

2 Aggregate and sectoral evidence on uptake and performance effects

This chapter draws on national accounts data to illustrate the strong uptake of ICTs in the Australian economy during the 1990s and to assess the contribution of ICTs to Australia’s economic performance. The material updates the estimates provided in Parham, Roberts and Sun (2001).

The chapter examines the contribution of information technology (IT), rather than ICT, to Australia’s output and productivity growth. The Australian Bureau of Statistics (ABS) has adopted the major conventions of SNA93. However, unlike practice in a number of countries, current ABS practice is to treat communications equipment as electronic equipment, rather than to group it with computing equipment. The data used covers IT products (both hardware and software), but excludes IT services. This chapter is precise in referring to IT, but elsewhere in this paper the broader ICT term is mostly used.

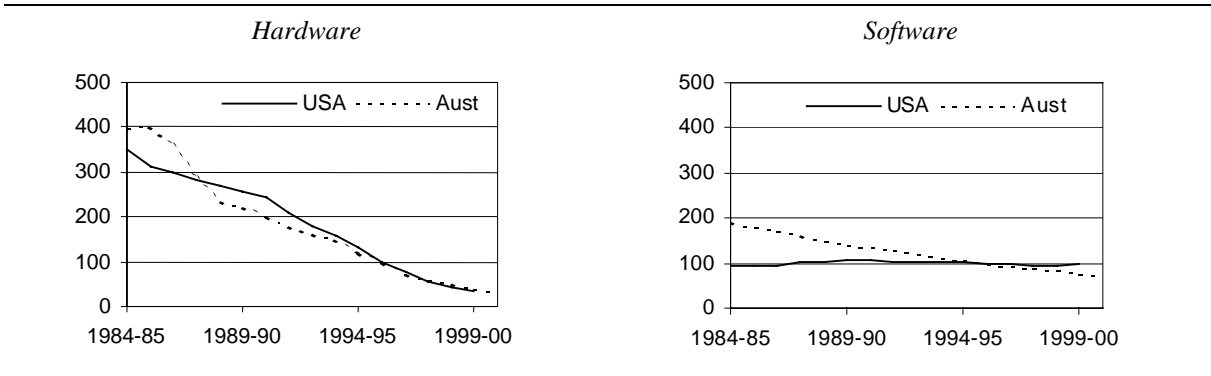
2.1 The uptake of IT

The ABS uses hedonic price deflators, which take account of improvements in the characteristics of products, to construct volume estimates of IT investment and usage.¹ The use of hedonic price deflators means that, to the extent that measurement is accurate, technological advances in hardware and software — including increases in processing speed, memory capacity and functions — are treated as embodied increases in the volume of IT purchased.

The price of IT products has fallen dramatically (figure 2.1).² Hardware prices fell 11 per cent annually over the 10 years to 1994-95 and by 19 per cent annually over the six years thereafter.

Figure 2.1 Hedonic price deflators for IT, Australia and the USA, 1984-85 to 2000-01

Index 1995-96 = 100



Data source: Unpublished ABS data and (US) Bureau of Labor Statistics.

¹ There have been rapid advances in the quality of computers, but relatively little movement in their nominal prices. Therefore, if allowance is made for the substantial improvements in technical characteristics, the price of equipment has fallen rapidly. The ABS deflators for IT in Australia are based on the US price deflator for hardware (adjusted for exchange rate movements and a lag) and an assumed 6 per cent a year decline in software prices.

² There has been a marked decline in prices since the 1960s (Parham, Roberts and Sun 2001).

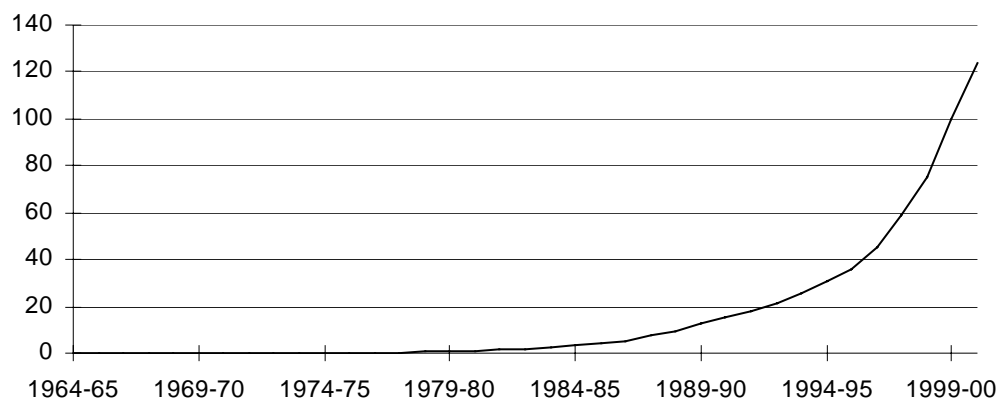
Falling IT prices have undoubtedly been a major reason for the rapid growth in investment in IT.³ Real IT investment grew by 28 per cent a year in the second half of the 1990s (table 2.1) — sufficient to double the level of investment every three years. This was up on the rate in the first half of the 1990s, but not on the rate in the 1980s. However, IT investment became more prominent in total market sector⁴ investment in the 1990s, growing from a 3 per cent share in 1989-90 to 19 per cent in 2000-01.⁵

Table 2.1 Growth in investment in the market sector from the mid-1980s
Per cent per year

	1984-85 to 1989-90	1989-90 to 1994-95	1994-95 to 1999-00
Information technology	35.1	17.3	28.0
- Hardware	31.3	24.0	36.1
- Software	36.5	14.8	23.4
Other capital	4.0	0.3	3.8
Total	4.4	1.0	6.1

Source: Productivity Commission estimates based on unpublished ABS data.

Figure 2.2 IT capital services, 1964-65 to 2000-01
Index (1999-2000 = 100)



Data source: ABS 5204.0.

³ More correctly, the falling prices of IT *relative* to prices of other inputs (and output) is pertinent. For example, the rental price of IT also fell rapidly compared with the rental prices of other forms of capital (Parham, Roberts and Sun 2001).

⁴ The market sector covers about 60 per cent of the measured economy and excludes industries (eg public administration, health, education, defence) for which output measures are inadequate for use in productivity analysis. A major difference between the market sector and the ‘business sector’ used in many other countries is the exclusion of business services from the Australian coverage. Business services are relatively intensive users of ICTs.

⁵ The IT share in nominal investment grew from 8 per cent in 1989-90 to 18 per cent in 2000-01. The stronger increase in the IT share in real terms reflects the decline in relative prices of IT.

Naturally, the strong growth in IT investment led to strong growth in IT capital services input into production (figure 2.2).⁶ IT capital services grew at 23 per cent a year through the 1990s. Growth was stronger in the second half of the 1990s (27 per cent a year) than in the first half (19 per cent a year). The share of IT in the total productive capital stock rose from 0.4 per cent in 1989-90 to 2.6 per cent in 1999-2000 (and to 3.1 per cent in 2000-01).

2.2 Contributions to aggregate output and productivity growth

This section assesses the contributions of IT and other factors to output and productivity growth in the market sector of the Australian economy. A standard growth accounting framework is used.

Contribution to output growth

Accounting for the contribution of IT capital inputs to output growth is straightforward in principle. As is well known, growth accounting attributes growth in output to: a contribution from growth in capital inputs; a contribution from growth in labour inputs;⁷ and growth in multifactor productivity (the efficiency with which labour and capital inputs are combined to generate output). The capital contribution to output growth is decomposed into an 'IT' and an 'other-capital' contribution. The IT contribution is the share-weighted growth in IT capital services input, where the appropriate share is the proportion of total income payments attributed to IT.⁸

The IT contribution to output growth has increased substantially over the decades, but with short-term variations that suggest sensitivity to the business cycle (figure 2.3). The annual IT contribution has increased from around one-fifth of a percentage point in the late 1970s to around one and a quarter percentage points in the late 1990s. However, there were dips in the early 1980s and early 1990s in association with recessions. The IT contribution surged in the second half of the 1990s, consistent with the strong uplift in investment. Figure 2.3 also indicates that, in contrast with earlier periods, the hardware contribution grew faster than the software contribution from around 1994.

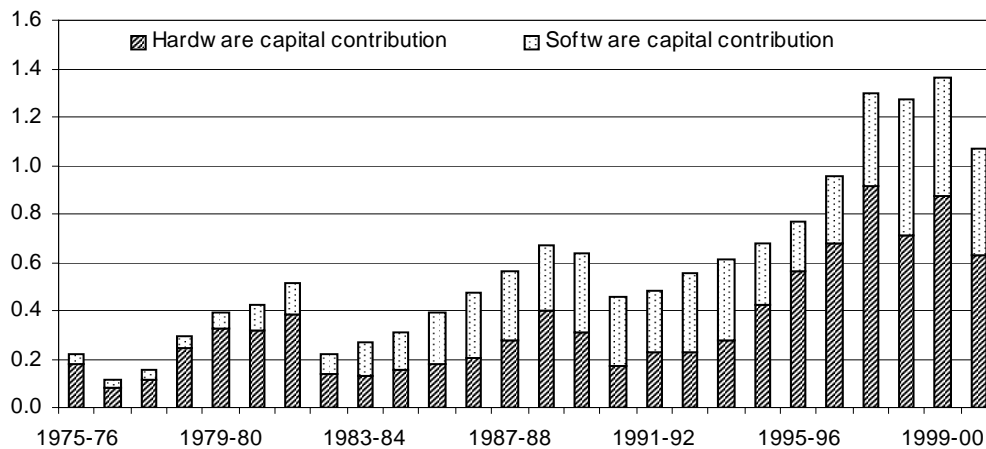
However, it appears that the strength of the post-1995 'boom' has been commonly overstated. First, the surge should be viewed partly in the light of the cyclical downturn in the first half of the 1990s. Second, the uncertainty about the Y2K bug may have spurred new IT investment late in the decade. A softening in IT capital deepening is evident in the 2000-01 rate. On the other hand, IT prices dropped more rapidly and Internet and other network opportunities and uses expanded after 1995.

⁶ Conceptually, capital services are the flow of inputs into production from the productive capital stock, which is the volume of capital in operation, adjusted for efficiency loss over time.

⁷ The contribution of capital input is the product of the growth in capital input and the share of capital in total payments to factors of production. Similarly, the labour contribution is the share-weighted growth in labour input.

⁸ The share of IT in total income payments to factors increased from 2.1 per cent in 1989-90 to 4.5 per cent in 1999-2000.

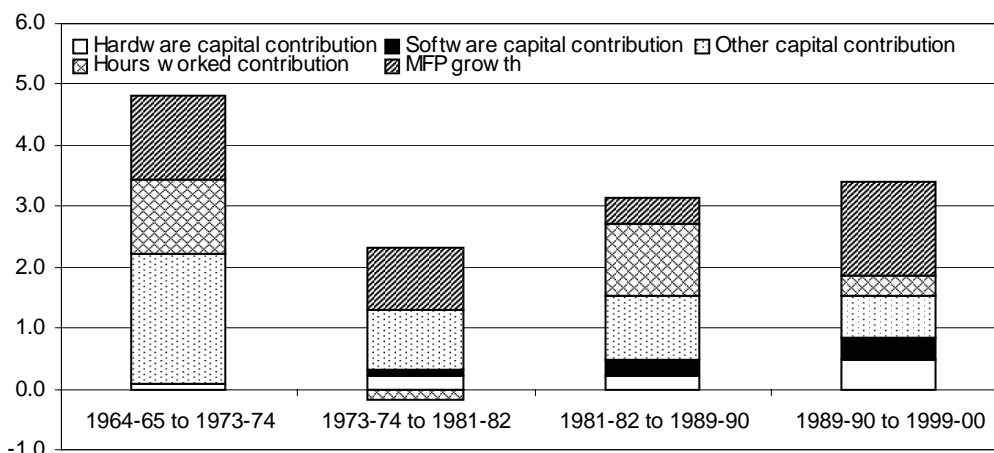
Figure 2.3 Contributions of IT capital to annual output growth, 1975-76 to 2000-01
Percentage points



Source: Productivity Commission estimates based on unpublished ABS data.

IT became a major contributor to output growth in the 1990s. Figure 2.4 shows contributions to output growth over output cycles — from output peak to output peak. These periods control for cyclical effects which, as just seen, appear to exert important influence on IT use. The IT contribution increased from a relatively negligible level in the 1964-65 to 1973-74 period to become stronger than both the labour and the ‘other capital’ contributions in the 1990s cycle. IT accounted for a quarter of the output growth of 3.4 per cent a year between 1989-90 and 1999-2000⁹ (table 2.2).

Figure 2.4 Contributions to average annual output growth over output cycles, 1964-65 to 1999-00
Percentage points



Source: Productivity Commission estimates based on unpublished ABS data.

However, slower growth in the use of other capital offset the contribution from increased use of IT. Table 2.2 shows that IT made a solid 0.3 of a percentage point contribution to the output

⁹ The year 1999-2000 was an output peak.

growth acceleration of 0.3 of a percentage point between the 1980s and the 1990s cycles. But the contribution of ‘other capital’ declined over the two cycles and its negative contribution to the output acceleration offset the entire IT contribution.¹⁰

Stronger MFP growth (a full percentage point higher) was the major contributor to the acceleration in output growth in the 1990s. The labour contribution was much weaker in the 1990s cycle, after the strong employment expansion in the 1980s.

Table 2.2 Contributions to the acceleration in average annual output growth^a in the 1990s

Per cent per year, percentage points and (per cent)

	1981-82 to 1989-90		1989-90 to 1999-00		Acceleration
Output growth	3.1	(100)	3.4	(100)	0.3
Capital contribution ^b	1.5	(49)	1.5	(45)	0.0
- Information technology	0.5	(15)	0.8	(25)	0.4
... Hardware	0.2	(7)	0.5	(14)	0.3
... Software	0.2	(8)	0.3	(10)	0.1
- Other capital	1.1	(34)	0.7	(21)	-0.4
Hours worked contribution ^b	1.2	(38)	0.3	(10)	-0.8
MFP growth	0.4	(13)	1.5	(45)	1.1

^a Numbers in brackets are percentage contributions to output growth. Factor income shares, used in calculating contributions, are averaged over the periods indicated. ^b Contributions from factors are their rates of growth multiplied by their respective factor income shares.

Source: Productivity Commission estimates based on unpublished ABS data.

It has been common in other studies to assess the contribution of IT and other factors to output growth in the first and second halves of the 1990s, without controlling for effects of the business cycle. Estimates based on this approach are presented in box 2.1 for the purposes of comparison with other studies. But they are not the preferred estimates.

Contribution to labour productivity growth

Growth in labour productivity can be decomposed into contributions from capital deepening — increases in the capital-labour ratio — and MFP growth. In principle, IT contributes to labour productivity growth through both capital deepening and MFP growth. The capital deepening part is assessed in the growth accounting framework by decomposing the total capital deepening contribution into an IT capital deepening component (the IT income share multiplied by the growth in the IT-labour ratio) and an other-capital deepening component. As discussed in chapter 1, the link between IT and MFP growth can come in principle through IT manufacture (although not in practice in Australia) or through use. However, there is no mechanism to explicitly link IT use and MFP growth in the growth accounting framework.¹¹

¹⁰ The relative contributions of IT and other capital depend on their relative rates of growth in capital services and income shares.

¹¹ Studies of the USA (for example, Oliner and Sichel 2000) have been able to decompose the MFP contribution into separate contributions from the production of ICTs and other factors.

The pattern of year-on-year contributions from IT capital deepening (figure 2.5) closely follows that of the IT contribution to output growth (figure 2.3). The annual IT capital deepening contribution also increased from around one-fifth of a percentage point in the latter half of the 1970s to around one and a quarter percentage points in the latter half of the 1990s. There was also a pronounced uplift in the IT capital deepening contribution in the second half of the 1990s. However, the dampening effects of the early 1990s recession on IT capital deepening, whilst still evident, are not as pronounced as they were on the IT contribution to output growth. The recession would have brought cutbacks in labour as well as IT investment, muting any effect on the IT capital-labour ratio.

Box 2.1 IT contributions during the first and second halves of the 1990s

The results in this paper differ from those in other studies (eg Simon and Wardrop 2002), which have accounted for growth and its acceleration between the first and second halves of the 1990s. The periods used in this paper are preferred because they generate underlying rates of output and productivity growth that control for cyclical effects. However, since the comparison between the second half of the 1990s with earlier periods is so commonly used in other studies, it is included here for the sake of comparison. The tables below show the full extent of the IT contribution to output growth and the IT capital deepening contribution to labour productivity growth during their peak in the second half of the 1990s. However, not much emphasis should be placed on other estimates in the tables.

Contributions to the acceleration in output growth over the first and second halves of the 1990s

Per cent per year and percentage points

	<i>1989-90 to 1994-95</i>	<i>1994-95 to 1999-2000</i>	<i>Acceleration</i>
Output growth	2.0	4.8	2.7
Capital contribution	1.1	2.0	0.9
- Information technology	0.6	1.2	0.6
- Other capital	0.5	0.8	0.4
Hours worked contribution	-0.1	0.7	0.8
MFP growth	1.0	2.0	1.0

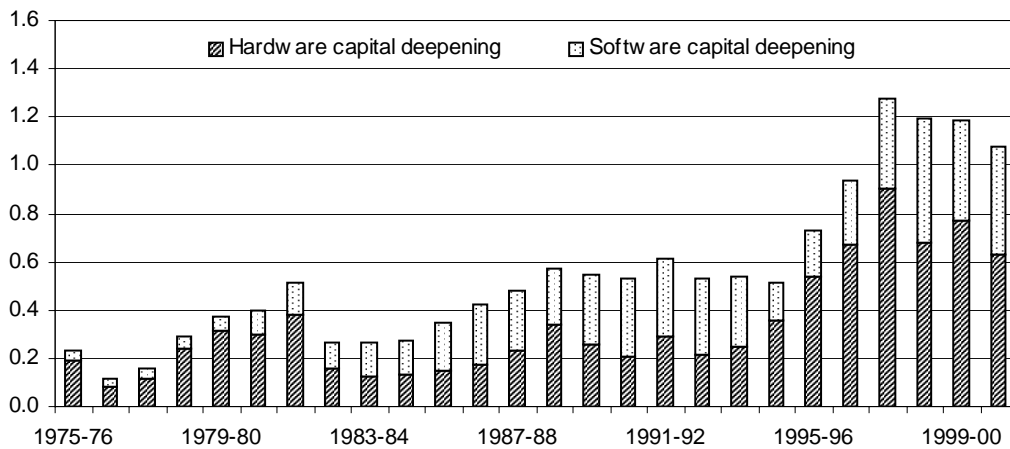
Contributions to the acceleration in productivity growth over the first and second halves of the 1990s

Per cent per year and percentage points

	<i>1989-90 to 1994-95</i>	<i>1994-95 to 1999-2000</i>	<i>Acceleration</i>
Labour productivity growth	2.2	3.5	1.3
Capital deepening	1.1	1.5	0.3
- Information technology	0.6	1.1	0.5
- Other	0.5	0.4	-0.1
MFP growth	1.0	2.0	1.0

Source: Productivity Commission estimates based on unpublished ABS data.

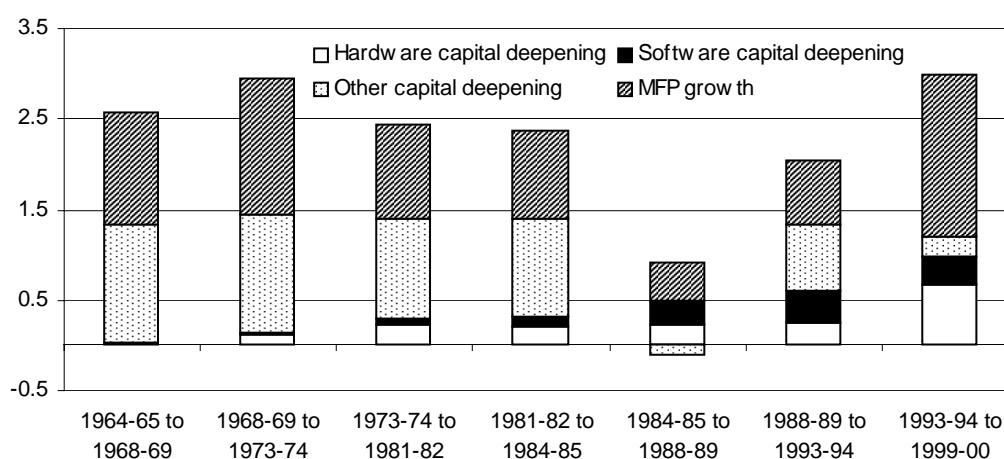
Figure 2.5 Contributions of IT capital deepening to annual labour productivity growth, 1975-76 to 2000-01
Percentage points



Source: Productivity Commission estimates based on unpublished ABS data.

IT's capital deepening contribution to labour productivity growth has increased steadily over time. Contributions to labour productivity growth over productivity cycles — from productivity peak to productivity peak — are illustrated in figure 2.6. The IT capital deepening contribution climbed to a very substantial proportion in the 1990s cycle (from 1993-94 to 1999-2000), when it accounted for a third of the very strong labour productivity growth of 3.0 per cent a year (table 2.3). IT capital deepening also made a strong contribution of 0.4 of a percentage point to the labour productivity acceleration of one percentage point between the last two productivity cycles (table 2.3).

Figure 2.6 Contributions to average annual labour productivity growth over productivity cycles, 1964-65 to 1999-00
Percentage points



Source: Productivity Commission estimates based on unpublished ABS data.

However, in an accounting sense, the larger IT capital deepening contribution has come at the expense of the other-capital deepening contribution. Again, controlling for cyclical effects, the faster growth in IT use has been offset by slower growth in use of other forms of capital. Figure 2.6 shows very little change in the overall rate of capital deepening — that is, no change in the rate of substitution of capital for labour — across productivity cycles (apart from the 1984-85 to 1988-89 cycle, during which there was strong employment growth). Table 2.3 confirms this offsetting effect over the last two cycles.

Table 2.3 Contributions to the acceleration in average annual labour productivity growth^a in the 1990s

Per cent per year, percentage points and (per cent)

	1988-89 to 1993-94		1993-94 to 1999-00		Acceleration
Labour productivity growth	2.0	(100)	3.0	(100)	1.0
Capital deepening	1.3	(65)	1.2	(40)	-0.1
- Information technology	0.6	(30)	1.0	(33)	0.4
... Hardware	0.3	(12)	0.7	(23)	0.4
... Software	0.4	(17)	0.3	(10)	0.0
- Other capital	0.7	(35)	0.2	(7)	-0.5
MFP growth	0.7	(35)	1.8	(60)	1.1

^a Numbers in brackets are percentage contributions to labour productivity growth. Factor income shares, used in calculating contributions are averaged over the periods indicated.

Source: Productivity Commission estimates based on unpublished ABS data.

MFP growth surged in the 1990s, to the extent that its acceleration fully accounted for the labour productivity acceleration (table 2.3). But, as noted earlier, there is no way of determining from the aggregate growth accounting whether, or to what extent, use of IT is associated with the acceleration in MFP growth. Comparison with the US experience suggests that one or two tenths of a percentage point of the MFP acceleration — up to a maximum of 0.3 of a percentage point — could be associated with IT use (box 2.2).

2.3 Uptake and performance effects at the sectoral level

Unpublished national accounts data on industry sectors show that the uptake of IT was not uniform across industry sectors. Moreover, the links between IT use and improved performance appear to be more prominent in certain industry sectors.

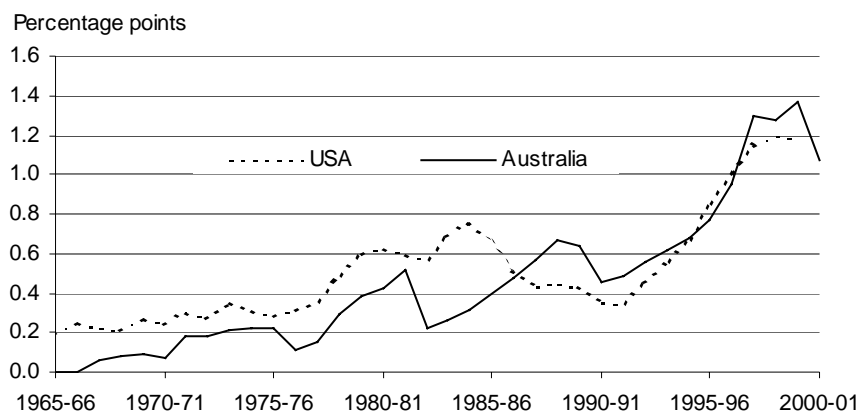
Growth in IT use

Services industries have dominated the uptake of IT since the mid-1980s, absorbing at least three-quarters of IT investment in the market sector (table 2.4). Mostly, this reflects the relative size of services industries, which account for about 65 per cent of market sector value added.

Box 2.2 The USA and Australia compared

There were strong similarities in the rate of uptake of IT in Australia and ICT in the USA. The figure below (which shows the I(C)T contribution — the share-weighted growth in I(C)T capital services — to annual output growth) suggests that the uptake was roughly the same in both countries, with a strong uplift in the second half of the 1990s.

Contributions of IT and ICT to annual output growth in Australia and the USA



Source: Productivity Commission estimates based on unpublished ABS data and (US) Bureau of Labor Statistics data

With a similar rate of uptake of ICT and its technological and productivity leadership, the USA can be used as a benchmark to assess the maximum productivity effects of ICT use in Australia. Controlling for cyclical effects in both countries, the maximum MFP acceleration that could be attributed to ICTs, as indicated by the US results in the table below, is 0.3 of a percentage point. (Other possible influences on the US productivity acceleration are assumed to be unimportant — see Parham 2002b). Some of this acceleration must be attributed to ICT production. Taking a number of factors into consideration, Parham (2002b) considered that 1 or 2 tenths of a percentage point, up to a maximum of 3 tenths of a percentage point, of productivity gains in the USA — and therefore Australia — can be associated with ICT use.

Contributions to labour productivity accelerations in the 1990s cycle in the USA and Australia

Per cent per year and percentage points

	USA ^a	Australia ^b
Labour productivity growth	0.5	1.0
Capital deepening	0.2	-0.1
- ICT capital	0.3	0.4
* Hardware	0.3	0.4
* Software	0.1	0.0
* Other	0.0	
- Other capital	-0.2	-0.5
MFP contribution	0.3	1.1

^a Growth in 1992 to 2000 less growth in 1986 to 1992. ^b Growth in 1993-94 to 1999-00 less growth in 1988-89 to 1993-94.

Source: Productivity Commission estimates based on unpublished ABS data and (US) Bureau of Labor Statistics data.

The Finance & insurance sector has been the major sectoral destination for IT, absorbing at least a quarter of total IT investment — more than double its output share. By the end of the 1990s, 26 per cent of the total IT productive capital stock was in Finance & insurance.¹² The sector accounted for over two-fifths of the acceleration in IT capital services in the market sector between the last two productivity cycles (table 2.5).¹³

Manufacturing has also been prominent in the IT takeover. It has absorbed at least 15 per cent of market sector IT investment¹⁴ (table 2.4) and contributed 1.2 percentage points of the 4.1 percentage point acceleration in market sector IT capital services in the 1990s (table 2.5).

Other industry sectors to feature in the IT uptake were Wholesale trade, Retail trade, Transport & storage and Communication services (all absorbing around 10 per cent of market sector investment). The above-mentioned six sectors together accounted for about 80 per cent of total IT investment.

Table 2.4 Sectoral growth in real IT investment and proportion of market sector investment

Per cent per year and per cent

	1984-85 to 1989-90		1989-90 to 1994-95		1994-95 to 1999-00	
	%pa	%	%pa	%	%pa	%
Agriculture	35	2	19	2	25	2
Mining	37	2	17	2	23	2
Manufacturing	37	15	18	16	28	17
Electricity, gas & water	13	4	28	4	28	4
Construction	35	5	19	6	22	5
Wholesale trade	36	11	17	11	25	10
Retail trade	37	9	21	10	25	10
Accom., cafes & restaurants	40	3	19	3	28	3
Transport & storage	36	10	16	10	23	8
Communication services	36	10	15	10	31	9
Finance & insurance	36	27	15	25	33	27
Cultural & rec. services	36	3	19	3	27	3
Market sector	35	100	17	100	28	100

Source: Productivity Commission estimates based on unpublished ABS data.

There was a strong acceleration in IT capital services in Electricity, gas & water in the 1990s. This contributed one fifth of the total market sector acceleration in IT use (table 2.5).

¹² The sectoral percentages of total IT investment shown in the right-most column of table 2.4 happen to roughly approximate the sectoral percentages of total IT productive capital stock in 1999-2000.

¹³ Table 2.5 references growth rates to productivity cycles to facilitate later comparison to sectoral productivity growth (see chapter 5).

¹⁴ Manufacturing accounts for about 21 per cent of market sector value added.

Table 2.5 Growth in IT capital services, by industry sector

Per cent per year, percentage points and per cent

	1988-89	1993-94	Acceleration	Contributions to aggregate acceleration	
	to 1993-94	to 1999-00		pp	%
Agriculture	20.4	27.4	7.0	0.1	2
Mining	20.6	25.0	4.4	0.1	2
Manufacturing	22.7	29.0	6.3	1.2	28
Electricity, gas & water	12.4	28.8	16.4	0.8	20
Construction	21.2	23.1	2.0	0.1	3
Wholesale trade	21.8	22.2	0.4	0.0	1
Retail trade	24.0	26.2	2.2	0.2	5
Accom., cafes & restaurants	24.2	28.6	4.5	0.1	3
Transport & storage	22.7	19.5	-3.2	-0.3	-8
Communications	22.9	22.5	-0.4	0.0	-1
Finance & insurance	20.5	26.8	6.4	1.7	43
Cultural & rec. services	23.6	26.2	2.6	0.1	2
Market sector	21.5	25.6	4.1	4.1	100

Source: Productivity Commission estimates based on unpublished ABS data.

Contributions to output growth

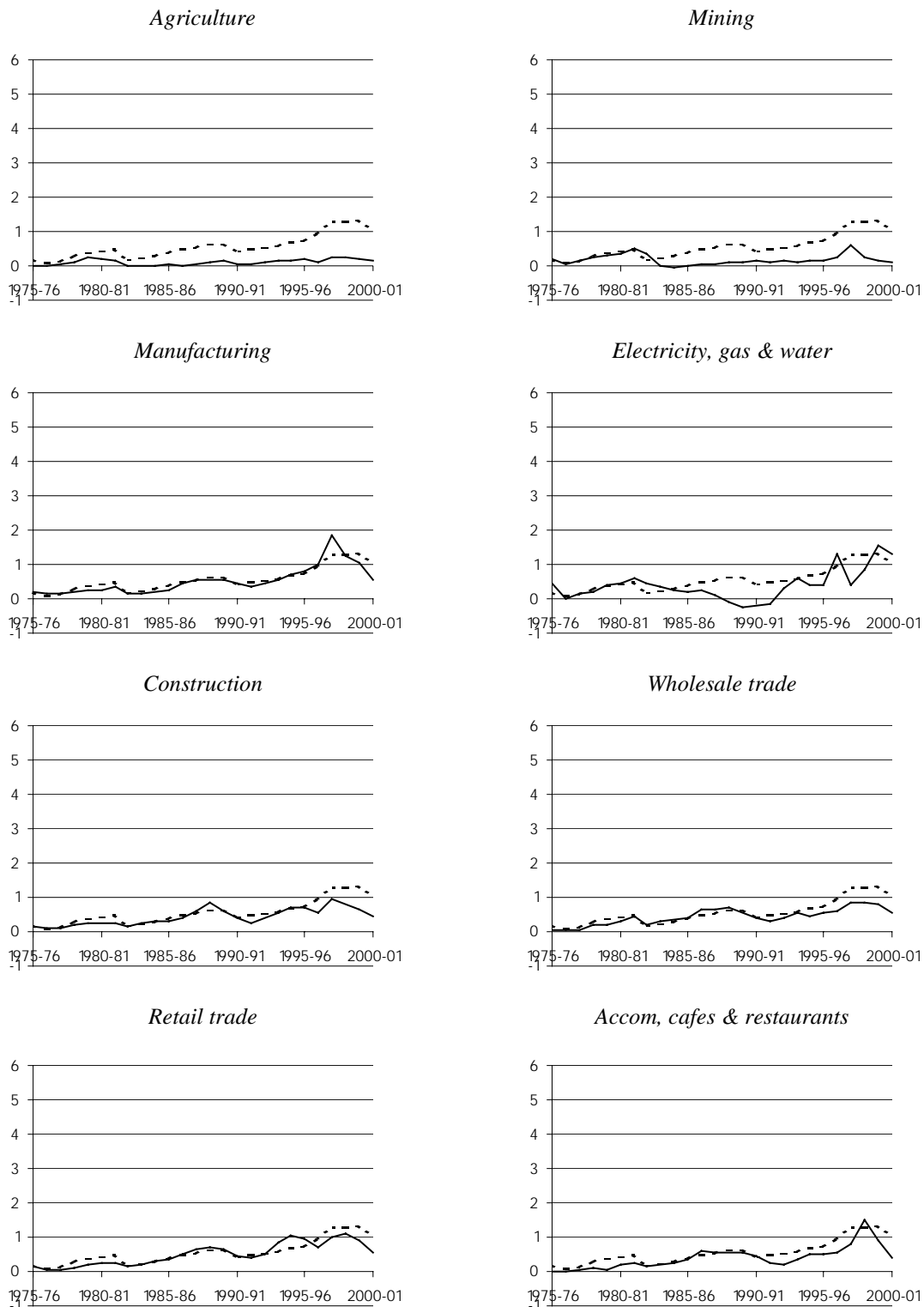
The relative importance of IT in each industry and the pattern of growth in IT use in each industry is illustrated in figure 2.7 by the contribution of IT to year-on-year sectoral output growth. The magnitude of the contributions reflects not only the growth in IT capital services but also the importance of IT in total production costs. In each panel, the sectoral IT contribution is compared with the market sector average.

Not surprisingly, given its dominance in uptake, the Finance & insurance sector stands out in terms of the contribution of IT to its output growth. It shows a much stronger contribution than other sectors, going back to the mid-1970s, as well as a much stronger uplift in the IT contribution in the 1990s.

The IT uptake has not just been a post-1995 phenomenon, at least in some sectors. Most industries show an increase in the IT contribution in the 1990s. However, it is also apparent that the IT contribution increased from the second half of the 1980s in Finance & insurance, Communication services and Cultural & recreational services.¹⁵ (Larger firms are generally found in a review of ICT uptake in the next chapter to have been early adopters.)

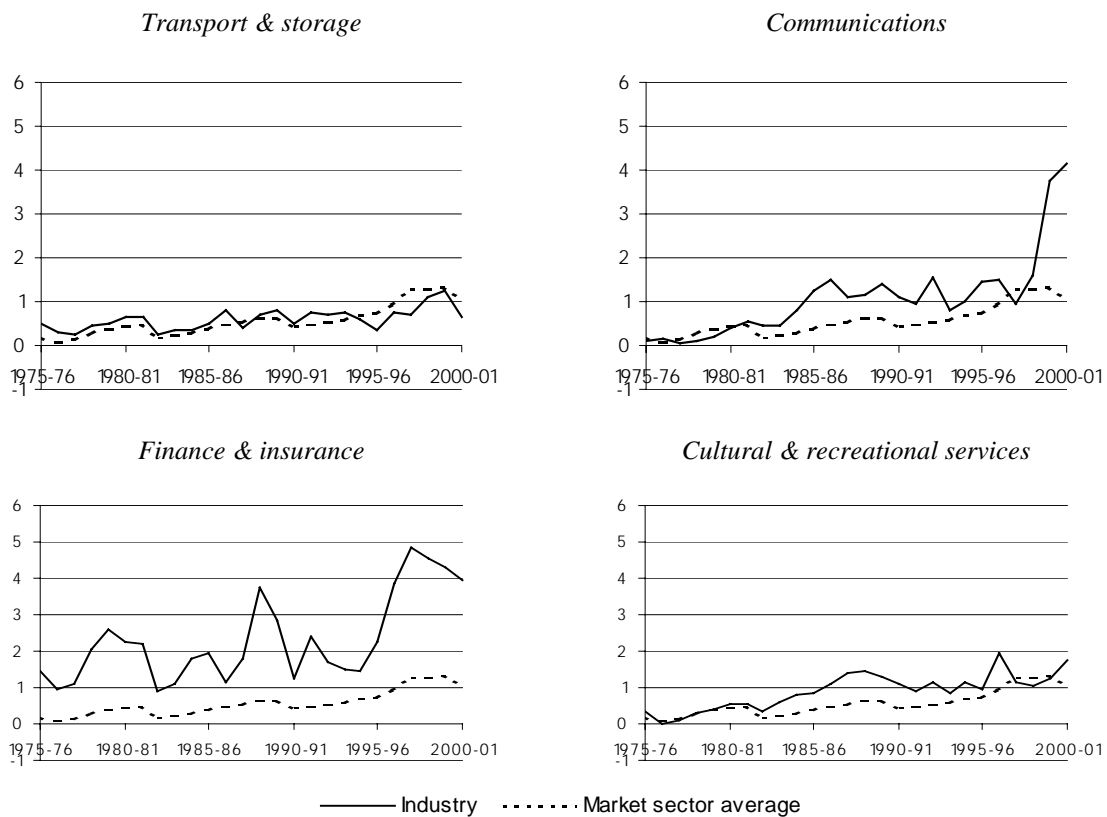
¹⁵ Triplett and Bosworth (2002) found strong impacts of ICTs in US services industries and that the impacts were as strong pre-1995 as they were post-1995.

Figure 2.7 Contribution of IT capital to annual output growth in industry sectors, 1984-85 to 2000-01
 Percentage points



(continued on next page)

Figure 2.7 (continued)



Source: Productivity Commission estimates based on unpublished ABS data.

Contributions to productivity growth

Three forms of evidence are examined for signs of a link between IT use and MFP at the sectoral level:

- Growth in sectoral IT use and MFP in the 1990s;
 - Table 2.6 accounts for contributions to sectoral labour productivity growth. Growth in IT use is indicated by the contribution from IT capital deepening.¹⁶ The time period used is the last aggregate productivity cycle and so no allowance is made for any industry-specific cyclical effects.
- Acceleration in sectoral IT use and MFP in the 1990s:
 - Table 2.7 accounts for the IT capital deepening and MFP contributions to the accelerations in sectoral labour productivity growth between the last two aggregate productivity cycles. It further shows the contribution of each sector to accelerations in market sector IT capital deepening and MFP.
 - Figure 2.8 plots observations of changes in IT use (increases in the IT share in each sector's productive capital stock) and acceleration in *trend* MFP (ie, with cyclical effects removed) between the last two aggregate productivity cycles.

¹⁶ Growth in IT use is most accurately indicated by growth in IT capital services (see table 2.5).

Table 2.6 Contributions to sectoral labour productivity growth, 1993-94 to 1999-2000

Per cent per year and percentage points

	<i>Labour productivity growth</i>	<i>Capital deepening</i>	<i>IT capital deepening</i>	<i>Other capital deepening</i>	<i>MFP growth</i>
	%pa	pp	pp	pp	pp
Agriculture	2.7	-0.7	0.2	-0.9	3.4
Mining	7.3	5.1	0.3	4.8	2.2
Manufacturing	2.8	1.9	1.2	0.8	0.9
Electricity, gas & water	6.7	5.1	1.1	4.0	1.6
Construction	1.0	-0.2	0.6	-0.8	1.1
Wholesale trade	6.0	0.8	0.7	0.1	5.2
Retail trade	1.9	0.9	0.8	0.0	1.1
Accom., cafes & restaurants	1.2	0.9	0.7	0.2	0.3
Transport & storage	2.4	0.6	0.7	0.0	1.8
Communication services	6.0	1.9	1.3	0.6	4.0
Finance & insurance	3.9	2.9	3.3	-0.4	1.2
Cultural & rec. services	-0.5	3.6	1.1	2.5	-3.7
Market sector	3.0	1.2	1.0	0.2	1.8

Source: Productivity Commission estimates based on unpublished ABS data.

Table 2.7 IT capital deepening and MFP contributions over the past two productivity cycles

Percentage points

	<i>Contributions to sectoral labour productivity acceleration</i>		<i>Contributions to acceleration in aggregate^a</i>	
	<i>IT capital deepening</i>	<i>MFP growth</i>	<i>IT capital deepening</i>	<i>MFP growth</i>
Agriculture	0.1	-0.8	0.0	-0.1
Mining	0.2	-0.1	0.0	-0.0
Manufacturing	0.5	-1.1	0.2	-0.4
Electricity, gas & water	1.0	-2.3	0.1	-0.2
Construction	0.1	1.6	0.0	0.3
Wholesale trade	0.2	7.3	0.0	1.2
Retail trade	0.2	0.4	0.0	0.1
Accom., cafes & restaurants	0.4	2.2	0.0	0.2
Transport & storage	-0.1	0.9	0.0	0.1
Communication services	0.0	-2.2	0.0	-0.2
Finance & insurance	1.1	1.1	0.2	0.2
Cultural & rec. services	0.1	-1.3	0.0	-0.1
Market sector	0.4	1.1	0.4	1.1

^a The entries in the first two columns are multiplied by the sectoral share in market sector value added.

Source: Productivity Commission estimates based on unpublished ABS data.

This evidence suggests the following:

- There is wide variation in IT use and productivity performance across industries. And there is no clear systematic relationship between IT use and productivity growth across industries.
- Finance & insurance features prominently in terms of both IT use and productivity growth in the evidence examined. The associations between IT use and productivity growth within the sector are strong; and the sector made relatively strong contributions to aggregate IT capital deepening and productivity growth.
- Wholesale trade also shows evidence of increased IT use (albeit weaker than in Finance & insurance) and very strong productivity acceleration.
- There is mixed evidence of positive associations between IT use and productivity growth in Retail trade, Accommodation, cafes & restaurants and Communication services.
- Manufacturing is relatively important in terms of IT use, but has shown less productivity response — indeed, a sizeable reduction in MFP growth in the 1990s. The pattern in Electricity, gas & water is similar.

The lack of a strong correlation between IT use and productivity growth across all industries reflects a number of factors. First, IT use is not the only influence on productivity growth. For example, policy reforms could have had greater effects in some industries, quite independent of IT usage.¹⁷ Second, the relationship between IT use and productivity growth is most likely to be more complex than examined here. The scope for ICT-related productivity gains could differ across industries. There could be lags between the uptake of IT and productivity response, whereas only contemporaneous correlations have been examined to this point. And some productivity responses may require factors complementary to IT (restructuring and product and process innovation). Variations in the scope for and application of complementary factors could lead to variations in the strength of association observed between IT and productivity across industries. This could be why Manufacturing has not shown a strong productivity response, despite its uptake of IT. (Complementary factors are examined in chapter 4.)

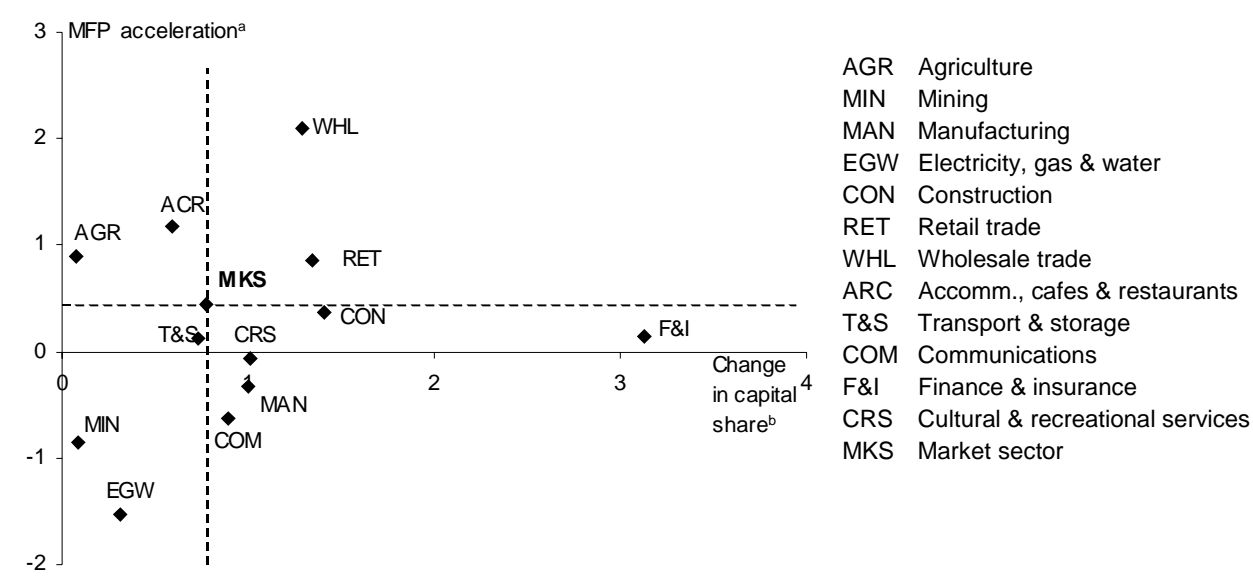
It also needs to be said that correlation between IT and productivity growth does not necessarily imply causation — that is, that an uptake of IT has led to a productivity boost. However, some evidence of a link between IT use and productivity comes from the fact that similar industries have emerged at least in the USA and Australia as being both relatively intensive IT users and displaying relatively strong productivity improvement. These industries include financial intermediation, distribution (wholesale and retail trade) and business services (Nordhaus 2001, CEA 2001 and Pilat and Lee 2001).

The strong productivity gains in Australia's Wholesale trade are consistent with transformation of some activities from storage-based configurations to 'fast flow-through' systems (Johnston et al 2000). ICTs have played a part in this transformation through the increased use of bar-coding and scanning technology, communications and tracking systems and inventory management systems. Less storage and handling has reduced input requirements.

Finance & insurance has also undergone substantial restructuring, with much greater use of electronic transactions and a reduction in face-to-face transactions. New financial and risk-management products, made possible by improved information storage and processing, have been developed and offered. Output has grown with fewer unit requirements for physical offices and staff (Weir 2002, Oster and Antioch 1995).

¹⁷ For example, the deceleration in productivity growth in Electricity, gas & water is likely to reflect the influence of policy reforms promoting very strong productivity growth in the 1980s and early 1990s.

Figure 2.8 Change in sectoral IT use and MFP acceleration in the 1990s
Per cent and per cent per year



^a Change in trend MFP growth between the last two aggregate productivity cycles. ^b Change in the IT share in productive capital stock between the mid-points of the last two aggregate productivity cycles.

Source: Productivity Commission estimates based on unpublished ABS data.

2.4 Main findings

ICT uptake

- IT investment has been growing strongly for decades, but initially from a small base. IT grew in prominence in total investment from the mid-1980s. Real IT investment grew from around 3 per cent of total market sector investment in 1989-90 to around 19 per cent in 2000-01.
- The extent of a post-1995 ‘boom’ may have been overstated somewhat. IT use appears sensitive to the business cycle. Some of the prominence of IT in the second half of the 1990s appears to be due to weaker growth in IT investment and use in the first half of the 1990s, in response to the early-1990s recession. Some of the strong investment late in the decade may also have been associated with uncertainty concerning the Y2K bug. On the other hand, IT prices fell more rapidly and uses for IT (eg Internet) expanded after 1995.
- Services have accounted for at least three quarters of market sector demand for IT, mostly in keeping with their relative size. Finance & insurance has been the major sectoral destination, absorbing at least a quarter of total IT investment in the market sector — more than double its output share. Manufacturing was also a major destination.
- With the strong growth in IT investment, there was strong growth in IT capital services input in the 1990s. However, a strong IT presence had been established by the late 1980s in some industries — Finance & insurance, Communication services and Cultural & recreational services.

Performance effects

- The aggregate and sectoral evidence suggests that the uptake and use of ICTs have contributed to Australia's strong economic performance in the 1990s, including through improved productivity growth.
- IT's contribution to output growth increased from one-fifth of a percentage point in the 1970s to around one and a quarter percentage points in the late 1990s. IT accounted for around a quarter of 1990s output growth of 3.4 per cent a year and made a prominent positive contribution of 0.4 percentage points to the output acceleration of 0.3 of a percentage point (controlling for cyclical effects).
- The IT capital deepening contribution to labour productivity growth showed a similar pattern — climbing from one fifth to just under one and a quarter percentage points. IT capital deepening accounted for around a third of labour productivity growth of 3.0 per cent a year in the 1990s productivity cycle. It was also prominent (0.4 of a percentage point) in the 1990s productivity acceleration of 1.0 percentage point.
- However, the contribution from increase in IT use — even in the 1990s — has been offset by a weaker contribution from use of other capital. Increased IT use has not added to the overall contribution of capital to output growth or to the overall contribution of capital deepening to labour productivity growth.
- Faster MFP growth has provided the major contribution (1.1 percentage points) to the acceleration in output and productivity growth in the 1990s. Comparison with the US experience suggests that one or two tenths of a percentage point — up to 0.3 of a percentage point — of the MFP acceleration could be associated with ICT use.
- There is wide sectoral variation in IT use and performance effects, and no strong correlation across industries. The lack of universal correlation is consistent with there being major influence from other factors unrelated to ICT use, differences in scope for ICT-related productivity gains and differences in factors complementary to ICT use. In addition, there could be lags between ICT uptake and performance effects that have not been examined to this point.
- The Australian sectoral evidence matches the limited evidence from other countries that the ICT uptake and performance effects are concentrated — at least, to date — in financial intermediation and distribution (and also likely in business services, although this sector has not been investigated in this chapter).