibles as follows

$[P_{K_t} K_t]/[P_{K_t} K_t + P_{R_t} R_t]$ for tangibles

$[P_{R_t} R_t]/[P_{K_t} K_t + P_{R_t} R_t]$ for intangibles.

where the expenditure shares are now

$$s_{C_t} \equiv [P_{C_t} C_t]/[P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t], \qquad s_{I_t} \equiv [P_{I_t} I_t]/[P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t] \qquad \text{and}$$
$$s_{N_t} \equiv [P_{N_t} N_t]/[P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t]$$

and the income shares are now

$$s_{L_t} \equiv [P_{L_t} L_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t], \qquad s_{K_t} \equiv [P_{K_t} K_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t] \qquad \text{and}$$
$$s_{R_t} \equiv [P_{R_t} R_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t].$$

Rearranging (B.10) MFP growth[6] is therefore

$$\dot{MFP}_t = \dot{Q}_t - s_{L_t} \dot{L}_t - s_{K_t} \dot{K}_t - s_{R_t} \dot{R}_t$$

Comparing (B.5) and (B.10), not only the growth terms $\dot{N}_t$ and $\dot{R}_t$ change, but also all the income and expenditure shares.

6 This can also be expressed in labour productivity (LP) terms by rearranging (B.10)

$$\dot{Q} = s_L \dot{L} + (1 - s_L)(\dot{TK}) + \dot{MFP} \qquad \text{where } TK \equiv K + R \text{ and } s_L + s_K + s_R = 1$$
$$(\dot{Q} - \dot{L}) = s_L \dot{L} + (1 - s_L)(\dot{TK}) + \dot{MFP} - \dot{L}$$
$$= (1 - s_L)(\dot{TK}) - (1 - s_L)\dot{L} + \dot{MFP}$$
$$(\dot{Q} / L) = (1 - s_L)(\dot{TK} / L) + \dot{MFP}$$
$$\dot{LP} = \dot{KD} + \dot{MFP}$$

The labour composition effect can be separately identified (not shown above for simplicity). This results in the expression $\dot{LP} = (\dot{Q} / H) = \dot{KD} + \dot{MFP}^* + s_L \dot{L}_{SC}$, where labour (L) is separated into two components, L_{sc} the skill composition component and H the labour quantity (hours), and MFP^* is MFP adjusted for skill composition change.

C Growth accounting

This appendix describes the methodology used in this paper to construct new growth accounting results for the market sector. These have been calculated using the three different definitions of capital detailed in chapter 5. The first definition includes all intangible and tangible assets. The second definition contains the same capital assets as the Australian Bureau of Statistics (ABS) national accounts, while the third definition of capital excludes all intangible assets.

Section C.1 details the methodology for constructing new capital services indexes for the market sector including intangible assets. This includes detailing how the new rental prices were calculated and how a rate of return for all assets including the new intangible assets was calculated. Section C.2 details changes to other terms in the production function. This includes output, labour inputs and the factor income shares.

Unpublished ABS data have been used for all of the tangible assets as well as for the intangible assets already capitalised in the national accounts (computer software, artistic originals and mineral exploration).[1] The capital services indexes including the new intangible assets (those not already capitalised in the national accounts) have been constructed using the intangible capital stock series estimated as described in chapter 4.

C.1 Construction of capital services indexes

To measure the impact of intangible investment on multifactor productivity (MFP) growth, new estimates of capital services growth need to be constructed for the market sector. Capital services reflect the amount of 'service' each asset provides during a set period. For each asset, the services provided are directly proportional to the asset's productive capital value. Aggregate capital services indexes are created using the volume index of the productive capital stock of each asset weighted using rental prices.

[1] All published and unpublished national accounts data used in the growth accounting in this paper are from the dataset underlying ABS *Australian System of National Accounts, 2006-07* (Cat. no. 5204.0).

The *productive capital stock* of an asset is the real stock of capital, adjusted for efficiency losses related to age (according to the relevant age-efficiency profile). The productive capital stock of each asset type is weighted and summed to form an aggregate capital services measure. For the purposes of this paper, the real economic capital stock (net capital stock) and the productive capital stock for new intangible assets are assumed to be equal.[2] The use of the net rather than productive capital stock means that the capital stock for intangible assets is understated.

The weights used in the summation of productive capital stocks are based on the *rental prices* for each asset type. Rental prices can be thought of as estimates of the rates each asset type would attract if leased under a commercial agreement. The use of rental prices as weights assumes that the rental price reflects the marginal product of an asset, hence more productive assets have a higher rental price and therefore a higher weight in the aggregate capital services measure. The compilation of rental prices is discussed below.

Aggregate estimates of capital services for the market sector are formed by combining estimates of the productive capital stock and rental price for each asset type into a Tornqvist[3] index of aggregate capital services. For some asset types[4], capital is also split by industry and institutional sector — this is not shown for simplicity. The flow of aggregate capital services $\dot{K}$ equals the product of the change in the capital stock of each asset K_j, weighted by the rental price weight of each asset w_j.

$$\dot{K} = \prod_j \left[\frac{K_j}{K_{j(t-1)}} \right]^{w_j} - 1 \qquad \text{(C.1)}$$

The rental price weight for each asset is based on its share of total market sector capital rent. Capital rent is the rental price r_{jt} multiplied by the real productive capital stock K_j.

2 The productive value and the economic value of an asset are slightly different. The productive capital stock represents an age-efficiency function while the net capital stock represents an age-price function. Because an asset's value depreciates faster than its productive capacity, the net capital stock is invariably smaller than the productive capital stock (ABS 2000).

3 A Tornqvist index is the weighted geometric mean of the component growth rates.

4 For the tangible assets and the national account intangibles, assets are split by type, industry and institutional sector (corporate, unincorporated). Splitting the new intangibles by industry and institutional sector has not been possible due to data limitations.

$$w_j = 0.5 * \left(\frac{r_j . K_j}{\sum_j r_j . K_{ij}} + \frac{r_{jt-1} . K_{jt-1}}{\sum_j r_{jt-1} . K_{jt-1}} \right) \quad \text{(C.2)}$$

This methodology differs from the ABS methodology because all assets in all industries are aggregated in a single stage. The ABS constructs capital services indexes for each of the twelve market sector industries separately, then weights these indexes together using the gross operating surplus (GOS) of each industry as a weight (see ABS 2000, chapter 27 for further details). It has not been possible to estimate the intangible assets for each industry due to data limitations, so the single stage aggregation had to be used. Because of this difference in methodology, the capital services indexes used in this paper differ from published ABS estimates.

The new methodology has been used to construct new capital services indexes for each of the three capital definitions described above — the existing national accounts assets, tangible assets only and tangibles plus all intangible assets. Constructing all the indexes using the new methodology allows a direct comparison of the change in the growth rate of capital services due to the treatment of intangibles as capital. The implications of changing the capital services methodology are discussed in detail below.

Rental prices

The rental price of an asset is equivalent to the user cost of capital.[5] It is the implicit price for employing or obtaining the productive value of a unit of capital for one period. Because the majority of capital is owned by its user rather than rented in the market, the rental price for the asset is an estimate of what the market rental price of the asset would be. The rental price includes most of the measurable costs incurred in the use of that asset. It covers the expected return on the asset, represented by the internal rate of return; the loss in market value of the good due to ageing; the capital gains or losses due to asset price inflation/deflation; a non-income tax parameter and adjustments for tax concessions made to correct for distortions in rental prices due to differential tax treatment across capital items.

[5] The rental price formula used in this paper is based on that used in the ABS's standard methodology for measuring capital services (see ABS 2000, chapter 27). This approach to the measurement of rental prices may differ from that used elsewhere. For a discussion of alternative rental price methodologies used in capital services measures see OECD (2001, chapter 9).

The rental price is derived using the following formula

$$r_j = T_j(i.p_j + d_j.p_j - p_j + p_{j(t-1)}) + p_j.x \qquad \text{(C.3)}$$

where for asset type j, the rental price r is a function of the income tax rate T; the internal rate of return i; the price deflator p; the depreciation rate d; and the non-income tax parameter x (which is assumed to be the same for all j).[6]

For existing tangible assets and the intangible assets currently capitalised in the national accounts, most of the above data have been provided by the ABS. However, capitalising the new intangible assets will change two of the parameters for the tangible assets and existing intangibles — the internal rate of return and the non-income tax parameter. The methodology used for calculating the rate of return is discussed below.

Because there is very little existing data about the new intangible assets, assumptions need to be made about the parameters to be used for them in the rental price calculations. Assumptions have been made for the depreciation rate, the income tax parameter, the deflator and the effective average non-income tax rate on production.

In this paper, the depreciation rates used for the new intangible assets are those used in Corrado, Hulten and Sichel (CHS 2006) and for the national accounts intangibles the ABS rates are used (table C.1). These depreciation rates are relatively high, which reflects the assumption that intangible investment has a relatively short productive life.

6 There is some debate as to whether or not all of the functions in the rental price equation should be included for intangible assets due to the nature of those assets. Sensitivity tests, detailed in appendix D, have been performed on several parts of the rental price equation for the new intangibles.

Table C.1 **Rental price components for intangible assets**
Average 1975-2006

	Depreciation rate[a]	*Income tax parameter*[b]
Computerised information	0.2	1.51
Business R&D	0.2	0.85
Mineral exploration	0.1	1.52
Artistic originals	0.6	0.62
Financial product development	0.2	1.67
New architectural and engineering designs	0.2	1.67
Advertising	0.6	1.67
Market research	0.6	1.67
Firm specific human capital	0.4	1.67
Purchased organisational capital	0.4	1.67
Own account organisational capital	0.4	1.67

[a] Depreciation rates are constant for the new intangibles and vary over time for the intangibles already capitalised in the national accounts (software, mineral exploration, and artistic originals). [b] A more detailed discussion of the assumptions behind this parameter is in appendix D.

Sources: CHS (2006); authors' estimates; ABS unpublished national accounts data.

The income tax parameter is calculated by using the corporate profit tax rate adjusted for depreciation allowances and other additional allowances (table C.1). For most of the new intangible assets it has been assumed that the income tax parameter is derived only from the corporate tax rate because there are currently no additional tax allowances for most intangibles. However, for business expenditure on research and development, an allowance has been included for the R&D tax incentive scheme (Australian Government 2008a, 2008b). Adjusting the tax rate to reflect the R&D tax concession lowers the effective income tax rate on R&D investment. (See appendix D for a discussion of the suitability of the tax parameter for intangibles.)

The deflator used for most intangible assets is the implicit price deflator (IPD) for market sector gross value added. For financial product development investment, the Finance & insurance gross value added IPD has been used. For firm specific human capital a wage price deflator has been used. These are the same deflators used in compiling the real capital stocks from the nominal investment series in chapter 3.

The effective average non-income tax rate on production is derived by the ABS by dividing the total non-income taxes allocated to capital for the market sector by the total net capital stock. The non-income tax parameter is therefore the same for every asset. The total taxes will not change after the inclusion of intangible assets but the total net capital stock will increase, hence the new non-income tax rate will be lower. Non-income taxes include land tax, local government authority rates, stamp

duties and other miscellaneous taxes (ABS 2000, chapter 27). Given the ABS method for allocating non-income taxes, the non-income tax rate changes for all assets when intangible capital is included — therefore rental prices for all tangible and existing intangible assets will also change.

All new intangible capital is allocated to the corporate sector because the required data are not available to split the intangibles between sectors. The corporate sector is much larger than the unincorporated sector and is likely to represent the bulk of investment in intangibles (if not all, in cases such as financial product development). However, it should be noted that the assumption that all intangible investment is contained within the corporate sector will overstate the impact of intangibles in the capital services index because rental prices for the unincorporated sector are derived as a function of corporate rental prices and are invariably lower.

Rental prices for the unincorporated sector are derived by the ABS as a function of the corporate rental price weighted by the ratio of unincorporated capital income to proprietors' labour income. This methodology is maintained in this paper as there will be no change in proprietors' labour income and no change in the unincorporated capital because all intangibles were allocated to the corporate sector.

Occasionally, rental prices calculated using equation (C.3) can be negative. If this occurs the approach used by the ABS is to set these rental prices to a very small positive number, usually 0.001. This is to prevent negative rental prices from causing complications in the later growth rate calculations. This approach is also followed in this paper. When calculating rental prices, only a limited number of asset types, such as agricultural land, regularly display negatives. Of the intangible assets, either national accounts or new, only software has a negative rental price in any year.

Internal rate of return

The rate of return represents the expected return on a unit of an asset after adjusting for all other price factors, taxes and depreciation. Normally the ABS calculates the rate of return for all assets in each particular industry, but for this paper a new rate of return had to be calculated for the entire market sector.[7] The rate of return for the market sector has been recalculated for each of the three definitions of capital, as the treatment of intangibles as capital will change the rate of return for all assets.

[7] The Jorgenson-Griliches methodology for estimating the rate of return as a common rate across all assets (both tangibles and intangibles) has been used. This assumes that businesses arbitrage their investments across all types of capital, investing in each type until the rate of return for all assets is equal (CHS 2006). This assumes there is no risk differential.

The rate of return for an asset can be either calculated or assumed. An endogenous rate of return can be calculated by assuming that capital income, or adjusted gross operating surplus, is equal to capital rent. Alternatively, an exogenous rate of return can be used, usually based on an external variable such as the consumer price index (CPI). The ABS currently uses a hybrid system, using an endogenous rate of return for each industry, but with an exogenous floor rate of return of the CPI growth plus 4 per cent as a lower limit (ABS 2000). This paper uses the same lower limit when deriving a rate of return for all market sector assets.

As mentioned above, under an endogenous model capital rent is assumed to equal capital income. If an endogenous model was used for the rates of return, with no lower limit as used by the ABS, then the sum of the rental prices for each asset multiplied by the productive capital stocks for each asset class would equal capital income.[8]

$$Q = \sum_j r_j . K_j \tag{C.4}$$

summed across assets j

Using this assumption, calculating the endogenous rates of return[9] is simply a case of reorganising the rental price equation to include capital income and the productive capital stock.

$$i = \frac{Q - \sum_j K_j (T_j (d_j . p_j - p_j + p_{j(t-1)}) + p_j . x)}{\sum_j K_j . T_j . p_j} \tag{C.5}$$

where Q is capital income (including non-income taxes attributed to capital) and K is the real productive capital stock.[10]

8 Provided all the endogenous rental prices are positive, as a negative rental price forced to zero would also affect the total capital income.

9 This rate of return takes account of taxes and capital gains/losses due to asset price inflation that may not be included in rates of return calculated for other purposes.

10 ABS (2007, p. 107) notes that there is a question as to whether the productive capital stock or the net capital stock should be used to estimate the endogenous rate of return. Currently the ABS uses the real productive capital stock but has noted that it will consider changing its approach in the future.

Figure C.1 **Internal rate of return for the market sector[a], all intangibles treated as capital**

a Using the ABS hybrid methodology, which is an endogenous rate with a floor of the CPI growth plus 4 per cent. Because the endogenous internal rate of return (IRR) rarely rose above this floor rate for the market sector in practice, the IRR is exogenous in most years.

Data sources: Authors' estimates; ABS unpublished national accounts data.

This paper follows the ABS method of using the hybrid rate of return (figure C.1). However, in practice this means that the paper uses mainly uses an exogenous rate of return as the endogenous rate only exceeds the exogenous rate in a few years (2004-05 and 2005-06 when all intangibles are treated as capital). The growth accounting results were sensitivity tested using a purely endogenous rate of return (as used in CHS 2006) and the results are presented in appendix D, section D.1. The rate of capital deepening, and hence the rate of MFP growth, is considerably changed by the use of the endogenous rate of return. However, the use of the endogenous rate of return creates problems with negative rental prices and is inconsistent with existing ABS productivity estimates for Australia.

Methodological issues

The differences in methodology between this paper and the ABS national accounts leads to different results for the market sector capital services index. As noted above, the difference is caused by the use of a single stage aggregation process to construct a market sector capital services index, rather than using industry capital services indexes aggregated using GOS weights.

There are several reasons for the difference in results between the two methods. The first difference is the effect of the new internal rate of return used in this paper. The

rate of return used in the estimates in this paper is calculated as a single rate for the market sector. This rate of return is generally equal to the minimum rate of return under the ABS methodology. Because the ABS calculates a separate rate of return for each industry, some of these rates of return exceed the minimum rate in some years. Therefore the average rate of return across all industries under the ABS methodology will be higher than the rate of return used in this paper, which is nearly always equal to the minimum ABS rate. If the gap between the ABS average rate of return and the minimum rate of return is increasing, then a capital services index calculated using rental prices based on the minimum rate of return will grow more slowly than that using the ABS average rate. An analysis of the results shows this to be the case, mainly due to strong growth in the internal rates of return calculated for assets in Construction and Finance & insurance.

The second difference between the methodologies concerns the rental price weight of each asset in the aggregate market sector capital services index. The ABS compiles indexes of capital services for each industry and then weights these together using GOS weights. However, because the intangible assets cannot be split between industries, in this paper the market sector capital services index is compiled in a single stage. Under the ABS methodology the rental price weight of an asset in the final market sector capital service index is equal to its weight in its relevant industry capital services index multiplied by that industry's GOS weight. Under the new methodology an asset's weight in the market sector capital services index is equal to its rental price weight in total industry capital income. The change of weighting will change the growth rate of market sector capital services.

The change in the rate of return will also affect the relative weight of each asset in the aggregate capital services index. Using a single rate of return across all industries will mean that some assets have their rental price weight affected by the change in the rate of return.

C.2 Growth accounting components

This section details the methodology and data sources used for the other (non-capital) parameters in the growth accounting framework.

Output

For the all intangibles case, output is equal to existing market sector gross value added (GVA) plus investment in the new intangible assets. For each of the new intangible assets expenditure series were constructed (as described in chapter 3) and these expenditure series were then used to calculate an investment series for

intangible assets. A new chain volume measure of value added for the market sector was calculated by adding this investment series to current price GVA for the existing market sector. This was then deflated using a market sector IPD and individual price deflators for each intangible asset.

Output for the market sector including only the existing national accounts intangible assets is equal to market sector GVA supplied by the ABS.

Output excluding all intangible assets was constructed by deducting current price investment in the existing intangible assets from existing market sector GVA.[11] The result was then deflated using a market sector IPD.[12]

Income shares

The inclusion of intangibles investment increases the level of capital income, which in turn increases the capital share of total income with an equivalent fall in the labour income share. The impact on the income shares is outlined in more detail in appendix B, section B.2.

Total factor income as currently measured in the national accounts was provided by the ABS.

- Capital income in the ABS national accounts is gross operating surplus (GOS) plus the capital share of Gross Mixed Income (GMI) and taxes.
- Labour income is Compensation of Employees (COE) plus the labour share of GMI and taxes.
- Labour and capital income estimates were supplied with GMI and taxes already split between capital and labour income.

11 Current price gross fixed capital formation (GFCF) for the existing national accounts intangible assets (computer software, artistic originals and mineral exploration) was used as the investment estimate for the national accounts intangibles.

12 When market sector output was reinflated after the exclusion of current price investment in the existing intangible assets, the market sector IPD was used to reinflate the output estimates. No adjustment was made to the IPD to reflect the removal of those intangible assets. Sufficient data were not available to construct an IPD for the reduced scope of output. However, testing was performed to approximately measure the impact of removing these assets on the price deflator using an adjustment based on the corporate sector asset price deflators only, without also including the unincorporated sector asset deflators. The outcome of this testing showed that adjusting for the removal of the existing intangible assets from the market sector price deflator had little effect on the market sector IPD and therefore little effect on total market sector output. It was therefore decided that using the original market sector IPD would be sufficient for calculating real output for the market sector minus the national accounts intangible assets.

Because this paper assumes all intangible assets are in the corporate sector, no change to the split of GMI (income of the unincorporated sector) was required when treating intangibles as capital.

Capital income for the three capital definitions are as follows.

- For the case including all intangible assets, capital income is equal to national accounts capital income (adjusted GOS) plus all investment in new intangibles.
- For the existing national accounts definition of capital, capital income is GOS adjusted for GMI and taxes (as outlined above).
- For the case excluding all intangible assets, capital income is equal to national accounts capital income minus GFCF in the national accounts intangible assets.

As detailed in chapter 5 and appendix B, investment in intangibles will increase total factor income and capital income while labour income is unchanged. Therefore treating intangibles as capital will decrease the labour income share while increasing the capital income share. For the case excluding all intangible assets, the reverse is true.

Labour inputs

The labour inputs index used in the growth accounting is the growth in hours worked for the market sector from the ABS national accounts. In chapters 5 and 6, a labour composition component has been included in the growth accounting results. This is calculated using a quality adjusted labour inputs index (QALI) supplied by the ABS for the period 1982-83 to 2005-06. This index is used to construct MFP estimates that are adjusted to take account of general improvements in the experience, education and training of the workforce. The ABS constructs this quality-adjusted index of hours worked by disaggregating total hours worked on the basis of educational attainment and potential workforce experience and weighting these hours by wages (see ABS 2001 and ABS 2005 for details).[13]

The contribution of QALI to MFP is included in tables 5.3, 6.3 and 6.4 from 1984-85. The contribution of QALI to MFP growth will stay constant with the treatment of intangibles as capital — therefore as the total rate of MFP growth falls with the treatment of intangibles as capital, the contribution of QALI to labour productivity growth will also fall.

[13] See chapter 3 for a discussion of the potential overlap between QALI and the firm-specific training intangible.

D Sensitivity testing

This appendix details the sensitivity testing undertaken on the growth accounting results from chapter 5. The appendix is split into three sections. The first section tests the results using a different methodology for calculating the internal rate of return for the capital stock. The second section tests different values for other parameters in the rental price equation. The third section tests the growth accounting results with different investment estimates for the new intangible assets.

D.1 Internal rate of return

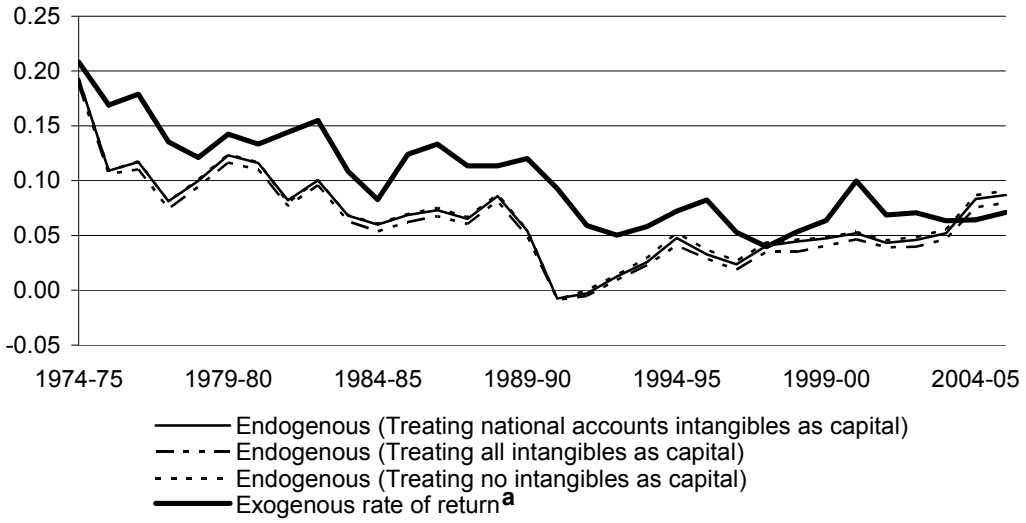
This paper applies the hybrid Australian Bureau of Statistics (ABS) methodology for calculating the internal rate of return on capital (see appendix C). The methodology uses an endogenous rate of return unless the rate falls below an exogenous rate equal to consumer price index (CPI) growth plus 4 per cent. If the rate falls below this floor level, the exogenous rate is used. In practice the rate of return, which is constrained to be the same across all assets, fell below this mark in most years when calculated for the aggregate market sector. Therefore, the rate of return used in this paper is mainly exogenous. Because this differs from the Corrado, Hulten and Sichel (CHS 2006) methodology, which used an endogenous rate of return, the Australian results have been re-estimated with an endogenous rate of return[1] for the purposes of international comparison. This section compares the Australian growth accounting results with an endogenous rate of return with those using the ABS hybrid method (as reported in chapters 5 and 6).

There is a considerable difference between the exogenous rate of return and the endogenous rates calculated for the three definitions of capital (figure D.1). In particular, the endogenous rate of return is negative for 1990-91 and 1991-92. The figure also shows there is only a small difference between the average endogenous rates of return for the three definitions of capital. Because the stock of intangibles is small relative to tangibles (and intangible investment is a small share of total capital

[1] It should be noted that the internal rates of return used in this paper relate to the specific context of calculating rental prices and take into account factors (such as taxes and asset revaluations) that may not be included in rates of return calculated for other purposes (see appendix C).

income), the capitalising of intangibles has only a small effect on the equalising internal rate of return across all assets.[2]

Figure D.1 **Comparison of endogenous and exogenous rates of return**



a Exogenous rate of return (CPI growth plus 4 per cent), used as the floor rate of return in the ABS hybrid methodology (which is an endogenous rate unless it falls below an exogenous floor rate of return).

Data sources: Authors' estimates; ABS unpublished national accounts data.

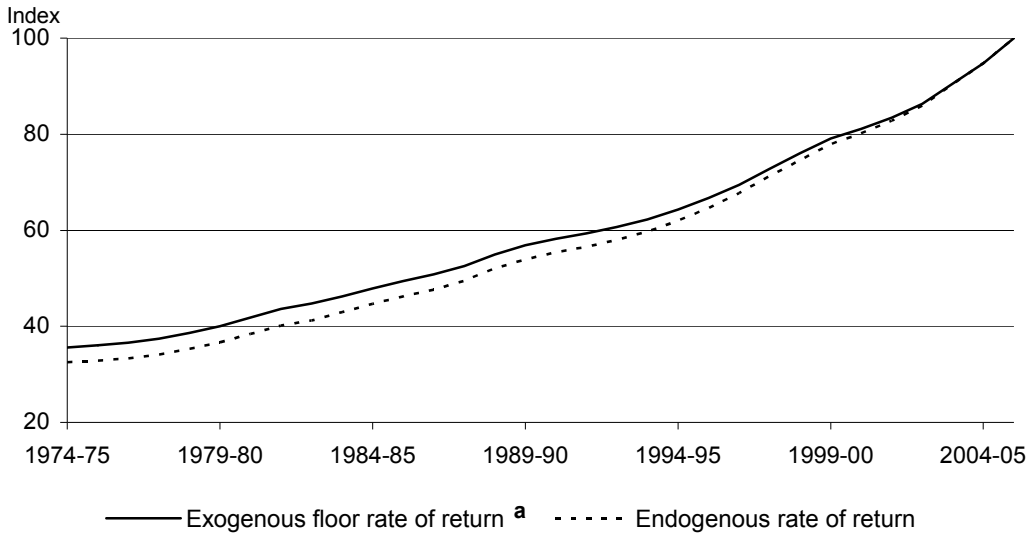
A change in the rate of return will alter the rental prices of all assets. And because the rental prices are used as weights to aggregate together the growth rates in the individual capital stocks to create an aggregate capital services index, a change in the rental prices can also affect the growth rate of the capital services index.

Figure D.2 shows a comparison of capital services indexes using an endogenous rate of return and an endogenous rate of return subject to an exogenous floor rate of return. Using the endogenous rate of return increases the growth in the capital services by an average of around 0.3 of a percentage point a year over the series for the all intangibles case.

2 In CHS (2006, table 4) capitalising intangibles also changes the equalising rate of return for all assets by only a small amount, slightly changing income accruing to tangible capital.

Figure D.2 **Capital services, alternative internal rates of return, all intangibles treated as capital**

Index 2005-06 = 100



a The ABS hybrid methodology has been used, which is an endogenous rate with an exogenous floor of the CPI growth plus 4 per cent. However, because in practice the endogenous IRR rarely rises above the floor rate for the market sector, the IRR is generally exogenous.

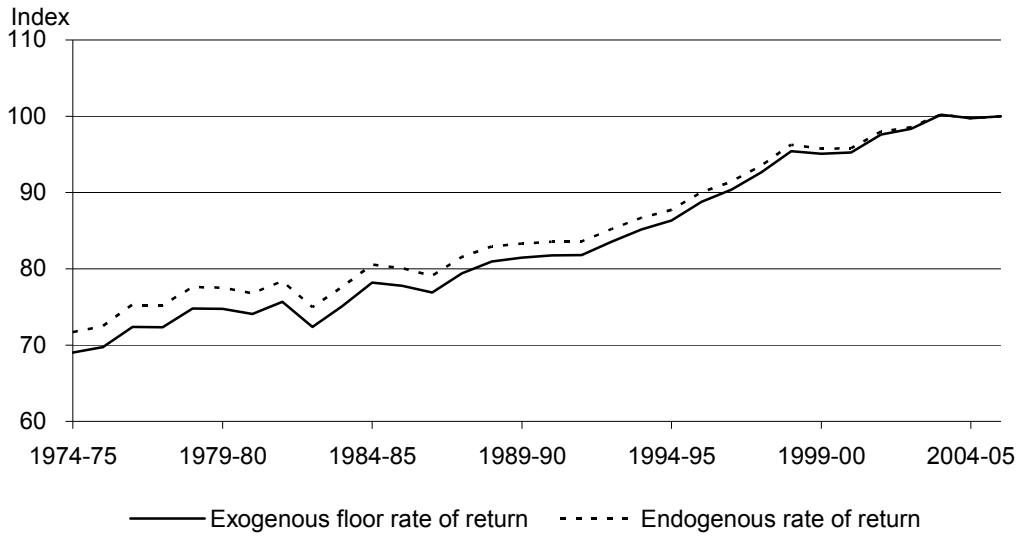
Data sources: Authors' estimates; ABS unpublished national accounts data.

The main reason a change in the rental price weights increases the growth in capital services is that the use of the endogenous rate lowers the rental price for all assets by an equivalent amount.[3] Therefore, the weight of assets with lower initial rental prices, such as land and non-dwelling construction, will decline by a relatively larger amount than those assets with higher initial rental prices, such as ICT equipment. The capital stock of assets with lower rental prices have tended to grow at a slower rate than those with relatively high rental prices — so the shift in weighting in the aggregate capital services index towards these faster growing assets increases growth in aggregate capital services.

[3] The change to an endogenous rate of return increased the number of rental prices that had to be adjusted because they fell below zero. Any rental price that drops below zero is adjusted to a very small positive number (0.001) to prevent the negative number distorting the weighting of the remaining assets. No adjustment has been made to the negative rates of return prior to the adjustment for negative rental prices. See appendix C for more information.

Figure D.3 **MFP[a] using alternate rates of return, all intangibles treated as capital**

Index 2005-06 = 100



a Includes labour composition change for comparability across periods.

Data sources: Published and unpublished ABS national accounts data; authors' estimates.

Using the endogenous rate of return considerably increased the growth rate of the capital services index (figure D.2), which had a corresponding downward effect on the multifactor productivity (MFP) growth estimates. For the case including all intangibles as capital, the change in the MFP index over the entire period was 10 per cent lower using the endogenous rate of return approach (figure D.3). The use of the endogenous rate did not change the productivity growth cycles.

Under all three capital definitions the rate of MFP growth fell considerably using the endogenous rate of return (table D.1) and capital deepening increased by an equivalent amount. The largest impact on MFP growth was with the all intangibles case. This was due to the larger relative weight of capital in total factor income, leading to the change in the rate of capital services growth having a larger impact on MFP growth.

Table D.1 **Comparison of MFP growth rates[a] using alternative rates of return**

Per cent per year

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
Including all intangibles assets				
Exogenous floor	1.20	1.25	1.00	1.35
Endogenous	1.08	1.16	0.86	1.20
Including national accounts intangible assets				
Exogenous floor	1.26	1.30	1.02	1.45
Endogenous	1.17	1.25	0.92	1.34
Excluding all intangible assets				
Exogenous floor	1.36	1.31	1.13	1.63
Endogenous	1.31	1.26	1.09	1.55

a Includes labour composition change for comparability across periods.

Sources: Published and unpublished ABS national accounts data; authors' estimates.

As mentioned in chapter 5, the reason for testing the results using a purely endogenous rate of return is for comparability with the other country studies. Table D.2 shows that the Australian results using an endogenous rate of return are considerably closer to the US results than those using an exogenous floor rate of return. The effect of treating all intangibles as capital (compared with no intangibles) is also closer between the two countries when using an endogenous rate, both in absolute value terms and percentages changes.

However, it should be noted that the Australian results using an endogenous rate of return may still not be directly comparable with the US results. It is not known whether CHS (2006) found any negative rates of return or made any adjustment for them — the negative rates of return in the Australian results have not been adjusted.[4]

4 The US Bureau of Labor Statistics methodology (as reported in Dean and Harper 2001, p. 68) is to assume a 3.5 per cent rate of return where the endogenous rate of return is negative and deduct nothing for asset revaluation in the rental price calculation. However, this is done at the industry level and mainly affects property industries. It is not known if CHS (2006) followed this methodology at the aggregate economy level.

Table D.2 **International comparisons using endogenous rate of return**

Per cent per year (Percentage share of total growth)

	Australia (exog.)[a]	*Australia (endog.)*[b]	*USA (endog.)*
	1994-95 –2002-03	*1994-95 –2002-03*	*1994-95 –2002-03*
All intangible assets			
LP growth	3.01	3.01	3.09
	(100)	(100)	(100)
Decomposition:			
Capital deepening	1.36	1.54	1.68
	(45)	(51)	(54)
Tangible	0.81	0.90	0.85
	(25)	(29)	(28)
Intangible	0.57	0.67	0.84
	(19)	(22)	(27)
Labour composition	0.24	0.24	0.33
	(8)	(8)	(11)
MFP growth[c]	1.41	1.23	1.08
	(47)	(41)	(35)
No intangible assets			
LP growth	2.90	2.90	2.78
	(100)	(100)	(100)
Decomposition:			
Capital deepening	0.92	1.02	0.98
	(32)	(35)	(35)
Labour composition	0.27	0.27	0.38
	(9)	(9)	(14)
MFP growth[c]	1.71	1.61	1.42
	(59)	(56)	(51)

[a] Using an exogenous floor rate of return (as in chapters 5 and 6). [b] Using an endogenous rate of return. [c] MFP growth adjusted for labour composition change.

Sources: CHS (2006); authors' estimates.

D.2 Growth accounting parameters

This set of tests relates to other parameters used in the calculation of the rental prices. There is a question as to whether some of the standard components included in the calculation of the rental prices are applicable to intangible assets, in particular the income tax parameter and the capital gain/loss term.

Income tax rates for intangible assets

As part of the rental price equation, a parameter for income taxes is included to reflect the impact of these on the user cost of capital. For most tangible assets and

intangible assets already capitalised in the national accounts, the corporate profit tax rate is used by the ABS with adjustments made for depreciation allowances and other factors (ABS 2000, paras 27.61 – 27.71). For this paper, income tax rates for the new intangible assets were assumed to be equal to the corporate income tax rate. The exception to this was business R&D, where a tax adjustment was made to compensate for the R&D tax incentive scheme.[5] Because investment in intangibles is currently treated as intermediate expenditure rather than being capitalised, including a tax adjustment for intangibles might not be ideal.[6] Therefore it is useful to test the results using an unity tax parameter to see what impact this could potentially have on the results.

Adjusting the income tax parameter to a neutral rate of one (no net taxes)[7] for the new intangible assets marginally decreases the growth rate of the aggregate capital services index (table D.3). This has the effect of slightly reducing the impact of capitalising intangibles on MFP growth. However, there is little difference in the aggregate MFP and capital deepening results due to the small size of intangibles in total capital services growth.

Capital gain/loss term

There is a question as to whether a capital gain/loss term should be included for some intangible assets. The purpose of this function is to adjust the value of an asset to reflect holding gains. Because many intangibles are not tradeable, it could be argued that holding gains are irrelevant and therefore should not be included when estimating the rental prices.

A sensitivity test was performed by removing the capital gain/loss term from the rental price equation for the new intangible assets. The effect of removing the capital gain/loss function was a slight increase in the growth rate of capital services. As with the sensitivity test of income tax rates, the impact of this adjustment was too small to appreciably change the final growth accounting results (table D.3).

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5 Including an adjustment for the R&D tax incentive scheme lowered the average tax rate on business R&D. For more information see appendix C.

6 Under current accounting rules, corporate investment in intangibles would come from pre-tax income, not post-tax income. The tax treatment of intangible investment is important because different tax treatments can potentially change the incentive to invest in intangibles.

7 The tax parameter for business R&D is therefore assumed to be less than one (a tax credit) due to the R&D tax concession.

Table D.3 **Comparison of parameter sensitivity testing results, all intangibles treated as capital**

Per cent per year

	1974-75 –2005-06	*1974-75 –1984-85*	*1984-85 –1994-95*	*1994-95 –2005-06*
Capital services growth				
Original[a]	3.38	3.00	3.00	4.10
Neutral income taxes for new intangibles[b]	3.31	2.92	2.93	4.03
No capital gain/loss term for new intangibles[c]	3.40	3.01	3.02	4.09
Combined inputs growth				
Original[a]	1.84	1.07	2.09	2.31
Neutral income taxes for new intangibles[b]	1.81	1.04	2.06	2.28
No capital gain/loss term for new intangibles[c]	1.84	1.07	2.10	2.31
MFP growth[d]				
Original[a]	1.20	1.25	1.00	1.35
Neutral income taxes for new intangibles[b]	1.23	1.28	1.03	1.38
No capital gain/loss term for new intangibles[c]	1.20	1.24	0.99	1.35
Capital deepening				
Original[a]	1.08	1.12	0.63	1.43
Neutral income taxes for new intangibles[b]	1.05	1.09	0.61	1.40
No capital gain/loss term for new intangibles[c]	1.08	1.13	0.64	1.43

[a] These series are the main results as contained in chapter 5. [b] The neutral tax rate series uses all the same assumptions as the original results but with the income tax parameter for all of the new intangibles (except business R&D) set to one (no net taxes). [c] These series use all of the same assumptions as the original results but with the capital gain/loss term removed from the rental price equation for each of the new intangible assets. [d] Includes labour composition change for comparability across periods.

Source: Authors' estimates.

D.3 Investment and capital stock size

As detailed in chapter 5, the estimates for investment in the new intangible assets used in this paper are experimental. Therefore, the results have been tested for their sensitivity to changes in the investment and capital stock estimates for the new intangibles.

The alternative investment and capital stock estimates are based on three sets of changes:

- changing the level of investment in all new intangibles by plus and minus 50 per cent[8]

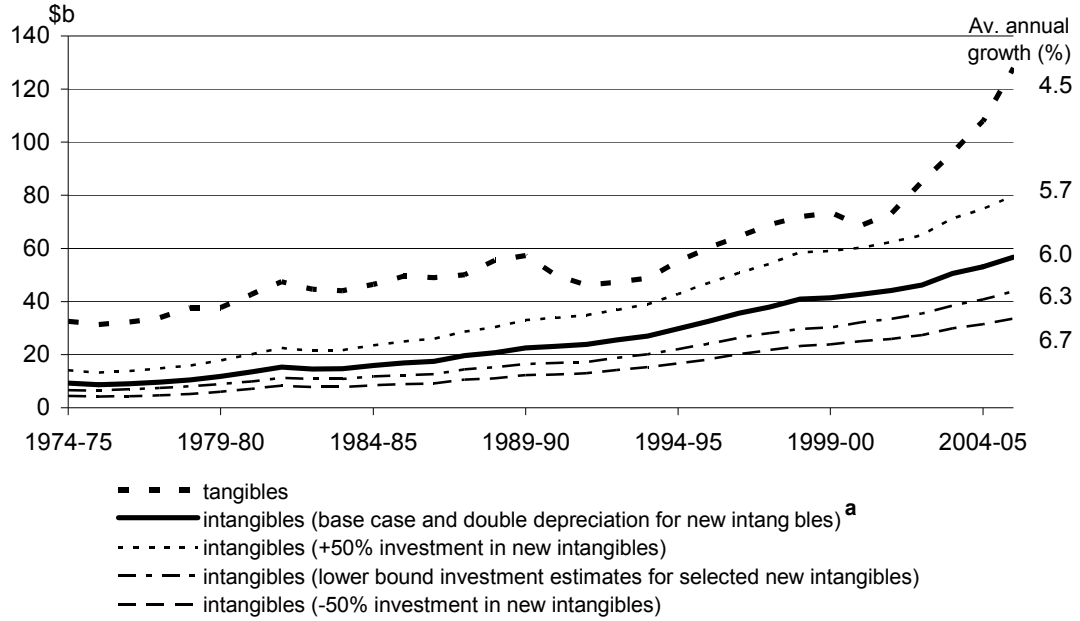
[8] This alternative can be thought of in two ways: testing underestimation or overestimation of intangible expenditure and therefore investment or, in the case of reducing investment by 50 per cent, halving the proportion of expenditure on intangibles that is assumed to be investment (as listed in table 3.1).

- reducing the investment estimates for specific new intangibles (financial R&D, architectural/engineering designs and purchased organisational capital) based on alternative data sources and assumptions[9] to create 'lower bound estimates' for new intangibles
- doubling the depreciation rate for all new intangibles (which changes the capital stock but not the level of investment).

The effect of these alternative investment estimates for new intangibles on *total intangible* investment is shown in figure D.4. For each alternative set of estimates, the ratio of total intangible to tangible investment rises — average growth in total intangible investment is higher than growth in tangible investment over the full period examined. Lowering the estimates for *new intangible* investment raises the growth rate in *total intangible* investment because of the relatively high growth rate of investment in national accounts intangibles (the other component of total intangibles).

Figure D.4 **Real investment, alternative estimates for new intangibles, market sector, 1974-75 to 2005-06**

2005-06 dollars, chain volume measures



a The investment level is obviously unaffected by the depreciation rate, which affects the capital stock.

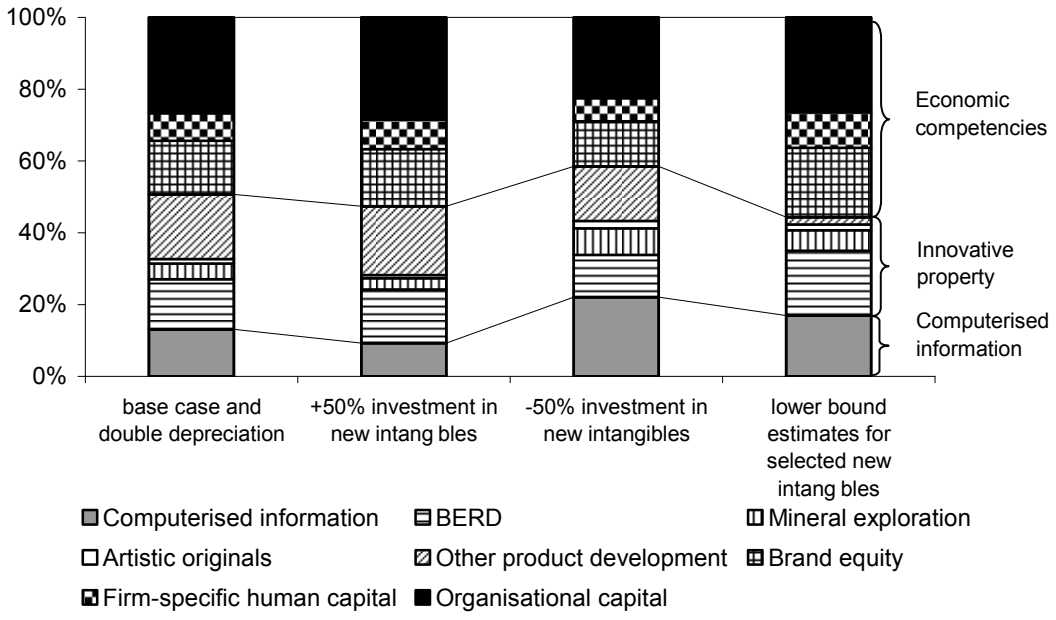
Data sources: Based on ABS national accounts data and authors' estimates.

9 The specific adjustments are detailed below in the sub-section 'Lower bound testing for selected new intangibles'.

Alternative estimates for investment in the new intangibles will obviously affect the ratio of total investment (including all intangibles) to output (shown in figure 3.2). However, for each of these alternative estimates the downward trend in the ratio of national accounts investment to output is moderated to some extent by the inclusion of investment in new intangibles.

The alternative estimates for new intangibles investment also change the composition of investment in *total intangibles* (figure D.5). Increasing the new intangibles investment by 50 per cent shifts the share of investment away from the national accounts intangibles, particularly computerised information, towards the new intangibles. The opposite is the case for decreasing the new intangibles investment by 50 per cent. The uniform percentage change in investment across all new intangibles means the relative contributions within total new intangibles are unchanged. The use of the 'lower bound estimates', which reduces other product development by the most, shifts the share of investment away from innovative property towards economic competencies and computerised information.

Figure D.5 **Shares of nominal total intangible investment, by asset type, alternative estimates for new intangibles, 2005-06**
Per cent



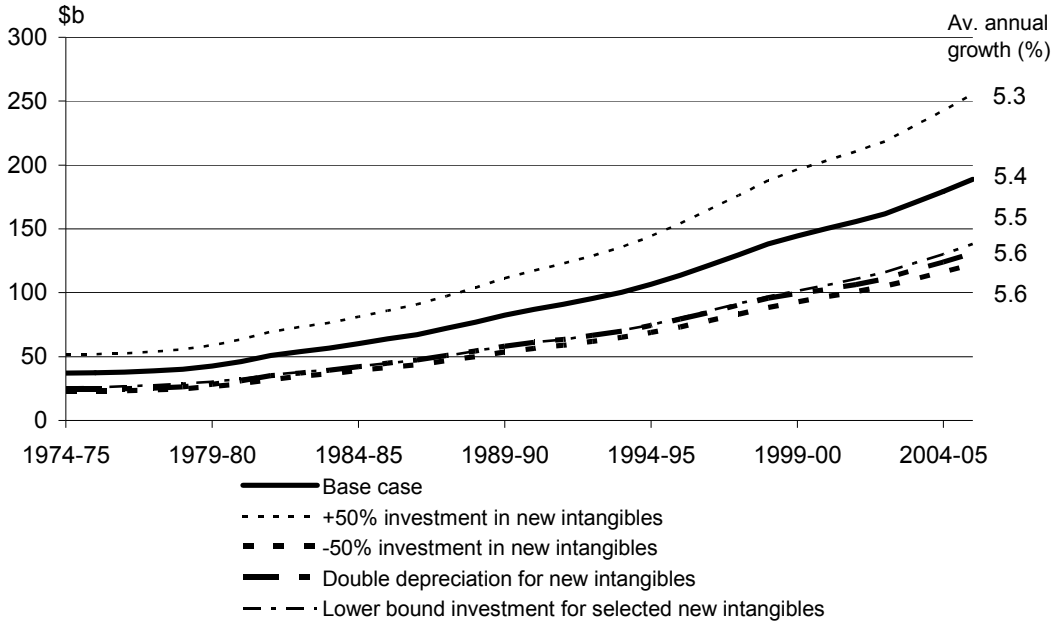
Data source: Authors' estimates.

Figure D.6 shows the effect on the *total intangible* capital stock of the alternative investment estimates and depreciation rates for new intangibles. Double depreciation has a similar effect on the capital stock to the 50 per cent decrease in

investment. There is little change in average growth rate in the capital stock over the full period in each case. This is because in most cases there is a uniform percentage change over time (in either investment or depreciation rate). The 'lower bound' set of estimates is the exception (where data for two of the new intangibles are replaced with alternative data rather than adjusted by a given percentage), although in practice the actual change is also fairly uniform. Growth in capital services varies slightly more because of differences in rental prices across intangible (table D.4).

Figure D.6 **Total intangibles capital stock, alternative estimates for new intangibles, market sector, 1974-75 to 2005-06**

2005-06 dollars, chain volume measure

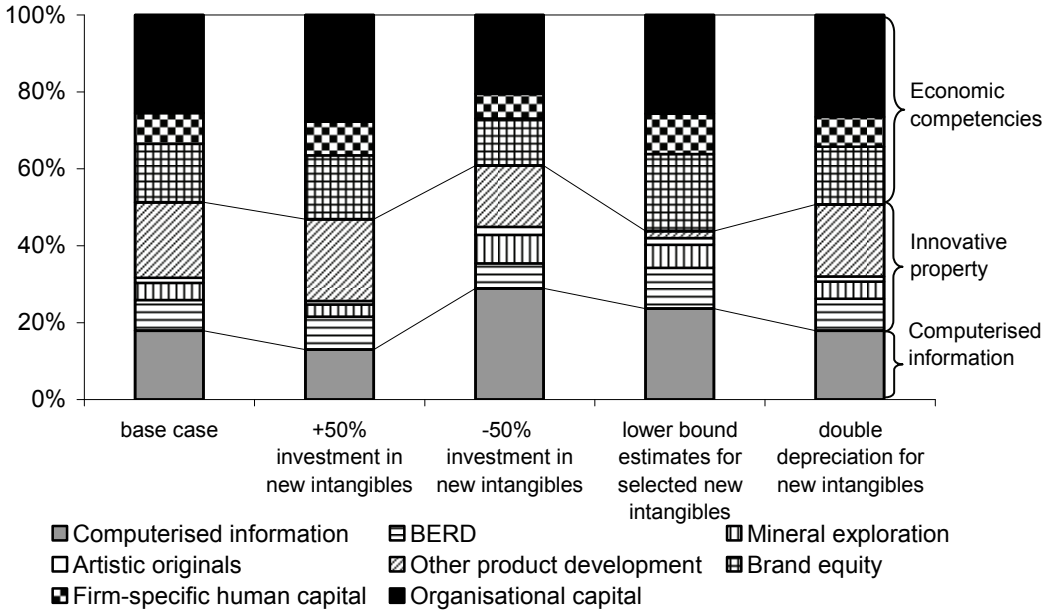


Data source: Authors' estimates.

Figure D.7 shows the difference in the composition of the service flow from intangible capital with the alternative estimates for the new intangibles. As with the changes for investment composition, the increase in investment in new intangibles shifts the composition towards the new intangibles and away from the national accounts intangibles. The opposite is the case for the decrease in investment. The lower bound estimates shift the service flow composition away from innovative property in particular. Doubling the depreciation rate for the new intangibles has very little effect on the composition of capital services because the lower capital stock is partially offset by increases in the rental prices.

Figure D.7 **Composition of total intangible capital services, alternative estimates for new intangibles, 2005-06**

Per cent



Data source: Authors' estimates.

The results of all these sensitivity tests on the components of the growth accounting are summarised in table D.4. The main results of the growth accounting are robust to these sensitivity tests. The direction of the effect of capitalising all intangibles, compared with capitalising only national accounts intangibles, is unchanged in each case — measured LP growth is increased, measured capital deepening is increased and measured MFP growth is decreased. As expected, the magnitude of these changes is affected by the estimated size of the investment and capital stock for the new intangibles. This is mainly because changes in the level of investment/capital stock for the new intangibles relative to the level of other outputs/inputs affects the weighting together of growth rates in the new intangibles and the other outputs/inputs.[10] However, within the bounds for which the estimates are varied, the magnitude of the changes in the rate of capital deepening and MFP growth is not large in percentage point terms (although a sizeable share of the small percentage point differences between the base case results for capitalising only national accounts intangibles and for capitalising all intangibles). The following sections discuss the growth accounting results for each sensitivity test in more detail.

[10] In most cases, the alternative investment/stock estimates for each new intangibles had little effect on the growth rate for that intangible because the alternative estimates were based on uniform percentage changes over time.

Table D.4 **Comparison of investment and capital size sensitivity testing results, all intangibles treated as capital**

Per cent per year

	1974-75 –2005-06	*1974-75 –1984-85*	*1984-85 –1994-95*	*1994-95 –2005-06*
Total intangible capital services growth				
Original – nat. a/cs intangibles treated as capital[a]	9.25	8.89	10.29	8.62
Original – all intangibles treated as capital[a]	5.83	5.08	6.35	6.03
50 per cent increase in new intangibles[b]	5.53	4.83	5.94	5.79
50 per cent decrease in new intangibles[c]	6.49	5.69	7.22	6.55
Lower bound for selected new intangibles[d]	5.97	5.19	6.37	6.32
Double depreciation for all new intangibles[e]	5.85	5.21	6.42	5.93
Total capital services growth				
Original – nat. a/cs intangibles treated as capital[a]	3.15	2.83	2.72	3.83
Original – all intangibles treated as capital[a]	3.38	3.00	3.00	4.10
50 per cent increase in new intangibles[b]	3.47	3.07	3.10	4.19
50 per cent decrease in new intangibles[c]	3.28	2.92	2.88	3.98
Lower bound for selected new intangibles[d]	3.30	2.93	2.88	4.02
Double depreciation for all new intangibles[e]	3.39	3.02	3.01	4.07
Combined inputs growth				
Original – nat. a/cs intangibles treated as capital[a]	1.67	0.93	1.94	2.09
Original – all intangibles treated as capital[a]	1.84	1.07	2.09	2.31
50 per cent increase in new intangibles[b]	1.91	1.13	2.16	2.41
50 per cent decrease in new intangibles[c]	1.76	1.00	2.02	2.21
Lower bound for selected new intangibles[d]	1.78	1.03	2.03	2.25
Double depreciation for all new intangibles[e]	1.84	1.08	2.10	2.30
MFP growth				
Original – nat. a/cs intangibles treated as capital[a]	1.26	1.30	1.02	1.45
Original – all intangibles treated as capital[a]	1.20	1.25	1.00	1.35
50 per cent increase in new intangibles[b]	1.18	1.23	0.99	1.30
50 per cent decrease in new intangibles[c]	1.23	1.28	1.00	1.39
Lower bound for selected new intangibles[d]	1.24	1.28	1.02	1.39
Double depreciation for all new intangibles[e]	1.20	1.24	0.99	1.36
Capital deepening				
Original – nat. a/cs intangibles treated as capital[a]	0.91	0.99	0.48	1.20
Original – all intangibles treated as capital[a]	1.08	1.12	0.63	1.43
50 per cent increase in new intangibles[b]	1.15	1.19	0.70	1.52
50 per cent decrease in new intangibles[c]	1.00	1.06	0.57	1.32
Lower bound for selected new intangibles[d]	1.02	1.08	0.58	1.36
Double depreciation for all new intangibles[e]	1.08	1.13	0.64	1.42

[a] These series are the main results as presented in chapter 5. [b] Increased investment in new intangibles by 50 per cent. [c] Decreased investment in new intangibles by 50 per cent. [d] These series have been adjusted with lower capital stock and investment estimates for some of the new intangible assets.[e] Doubled all depreciation rates for all new intangible assets except brand equity. The depreciation rate for brand equity (advertising and market research) has been increased to 0.9.

Source: Authors' estimates.

Lower bound testing for selected new intangibles

The specific variations for the lower bound estimates are:

- for financial product development, the CHS-based estimate of 20 per cent of intermediate usage of the Finance industry is replaced by financial services R&D from the ABS survey of business expenditure on R&D
- for architectural and engineering designs, it is assumed that all relevant expenditure is already capitalised as part of the associated tangible assets so no additional investment is included
- for purchased organisational capital, the proportion of the business management services industry that is included is reduced from 77 per cent (which was to exclude public relations) to 50 per cent (which aims to also exclude some other services that may not be within the scope of the CHS variable). Investment is still assumed to be 80 per cent of this reduced expenditure.

These changes all reduce the size of total new intangibles investment — the degree to which investment is reduced varies by type of intangible and over time.

- Total nominal investment in new intangibles is reduced by around a quarter (25 per cent in 1974-75 up to 28 per cent in 2005-06).
- Financial product development investment is reduced by an average of around 93 per cent (a range of 98 to 83 per cent between 1974-75 and 2005-06).
- Architectural and engineering designs investment (as separately identified) is reduced by 100 per cent in each year (to zero). The amount of expenditure already capitalised by the ABS as part of associated tangible assets cannot be separately identified.
- Purchased organisational capital is reduced by 35 per cent in each year (since it is a fixed percentage adjustment made in each year).

Incorporating these lower bound estimates into the growth accounting affects the MFP growth results by a small amount (table D.5). Compared with the original all intangibles case, the rate of MFP growth falls from 1.36 per cent a year when excluding all intangible assets, to 1.24 per cent a year rather than 1.20 per cent (a 3 per cent difference).

The change in MFP growth is small for two reasons:

- the intangible investment series that are changed contribute only a small percentage of total investment and capital services growth

- the reduction in these assets changes the individual asset weightings in the aggregate capital services index, but not by enough to appreciably alter the capital services growth rate.

Table D.5 **Comparison of MFP and capital services growth rates using lower bound intangible estimates**

Per cent per year

	1974-75 – 2005-06	*1974-75 – 1984-85*	*1984-85 – 1994-95*	*1994-95 – 2005-06*
MFP growth				
All intangible assets (original)	1.20	1.25	1.00	1.35
All intangible assets ('lower bound')	1.24	1.28	1.02	1.39
No intangible assets	1.36	1.31	1.13	1.63
Total capital services growth				
All intangible assets (original)	3.38	3.00	3.00	4.10
All intangible assets ('lower bound')	3.30	2.93	2.88	4.02
No intangible assets	2.81	2.62	2.31	3.44

Source: Authors' estimates.

Adjusting investment sizes for all new intangibles

Increasing investment by 50 per cent for new intangibles resulted in only a 0.09 percentage point increase in capital services growth (for the all intangibles case) over the full period. This is a result of a higher weighting of intangibles, which grew faster than tangible assets, in the aggregate capital services index. Decreasing investment in intangibles by the same amount had the reverse effect.

Table D.6 shows that increasing new intangibles investment by 50 per cent increases capital deepening attributable to new intangibles as a percentage of all capital deepening from 22 per cent to 29 per cent. Capital deepening attributable to all intangibles also increases, from 37 per cent to 43 per cent. When new intangibles investment is decreased by 50 per cent, capital deepening attributable to new intangibles falls to 12 per cent and total capital deepening attributable to all intangibles falls to 29 per cent.

Table D.6 **Contributions to capital deepening, all intangibles treated as capital, 1974-75 to 2005-06**

Per cent per year (Percentage share of total capital deepening)

	Original[a]	*50 per cent increase in new intangibles*[b]	*50 per cent decrease in new intangibles*[c]
All intangibles	0.41	0.51	0.29
	(37)	(43)	(29)
National accounts intangibles	0.17	0.16	0.17
	(15)	(14)	(17)
New intangibles	0.24	0.35	0.12
	(22)	(29)	(12)
Tangibles	0.69	0.67	0.71
	(63)	(57)	(70)
Total capital deepening	**1.08**	**1.16**	**1.00**
	(100)	**(100)**	**(100)**

[a] These series are the main results as contained in chapter 5. [b] Increased investment in new intangibles by 50 per cent. [c] Decreased investment in new intangibles by 50 per cent.

Source: Authors' estimates.

When intangibles investment was increased by 50 per cent, MFP growth decreased by 0.02 of a percentage point, or 2 per cent (an average of 1.20 per cent a year, down from 1.23 per cent for the all intangibles case over the full period). Decreasing intangibles investment increased MFP growth by a similar margin (table D.4).

The results from the higher and lower investment tests are as expected. A 50 per cent increase in the level of new intangibles investment increases the capital deepening effect and decreases the MFP growth effect (compared with the results in chapter 5). The reverse is true for a 50 per cent decrease.[11]

Increased depreciation rates

The results show that the growth accounting results are very robust to doubling depreciation rates for the new intangibles. This is because smaller capital stocks[12] due to faster depreciation in the perpetual inventory method are counterbalanced by rental price increases. This is consistent with the findings of MHW (2007) — doubling the depreciation rates for intangibles had little impact on their growth accounting results.

[11] However, this ignores the issue of potential complementarities between intangibles and other capital and labour inputs.

[12] For 2005-06, the estimated real net capital stock of intangibles is $189 billion for the base case and $131 billion when the depreciation rates for new intangibles are doubled (figure D.6).

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