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Investments in Intangible Assets and Australia's Productivity Growth: Sectoral Estimates

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Preface

This staff working paper examines sectoral investment in intangible assets in Australia following on from an examination of intangibles assets in the market sector as a whole (Barnes and McClure 2009). It highlights some significant issues relating to the measurement of intangibles and their contribution to productivity, finding that estimates of intangibles at the aggregate level mask considerable sectoral differences.

Helpful comments on a draft of the paper were received from Derick Cullen (Australian Bureau of Statistics), Jonathan Haskel (Imperial College London), Kate Maddern (Productivity Commission) and Ryan Macdonald (Statistics Canada). The Australian Bureau of Statistics provided vital assistance through the provision of unpublished data. Tracey Horsfall from the Productivity Commission assisted in the preparation of the paper.

The views expressed in this paper are those of the author and are not necessarily those of the Productivity Commission.

Abbreviations and explanations

Abbreviations

ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
BERD	Business expenditure on research and development
CEASA	Commercial Economic Advisory Service of Australia
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
EU KLEMS	European Union Capital, Labour, Energy, Materials and Services database
GDP	gross domestic product
GFCF	gross fixed capital formation
GMI	gross mixed income
GOS	gross operating surplus
GVA	gross value added
ICT	information and communication technology
IO	input-output
IPD	implicit price deflator
IT	information technology
LP	labour productivity
MFP	multifactor productivity
MH	Marrano and Haskel
MHW	Marrano, Haskel and Wallis

NBER	National Bureau of Economic Research
NCETS	National Centre for Education and Training Statistics
OECD	Organisation for Economic Cooperation and Development
PC	Productivity Commission
PIM	perpetual inventory method
PKS	productive capital stock
R&D	research and development
SOG	sources of growth
SU	supply-use
SUIC	supply-use industry code
SUPC	supply-use product code

Explanations

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

OVERVIEW

Key points

- In addition to tangible assets, such as plant and equipment, intangible assets, such as knowledge, firm-specific skills, and better ways of doing business, are important for economic growth.
- Most spending on intangibles is treated as a current expense in the national accounts rather than as an investment. This understates total investment and value added (production less intermediate inputs) in any period. The effect on measured productivity growth will vary by industry sector.
- Australian investment in intangibles in 2005-06 was estimated to be almost 65 per cent of tangible investment in the manufacturing sector, but only 50 per cent of tangible investment in the service sector.
  - Manufacturing invested almost $14 billion in intangible assets, while the service sector invested $35 billion.
  - By not fully capitalising intangibles, value added was understated by almost 13 per cent in manufacturing, and by almost 8 per cent in services.
  - Since 1993-94 average annual growth in total intangible investment in manufacturing has been somewhat less than in services; with relatively high growth rates in organisational capital (strategic planning, adaptation and reorganisation) and computerised information in both sectors.
  - Manufacturing invests a larger share of its total intangible investment in innovative property than does the service sector, as a result of the concentration of 'traditional' R&D in manufacturing. The service sector has a larger share in computerised information, while economic competencies account for around 50 per cent in each sector.
- Treating intangibles as investment increases both the capital stock *and* capital income. Hence the average rate of return on *all* capital can rise or fall. In practice, in each sector, capitalising the new intangibles increases the rate of return in about half the years and decreases it in the other half. Unmeasured intangibles do not appear to be the main factor behind rate of return differences between these sectors.
- 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 multifactor productivity (MFP) growth is complex. While adjusting for the 'new' intangibles does not have a large direct effect on conventionally-measured MFP growth for the Australian market sector as a whole, this conceals considerable sectoral differences.
  - In the 1998-99 to 2003-04 productivity cycle, the contribution of these intangibles to conventionally-measured MFP growth was -0.03 of a percentage point in manufacturing but 0.15 of a percentage point in services.
  - In the period of the market sector productivity surge (1993-94 to 1998-99), the contribution was 0.09 of a percentage point in manufacturing but only 0.04 of a percentage point in services.
  - However, capitalising intangibles did not change the pattern of MFP growth between cycles in either sector in Australia — in contrast with Japan, where it changed in both sectors. Prior to capitalising intangibles, Australian service sector MFP growth in the early 2000s was higher than the Japanese rate, but after capitalising intangibles the rate was lower in Australia than in Japan.

Overview

In recent years increased attention has been given to the contribution to economic growth of intangible assets such as knowledge, firm-specific skills and better ways of doing business. But most intangibles are treated as current expenses in official statistics, rather than as assets — despite the fact that they provide services in more than one period. This makes it difficult to examine their role in the economy. It leads to an understatement of investment in the economy and may also affect measures of productivity growth.

Corrado, Hulten and Sichel (CHS 2005, 2006) developed an experimental methodology for measuring investment in a wide range of intangibles that has been applied in a number of countries, including Australia. These estimates have been applied in a growth accounting framework to explicitly identify the contribution of intangibles to conventional productivity measures.

Experimental estimates for Australia, based on this method, suggest that intangibles are an increasingly important share of total investment in the market sector of the economy, making up around one-third of investment in 2005-06 (Barnes and McClure 2009). Including expenditure on intangibles as investment virtually removes the past declining trend in the market sector ratio of investment to output. But it does not have a large effect on the size or pattern of aggregate multifactor productivity (MFP) growth in the market sector in Australia (in contrast with some other countries). However, aggregate results can hide a range of offsetting changes across industries and do not provide information about the importance of intangibles to different industries.

This paper therefore extends this work on intangibles by applying the method to two key industry sectors within the Australian economy. The paper addresses two questions.

- Does the importance of intangibles as part of total investment vary across sectors?
- Does the exclusion of many intangibles from investment measurement affect the measures of sectoral economic growth and productivity?

The CHS methodology is applied to data for the manufacturing and service sectors of the Australian economy to estimate the level and growth of investment in a range of intangibles. The service sector measures only include those service industries in the market sector — Electricity, gas & water; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Communication services; Finance & insurance; and Cultural & recreational services. (The remaining industries in the market sector, Agriculture and Mining, are not examined.) The paper also examines, for each sector, the direct contribution to conventionally-measured productivity growth of those intangibles not currently treated as investment in the national accounts. The analysis also addresses the broader issue of whether differences in unmeasured investment in intangibles are behind sectoral differences in the rate of return on capital.

Given the experimental nature of the methodology, the assumptions required, measurement challenges and data limitations, the estimates are indicative only. With this caveat, the study finds that Australia has large and growing levels of investment in intangibles in both sectors but that the manufacturing sector invests more intensively in intangibles relative to output than the service sector. The direct contribution of intangibles to conventionally-measured MFP growth varies across sectors and periods, but it is generally higher in services than in manufacturing. Accounting for intangibles does not have a large effect on the pattern of sectoral productivity growth in Australia, unlike the sectoral results for Japan (Fukao et al. 2008).

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.

CHS use expenditure-based measures of intangibles, 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 R&D (reflecting knowledge embedded in patents, licences and general know-how) but is much broader —

including 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).

This paper employs the CHS categorisation to create a set of experimental estimates for intangibles in the manufacturing and service sectors in Australia (box 1). For those intangibles already treated as investment in the national accounts — computerised information, artistic originals and mineral exploration — ABS national accounts measures have been used.[1] For some of the 'new' 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, the estimates here provide a starting point and a first attempt (as far as can be ascertained) to apply the CHS methodology to measure the range of intangibles for the Australian manufacturing and service sectors.

[1] The analysis for this paper was undertaken before the Australian Bureau of Statistics (ABS) included R&D as investment in the national accounts in December 2009. The ABS estimates are based on a different industry classification to that used in this paper and are therefore not directly comparable. Nonetheless, a comparison of broadly similar industry divisions suggests a similar general pattern of movements over time in the R&D estimates in this paper and the ABS estimates (appendix A).

Box 1 **Measurement of intangibles**

CHS (2006) identified three main groups of intangibles, covering 13 individual intangibles. The measures and data sources used for the Australian sectoral 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 is discussed in chapter 2 and appendix A.

Type of intangible	Investment measure and main data source
Computerised information	
Computer software; Computer databases	Investment from Australian Bureau of Statistics (ABS) national accounts
Innovative property	
Scientific R&D; Social sci. R&D (Business R&D)	Expenditure on R&D from ABS business R&D survey
Mineral exploration	Investment from ABS national accounts (included in the market sector but not the manufacturing or service sectors)
Copyright and licence costs (Artistic originals)	Investment from ABS national accounts (service sector only)
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 (service sector only)
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

Less intensive investment in intangibles in services than in manufacturing

Australian investment in intangibles is large and has grown considerably over time, but varies across sectors. In 2005-06, nominal investment in intangibles is estimated to have been almost $14 billion in the manufacturing sector (almost 65 per cent of sectoral investment in tangibles) and $35 billion in the service sector (around 50 per cent of sectoral tangibles) (figure 1).

In manufacturing around 95 per cent of total intangible investment was in 'new' intangibles (those not already treated as capital in the national accounts). In services it was 80 per cent (as a result of the higher investment in computerised information than in the manufacturing sector). By not capitalising the 'new' intangibles, value added in the national accounts was effectively understated by around $13 billion in manufacturing and $28 billion in services — around 13 per cent of value added in manufacturing and 8 per cent in services. (Changing the treatment of intangible expenditure from a current expense to investment raises value added by the amount of the intangible investment.)

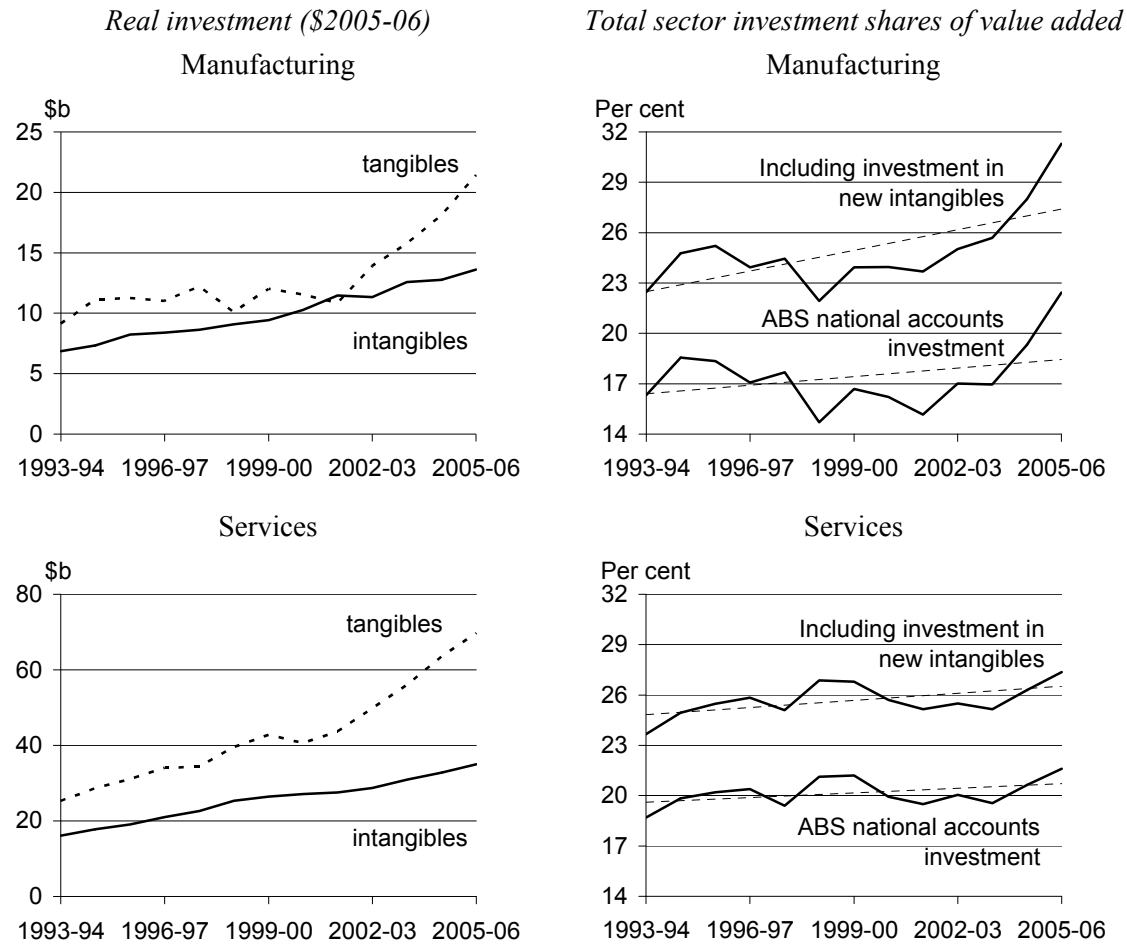
Since 1993-94 sectoral investment in intangibles as a percentage of sectoral gross value added (including intangible investment) has increased: from 8.0 per cent to 12.2 per cent in manufacturing; and to a lesser extent from 7.8 per cent to 9.1 per cent in services (in nominal terms). The higher ratio in manufacturing is partly, but not solely, because of a concentration of scientific R&D in manufacturing.

Investment in intangibles increases the trend in total investment shares

Since 1993-94 average annual growth in intangible investment in manufacturing (5.9 per cent) has been less than in services (6.7 per cent). In both sectors this has been less than tangible investment growth, due to a period of sharp growth in tangibles since 2001-02 (figure 1).

Including expenditure on the new intangibles within total investment increases the upwards trend in the sector ratios of total investment to gross value added seen in the Australian national accounts. The extent of this increase was greater in manufacturing than in services (figure 1).

Figure 1 **Investment by sector**



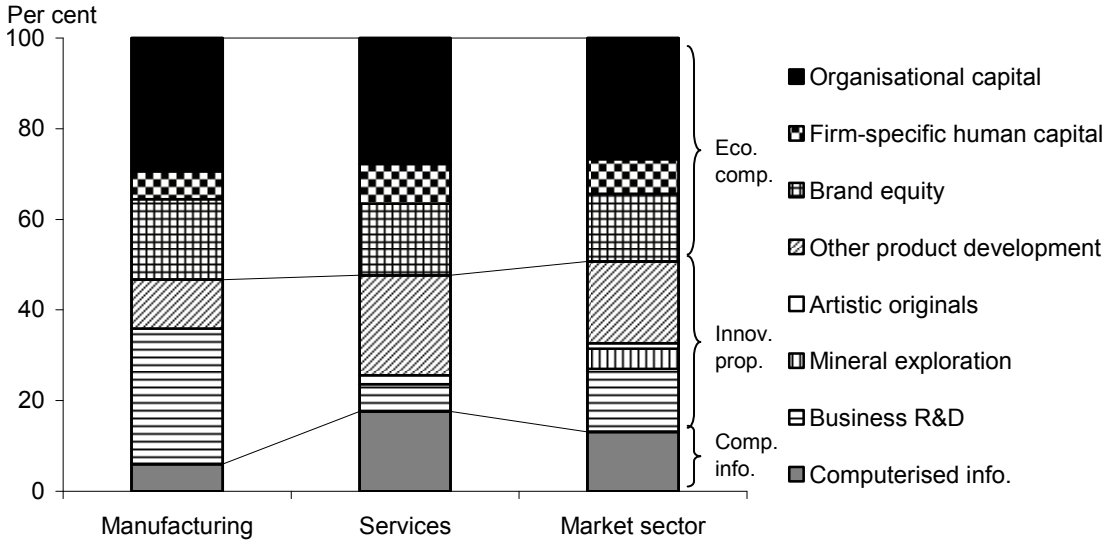
The composition of intangible investment varies by sector

There is considerable difference in the composition of intangible investment across sectors (figure 2). Intangible investment is more heavily concentrated in innovative property and less in computerised information in manufacturing than in services, as a result of the concentration of 'traditional' R&D in manufacturing. However, manufacturing has only a slightly higher proportion of intangible investment in economic competencies than does services.

Figure 2 **Shares of total intangible investment, by sector, 2005-06**

Percentage shares

53	52	49	Economic competencies
41	30	38	Innovative property
6	18	13	Computerised information



In 2005-06, 53 per cent of intangible investment in manufacturing was in economic competencies (of which 30 percentage points was organisational capital), 41 per cent in innovative property and 6 per cent in computerised information. In services, 52 per cent of intangible investment was in economic competencies (of which 28 percentage points was organisational capital), 30 per cent in innovative property and 18 per cent in computerised information. The difference in the composition of innovative property — with a much lower share of business R&D in services than in manufacturing — shows how traditional R&D measures particularly understate the level of innovative activity within the service sector compared with broader innovation measures.

In both sectors, this composition of intangible investment in the three main groups has been relatively stable over time. But within economic competencies organisational capital has become relatively more important than both firm-specific human capital and brand equity.

The intangible capital stock is growing in both sectors

The real intangible capital stock of the sectors has grown considerably since 1993-94 — at an average rate of around 6 per cent a year in both sectors. In 2005-06, the intangible capital stock is estimated to have reached $40 billion in the manufacturing sector (almost one-third of the sector's tangible capital stock). In the

service sector, the intangible capital stock is estimated at $101 billion in 2005-06, which is smaller relative to the sector's tangible stock (13 per cent) than in manufacturing.

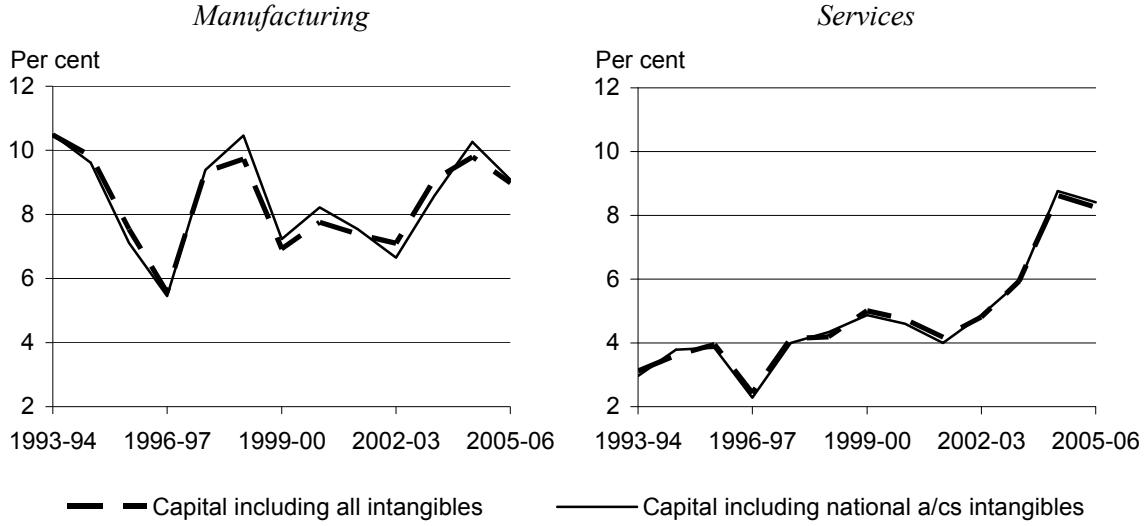
The composition of the intangible capital stock has been relatively stable in both sectors over the period 1993-94 to 2005-06, with a small shift towards economic competencies. In 2005-06, economic competencies made up a similar share of the total intangible capital stock in both sectors (around 38 per cent), with the difference between sectors being in innovative property and computerised information. Innovative property was more than half of this stock in manufacturing (56 per cent), but less than half in services (44 per cent). Computerised information was only 6 per cent in manufacturing but 19 per cent in services.

Capitalising new intangibles changes the average rate of return on capital

When intangible expenditure is not treated as investment, the rate of return on capital can be affected, as part of capital income is actually a return on unmeasured capital. As a result, differences in the intensity of investment in intangibles can lead to differences in rates of return on capital across sectors (as can a range of other factors). But treating intangible expenditure as investment increases the capital stock *and* capital income; hence the average rate of return on capital can rise or fall.

For each sector, in about half of the years during this period, capitalising the new intangibles increases the rate of return (compared with the rate when the only intangibles capitalised are those in the national accounts) (figure 3). In the other years the rate of return falls. But overall the size of the effect is relatively small in most years in both sectors. Therefore, it appears that unmeasured intangibles are generally not the main factor behind the observed difference in rates of return on capital between manufacturing and services. Indeed, capitalising intangibles increases this difference slightly in some years.

Figure 3 **Rates of return on capital, with and without capitalising the 'new' intangibles**



Effect on MFP growth varies across sectors

Treating intangible assets as capital can affect estimates of MFP. Growth accounting is a technique to estimate the proportion of output growth 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 growth. Conventional growth accounting treats most expenditure on intangibles as current expenses, rather than investments — this can result in biased measures of MFP growth (box 2).

Intangible assets *directly* account for varying amounts of conventionally-measured MFP growth in the manufacturing and service sectors. (This does not account for any *indirect* spillovers captured in MFP growth from, for example, complementarities between ICTs and some types of intangible capital.)

Box 2 **Growth accounting framework**

The growth accounting framework, first laid out in Solow (1957), 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 and it only accounts for the *direct* effect of inputs. Any indirect or spillover effects, such as from complementarities between different types of capital, remain within the residual.

When output is measured as gross valued added (total production less intermediate inputs), this 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 the combined inputs.* The residual is commonly referred to as multifactor productivity (MFP) growth, rather than technological change. Calculated as the residual, it will not only include pure technological change but also the effect of any measurement approximations and violations of underlying assumptions.

In the ABS official estimates of MFP growth, 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 can affect the estimates. Treating intangibles as capital 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.

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.

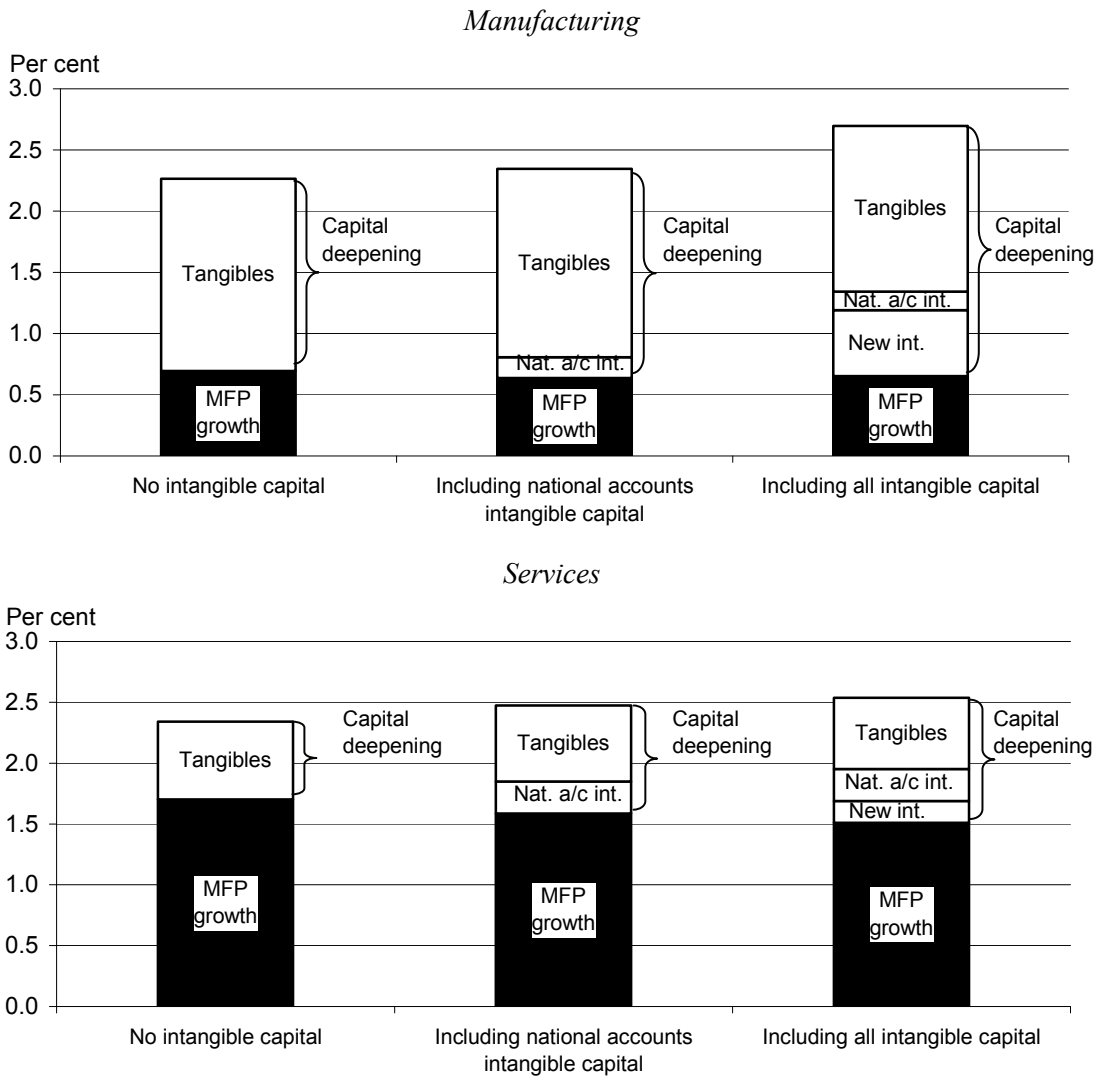
Measured MFP growth — the effect on measured MFP growth can be positive or negative depending on the relative size of the effects on output and input growth, that is, the difference caused by intangible investment (part of output not previously measured) and by intangible capital inputs (the services 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 (the weighted average of capital growth and labour growth) which changes as the capital and labour shares of total inputs change.

*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 the capital income share weighted growth in the capital-labour ratio (capital deepening) plus MFP growth.

Growth accounting estimates for the Australian manufacturing and service sectors are presented for three definitions of capital — including all intangibles, only the national accounts intangibles and no intangibles.[2] Labour productivity (LP) growth (growth in gross value added per hour worked in the sector) is decomposed into the contributions of capital deepening and MFP growth (figure 4).

Figure 4 **Decomposition of average annual labour productivity growth, 1993-94 to 2005-06**

Per cent per year



[2] 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.

In each sector, the effect of treating intangibles as capital is to raise value added and consequently raise measured LP growth and to shift the relative importance of the sources of growth — towards capital deepening and away from MFP growth (which is derived as the residual). While these results are experimental, sensitivity testing suggests that this finding is robust to a range of changes in the underlying estimates and assumptions within the reasonable bounds tested.

The extent of the effect varies across sectors. When all intangibles are capitalised, on average they contribute 43 per cent of total capital deepening and 17 per cent of LP growth between 1993-94 and 2005-06 in the service sector. In the manufacturing sector, all intangibles contribute less to total capital deepening (33 per cent) but more to LP growth (26 per cent) than in the service sector.

In services, compared with the case of no intangibles:

- LP growth is 0.19 of a percentage point (or 8 per cent) higher
- capital deepening is 0.38 of a percentage point (or 59 per cent) higher
- MFP growth is 0.19 of a percentage point (or 11 per cent) lower (this is the amount of MFP growth under the no intangibles case that is actually attributable to unaccounted for intangible capital).

In manufacturing, the effects on LP growth and capital deepening are almost offsetting, with the effect on MFP growth (as the residual) being small. Compared with the case of no intangibles:

- LP growth is 0.43 of a percentage point (or 19 per cent) higher
- capital deepening is 0.47 of a percentage point (or 30 per cent) higher
- MFP growth is 0.04 of a percentage point (or 6 per cent) lower.

These results reveal the sectoral differences within the aggregate market sector results in Barnes and McClure (2009).

Capitalising the new intangibles affects MFP growth in opposite directions in manufacturing and services

Some intangibles (computer software and artistic originals) are already capitalised in the ABS national accounts.[3] Not capitalising the 'new' intangibles affects the national accounts estimates of MFP growth by a small amount in each sector. But

[3] As noted, ABS R&D estimates were not available at the time analysis was being undertaken for this paper, so R&D is included as a 'new' intangible. Mineral exploration is also capitalised but is not relevant to the manufacturing and service sectors.

notably, the direction of the effect is different between manufacturing and services (in contrast to the effect of capitalising the national accounts intangibles).

In the service sector, 0.07 of a percentage point or 4 per cent of conventionally-measured average annual MFP growth is attributable to the new intangibles between 1993-94 and 2005-06. But in the manufacturing sector, -0.01 of a percentage point or -2 per cent of conventionally-measured average annual MFP growth is attributable to the new intangibles over this period. This means that capitalising the new intangibles *increases* measured MFP growth in manufacturing — although the change is very small indeed. While capitalising the new intangibles has a larger effect on capital deepening and LP growth in manufacturing than in services, for manufacturing these effects are largely offsetting so the effect on MFP growth is smaller than that for services.

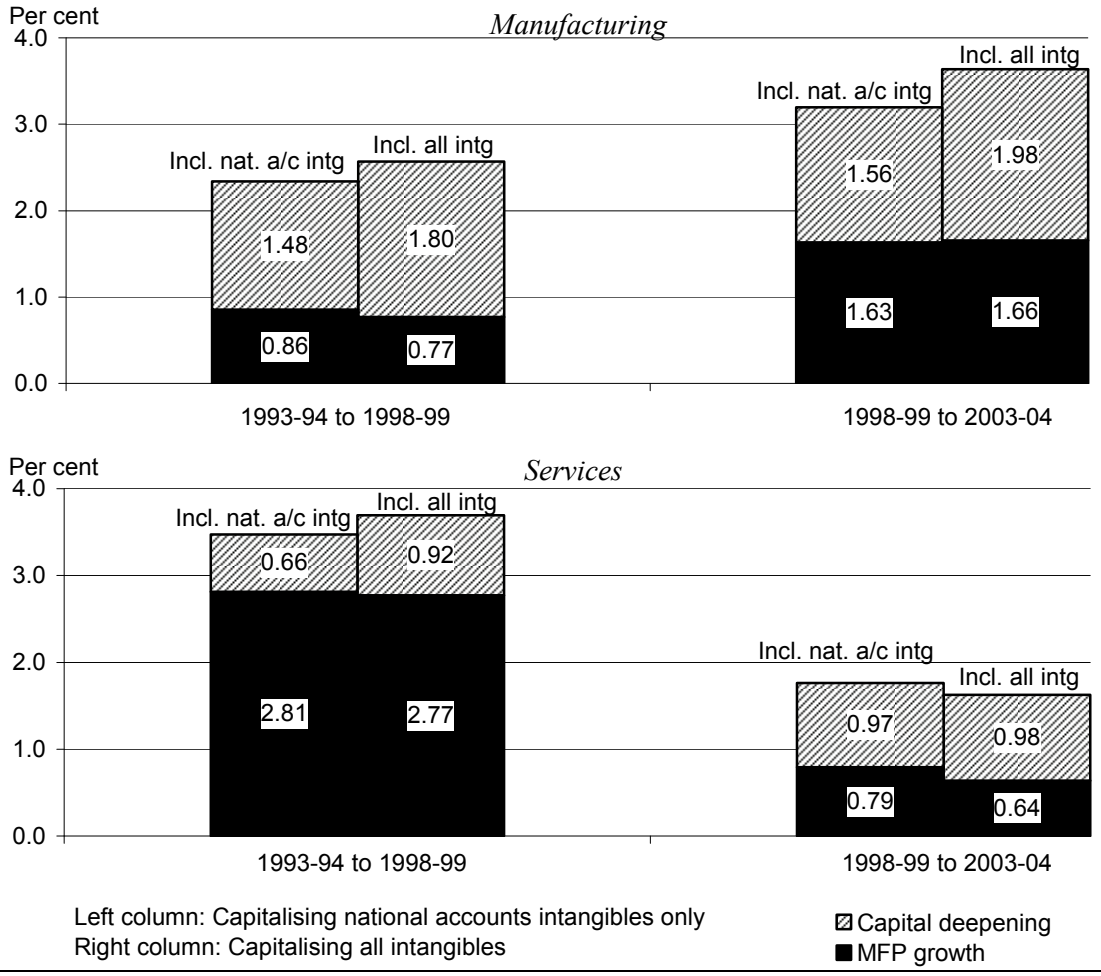
The size of the effect of the 'new' intangibles on MFP growth varies considerably over time

The effect of capitalising the new intangibles in each sector is not constant over time. Looking at MFP over growth cycles (which controls for influences of the business cycle), the amount of conventionally-measured MFP growth attributable to new intangibles varies considerably (figure 5). This reflects the differences in the extent to which the effect of capitalising intangibles on LP growth offsets the effect on capital deepening.

- During the market sector productivity surge (1993-94 to 1998-99), the contribution to conventionally-measured MFP growth of the new intangibles was positive in both sectors — 10 per cent (0.09 of a percentage point) in manufacturing but only 1 per cent (0.04 of a percentage point) in services. This decrease in MFP growth after capitalising these intangibles reflects the increase in capital deepening outweighing the increase in LP growth.
- In the next productivity cycle (1998-99 to 2003-04), the contribution of these intangibles to conventionally-measured MFP growth was -2 per cent (-0.03 of a percentage point) in manufacturing but 19 per cent (0.15 of a percentage point) in services. The increase in MFP growth in manufacturing after capitalising these intangibles reflects the increase in LP growth outweighing the increase in capital deepening, while the decrease in MFP growth in services reflects an increase in capital deepening *and* a decrease in LP growth.
- In manufacturing, capitalising the new intangibles led to a larger *increase* in the MFP growth rate between the first and second cycles. In services, there was a larger *decrease* in the MFP growth rate between the first and second cycles after capitalising the new intangibles.

Figure 5 **Contributions to labour productivity growth over MFP growth cycles, 1993-94 to 2003-04**

Per cent per year



International comparisons

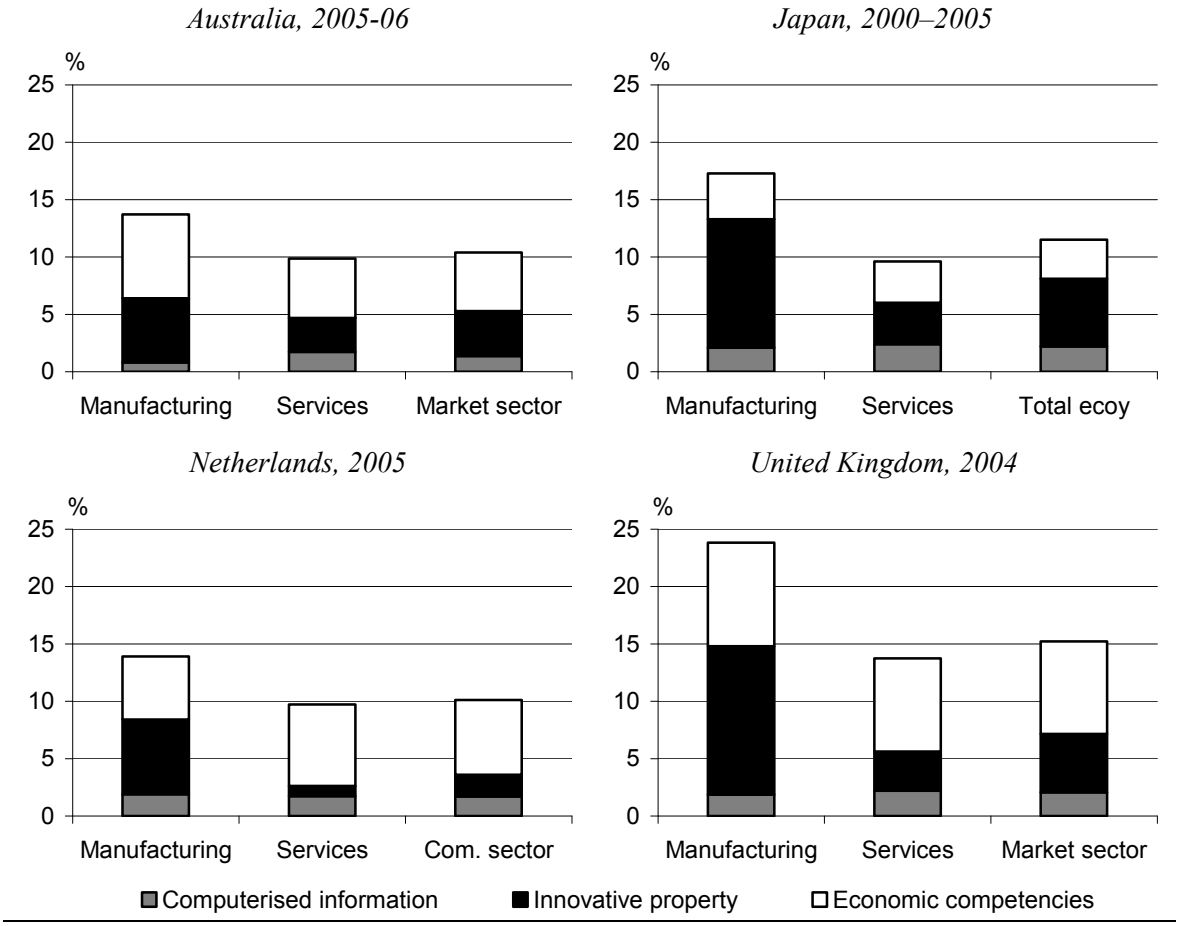
Comparing any measures across countries faces various difficulties. Even using measures based on the same methodology, as in this case, differences remain because of variations in underlying data and data limitations. The extent to which differences between the estimates in this paper and those in other country studies represent real differences rather than measurement differences is not known. And any real differences between countries should also be interpreted carefully — country-specific circumstances, including industry composition, will affect their appropriate level and type of intangible investment. It should also be noted that the growth accounting approach does not provide information about the causal links between intangible investment and productivity growth.

Greater similarity across countries in intangible investment in services than in manufacturing

With these caveats in mind, experimental estimates based on the CHS methodology suggest that Australia's intensity of investment in intangibles is more similar to other countries in the service sector than in manufacturing (figure 6).

Figure 6 **Intangible investment, by sector, by country**

Percentage of unadjusted sector value added (before 'new' intangibles capitalised)



Australia has a ratio of intangible investment to output in services similar to the Netherlands and Japan, which are also lower than the United Kingdom. In manufacturing, there is greater variation with Australia and the Netherlands having similar rates, slightly less than Japan and considerably less than the United Kingdom. Common to each country, the rate of intangible investment in services is less than in manufacturing — largely because of the concentration of innovative property in manufacturing but also because of a higher rate of investment in economic competencies in manufacturing (except in the Netherlands).

There is even more variation across countries at the individual intangible level, particularly in manufacturing (table 1). Australia's relatively low rate of investment in innovative property in manufacturing (around half that in the United Kingdom and Japan) is due to relatively low investment in both scientific and non-scientific R&D. Japan has considerably higher investment in scientific R&D compared with Australia, but a large part of this difference is the result of differences in the industry composition of the manufacturing sector. In services, rates of investment in the two types of innovative property are more similar across countries — except for the Netherlands but that estimate is affected by measurement differences.

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

Percentage of unadjusted sector value added (before 'new' intangibles capitalised)

	Australia (2005-06)	*Netherlands (2005)*	*Japan (2000–2005)*	*UK (2004)*
Manufacturing				
Computerised information	*0.8*	*1.9*	*2.1*	*1.9*
Innovative property	*5.6*	*6.5*	*11.2*	*12.9*
Scientific R&D	4.1	na	7.8	5.7
Non-scientific R&D	1.5	na	3.4	7.2
Economic competencies	*7.3*	*5.5*	*4.0*	*9.0*
Brand equity	2.4	na	1.6	1.7
Firm-specific human capital	0.8	na	0.5	3.2
Organisational capital	4.0	na	1.9	4.1
Total intangible investment	***13.7***	***13.9***	***17.3***	***23.8***
Ratio of intangible to tangible investment	0.64	1.45	0.90	2.63
Services				
Computerised information	*1.7*	*1.7*	*2.4*	*2.2*
Innovative property	*3.0*	*0.9*	*3.6*	*3.4*
Scientific R&D	0.6	na	0.4	0.2
Non-scientific R&D	2.4	na	3.1	3.3
Economic competencies	*5.2*	*7.1*	*3.6*	*8.1*
Brand equity	1.6	na	1.3	1.8
Firm-specific human capital	0.9	na	0.5	3.7
Organisational capital	2.7	na	1.7	2.7
Total intangible investment	***9.9***	***9.6***	***9.5***	***13.7***
Ratio of intangible to tangible investment	0.50	0.99	0.50	1.09

For economic competencies, the range of investment rates across countries is quite wide in both sectors. Australia has the second highest rate in manufacturing and the third highest in services.

Australia has the lowest intensity of investment in computerised information in both sectors (although this may be affected by the variation in the measure of computerised information used across countries). While it might be assumed that this is due to differences in industry structure, underlying industry level data show that Australia has relatively lower intensity across a range of industries within each sector.

There is also considerable variation in the ratios of intangible to tangible investment across countries, although in each country this ratio is higher in manufacturing than in services (table 1). The Australian ratio for manufacturing is less than half the equivalent ratio for the Netherlands and around a quarter of that for the United Kingdom, but is closer to that for Japan. For services, the Australian ratio is about the same as for Japan but around half that for the Netherlands and the United Kingdom. The lower ratios in Australia may be due in part to recent strong growth in tangible investment, which has generally not occurred in the other countries.

Adjusting for intangibles affects the pattern of MFP for some countries

The effect on MFP growth of capitalising all intangibles varied across countries in the early 2000s. Generally the size of the effect was larger in services than in manufacturing, but the direction of change differed across countries. In manufacturing, MFP growth was unchanged in Australia, fell in the United Kingdom and rose in Japan. In services, MFP growth fell in Australia and the United Kingdom but in Japan, again, there was a rise in MFP growth after capitalising intangibles. Notably, for the service sector, this meant that Australia's MFP growth ranking declined relative to Japan. (For manufacturing the ranking was unchanged because Japan already had higher MFP growth than Australia.)

Overall, capitalising all intangibles raised the contribution of capital deepening and lowered the contribution of MFP growth to LP growth in Australia and the United Kingdom in both manufacturing and services. The reverse was the case in Japan.

Treating intangibles as capital does not have a large effect on the pattern of MFP growth over productivity cycles for Australia. It only alters the extent of any increase/decrease in MFP growth between periods. This contrasts with Japan (the only country for which comparable estimates were available for sub-periods). In Japan a slowdown in MFP growth in manufacturing between 1995–2000 and 2000–05 became an increase after capitalising intangibles; and in services there was a similar reversal of the pattern of MFP growth between 1990–95 and 1995–2000 (Fukao et al. 2008).

Further research is needed

While the sectoral estimates in this paper extend the understanding of intangibles in the Australian economy, the estimates are exploratory and a number of measurement challenges remain. The development of improved measures (and data collections to support them), in conjunction with national statistics agencies, would be required before some intangibles could be considered for formal identification in the national accounts or even inclusion in a separate dataset focused on growth accounting. The recent recognition of R&D as capital in the ABS national accounts is one step towards greater understanding of the role of intangibles.

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 around the same size as business R&D in manufacturing and considerably larger than business R&D in services. While business R&D has now been capitalised, 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 indicates that the measurement and effects of organisational capital (including complementarities with ICTs) warrant further investigation. Surveys to gather data on organisational capital are underway in some countries (see, for example, Whittard et al. 2009).
- *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. van Ark et al. (2009) have started to use this pool of data to look at correlations between a range of variables and intangibles estimates from studies of 16 countries (including Australia).

1 Introduction

The contribution to economic growth made by intangible assets, such as knowledge, firm-specific skills, and better ways of doing business, has become the focus of increased attention in recent years. A recent survey by Hunter, Webster and Wyatt (2009) identified that many intangibles were considered value drivers for large Australian companies.

While intangible capital is not new[1], changes in the economy have raised its profile. Lev (2001) suggests intensified competition, due to globalisation of trade and deregulation in key economic sectors, and ICTs have changed the structure of firms and elevated the role of intangibles. However, despite this, the role and quantitative impact of intangibles are still not well understood.

The treatment of most intangibles as current expenses in official statistics, rather than as assets (despite the fact they provide services in more than one period) makes it difficult to examine their role in the economy. It leads to an understatement of investment in the economy and may also affect measures of productivity growth and the view of dynamic changes in the economy.[2] And there is the potential that distortions in resource allocation and policy may arise from this incomplete picture of the effect of intangibles (see Mortenson 2000, Vickery 2000 and Lev 2001).

The development by Corrado, Hulten and Sichel (CHS 2005, 2006) of a new framework for examining intangibles has led to experimental analysis of the importance of intangibles in an increasing number of countries, including Australia. CHS developed a 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.

More recently, national statistical agencies in some countries have moved to collect data on a wider range of intangibles — for example, the US Bureau of Economic Analysis is exploring the feasibility of creating satellite accounts reporting investment in a variety of 'new' intangibles (Aizcorbe et al. 2009); and the UK

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

2 Barnes and McClure (2009) provides a detailed discussion of the justification for recognising intangibles as assets and the associated measurement issues.

Office of National Statistics is undertaking a survey of new intangible assets identified within the CHS framework (Whittard et al. 2009).

Experimental estimates for Australia suggest that intangibles are an increasingly important share of total investment in the market sector of the economy, amounting to around one-third in 2005-06 (Barnes and McClure 2009). Including expenditure on intangibles as investment virtually removes the past declining trend in the market sector ratio of investment to output. But this has not had a large effect on the size or pattern of aggregate multifactor productivity (MFP) growth in Australia (in contrast with some other countries). However, aggregate results can hide a range of offsetting changes across industries and do not provide information about the importance of intangibles to different industries.

Recent work at the industry/sector level for Japan (Fukao et al. 2008), the Netherlands (van Rooijen-Horsten et al. 2008), the United Kingdom (Gil and Haskel 2008, Clayton et al. 2009), and Canada (Baldwin et al. 2009) suggests that intangibles are likely to be relatively more important in some industries than others. And the type of intangible investment also varies across industries. These studies have found that investment in total intangibles is generally more intensive in manufacturing than services. This might be expected, given the concentration of scientific R&D in manufacturing, but the extent of the difference between manufacturing and services varies considerably across countries. Perhaps less expected is the result that in some countries organisational capital (strategic planning, adaptation and reorganisation), which is often seen as being related to investment in IT, is also more intensive in manufacturing than in services.

Australia's aggregate ratio of investment in intangibles to output is mid-range of the countries for which estimates have been made, but is Australia's ratio lower than some countries due to lower levels across-the-board or lower levels in particular sectors? Establishing which intangibles are the most important in the different sectors may provide an indication of the potential for links between intangibles and productivity growth.

In addition, sectoral analysis of intangibles allows the exploration of a new dimension of the broader issue of differences in rates of return on capital across sectors. One possible explanation could be that the measured returns include that to unmeasured intangible capital.

This paper examines these issues through an analysis of intangibles in the Australian manufacturing and service sectors.

1.1 Definition and classification of intangibles

Intangible capital is variously defined but is basically assets that do not have a physical embodiment yet provide future benefits (see, for example, Lev 2001 and Sichel 2008).

This paper focuses on intangibles used by businesses and follows the Corrado, Hulten and Sichel (2005, 2006) categorisation of intangible capital:

- *computerised information* — the knowledge embedded in computer programs and databases
- *innovative property* — the relatively familiar R&D (reflecting knowledge embedded in patents, licences and general know-how) and mineral exploration, but also creative property (innovative and artistic content in commercial copyrights, licences and designs)
- *economic competencies* — brand equity[3] (for example, investments to retain or gain market share and investment in brand names); firm-specific human capital (employee skills); and organisational capital (investments in strategic planning, adaptation, organisational structures and business processes)

Organisational capital is perhaps the least well known of these. Examples include business processes built around computer systems; quality management systems, supply chain management solutions and innovation processes for product development.

Software and databases, mineral exploration and entertainment, literary or artistic originals have been capitalised in the Australian national accounts for some time. R&D was capitalised for the first time in national accounts in December 2009. It was not possible to use these estimates as the Australian Bureau of Statistics (ABS) estimates are based on a different industry classification to that used in this paper and were also not available at the time the main analysis was undertaken. The two sets of R&D estimates, while based on the same underlying ABS data, are not directly comparable because of the difference in industry classification but also because of differences in methodology. This paper employs a methodology comparable with that used in the other CHS-type studies, but which is less sophisticated than that used by the ABS. The measurement of the 'national accounts' intangibles and the 'new' intangibles (the other intangibles in the CHS classification including R&D) is discussed in chapter 2.

[3] There is some debate over whether expenditure on brand equity should be treated as an investment (see appendix A for a discussion of this issue).

The CHS classification and methodology is now widely accepted as a comprehensive framework for measuring intangibles but one which is experimental. As noted above, further research to refine the measures of some of the included intangibles is very much a work in progress. For a discussion of alternative definitions of intangibles and alternative measurement frameworks, see chapter 2 of Barnes and McClure (2009).

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 and their impact on the productivity of the manufacturing and service sectors (hereafter referred to as 'at the sectoral level') in Australia. For the purposes of this paper, the service sector is defined to consist of those service industries in the market sector[4]: Electricity, gas & water; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Communication services; Finance & insurance; and Cultural and recreational services.

More specifically the objectives are to:

- quantify Australian investment in intangibles at the sectoral level and examine its importance relative to tangible investment and output
- quantify the contribution of intangibles to conventionally-measured MFP growth at the sectoral level
- examine differences across sectoral rates of return on capital with and without intangible capital
- compare Australian sectoral estimates with those of other countries.

Measuring intangibles contributes to:

- a better understanding of the changing composition of total investment and the rate of return on all capital at the sectoral level
- a better understanding of whether measured sectoral MFP growth is reflecting actual dynamic changes in the economy (as distinct from changes in unmeasured assets)

4 In this paper, the market sector has the scope defined in ABS (2007a) under the Australian and New Zealand Standard Industrial Classification 1993 edition — Agriculture, forestry & fishing, Mining, Manufacturing, and the service industries listed above.

- a better understanding of the potential for interactions between intangible and other capital (for example, complementarities between ICT and organisational capital).

This study builds on previous Commission research on intangible assets in the market sector of the economy and is a continuation of the Commission's stream of research that has 'parcelled out' elements of MFP growth. As a companion piece to the market sector study, this paper focuses on the results of the analysis rather than the broader intangibles literature and the full details of the CHS methodology (which can be found in Barnes and McClure 2009).

1.3 The rest of the paper

The remainder of this paper is organised as follows.

- Chapter 2 outlines the way in which investment in each of the intangibles has been measured and presents the sectoral estimates of intangibles investment and capital stocks. It also discusses the effect of capitalising intangibles on the measured rate of return on all capital. Appendix A provides details of the data sources and assumptions used.
- Chapter 3 outlines the methodology for explicitly identifying the contribution of intangibles in sectoral growth accounting in the Australian context and presents the results. Appendix B provides further details of the methodology. Appendix C provides details of the sensitivity testing of results.
- Chapter 4 compares the Australian results with those from other country studies.

2 Measures of intangible assets

This chapter outlines the methodology for measuring intangibles investment and capital stocks. The experimental results are then presented for the manufacturing and service sectors of the Australian economy.

2.1 Measurement of intangibles

As noted in chapter 1, Corrado, Hulten and Sichel (CHS 2005, 2006) classify intangibles into three main categories — computerised information, innovative property and economic competencies. This classification is adopted in this paper. Measurement of these intangibles is a complex task, which involves the estimation of investment in each intangible, building intangible capital stocks and constructing capital services measures (box 2.1).

Box 2.1 Estimation of intangibles

Measurement of intangibles requires a number of steps, many of which involve difficult measurement issues.

- Estimate investment in each intangible asset for each industry sector
  - 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 for each industry sector
  - 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 measures of all capital inputs (tangible and intangible) for each industry sector 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 (tangible and intangible) in each industry sector.

Table 2.1 summarises the data sources and assumptions used to construct the real investment estimates for each of the intangibles. In most cases, the measures follow CHS (2005, 2006) in order to facilitate international comparisons. The exceptions are where Australian Bureau of Statistics (ABS) measures are available — computer software, artistic originals and mineral exploration. Mineral exploration is conducted by the mining industry and will not be relevant to the manufacturing and service sectors, but is included in the market sector totals reported for comparison. The ABS allocates all artistic originals to Cultural & recreational services, which is part of the service sector.

Table 2.1 Data sources and assumptions used to construct investment and stocks of intangibles by sector[a]

Type of intangible	*Expenditure measure and main data sources*[b]	*Invest't share*[c]	*Deflator*	*Dep'n rate*[d] *(%)*
Computerised information				
Computer software	Computer software investment by each sector ABS national accounts (Cat. no. 5204.0)	1	ABS computer software implicit price deflator (IPD)	24 (Mfg) 23 (Serv.)
Computer databases	Included in software estimates			
Innovative property				
Business expenditure on R&D (BERD)	Business R&D expenditure by each sector ABS BERD survey (Cat. no. 8104.0)	1	Implied sector gross value added (GVA) deflator	20
R&D in social sci. and humanities	Included in BERD estimates			
Artistic originals[e]	Artistic originals investment by service sector ABS national accounts (Cat. no. 5204.0)	1	ABS artistic originals IPD	60
Other product development, design and research				
New product development in financial industry[e]	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	20
New architectural and engineering designs	50 per cent of sales of architectural and consulting engineering services to each sector ABS Industry survey (Cat. no. 8155.0) and ABS IO/SU tables (Cat. no. 5215.0/ unpublished)	1	Implied sector GVA deflator	20

(continued on next page)

Table 2.1 **(continued)**

Type of intangible	*Expenditure measure and main data sources*[b]	*Invest't share*[c]	*Deflator*	*Dep'n rate*[d] *(%)*
Economic competencies				
Brand equity				
Advertising	Each sector's 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 sector GVA deflator	60
Market research	Sales of market research services to each sector. 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 sector GVA deflator	60
Firm-specific human capital	Direct costs and wage costs of employee time in training for each sector. ABS Training surveys (Cat. nos 6353.0, 6278.0)	1	Sector average weekly full-time ordinary earnings deflator	40
Organisational capital				
Purchased	Sales of management consulting services to each sector. Assumed to be 77 per cent of sales of all business management services to each sector. ABS Industry survey (Cat. no. 8155.0) and ABS IO/SU tables (Cat. no. 5215.0/ unpublished)	0.8	Implied sector GVA deflator	40
Own account	20 per cent of salaries of Managers & administrators (excluding farm managers and IT managers) in each sector. ABS Labour Force Survey (Cat. no. 6310.0)	1	Implied sector GVA deflator	40

[a] Manufacturing and service sectors. Barnes and McClure (2009) provides details of estimates for the market sector including mineral exploration, which is already capitalised in the national accounts and is only relevant to the mining industry. [b] Full details of data sources are provided in appendix A. [c] As used in CHS (2005, 2006). Basis for assumptions discussed in appendix A and sensitivity testing of some of these assumptions reported in appendix C. [d] For the new intangibles the depreciation rate is assumed to be constant over time. For the intangibles already included in the national accounts (software and artistic originals) the ABS varies the rate over time — the rate shown is the average for the period 1993-94 to 2005-06. [e] Only relevant to the service sector.

As noted in chapter 1, business R&D was capitalised for the first time in ABS national accounts in December 2009. However, as it was not possible to use those estimates in this paper, business R&D is still included as one of the 'new' intangibles in this paper. The R&D estimates in this paper, while based on the same underlying ABS data, are not directly comparable with the new ABS estimates — for methodological reasons and because of the use of a different industry classification (see appendix A for further discussion).

The assumptions are the same for the manufacturing and service sectors unless otherwise specified. The deflators differ across sectors — following the CHS methodology output deflators have been used for most intangibles, that is the implied sector gross value added (GVA) deflator for each of the sectors. The use of different deflators across industries means that in real terms the estimates will not be additive — that is, the sum of the services and manufacturing sectors can not be deducted from the market sector estimate to derive an estimate for the agricultural/mining sector.

The issue of appropriate deflators for intangibles is a difficult one. As noted by CHS (2005), 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. While appropriate deflators for intangibles have been the subject of discussion in more recent literature (see for example, Nakamura 2009), they remain an issue for further work.

There are other measurement assumptions that also need further work. However, at present there is limited information available to refine these assumptions. For this paper, attempts were made to assess the appropriateness for the Australian context of two of the assumptions used by CHS — the amount of manager's time used as a proxy for own account organisational capital and the depreciation rate for advertising. While it has not been possible to validate these assumptions for the Australian context, the available literature suggests the CHS assumptions are not unreasonable 'placeholders' until other information becomes available (see appendix A). Recent intangibles research has moved into the area of conducting surveys to directly collect data from firms on some of these aspects of the new intangibles (see, for example, Whittard et al. 2009).

Further details of the data sources and methodology for estimating intangibles are provided in appendix A and a detailed discussion of the underlying methodology can be found in Barnes and McClure (2009).

2.2 Current intangible investment

Applying the measurement assumptions discussed above, it is estimated that investment in intangibles was almost $14 billion in manufacturing and $35 billion in services in 2005-06 (table 2.2). This is 24 per cent and 61 per cent, respectively, of market sector investment in intangibles of $57 billion in 2005-06.

Table 2.2 **Nominal intangible investment, by sector, 2005-06**

	Manufacturing		*Services*[a]		*Market sector*[b]	
	$m	% of total	$m	% of total	$m	% of total
Computerised information	*817*	*6.0*	*6 160*	*17.6*	*7 435*	*13.1*
Innovative property	*5 540*	*40.7*	*10 534*	*30.1*	*21 346*	*37.6*
BERD	4 076	29.9	2 105	6.0	7 904	13.9
Mineral exploration	-	-	-	-	2 503	4.4
Artistic originals	-	-	698	2.0	698	1.2
Other product development	1 464	10.8	7 732	22.1	10 241	18.1
Financial product development	-	-	5 591	16.0	5 591	9.9
New arch./eng. designs	1 464	10.8	2 141	6.1	4 650	8.2
Economic competencies	*7 254*	*53.3*	*18 311*	*52.3*	*27 942*	*49.3*
Brand equity	2 412	17.7	5 509	15.7	8 444	14.9
Advertising	2 152	15.8	4 786	13.7	7 337	12.9
Market research	260	1.9	723	2.1	1 107	2.0
Firm-specific human capital	832	6.1	3 062	8.7	4 353	7.7
Organisational capital	4 009	29.5	9 740	27.8	15 146	26.7
Purchased org. capital	2 401	17.6	6 669	19.1	10 208	18.0
Own account org. capital	1 608	11.8	3 071	8.8	4 938	8.7
Total intangibles investment	**13 611**	**100.0**	**35 006**	**100.0**	**56 724**	**100.0**
New intangibles	12 794	36.5	28 148	26.9	46 088	25.0
National accounts intangibles	817	2.3	6 858	6.5	10 636	5.8
Tangibles	21 426	61.2	69 777	66.6	127 935	69.3
Total investment	**35 037**	**100.0**	**104 783**	**100.0**	**184 659**	**100.0**

[a] The service sector includes: Electricity, gas & water; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Communication services; Finance & insurance; and Cultural and recreational services. [b] The market sector includes: Agriculture, forestry & fishing; Mining; Manufacturing; and the service sector

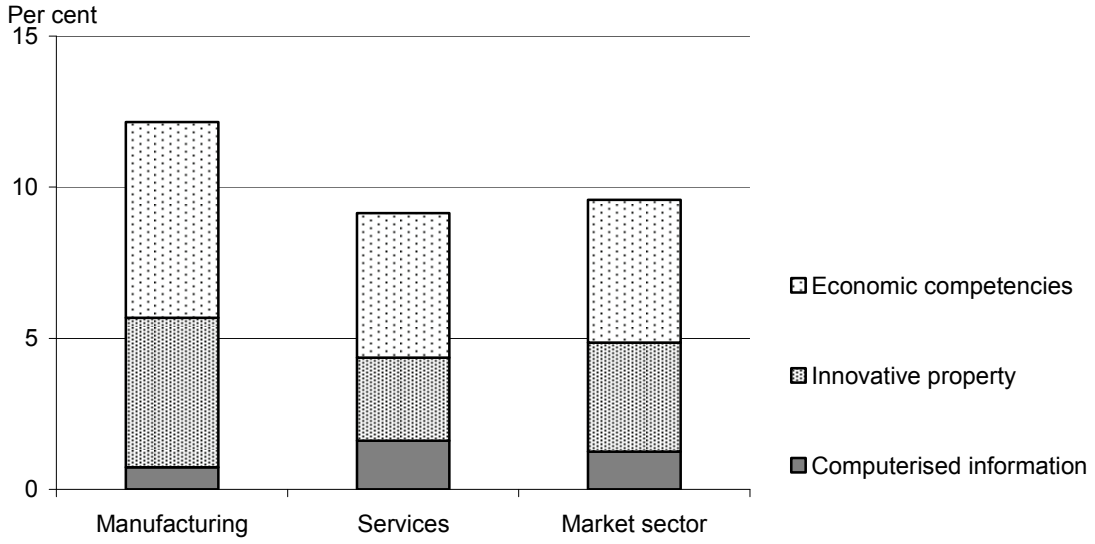
Sources: Author's estimates; Barnes and McClure (2009).

There is considerable variation in the intensity of intangible investment by sector (figure 2.1). For manufacturing, total intangibles investment was 12.2 per cent of adjusted gross value added (that is, sector gross value added including the

investment in the intangibles), but in services it was only 9.1 per cent. The equivalent measure for the market sector was 9.6 per cent. This means that by not capitalising the *new* intangibles, value added in the national accounts is understated by around $13 billion (or 13 per cent) in manufacturing and $28 billion (or 8 per cent) in services. The service sector makes up 65 per cent of market sector (unadjusted) value added in the national accounts, while manufacturing is 18 per cent.

Figure 2.1 **Intangible investment as a share of output[a], by sector, 2005-06**

Percentage share



a Treating expenditure on intangibles as investment increases the measured level of value added by the amount of intangible investment. So output is unadjusted gross value added of the relevant sector plus intangible investment of relevant sector.

Data sources: Author's estimates; Barnes and McClure (2009).

Types of intangible investment differ across sectors

Manufacturing has a higher ratio of investment to output for innovative property and economic competencies than the service sector, while the opposite is the case for software (figure 2.1).

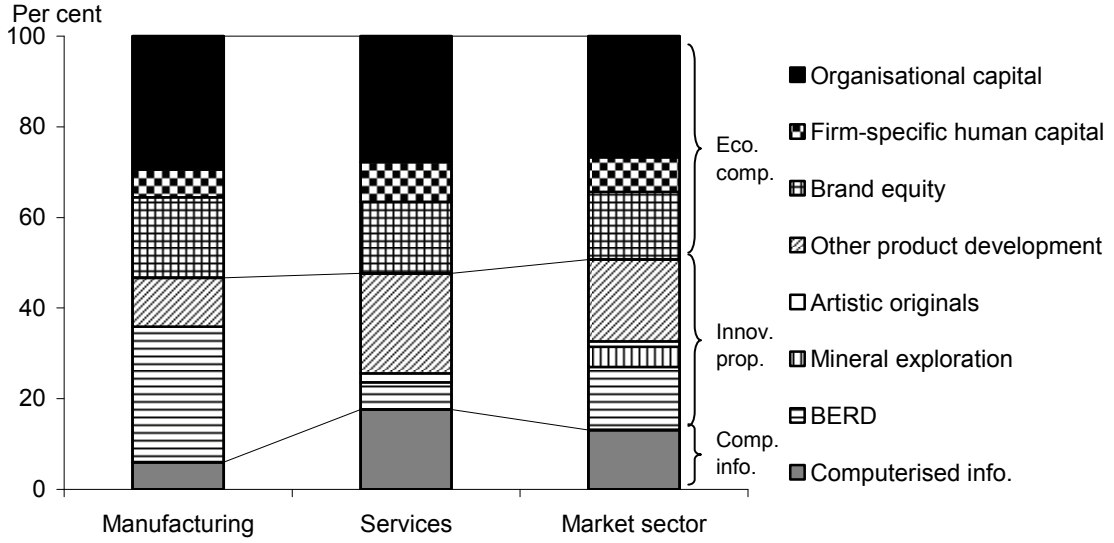
The higher total ratio in manufacturing is not unexpected, given the concentration of scientific R&D in manufacturing. Perhaps less expected is that manufacturing also has a higher ratio of investment in economic competencies to output than services — although these findings for Australia are similar to those found in other country studies (see chapter 4). Economic competencies, such as organisational capital, are

often thought of as being associated with computerised information and the provision of services (for example, with financial sector databases and customer interfaces). However, there are many forms of organisational capital that are relevant to manufacturing, for example, just-in-time inventory systems and quality control systems. Also, some computer software used in manufacturing may be embedded in tangible capital, such as machinery, and may not be included in the measure of investment in computerised information.

Figure 2.2 **Shares of nominal total intangible investment, by asset, by sector, 2005-06**

Percentage share

53	52	49	Economic competencies
41	30	38	Innovative property
6	18	13	Computerised information



Data sources: Author's estimates; Barnes and McClure (2009).

Figure 2.2 (together with table 2.2) provides a more detailed picture of the compositional differences in total intangible investment across the sectors in 2005-06.

- Of the main groups of intangibles, computerised information is the smallest share of total investment in intangibles in each sector — but in services the share is three times that in manufacturing (18 per cent compared with 6 per cent).
- In each sector the largest group of intangibles is economic competencies. While as a ratio to output, manufacturing invests more in economic competencies than does services, economic competencies makes up a similar share of total investment in intangibles in both sectors (53 per cent in manufacturing and 52 per cent in services). And of this, in both sectors more than half was organisational capital.

- Innovative property was the second largest group in both sectors (41 per cent in manufacturing and 30 per cent in services). But the split between non-scientific R&D (other product development and artistic originals) and BERD was quite different across sectors, as noted above. BERD was dominant for manufacturing (three-quarters of innovative property) while non-scientific R&D dominated for services (almost 80 per cent).
  - The difference in the composition of innovative property shows how traditional R&D measures particularly understate the level of innovative activity within the service sector compared with broader R&D measures.
- The 'new' intangibles (that is, those not already treated as investment in the national accounts) are the majority of total intangible investment in both sectors — making up almost 95 per cent of total intangible investment in manufacturing and 80 per cent in services.

Figure 2.2 highlights the differences in the ratio of organisational capital to computerised information across manufacturing and services. These estimates suggest that manufacturing invests more in organisational capital relative to software than the service sector (although, given assumptions and data limitations, it is not possible to rule out measurement error as a possible cause of part of this difference across sectors[1]). As noted above, while organisational capital is perhaps most often thought of as a complement to computerised information (where the service sector invests more), there are many forms of organisational capital. But it is also the case that some service industries will require large amounts of software relative to organisational capital. For example, in 2005-06 the three service industries with the highest ratio of software investment to output were Communications, Finance & insurance and Electricity, gas & water. While estimates of organisational capital at the industry level are not available, these three industries have network characteristics that are likely to require large amounts of

[1] Uniform assumptions across sectors, made in the absence of sectoral measures, may not reflect actual sectoral differences in investment in organisational capital. For example, in the actual percentage of managers' time spent on building organisational capital may vary by sector.

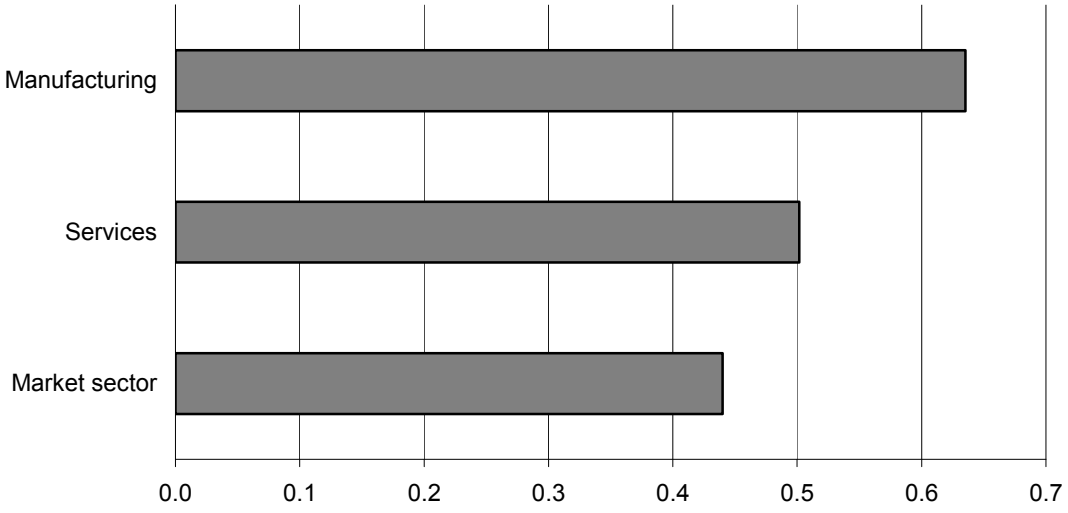
Data limitations also may affect sectors differently. For example, purchased organisational capital is measured using data on the closest available group of business services to that suggested by CHS as a relevant measure of organisational capital (management consultancy services). Business management services includes a broader group of services including personnel management and public relations consultancy services. While a percentage adjustment is made to attempt to exclude these services it is based on limited data and is not industry sector specific. If there is significant variation across industry sectors in the composition of total business services then the measure of purchased organisational capital may be distorted to a differing extent in each industry making the comparison biased. Unfortunately there are no readily available data to estimate the extent of any such bias.

software to operate their distribution networks and customer interfaces relative to the organisational capital that may be involved in designing these systems.

Investment in intangibles relative to tangibles

Manufacturing invests considerably more in intangibles relative to tangibles than services. The ratio of intangible to tangible investment was around 0.64 in manufacturing and 0.50 in services, compared with a ratio of around 0.44 for the market sector (figure 2.3). While manufacturing might be expected to be a relatively intensive user of tangible capital, the scope of the service sector used in this paper includes Electricity, gas & water, and Transport & storage, which are very intensive users of tangible capital. And in 2005-06 the manufacturing and service sectors actually had a similar ratio of tangible investment to output (around 20 per cent).

Figure 2.3 **Ratio of intangible to tangible investment, by sector, 2005-06**



Data sources: Author's estimates; Barnes and McClure (2009).

2.3 Growth in intangible investment

Average annual growth in the real level of intangibles investment between 1993-94 and 2005-06 was 5.9 per cent in manufacturing and 6.7 per cent in services (table 2.3). This contrasts with higher growth in investment in tangible assets, for which average annual growth was 7.4 per cent in manufacturing and 8.9 per cent in services.

Table 2.3 **Growth in real intangible investment[a], by sector, 1993-94 to 2005-06**

Per cent per year

	Manufacturing	*Services*	*Market sector*
Computerised information	*9.1*	*11.5*	*11.4*
Innovative property	*5.7*	*4.4*	*4.8*
BERD	5.3	12.3	7.8
Mineral exploration	-	-	2.5
Artistic originals	-	3.6	3.6
Other product development	6.8	3.1	3.7
Financial product development	-	1.6	1.6
New arch./eng. designs	6.8	8.0	6.8
Economic competencies	*5.5*	*6.1*	*5.9*
Brand equity	3.9	3.1	3.2
Advertising	3.3	2.3	2.5
Market research	11.5	11.6	11.5
Firm-specific human capital	-3.5	0.7	-0.3
Organisational capital	10.9	11.6	11.4
Purchased organisational capital	16.1	16.2	16.1
Own account organisational capital	6.5	6.2	6.0
Total intangibles investment	**5.9**	**6.7**	**6.4**
New intangibles	5.6	5.5	5.6
National accounts intangibles	9.1	10.8	8.9
Tangibles	7.4	8.9	8.4
Total investment	**6.8**	**8.1**	**7.7**

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

Sources: Author's estimates; based on data from Barnes and McClure (2009).

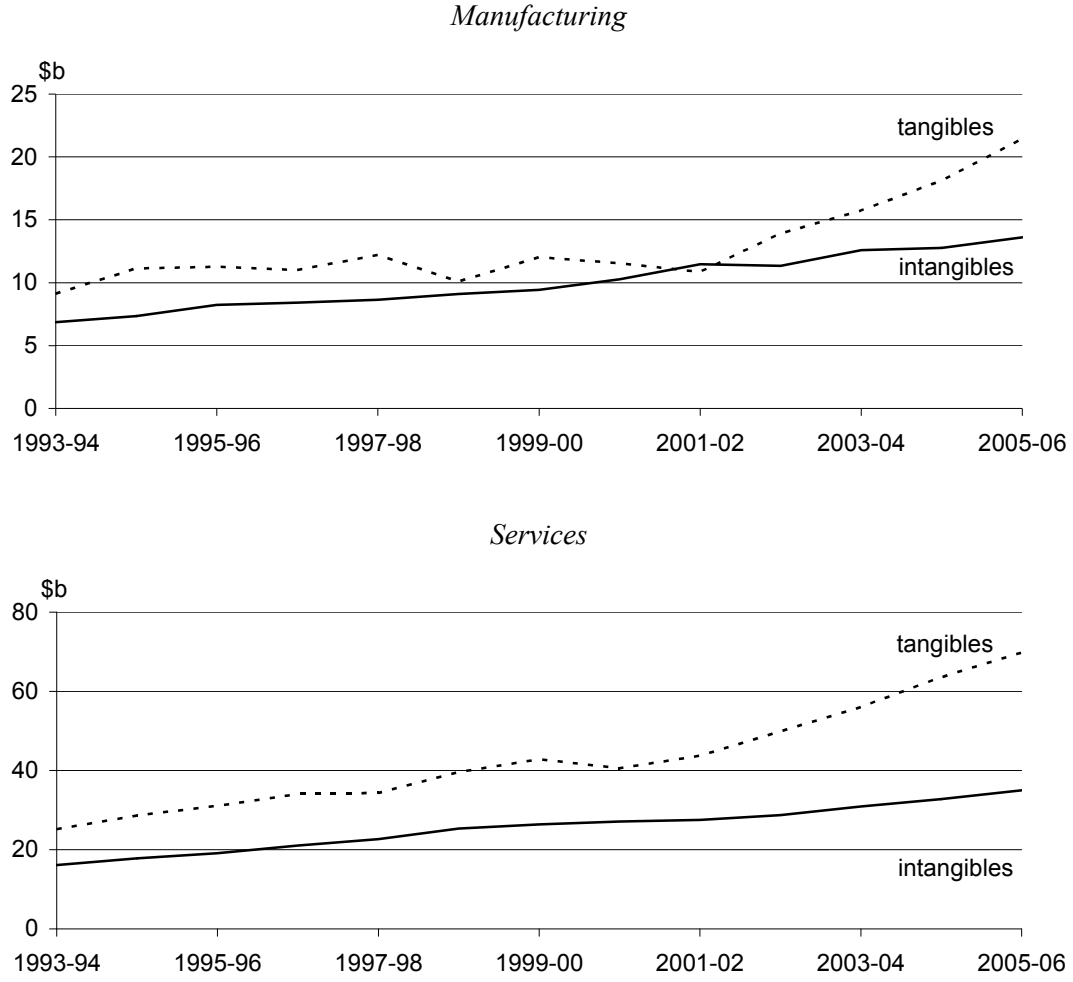
However, the higher average growth rate for tangibles than intangibles over this period was due to a sharp rise in investment in tangibles from around 2001-02 (figure 2.4). Prior to this, intangible investment growth in manufacturing was 6.6 per cent a year compared with 2.2 per cent a year in tangibles. In services, investment growth was similar for tangibles and intangibles, at an average of around 7 per cent a year up to 2001-02.

In both sectors, growth in investment in total intangibles was relatively smooth compared with investment in tangibles (although growth in investment in some individual intangibles is less smooth). Baldwin et al. (2009) also found that intangible investment was less cyclical than tangible investment. They suggested that intangibles share this characteristic with inputs that have higher adjustment

costs (such as skilled workers), perhaps because they are complementary with those inputs.

Figure 2.4 **Real investment, tangibles and intangibles[a], by sector, 1993-94 to 2005-06**

2005-06 dollars, chain volume measures



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

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

Growth by type of intangible

Growth in investment varied by type of intangible across the industry sectors (table 2.3). While computerised information was the fastest growing group in each sector, investment in economic competencies grew faster than in innovative property in services but in manufacturing it was the opposite. The average growth rate for new intangibles in total was similar in manufacturing and services.

At the individual intangible level, the largest differences in growth rates between sectors are for investment in business R&D and firm-specific human capital. Growth in business R&D in manufacturing was much lower than that in the service sector (but it was growth from a much lower base in the service sector). The firm-specific human capital series are subject to a number of measurement errors that may be compounded in growth rate calculations and all the growth rates should be interpreted cautiously.[2] For example, as a result of very limited data for employer-provided training expenditure the estimates of investment in firm-specific human capital are based on aggregate trends and do not fully incorporate sectoral differences in costs of training.

Despite varying growth rates across individual intangibles, the composition of total intangible investment across the three main groups has been relatively stable over time in both sectors — with a slight increase in the share of economic competencies and a slight fall in the computerised information share. However, within economic competencies in both sectors, organisational capital has increased in relative importance compared with brand equity and firm-specific human capital. As a share of total intangible investment by sector, organisational capital has risen from 16 to 30 per cent in manufacturing and from 15 to 28 per cent in services.

Growth in intangible investment relative to output

Although growth in intangible investment in services has been faster than in manufacturing, the ratio of intangible investment to adjusted value added (in nominal terms) has risen more in manufacturing than services — from 8.0 per cent in 1993-94 to 12.2 per cent in 2005-06 in manufacturing and from 7.8 to 9.1 per cent in services. This reflects slower growth in value added (including investment in intangibles) in manufacturing than in services. While the intensity of investment in intangibles in 2005-06 is higher in manufacturing than services it was similar across the two sectors in 1993-94.

In both sectors intangible investment increased in importance relative to tangible investment between 1993-94 and 2005-06. In manufacturing, the ratio of intangible to tangible investment was 0.56 in 1993-94 and 0.64 in 2005-06 — having reached 0.87 in 2001-02 prior to recent period of rapid growth in tangibles. In services the

[2] 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 and the cause of differences between the sectors. This exercise was beyond the scope of this paper. See appendix A for further discussion of the data limitations.

ratio was about 0.50 at the beginning and the end of the period, having reached 0.59 in 2000-01.[3]

Barnes and McClure (2009) found that as a result of this increasing ratio of intangible to tangible investment at the market sector level, capitalising all intangibles investment virtually removed the declining long-term trend in the market sector ratio of total investment to gross value added shown by ABS national accounts data (between 1974-75 to 2005-06). Over the shorter period for which sectoral results have been estimated, the trend in the ABS national accounts data is already upwards (figure 2.5). ABS national accounts data (which include only a subset of intangibles as investment) show an increasing trend in nominal total investment as share of sector gross value added (bottom line). However, after including the 'new' intangibles as investment the trend is steeper (top line).[4] The inclusion of the new intangibles increases the upwards trend to a larger extent in manufacturing than services. The gap between sectors is also changed — in 2005-06 the inclusion of the new intangibles increases the difference between the investment to output shares of manufacturing and services from less than 1 percentage point to almost 4 percentage points.

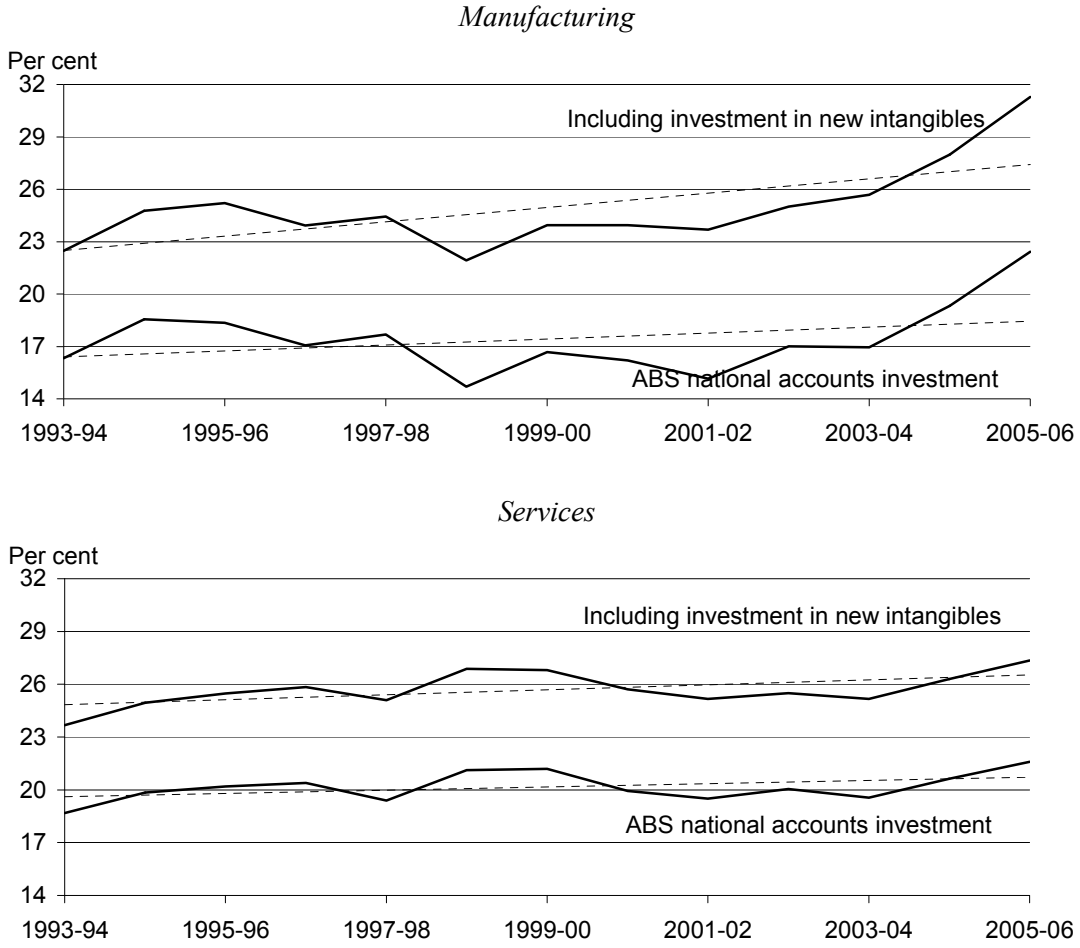
[3] These ratios are in nominal terms. Looking at the series for real investment in intangibles and tangibles in figure 2.4 provides a different picture of the ratio of intangible to tangible investment. This is because the deflator used to derive the real *intangible* investment series is not the same as the deflator used for the real *tangible* investment series — and the trends in these two deflators are very different. The deflator for intangibles is output-related and shows a 'normal' rising price trend. The deflator for tangibles is affected by falling machinery and equipment prices (particularly computers) and on average has fallen slightly over the period examined.

The comparison in real terms shows in a particular year the volume of intangible investment relative to the volume of tangible investment. The nominal ratios show the current price value of intangible investment relative to the current price value of tangible investment. The nominal ratios are included in addition to the real ratios because the deflators used for the intangible assets have been identified as needing further work.

[4] This trend is obviously sensitive to the assumptions used in estimating investment in the new intangibles (see appendix C for the variability of investment to these assumptions).

Figure 2.5 **Total investment shares of gross value added, 1993-94 to 2005-06**

Percentage of sector gross value added[a]



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

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

2.4 Intangible capital stocks

Current capital stock

The value of the total intangible capital stock is estimated to have been around $40 billion in manufacturing and $101 billion in services in 2005-06 (table 2.4). Of the market sector stock of $189 billion, manufacturing accounts for 21 per cent and services for 53 per cent.

Just under 94 per cent of the total intangible stock in manufacturing was the new intangibles (that is, those not already treated as capital in the national accounts) — a higher share than in services (80 per cent), which has a higher share of computerised information (a national accounts intangible) in its total intangible stock.

Intangibles make up a considerably larger share of the total capital stock in manufacturing (24 per cent) than services (11 per cent).

Table 2.4 **Value of intangible capital stock[a], market sector, 2005-06**

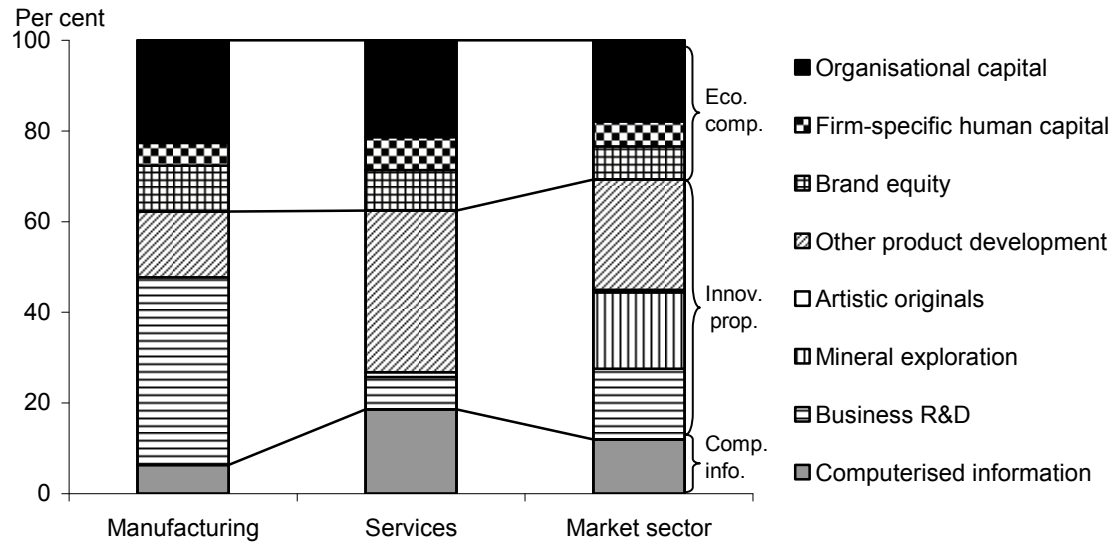
	Manufacturing	*Services*	*Market sector*
	$m	$m	$m
Computerised information	*2 530*	*18 716*	*22 619*
Innovative property	*22 322*	*44 100*	*108 240*
Business R&D	16 518	7 173	29 490
Mineral exploration	-	-	31 737
Artistic originals	-	1 102	1 102
Other product development	5 804	35 825	*45 911*
Financial product development	-	27 507	27 507
New arch./eng. designs	5 804	8 319	18 405
Economic competencies	*15 059*	*37 772*	*58 032*
Brand equity	4 011	8 991	13 867
Advertising	3 604	7 881	12 160
Market research	406	1 110	1 707
Firm-specific human capital	2 015	7 308	10 429
Organisational capital	9 034	21 473	33 737
Purchased organisational capital	5 427	14 704	22 650
Own account organisational capital	3 607	6 770	11 086
Total intangible capital stock	**39 912**	**100 588**	**188 891**
New intangible capital stock	37 382	80 770	133 433
National accounts intangible capital stock	2 530	19 818	55 458
Tangible capital stock	124 799	796 791	1 124 783
Total capital stock	**164 711**	**897 379**	**1 313 674**
	Ratio	Ratio	Ratio
Ratio of intangible to tangible capital stock	0.32	0.13	0.17

a Net capital stock.

Sources: Author's estimates; Barnes and McClure (2009); ABS national accounts data.

Figure 2.6 **Shares of total intangible capital stock, by asset, by sector, 2005-06**

Percentage shares



Data sources: Author's estimates; Barnes and McClure (2009).

The composition of the total intangible stock was as follows (figure 2.6).

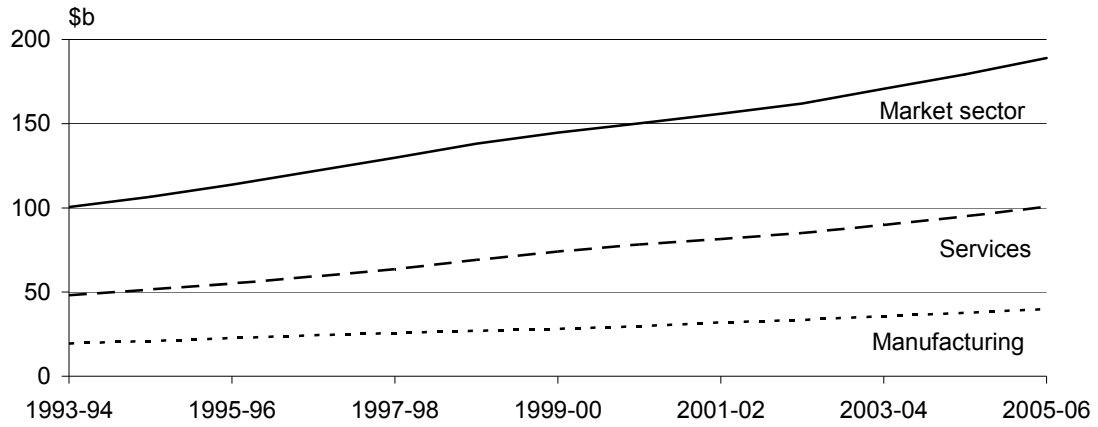
- Innovative property was more than half of this total stock in manufacturing (56 per cent), but less than half in services (44 per cent).
  - Not unexpectedly, the largest individual component was business R&D in manufacturing. In services, the largest component was other product development.
- Economic competencies made up around 38 per cent of the total intangible stock in both sectors.
  - Organisational capital was the largest component of this group in each sector.
- The remainder was computerised information (6 per cent of the total stock of intangibles in manufacturing and 19 per cent in services).
  - The computerised information stock was smaller than some of the new intangibles, including organisational capital in both sectors.

Growth in the capital stock

Between 1993-94 and 2005-06, the stock of intangibles in the manufacturing sector grew from $19 to $40 billion (average growth of 6.2 per cent a year). In the service

sector it grew from $48 to $101 billion (average growth of 6.3 per cent a year) (figure 2.7).

Figure 2.7 **Total intangible capital stock[a], 1993-94 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 C.
Data sources: Author's estimates; Barnes and McClure (2009).

The composition of the intangible capital stock has been relatively stable between 1993-94 and 2005-06 — with a small increase in the shares of economic competencies and innovative property and a small decrease in the share of computerised information in manufacturing; and a small increase in the share of economic competencies and a small decrease in the share of innovative property in services. As is the case for investment, the shift in the relative importance of organisational capital within economic competencies is larger (from 13 to 23 per cent in manufacturing and from 11 to 21 per cent in services).

2.5 Intangible 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. 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; 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, asset price deflators, the depreciation rate and income and non-income tax parameters (see appendix B for further details of the rental price components and the estimated rental prices for the new intangibles).

The rate of return for each sector is assumed to be the same for all included assets — that is, there is one rate of return for all manufacturing assets and one rate of return for all service sector assets. 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 appendix B for further discussion).

In line with ABS methodology, a hybrid approach to deriving the rate of return has been applied — a calculated endogenous rate of return is used unless it is below an exogenous floor rate of return (assumed to be equal to consumer price index growth plus 4 per cent). The capitalisation of intangibles requires the equalising endogenous rate of return on all assets (tangible and intangible) in each sector 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 increased. The equalising rate of return across all assets (tangible and intangible) therefore changes and this affects the rental prices for *all* assets, not just the intangibles.

This hybrid approach differs from CHS (2006), which uses a purely endogenous rate. The effects of this difference and the sensitivity of the results to the rate of return assumption are discussed in appendix C.

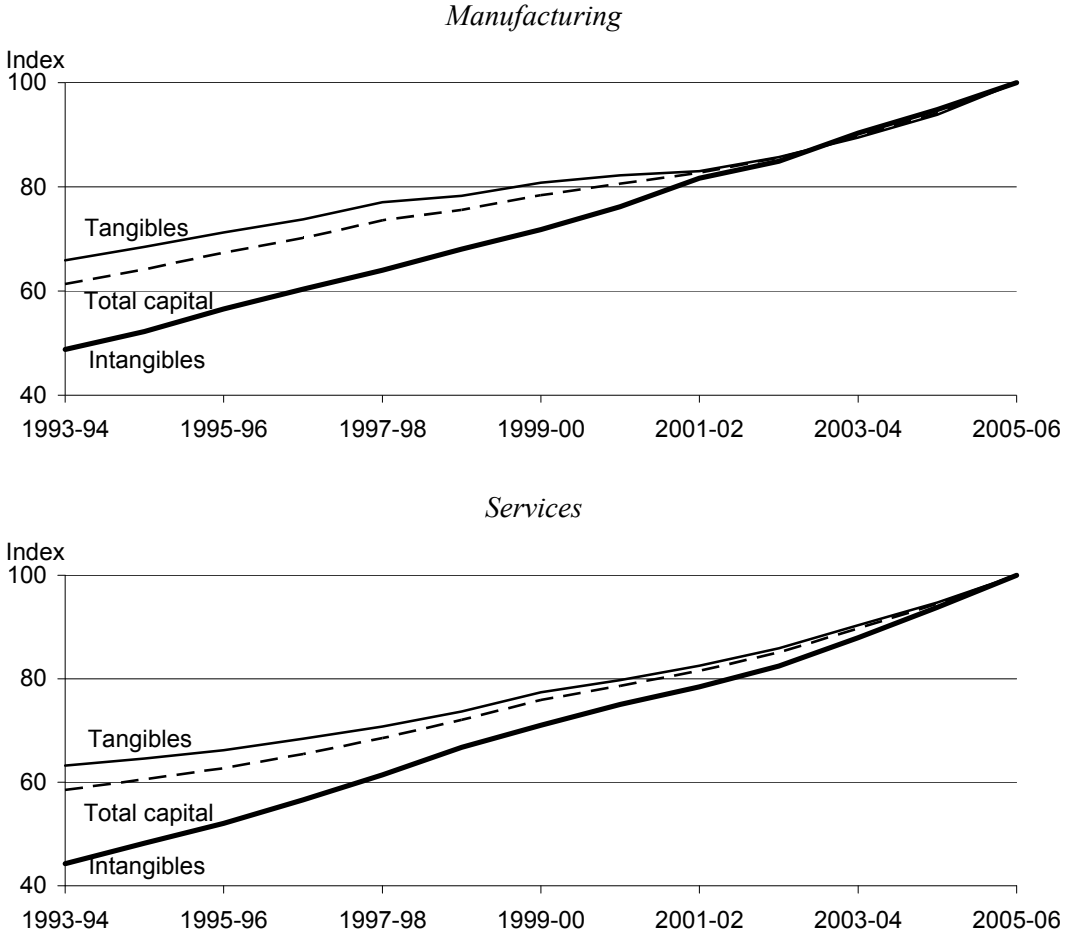
Growth in capital services indexes

In each sector, capital services from intangible assets grew at a higher rate compared with capital services from tangible assets over the period 1993-94 to 2005-06 (figure 2.8). On average, manufacturing capital services from total intangible assets grew around 6 per cent a year compared with 3.5 per cent a year for tangible capital services (table 2.5). For services, the equivalent growth rates were 7 per cent for intangibles and 3.9 per cent for tangibles. The average contribution of intangibles to growth in total capital services for manufacturing was 36 per cent — of which 9 percentage points were national accounts intangibles and 27 percentage points were the new intangibles. For services, the contribution was 34 per cent — of which 18 percentage points were national accounts intangibles and 16 percentage points were the new intangibles. The difference in contribution between the ‘old’ and ‘new’ intangibles between sectors is mainly due to the

relatively large stock of computerised information in services and the relatively large stock of business R&D in manufacturing.

Figure 2.8 **Capital services index, tangibles and intangibles, by sector, 1993-94 to 2005-06**

Index 2005-06 = 100



Data source: Author's estimates.

Of the three major groups of intangibles, computerised information had the fastest average growth in each sector (9 per cent a year in manufacturing and 12 per cent a year in services). In manufacturing, innovative property grew at 5.9 per cent and economic competencies grew at 5.3 per cent. In services, innovative property grew at 3.7 per cent and economic competencies grew at 5.8 per cent.

There were considerable differences in growth rates amongst the components of innovative property and economic competencies. For example, in the service sector average growth in business R&D was more than three times that of other product development. Growth in organisational capital (11 per cent a year) far exceeded

brand equity (2.9 per cent) and firm-specific human capital (0.5 per cent). In the manufacturing sector, average growth in business R&D was lower than growth in other product development. For organisational capital similar relativities were observed to those for the service sector.

Table 2.5 **Growth rate of intangible capital services, by sector, 1993-94 to 2005-06**

Per cent per year (percentage contribution to total growth)

	Manufacturing		*Services*	
Computerised information	*9.3*	*(25)*	*11.8*	*(53)*
Innovative property	*5.9*	*(35)*	*3.7*	*(13)*
Business R&D	5.5	(24)	9.6	(4)
Artistic originals	-		3.4	(1)
Other product development	7.2	(11)	3.0	(9)
Financial product development	-		1.6	(4)
New arch./eng. designs	7.2	(11)	8.4	(5)
Economic competencies	*5.3*	*(40)*	*5.8*	*(34)*
Brand equity	3.8	(11)	2.9	(7)
Advertising	3.3	(9)	2.2	(5)
Market research	10.5	(2)	10.5	(2)
Firm-specific human capital	-3.8	(-5)	0.5	(1)
Organisational capital	10.5	(34)	11.0	(26)
Purchased organisational capital	15.9	(24)	15.7	(21)
Own account organisational capital	5.8	(9)	5.4	(5)
Total intangibles	**6.2**	**(100)**	**7.0**	**(100)**
New intangibles	5.6	(27)	5.0	(16)
National accounts intangibles	9.3	(9)	11.2	(18)
Tangibles	3.5	(64)	3.9	(66)
Total capital services	**4.2**	**(100)**	**4.6**	**(100)**
Intangibles to tangibles[a]	0.32		0.28	

Components may not add to totals due to rounding. [a] Share of capital income.

Source: Author's estimates.

Composition of capital services

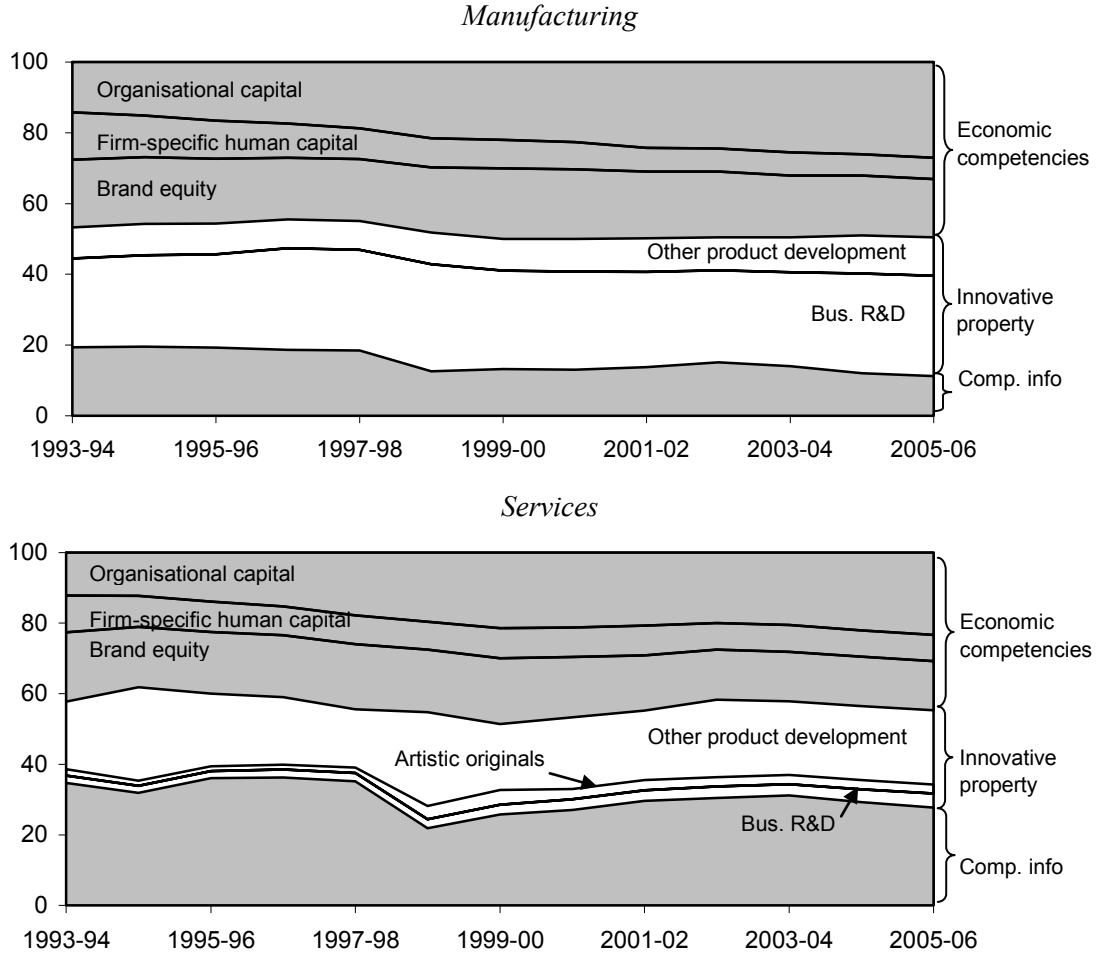
Figure 2.9 highlights the changing composition of the service flow from intangible capital in each sector. While the composition is quite different across sectors, the trends are similar. In each sector, computerised information decreased in relative importance over the period 1993-94 to 2005-06, while economic competencies and innovative property became relatively more important. In both sectors, the

contribution of organisational capital grew strongly relative to the other two types of economic competencies. High growth in purchased organisational capital is behind this trend. There has been relatively little compositional change within innovative property.

Comparing figures 2.6 and 2.9 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 2.9 **Composition of total intangible capital services[a], 1993-94 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 B). For sensitivity of the composition of intangible capital services to some of the assumptions in its compilation, see appendix C.

Data source: Author's estimates.

2.6 Effect on the rate of return on capital

As discussed in section 2.5, capitalising rather than expensing intangibles requires the recalculation of the endogenous rate of return on capital in each sector. This section outlines how this change in the treatment of intangible expenditure affects the rate of return on capital. It also examines whether the change affects the manufacturing and service sectors to differing extents and, therefore, whether capitalising intangibles changes any gap between the rates of return in the two sectors. (A broader examination of the range of factors that might explain a gap in the rates of return between sectors is beyond the scope of this paper.)

Schreyer (2004) notes that national accounts provide data according to the accounting identity that the sum of current price output in the economy is equal to labour remuneration plus gross operating surplus (GOS). And productivity analysts assume that GOS is exactly equal to the value of services from fixed assets. The endogenous rate of return on capital (that is, GOS divided by the value of fixed assets) is that which satisfies this assumed equality. However, the endogenous rate of return may not be an accurate reflection of the rate of return on all assets if the set of assets in the national accounts is not complete. The source of differences in rates of return across industries could be that part of this return is to unmeasured intangible capital and the proportion of the capital stock that is unmeasured differs across industries.[5] Schreyer (2004, p. 3) points out that:

> The national accounts provide no indication as to exactly which factor of production is remunerated through GOS. Fixed assets are certainly among them but they are not necessarily the only ones. The business literature offers a wealth of discussions about the importance of intangible assets, and there are good reasons to argue that such assets account at least for part of GOS.

In its simplest sense, the rate of return on capital is capital income divided by the capital stock (although in this paper, the rate of return is after tax and net of depreciation and revaluations of capital[6]). Expensing rather than capitalising intangibles understates the capital stock and this could result in an overstatement of the rate of return on tangible capital. But expensing rather than capitalising

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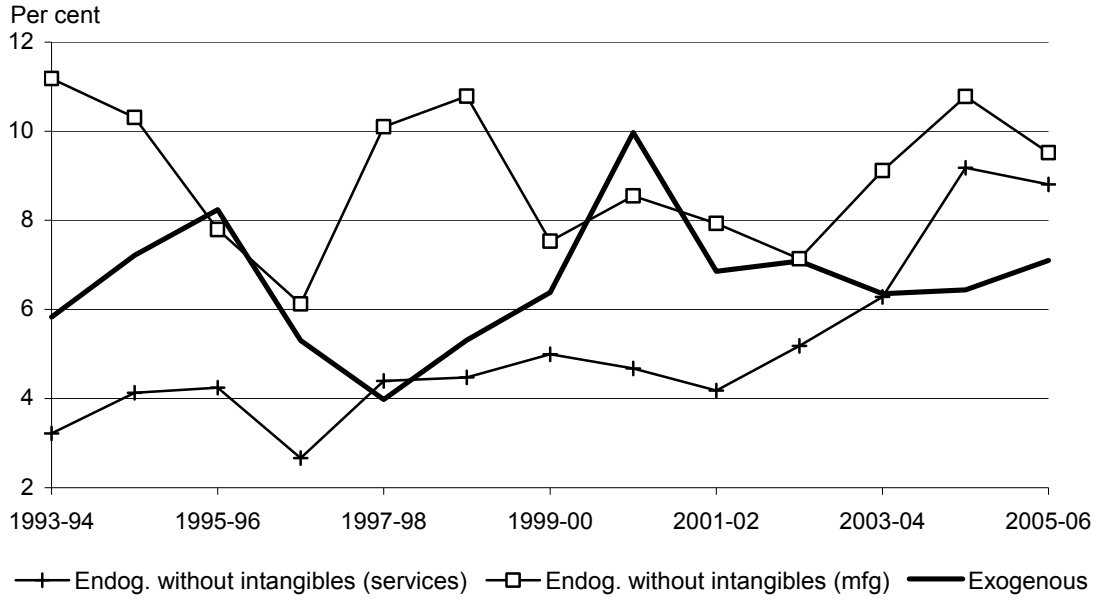
5 McGrattan and Prescott (2008) examined the effect of the treatment of expenditure on intangibles on rates of return from a different perspective. Using a multicountry general equilibrium model including foreign direct investment they estimated that 60 per cent of the difference in returns on investment of foreign subsidiaries of US multinational companies and US subsidiaries of foreign multinational companies is accounted for by mismeasurement of intangible investments. Their focus was on the effect on rates of return of the use of an intangible asset in both foreign *and* domestic locations but the expensing of the intangibles in only the foreign *or* domestic location.

6 The calculation of rate of return as used in the growth accounting in this paper takes account of factors such as depreciation, revaluation of the capital stock and differences in tax treatment — all of which are also affected when intangibles are capitalised (see chapter 3 and appendix B).

intangibles also understates capital income (by the amount of intangible investment). With both the numerator and denominator of the rate of return calculation affected by capitalising intangibles, the rate of return can potentially rise or fall. This is further complicated by any departures from the use of a pure endogenous rate of return — such as a purely exogenous rate of return or an exogenous floor rate of return (section 2.5).

In general the rate of return approach used in this paper for the purpose of calculating productivity growth is the hybrid ABS methodology. An endogenous rate of return, which is constrained to be the same across all tangible and intangible assets within a sector, is used unless this rate falls below a floor level. This floor level is an exogenous rate equal to the consumer price index (CPI) growth plus 4 per cent. In practice, the endogenous rate of return (with no intangibles capitalised) rarely fell below the exogenous floor when calculated for the manufacturing sector but fell below in all but three years for the service sector (figure 2.10). The (endogenous) rate of return in services is lower than manufacturing in each year.

Figure 2.10 **Rates of return on capital, without intangibles**



Data sources: Author's estimates; ABS unpublished national accounts data.

Obviously, the use of a floor rate of return affects the impact of capitalising intangibles on the rate of return used in the capital services index. While including intangible capital will affect the endogenous rate of return, if this rate remains below the exogenous rate of return the capital services index will not be affected. There is some debate in the growth accounting literature about whether to use an endogenous or exogenous rate of return in growth accounting (see OECD 2009).

However, it is still possible to examine the effect of capitalising intangibles on the purely endogenous rate of return for the Australian manufacturing and service sectors.

Figure 2.11 shows the purely endogenous rate of return before and after capitalising different groups of intangibles. There are relatively small differences between the rates of return for the three definitions of capital in each sector — although the difference is larger in manufacturing than services. Capitalising intangibles has only a small effect on the equalising endogenous rate of return across all assets, because the stock of intangibles is small relative to tangibles (and the adjustment to capital income from treating intangible expenditure as investment is a small share of unadjusted total capital income).[7]

In some years there is a notable difference in the direction of the effect on the rate of return of capitalising the new intangibles compared with the national accounts intangibles. Capitalising the national accounts intangibles lowers the average endogenous rate of return on all capital (compared with a definition of capital including no intangibles) in every year in both sectors. Adding in the new intangibles as well raises the average endogenous rate of return (compared with that where capital includes the national accounts intangibles) in about half the years in each sector — in the other half of the years it is lowered. But only in the service sector, in a few years, is the increase in the rate of return from adding in the new intangibles large enough to outweigh the fall in the rate of return from capitalising the national accounts intangibles — leading to an average rate of return on all capital when all intangibles are capitalised that is higher than the rate of return on all capital when no intangibles are included.

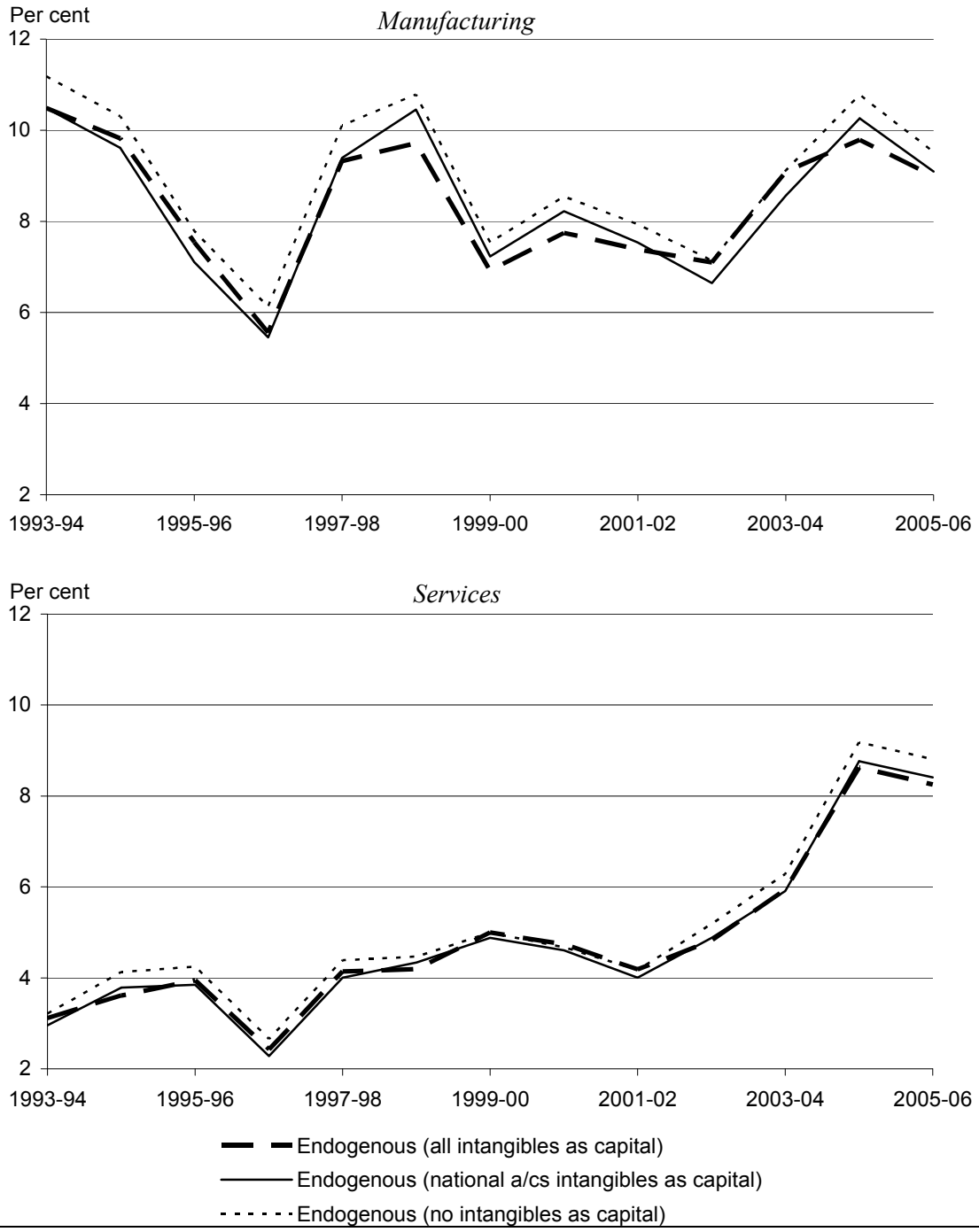
Therefore, the direction of the effect of capitalising intangibles on the rate of return is sometimes different between the manufacturing and service sectors. For example, from 1999-2000 to 2001-02 capitalising all intangibles lowered the endogenous rate of return (compared with that where capital includes no intangibles) in manufacturing but increased it in services.

The rate of return calculated including a group of intangibles will be greater than the rate of return calculated excluding those intangibles if intangible investment as a proportion of the intangible capital stock is greater than the rate of return if those

[7] Relatively high depreciation rates for many intangibles mean that for the same size capital stock greater replacement investment will be required to maintain the intangible capital stock than the tangible capital stock.

intangibles are not capitalised.[8] This is the case for the new intangibles in some years but not for the national accounts intangibles.

Figure 2.11 **Endogenous rates of return on capital, with and without intangibles**



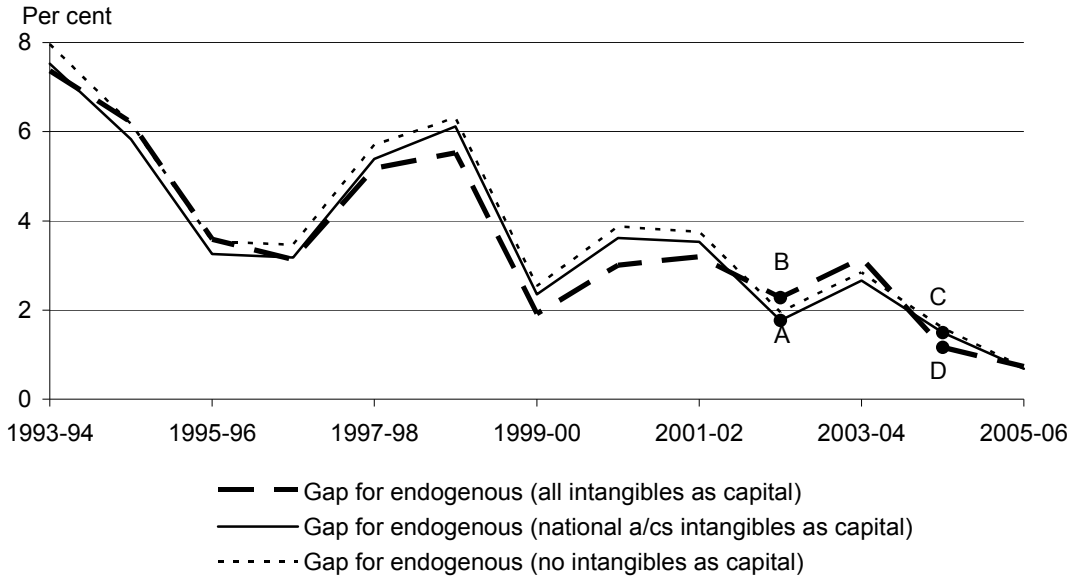
Data source: Author's estimates.

[8] This is simplified for the purposes of exposition. Appendix B shows the derivation of the more complex condition when depreciation, asset revaluations and tax parameters are included.

Overall, it appears that unmeasured intangibles are generally not the main factor behind the observed difference in rates of return on capital between manufacturing and services. Figure 2.12 shows the gap between the endogenous rates of return for the manufacturing and service sectors over time for the different scopes of capital. Increasing the scope of capital from including no intangibles to including the national accounts intangibles decreases the gap in each year, but by around 10 per cent at most. Increasing the scope of capital from including only the national accounts intangibles to including all intangibles decreases the gap in some years and increases it in others. But in each year, this change is less than a third of the gap in the rates of return before the scope of capital is altered.

For example, in 2002-03 the gap between the rates of return of the two sectors *increases* by 29 per cent (or 0.51 of a percentage point) when the new intangibles are capitalised (point B in the figure) compared with the gap when only the national account intangibles being capitalised (point A). That is, unmeasured intangibles explain less than a third of the gap in the rates of return between manufacturing and services. By contrast, in 2004-05 capitalising the new intangibles (moving from C to D in the figure) *decreases* the gap in the rates of return by 22 per cent (or 0.33 of a percentage point).

Figure 2.12 **Gap[a] between manufacturing sector and service sector endogenous rates of return, with and without intangibles**



a Manufacturing rate of return less service sector rate of return.

Data source: Author's estimates.

3 Sectoral growth accounting results

This chapter presents the model and experimental 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 each of the manufacturing and service sectors (with some comparisons with the market sector as a whole):

- 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 chapter 2 and appendix A.

3.1 Model

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 inputs — usually labour and capital inputs. The residual growth not explained by changes in these inputs is due to other factors, and is called

1 For the purposes of this paper, the ABS definition of capital includes only three intangible assets: software, mineral exploration and artistic originals (ABS 2000, paras 16.47 - 16.56). It does not include the recently released ABS estimates for R&D.

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). 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 (see appendix B). The national accounts case was re-estimated for comparability with the other estimates in this paper.

multifactor productivity (MFP) growth. The measure of output used is value added (that is, total production less intermediate inputs).

The growth accounting results presented in this chapter are decompositions of 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 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.

MFP growth is derived from

$$\dot{MFP}'_t = \dot{Q}'_t - s'_{L_t} \dot{L}_t - s'_{K_t} \dot{K}_t \qquad (3.1)$$

where Q'_t is value added, L_t is labour input, K_t is (tangible) capital input and s'_{L_t} is the labour income share and s'_{K_t} is the (tangible) capital income share. $\dot{x}_t$ denotes the rate of growth of variable x_t.

In terms of a standard labour productivity (LP) growth decomposition, this is

$$\dot{LP}' = (\dot{Q}'/\dot{L}) = \dot{KD}' + \dot{MFP}' \qquad (3.1a)$$

where capital deepening is $\dot{KD}' = s'_K (\dot{K}/\dot{L})$

Conventional growth accounting treats expenditure on intangibles as current expenses, rather than as investments, and intangibles do not appear separately. But this treatment can result in biased measures of MFP when intangibles expenditure is actually investment. Corrado, Hulten and Sichel (CHS 2006) set out the effect of treating intangibles expenditure as investment on national account measures and standard growth accounting (for a full derivation of their model see appendix B and Barnes and McClure 2009). There are several effects on the growth accounting equation as a result of this change in the treatment of intangibles — with the effect on MFP growth (as the residual) depending on relative changes in output and input growth.

Adjusted MFP growth is derived from

$$\dot{MFP}_t = \dot{Q}_t - s_{L_t} \dot{L}_t - s_{K_t} \dot{K}_t - s_{R_t} \dot{R}_t \qquad (3.2)$$

where Q_t is value added plus intangible investment $(Q_t = Q'_t + N_t)$, R_t is intangible capital input, s_{L_t} is the labour income share, s_{K_t} is the tangible capital income share and s_{R_t} is the intangible capital income share.

In terms of a LP growth decomposition[3], this is

$$\dot{LP} = (\dot{Q}/L) = \dot{MFP} - \dot{KD} \qquad (3.2a)$$

where capital deepening is $\dot{KD} = s_K (\dot{K}/L) + s_R (\dot{R}/L)$

Comparing the resulting MFP equations under the conventional and CHS approaches, most of the variables have changed.

- The level of value added has increased because intangible expenditure is no longer deducted. But value added growth may be higher or lower, depending on whether the growth rate of intangible investment is higher or lower than the growth rate of unadjusted value added.
- Total capital inputs increase because of intangible capital. But again total capital growth may be higher or lower, depending on whether growth in intangible capital is higher or lower than growth in tangible capital.
- All the factor income shares are different because both value added and the total payments to capital differ. Tangible capital and labour income *shares* fall (because there is a payment to intangible capital as an extra factor of production).
- Only labour input growth does not change.

The effect on measured MFP growth will depend on the balance of changes in value added growth, input growth and the income shares — so it is ambiguous a priori. The effect can be positive or negative depending on the relative size of the effects on value added 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). The effect also depends on the combined input growth rate which changes as the capital and labour shares of total inputs change.

[3] The relationship between LP growth with and without intangibles as capital is $\dot{LP} = \dot{LP}' + (1-\mu)(\dot{N} - \dot{Q}')$ where $\mu \equiv Q'/(Q'+N)$ (see appendix B for a full derivation).

Implementation of the model

The methodology for explicitly identifying the contribution of intangible assets in growth accounting requires a number of steps for each of the manufacturing and service sectors, many of which involve difficult measurement issues.

- Adjust output and income to include intangibles
  - recalculate output (measured as sector gross value added for Australia) to include intangibles output
  - adjust the operating surplus for sector gross value added by adding intangibles investment.
- Construct a volume index of capital services measures of all capital inputs (tangible and intangible) for each sector using capital stocks and rental prices (as discussed in chapter 2 and appendix B)
- Undertake growth accounting as per equation (3.2) for each sector for the period 1993-94 to 2005-06
  - using the data for intangibles estimated as outlined in chapter 2, together with the published and unpublished ABS national accounts data used in standard growth accounting.

3.2 Growth accounting components

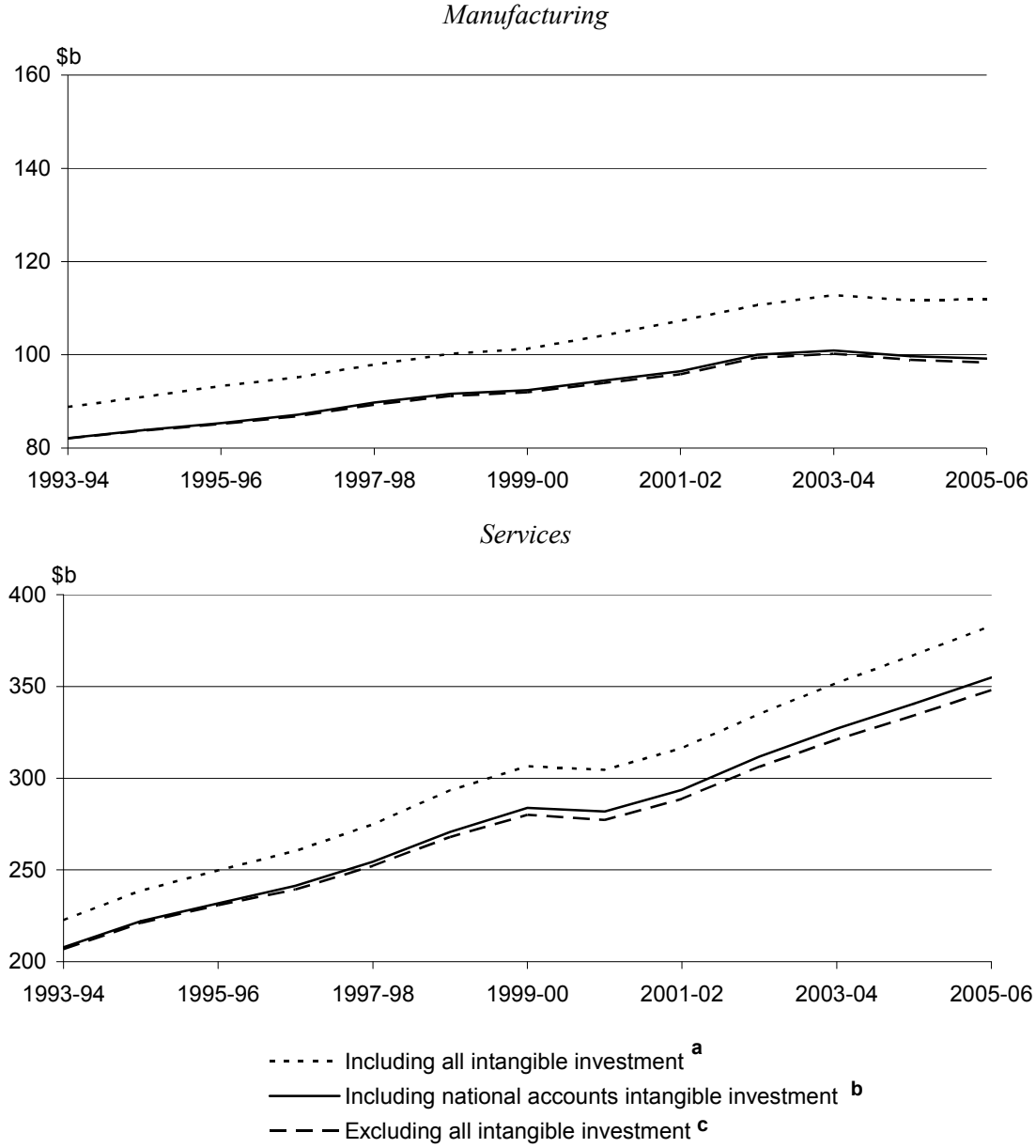
As explained above, capitalising intangible assets will affect several components of the production function and each of these will affect the productivity results. The first question is how much are the growth measures actually affected by not including intangible investments as outputs in the Australian manufacturing and service sectors. The second 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.

Value added

Sector gross value added (GVA) is the output measure used for the growth accounting. Figure 3.1 compares 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 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 investment in intangibles in total has grown as a percentage of GVA.

Figure 3.1 **Sector gross value added, 1993-94 to 2005-06**
2005-06 dollars, chain volume measures



a Sector GVA including all intangibles is existing sector GVA plus sectoral investment in new intangibles. **b** Sector GVA including national accounts intangibles is existing sector GVA supplied by the ABS national accounts. **c** Sector GVA excluding all intangibles is existing sector GVA minus sectoral gross fixed capital formation (GFCF) in the national accounts intangible assets.

Data sources: Author's 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 (table 3.1). The largest difference was for manufacturing where GVA growth was 0.42 of a percentage point (28 per cent) higher with the inclusion of all intangible investment compared with the no intangibles case. For services, the difference was less than 5 per cent. The increase in manufacturing was higher than in services because of the combined effect of a larger difference between growth in intangibles investment and growth in other output and a higher ratio of intangible investment to output.

Table 3.1 **Growth in sector gross value added, 1993-94 to 2005-06**
Per cent per year[a]

	Manufacturing	*Services*
Including all intangible investment	1.94	4.62
	(28)	(4)
Including national accounts intangible investment	1.58	4.56
	(4)	(3)
Excluding all intangible investment	1.52	4.43

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

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

In the manufacturing sector, the new intangible assets contributed more than the national accounts intangible assets to this difference in growth rates. This is the result of the investment in the new intangibles making up a larger share of total adjusted output than the national accounts intangibles, despite having a lower growth rate than for the national account intangibles.

In the service sector, the opposite is the case — the investment in the national accounts intangible assets contributed more to the difference in growth rates than the new intangibles. This is because, while the new intangibles made up a larger share of total adjusted output than the national accounts intangibles, the gap was not as large as for manufacturing and was outweighed by the national accounts intangibles having a higher growth rate than the new intangibles.

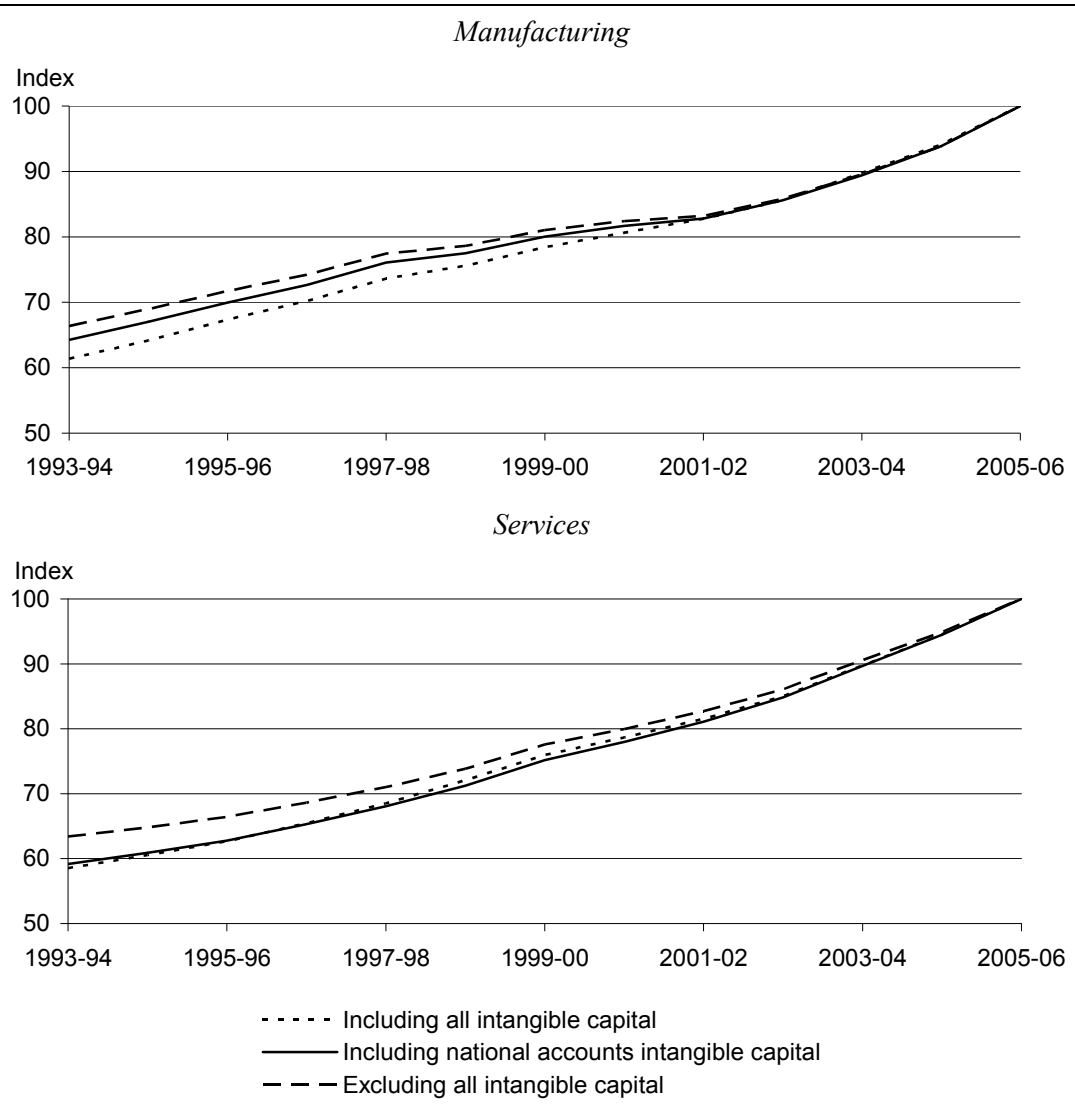
Capital services

As discussed in chapter 2, aggregate capital services indexes are created using the volume index of the capital stock for each asset weighted using rental prices as weights. The treatment of intangibles as capital will only increase the growth rate of

the aggregate capital services index if the growth of the intangibles stock is greater than the growth of the tangibles stock — which is the case over the period examined in this paper.[4]

Figure 3.2 shows the total capital services indexes for each of the three definitions of capital in the two sectors. In each sector, growth in capital services from intangibles was faster than growth in capital services from tangible assets.

Figure 3.2 **Capital services, by sector, 1993-94 to 2005-06**
Index 2005-06 = 100



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

4 This is the opposite to investment — for which growth in intangibles was slower than tangibles — but intangible investment as a percentage of the existing intangible capital stock is higher than the equivalent for tangibles (even in net investment terms taking account of the higher average depreciation rate for intangibles).

Growth in manufacturing sector capital services before the treatment of any intangibles as capital averaged 3.5 per cent a year over the full period. With the treatment of all intangibles as capital this increased to 4.2 per cent a year, an increase of 20 per cent. Growth in service sector capital services before the treatment of any intangibles as capital averaged 3.9 per cent a year over the full period. With the treatment of all intangibles as capital this increased to 4.6 per cent a year, an increase of 18 per cent.

As shown in figure 3.2, including the national accounts intangible assets has a larger impact on capital services *growth* than the new intangible assets in the service sector.[5] 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 considerably higher investment growth than the new intangibles.[6] The opposite is the case for manufacturing because, despite a higher investment growth rate, the national accounts intangible (software) is a smaller proportion of total intangibles in this sector.

Factor income shares

Table 3.2 shows the contribution of intangible assets to changes in the factor income shares. Capitalising all intangibles has increased the average capital income share for the period 1993-94 to 2005-06 from 37 per cent to 42 per cent in manufacturing and from 36 per cent to 41 per cent in services, with corresponding falls in the labour income shares. (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 in each sector, the investment in the new intangible assets increases the capital income share by a greater percentage than the national accounts intangible assets in each of the sectors.

5 The effect on capital services growth of adding the national accounts intangibles can be seen by comparing the capital services indexes for 'including national accounts intangible capital' and 'excluding all intangible capital'. Similarly, the effect of adding the new intangibles can be seen by comparing the capital services indexes for 'all intangible capital' and 'including national accounts intangible capital'.

6 In services, investment growth in the national accounts intangibles averaged 10.8 per cent a year for the period 1993-94 to 2005-06 (mainly due to high growth in computerised information), compared with 5.5 per cent for the new intangible assets.

Table 3.2 **Capital[a] and labour income shares, by sector, 1993-94 to 2005-06**

	Manufacturing	*Services*
Including all intangible assets		
New intangible assets	0.08	0.06
National accounts intangible assets	0.01	0.03
Tangible assets	0.32	0.32
Total capital	0.42	0.41
Labour	0.58	0.59
Including national accounts intangible assets		
National accounts intangible assets	0.02	0.03
Tangible assets	0.36	0.34
Total capital	0.38	0.37
Labour	0.62	0.63
Excluding all intangible assets		
Capital	0.37	0.36
Labour	0.63	0.64

Components may not add to totals due to rounding. [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: Author's estimates; published and unpublished ABS national accounts data.

3.3 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 LP 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 3.3 shows the relative contributions of MFP growth and capital deepening to overall LP growth for each sector (as specified in equations 3.1a and 3.2a).

Table 3.3 **Contributions to labour productivity growth, by sector, 1993-94 to 2005-06**

Per cent per year (Percentage share of total growth)

	Manufacturing	*Services*
Including all intangible assets		
Capital deepening	2.04	1.02
	(76)	(40)
MFP growth	0.65	1.51
	(24)	(59)
Labour productivity growth	2.69	2.54
	(100)	(100)
Including national accounts intangible assets		
Capital deepening	1.69	0.88
	(73)	(36)
MFP growth	0.64	1.58
	(27)	(64)
Labour productivity growth	2.32	2.48
	(100)	(100)
Excluding all intangible assets		
Capital deepening	1.57	0.64
	(70)	(27)
MFP growth	0.69	1.70
	(31)	(72)
Labour productivity growth	2.26	2.35
	(100)	(100)

Components may not add to totals due to rounding.

Source: Author's estimates.

In each sector, LP growth rose after capitalising all intangibles (compared with no intangibles) — to a larger extent in manufacturing than services.

- For the manufacturing sector, LP grew at a rate of 2.69 per cent a year between 1993-94 and 2005-06, compared with 2.26 per cent a year for the case where no intangibles are treated as capital — an increase of 0.43 of a percentage point, or around 19 per cent.
- For the service sector, LP grew at a rate of 2.54 per cent a year, compared with 2.35 per cent a year for the case where no intangibles are treated as capital — an increase of 0.19 of a percentage point, or around 8 per cent.

The contribution of capital deepening to LP growth after capitalising all intangibles was also higher in each sector.

- Manufacturing capital deepening after the inclusion of all intangible capital increased from 1.57 per cent a year to 2.04 per cent a year, or a 30 per cent increase.
- Services capital deepening increased from 0.64 to 1.02 per cent a year, or a 59 per cent increase (but from a relatively low level of capital deepening compared with manufacturing).

In each sector, MFP growth (as the residual) fell reflecting the rise in capital deepening outweighing the rise in LP growth.

- In manufacturing, the contribution of MFP growth decreased from 0.69 per cent a year to 0.65 per cent, or a 6 per cent fall.
- In services, the contribution of MFP growth decreased from 1.70 to 1.51 per cent, or a 11 per cent fall.
- These falls in MFP growth after capitalising all intangibles are the amounts of MFP growth under the no intangibles case that are actually attributable to unaccounted for intangible capital.

The reason the fall in MFP growth is larger in services than manufacturing is that the increase in LP growth is higher in manufacturing than services, thereby largely offsetting the increase in capital deepening (a difference across sectors that was not apparent from the aggregate market sector results in Barnes and McClure 2009). As noted above, this is the result of manufacturing (compared with services) having a larger gap between the growth rates of intangible investment and other output and intangible investment being a larger share of adjusted output.

Capitalising all intangibles shifted the sources of LP growth towards capital deepening compared with MFP growth — although in the service sector capital deepening was still a much smaller contributor than in manufacturing.

In both sectors, the fall in the rate of MFP growth indicates that some LP growth that was attributed to MFP growth before the capitalisation of intangibles was actually driven by capital deepening due to intangibles.

The average percentage contribution of all intangibles to total capital deepening was large in both sectors — 33 per cent in manufacturing and 43 per cent in services between 1993-94 and 2005-06 (table 3.4).

Table 3.4 **Contributions to capital deepening, by sector, 1993-94 to 2005-06**

Per cent per year (Percentage share of total capital deepening)

	Manufacturing	*Services*
Including all intangible assets		
National accounts intangible assets	0.15	0.26
	(7)	(26)
New intangible assets	0.54	0.18
	(26)	(17)
Tangible assets	1.35	0.59
	(66)	(57)
Total capital deepening	2.04	1.02
	(100)	(100)
Including national accounts intangible assets		
National accounts intangible assets	0.17	0.27
	(10)	(30)
Tangible assets	1.54	0.62
	(90)	(70)
Total capital deepening	1.69	0.88
	(100)	(100)
Excluding all intangible assets		
Total capital deepening	1.57	0.64

Components may not add to totals due to rounding.

Source: Author's estimates.

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 redistribution of a portion of existing capital income from tangibles to intangibles reflects the fact that some capital income that was attributed to tangible assets is actually a return on unmeasured intangible capital.

[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 endogenous rate of return across all assets, that will change for national accounts tangible assets after capitalising intangibles. More detail on these changes is included in appendix B.

Comparing the impact of the new and existing intangibles

There were similarities and differences across sectors in the effect on MFP growth from capitalising the new intangibles compared with the national accounts intangibles — again highlighting how aggregate market sector results can conceal offsetting changes across sectors.

Capitalising the national accounts intangibles lowered MFP growth in both sectors — reflecting the increase in capital deepening outweighing the increase in LP growth (table 3.3). The extent of the change in MFP growth (in percentage terms) was also similar across sectors — although capital deepening and LP growth both increased by more in services than in manufacturing because the national accounts intangibles were a relatively larger share of capital and output in the service sector.

But the effect on MFP growth of capitalising the new intangibles was different across sectors — in services MFP growth went down but in manufacturing it rose very slightly. In manufacturing the effect on capital deepening and LP growth, while both larger than in services, were almost entirely offsetting, so there was little effect on MFP growth. In services the effect on LP growth, in particular, was much smaller than in manufacturing so that the effect of capital deepening outweighed it, leading to a small fall in MFP growth.

As discussed above, in manufacturing the effect on GVA growth (and therefore LP growth) was much larger than in services because GVA growth before capitalising the new intangibles was relatively low compared with services. The effect of 'adding in' the new intangibles, which had a higher growth rate, was therefore more pronounced.

Growth accounting periods

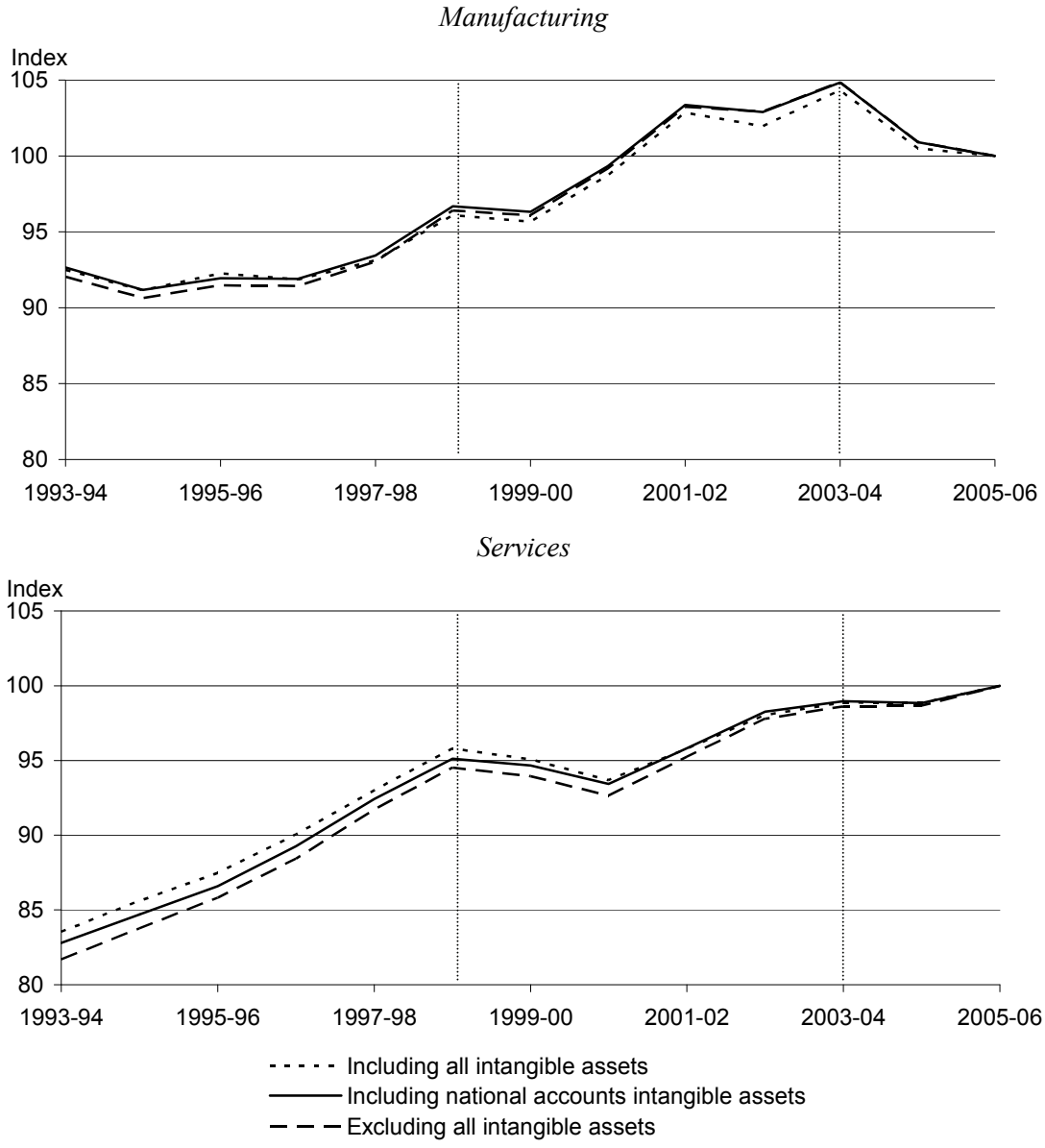
The impact of intangible investment on the growth in MFP can vary over time and could potentially affect the timing and magnitude of MFP growth cycles. The growth cycles are the trend periods in MFP growth identified by the ABS in the national accounts.[9] Marrano, Haskel and Wallis (MHW 2007) identified that for the United Kingdom capitalising intangibles changed the pattern of the MFP cycles at the market sector level in that country. Fukao et al. (2008) also found a change in

[9] Calculating productivity trends over cycles, 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.

the pattern of MFP growth for both manufacturing and services, despite finding no change in pattern at the aggregate economy level.

The readily available data restricts an examination of the effect on Australian sectors to only two cycle periods — 1993-94 to 1998-99 and 1998-99 to 2003-04. It should be noted that the ABS cycle periods are for the market sector as a whole. At this stage the ABS does not identify industry-specific cycles. Moreover, the aim is to examine the extent to which there are offsetting sectoral differences underlying the market sector estimates — a task for which a common time period is needed.

Figure 3.3 **Multifactor productivity, by sector, 1993-94 to 2005-06**
Index 2005-06 = 100



Data source: Author's estimates.

Figure 3.3 (which also includes the incomplete cycle period from 2003-04 to 2005-06) shows that while capitalising intangibles expenditure has changed the average rate of MFP growth, the pattern of MFP growth, including all of the turning points, is virtually unchanged.

Table 3.5 shows the average growth rates, over each of the cycle periods (as well as over the full time series) for the manufacturing, service and market sectors. Before capitalising intangibles, the pattern of MFP growth, in terms of increase or decrease between the first and second cycles, differs between manufacturing and services — there is a decrease in MFP growth in the service sector (and in the market sector aggregate) between the cycles; but the opposite is the case for manufacturing. And capitalising intangibles does not change this.

However, in some cycles there are differences between sectors in the *direction* of the effect of capitalising intangibles on some growth accounting components that are hidden in the aggregate market sector results.

- MFP growth did not decline after capitalising intangibles in all cases — capitalising the *new* intangibles (compared with including the national accounts intangibles) led to a slight increase in manufacturing MFP growth in the second cycle (and, as noted above, over the full period).
- Capitalising the new intangibles did not lead to an increase in LP growth in all cases — capitalising the *new* intangibles led to a decrease in services LP growth in the second cycle (growth in new intangibles investment was low relative to growth in other output so adjusted LP growth was lower).

Figure 3.4 illustrates these differences across sectors and highlights how results for the market sector aggregate conceal sectoral differences in the magnitude of the effect of capitalising the intangibles as well as the direction of change. As it is the new intangibles that are not currently capitalised in the national accounts, the figure focuses on the difference between the national accounts definition of capital (the left hand column in each time period) and capital including all intangibles (the right hand column in each time period).

The extent of the effect of capitalising the new intangibles on MFP growth was not uniform across sectors. In the first cycle period, the change in MFP growth was -10 per cent in manufacturing (from a growth rate of 0.86 per cent a year to a rate of 0.77 per cent a year) but only -1 per cent in services (from 2.81 to 2.77 per cent). The relative size of the effect was reversed in the second cycle, with a -19 per cent change in MFP growth in services (from 0.79 to 0.64 per cent) but only a +2 per cent change in manufacturing (from 1.63 to 1.66 per cent). Between cycles, this led to a larger increase in MFP growth in manufacturing and a larger decrease in MFP growth in services.

Table 3.5 **Productivity growth cycle analysis[a], by sector**
Per cent per year

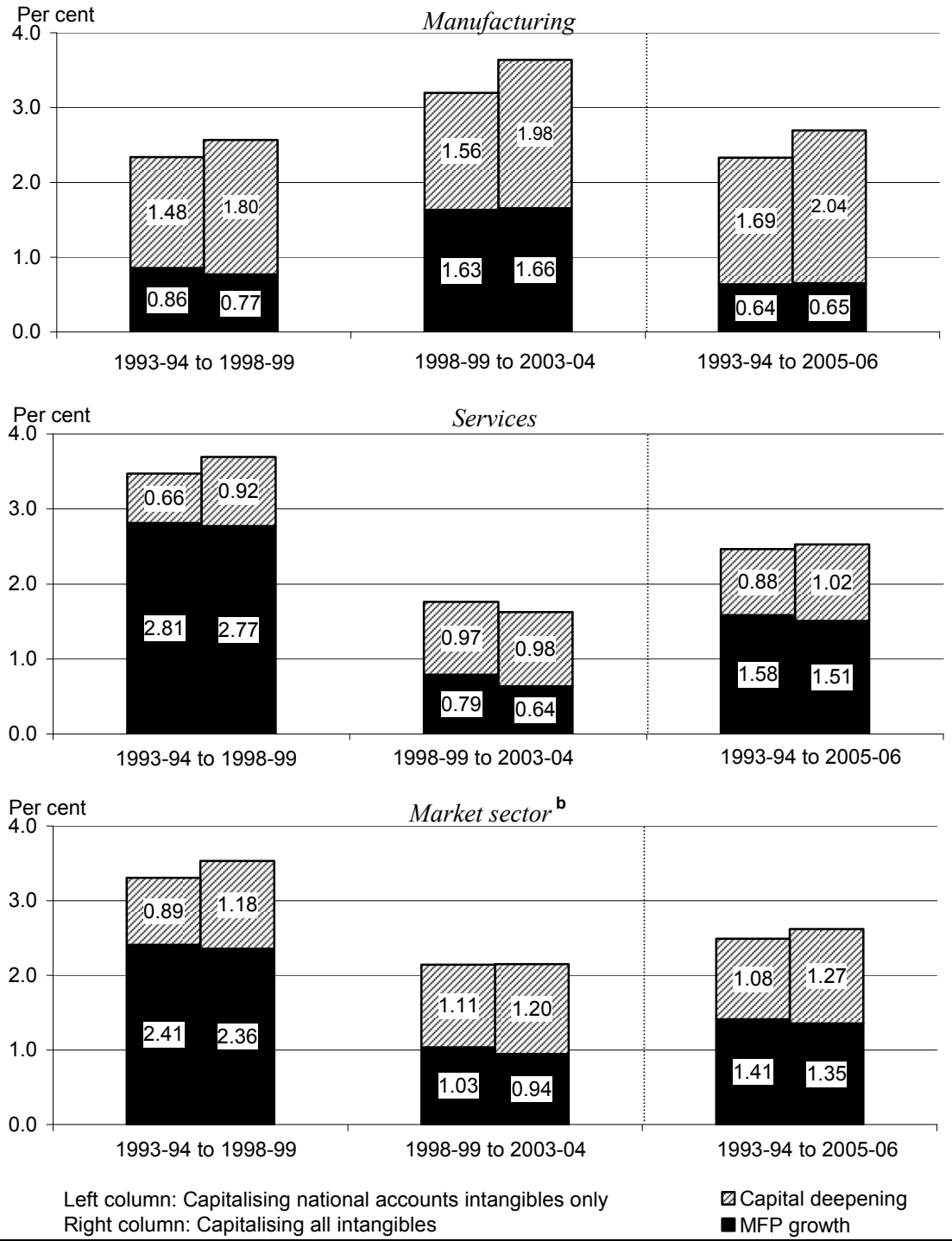
	1993-94 –1998-99	*1998-99 –2003-04*	*1993-94 –2005-06*
Manufacturing			
Labour productivity			
Including all intangible assets	2.56	3.66	2.69
Including national accounts intangible assets	2.33	3.21	2.32
Excluding all intangible assets	2.24	3.16	2.26
Multifactor productivity			
Including all intangible assets	0.77	1.66	0.65
Including national accounts intangible assets	0.86	1.63	0.64
Excluding all intangible assets	0.93	1.70	0.69
Capital deepening			
Including all intangible assets	1.80	1.98	2.04
Including national accounts intangible assets	1.48	1.56	1.69
Excluding all intangible assets	1.32	1.45	1.57
Services			
Labour productivity			
Including all intangible assets	3.71	1.63	2.54
Including national accounts intangible assets	3.48	1.77	2.48
Excluding all intangible assets	3.37	1.60	2.35
Multifactor productivity			
Including all intangible assets	2.77	0.64	1.51
Including national accounts intangible assets	2.81	0.79	1.58
Excluding all intangible assets	2.96	0.85	1.70
Capital deepening			
Including all intangible assets	0.92	0.98	1.02
Including national accounts intangible assets	0.66	0.97	0.88
Excluding all intangible assets	0.41	0.74	0.64
Market sector[b]			
Labour productivity			
Including all intangible assets	3.55	2.17	2.64
Including national accounts intangible assets	3.31	2.16	2.51
Excluding all intangible assets	3.21	2.04	2.40
Multifactor productivity			
Including all intangible assets	2.36	0.94	1.35
Including national accounts intangible assets	2.41	1.03	1.41
Excluding all intangible assets	2.52	1.10	1.49
Capital deepening			
Including all intangible assets	1.18	1.20	1.27
Including national accounts intangible assets	0.89	1.11	1.08
Excluding all intangible assets	0.69	0.92	0.89

a Market sector MFP growth cycles. **b** These results differ from those in Barnes and McClure (2009) because of a change in the base case assumptions for tax parameters for the new intangibles, the method of deriving the non-income tax parameter and improved data for chain volume measures of output excluding all intangible assets.

Source: Author's estimates.

Figure 3.4 **Contributions to labour productivity growth over MFP growth cycles[a], by sector, 1993-94 to 2005-06**

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 of Barnes and McClure (2009). **b** These results differ from those in Barnes and McClure (2009) because of a change in the base case assumptions for tax parameters for the new intangibles and the method of deriving the non-income tax parameter (see appendix B).

Data source: Author's estimates.

Sensitivity testing results

The estimates for investment in the new intangible assets used in this paper are experimental, as are the assumptions 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 assumptions. The tests include higher and lower estimates of investment in intangibles (based on alternative assumptions about the proportion of expenditure on different types of intangibles that is to be treated as investment), increasing the depreciation rate on intangible assets, and using a purely endogenous rate of return. See appendix C 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 for the market sector estimates for Australia in Barnes and McClure (2009) and in other country studies, for example, MHW (2007) and Fukao et al. (2008).

The only test to produce a large change in the MFP growth estimates was the use of a purely endogenous rate of return rather than using the ABS methodology with an exogenous floor rate of return (which has been used for comparability with ABS results).[10] The change was large in only the service sector, because in the manufacturing sector the ABS floor rate of return applied less often. 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. Nor did it change the pattern of MFP growth over the cycles. 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 — this is discussed in chapter 4.

[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. This use of a floor rate differs from the CHS (2006) methodology, which used a purely endogenous rate of return.

4 International comparisons

This chapter examines the experimental estimates of Australian intangibles at the sectoral level in an international context. The Corrado, Hulten and Sichel (CHS) methodology has also been used to measure sectoral intangible investment and its effect on productivity for the United Kingdom (Gil and Haskel 2008; Clayton et al. 2009), Japan (Fukao et al. 2008) and the Netherlands (van Rooijen-Horsten et al. 2008). An alternative but related methodology has also been applied to Canadian data, but without examining the effect on productivity (Baldwin et al. 2009).

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 (see Barnes and McClure 2009 for further discussion).

- National statistical systems differ from country to country and this affects comparability of the underlying data.
- Although the basic methodology for measuring intangibles is quite similar, data limitations have led to some differences in its application across countries. For example, there are 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. It has not been possible to determine the extent of any relative underestimation or overestimation.
- The implementation of growth accounting differs across countries and this affects the comparability of the results (for example, different assumptions are made about the rate of return on capital and some studies take a gross output rather than a value added approach to multifactor productivity (MFP) measurement).
- The estimates do not cover the same time period for each country. Nor do they necessarily coincide with the growth cycle periods that provide the most accurate view of productivity growth.
- The composition of the manufacturing and service sectors differs across countries — there are differences in the actual industry structure of the economies but also in how the sectors are defined in the available data.

– The characteristics of the manufacturing sector will differ across countries because the same set of manufacturing activities are not being undertaken in each country (for example, compared with the other countries, Australia has a lower share of its manufacturing output in Electrical and optical equipment and a higher share in Basic metals and fabricated metals).

– The definition of the 'service sector' is different across countries (table 4.1) — compared with Australia, the service sector for Japan does not include construction; for the United Kingdom it includes a wider range of business services; and for the Netherlands it includes a wider range of both business services and care services.

Table 4.1 **Service sector[a] scope by country**

Australia	*Japan*	*Netherlands*	*United Kingdom*
Electricity, gas & water	Total economy less Manufacturing; Agriculture, forestry & fishing; Mining; Construction; and the Public sector	Electricity, gas & water	Electricity, gas & water
Construction		Construction	Construction
Wholesale trade		Trade, hotels, restaurants & repair	Wholesale & retail trade, hotels & restaurants, transport & communications
Retail trade		Transport, storage & communication	
Accommodation, cafes & restaurants		Financial and business activities	Financial intermediation & business services
Transport & storage		Care & other services	
Communication services			
Finance & insurance			
Cultural & recreational services			

a The United Kingdom and Netherlands studies do not report aggregate service sector estimates. In this chapter, aggregates of the industries listed above have been derived where possible.

Sources: Gil and Haskel (2008); Fukao et al. (2008); van Rooijen-Horsten et al. (2008).

As discussed in Barnes and McClure (2009), there are also a number of other points to note about the interpretation of the type of 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 to be uniform across countries because of limited information.)
- 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.

4.1 Intangible investment as a share of output

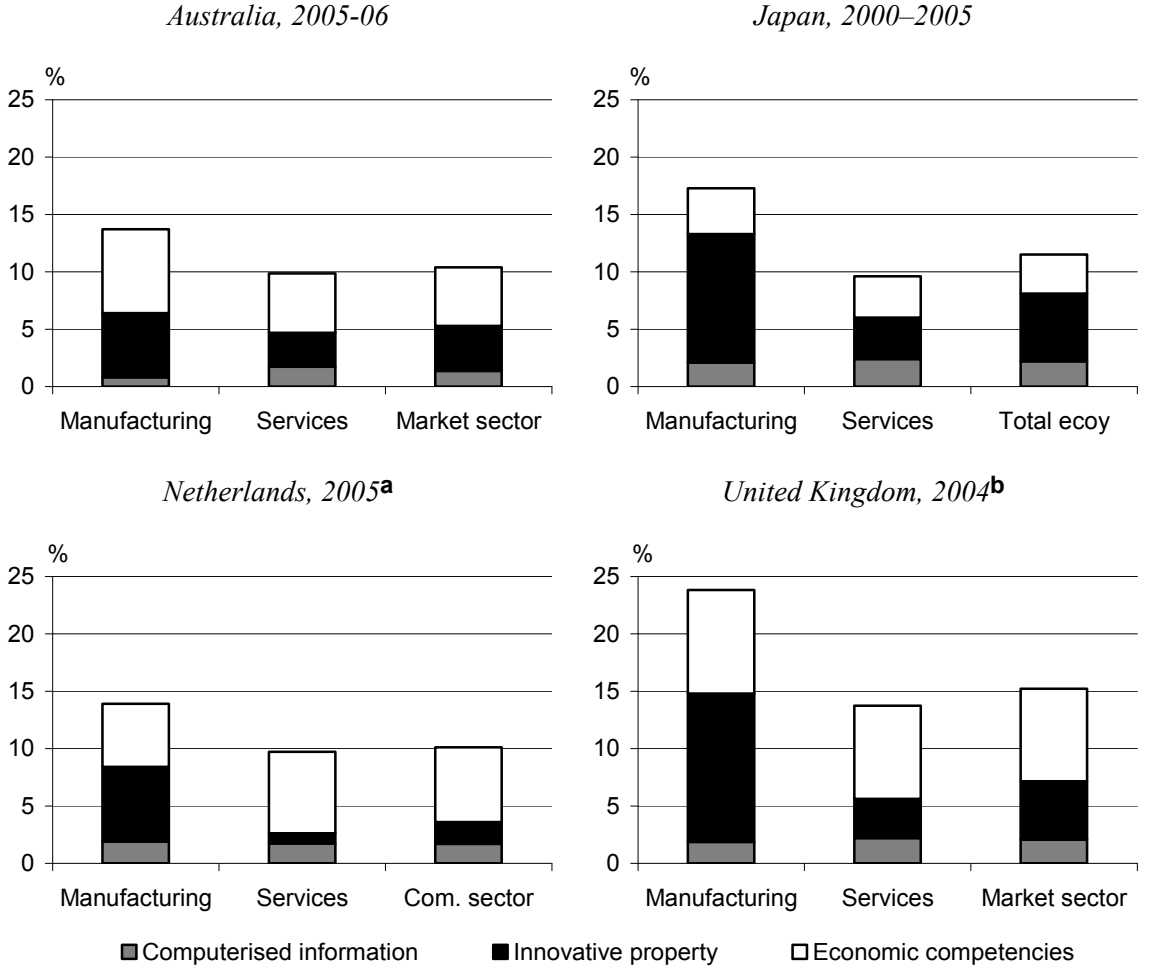
To compare the importance of intangible investment across countries, it is necessary to scale this investment to a common output measure. Intangible investment as a percentage of value added for each sector was available from the studies of the United Kingdom, Japan and the Netherlands and has therefore been estimated for Australia (figure 4.1). Similar data for Canada were not available. The methodology used in Baldwin et al. (2009) is not directly comparable with the other studies — it does not include organisational capital or firm-specific human capital but does include additional measures of R&D based on scientific and engineering personnel. However, the Canadian study is drawn on in the following discussion, where possible.

Based on the intangible investment as a percentage of value added measure, Australia is more similar to the Netherlands in its rates of total intangible investment than to Japan and quite different to the United Kingdom (figure 4.1).

- Australia and the Netherlands have a ratio of intangible investment to output of around 14 per cent in manufacturing and 10 per cent in services.
- Japan also has around 10 per cent in services but a higher proportion in manufacturing (17 per cent), mainly because of higher investment in innovative property.
- The United Kingdom has the highest proportions of intangible investment to output in both sectors — 24 per cent in manufacturing and 14 per cent in services — mainly because of higher investment in economic competencies in both sectors and in innovative property in manufacturing.
- Common to each country is that manufacturing invests more intensively in intangibles than the service sector.
  - This is largely because of the concentration of innovative property investment in manufacturing, but also because of a higher rate of investment in economic competencies (except in the Netherlands).
  - Australia has the smallest difference between sectors because of relatively low investment in innovative property in manufacturing compared with the other countries.

Figure 4.1 **Intangible investment, by sector, by country**

Percentage of sector value added (before 'new' intangibles are capitalised)



a For the Netherlands, services aggregate derived from individual industry data provided in van Rooijen-Horsten et al. (2008). **b** For the United Kingdom services aggregate derived from individual industry data in Gil and Haskel (2008) and original data from sources cited in that study.

Data sources: Author's estimates; Fukao et al. (2008, tables 4 and 5); derived from van Rooijen-Horsten et al. (2008, tables A4 and A5); derived from Gil and Haskel (2008, table 4) and EU KLEMS (2008).

There is even more variation across countries in intangible investment at the individual intangible level (table 4.2).

Table 4.2 Intangible investment as a share of output, by sector, by country

Percentage of sectoral gross value added[a]

	Australia (2005-06)	*Netherlands[e] (2005)*	*Japan (2000–2005)*	*UK (2004)*
Manufacturing				
Computerised information	*0.8*	*1.9*	*2.1*	*1.9*
Innovative property[b]	*5.6*	*6.5*	*11.2*	*12.9*
Scientific R&D[c]	4.1	na	7.8	5.7
Non-scientific R&D[d]	1.5	na	3.4	7.2
Economic competencies	*7.3*	*5.5*	*4.0*	*9.0*
Brand equity	2.4	na	1.6	1.7
Firm-specific human capital	0.8	na	0.5	3.2
Organisational capital	4.0	na	1.9	4.1
Total intangible investment	***13.7***	***13.9***	***17.3***	***23.8***
Services				
Computerised information	*1.7*	*1.7*	*2.4*	*2.2*
Innovative property[b]	*3.0*	*0.9*	*3.6*	*3.4*
Scientific R&D[c]	0.6	na	0.4	0.2
Non-scientific R&D[d]	2.4	na	3.1	3.3
Economic competencies	*5.2*	*7.1*	*3.6*	*8.1*
Brand equity	1.6	na	1.3	1.8
Firm-specific human capital	0.9	na	0.5	3.7
Organisational capital	2.7	na	1.7	2.7
Total intangible investment	***9.9***	***9.6***	***9.5***	***13.7***

Components may not add to totals due to rounding. [a] Sectoral gross value added as reported in national accounts — includes investment in intangibles already capitalised in the national accounts but not the new intangibles. [b] Innovative property intangibles are grouped into scientific R&D and non-scientific R&D to facilitate international comparisons (although there are still differences across countries). [c] Also includes R&D in social sciences for Australia. [d] Includes other product development and artistic originals for each country and R&D in social sciences for the United Kingdom. R&D in social sciences is not measured for Japan and is included in scientific R&D for Australia. [e] Disaggregated data are not available for the Netherlands.

Sources: Author's estimates; derived from van Rooijen-Horsten et al. (2008, tables A4 and A5); Fukao et al. (2008, table 5); and derived from Gil and Haskel (2008, table 4) and EU KLEMS (2008).

Some of the largest variations are in manufacturing.

- Australia's rate of investment in innovative property is only around half that in Japan and the United Kingdom because of relatively low investment in both scientific and non-scientific R&D.
  - Compared with the United Kingdom, the difference in intensity of investment is largest in non-scientific R&D.

  - Compared with Japan, the largest difference is in the intensity of scientific R&D. But differences in the industry structure within manufacturing appear to explain more than half of this difference between Australia and Japan.[1]

- Australia has the second highest intensity of investment in economic competencies after the United Kingdom.
  - Organisational capital is the largest of this group of intangibles in each country. The rate of investment is similar in Australia and the United Kingdom, and is twice the rate for Japan.
  - The United Kingdom has considerably larger investment in firm-specific human capital and is the only country for which firm-specific human capital is larger than brand equity. However, in both Australia and Japan the firm-specific human capital estimates are affected by data limitations.[2]
- Australia has the lowest intensity of investment in computerised information, around half that in the other countries, but this may be due, in part, to measurement differences.
  - It might be assumed that this is explained by differences in the structure of manufacturing in Australia. But, while Australia does have a smaller share of its manufacturing industry in the industries that are relatively software intensive in the other countries, such as electrical and optical equipment, this appears not to be the main explanation. Australia also has a relatively low intensity of software investment across a wide range of manufacturing sub-industries.[3]

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1 Calculations based on OECD business R&D and value added data by manufacturing sub-industry for 2006 (Structural Analysis database from OECD.Stat) suggest that industry structure differences account for about 60 per cent of the difference in the intensity of investment in business R&D between Australia and Japan. This database is based on the OECD Frascati Manual definition of business R&D, which includes R&D in social sciences. This is the same definition applied in the Australian business R&D survey but may differ from that used in the Fukao et al. (2008) estimates of scientific R&D.

2 Fukao et al. (2008, p. 11) notes that investment in firm-specific resources depends on the business customs of each country. They suggest that Japanese firms often utilise informal on-the-job training (which is not included in the estimate of firm-specific human capital by CHS or in the Australian estimates). They also note that a recent Japanese survey suggests that Japanese executives only spend 9 per cent of their time working on organisational capital, compared with the CHS assumption of 20 per cent (which Fukao et al. use in their base case estimates). As noted in chapter 2, the Australian estimate is affected by crude approximations due to very limited availability of data.

3 For example, based on comparable EU KLEMS data for 2005, Australia has a lower ratio of software investment to value added in 9 out of 11 manufacturing sub-industries compared with the Netherlands and Japan and in all sub-industries compared with the United Kingdom.

– However, some caution is needed in the interpretation of this comparison because of differences in the measure of computerised information used across countries. The Japanese estimate is based on a wide range of surveys of expenditures related to computerised information. And while the estimates for the United Kingdom, the Netherlands and Australia are based on estimates under the United Nations System of National Accounts, there are differences in the implementation of this system across countries. It has not been possible to determine the extent to which this affects the estimates.

In the service sector, while the ratio of total intangible investment to output is fairly similar across Australia, Japan and the Netherlands (and quite different from the United Kingdom), the distribution across individual intangibles is more variable (table 4.2).

- Again, Australia invests less intensively in computerised information investment than Japan and the United Kingdom (although there are some limitations on cross-country comparability).
  - As in the case of manufacturing, it appears that Australia is less computer intensive in a range of service industries (although the comparability of these estimates is affected by measurement differences across countries).[4]
- The rate of investment in innovative property is more similar than in manufacturing — with non-scientific R&D larger than scientific R&D in Australia, the United Kingdom and Japan.
  - The considerably lower rate of investment in total innovative property for the Netherlands appears to be largely due to measurement differences.[5]
- Investment in economic competencies is the largest (or equal largest) share of intangible investment in services in each country.
  - Organisational capital is the largest of this group, except in the United Kingdom where it is firm-specific human capital. However, as noted for manufacturing, there are some measurement differences that affect firm-specific human capital for Japan and Australia.

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4 This is based on a comparison using EU KLEMS data for the individual service industries. It should be noted that the computerised information intensity for the aggregate Japanese service sector estimate derived from the EU KLEMS database is considerably different to that reported in Fukao et al. (2008) and table 4.2. This is likely to reflect a difference in scope of the estimate of computerised information/software. Disaggregated data by service sector industry are not available from Fukao et al. (2008).

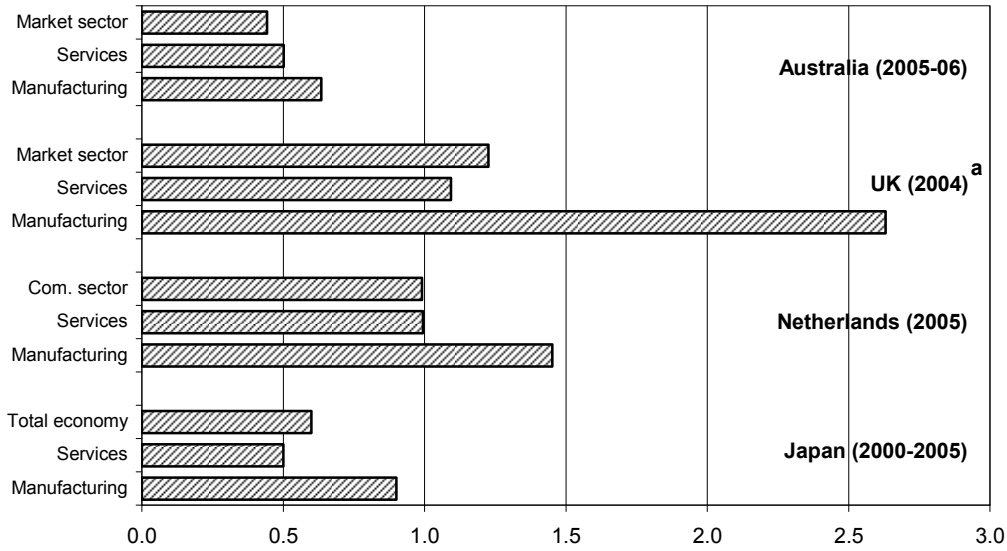
5 Although data for individual intangibles disaggregated by industry are not available for the Netherlands, van Rooijen-Horsten et al. (2008) report considerably lower investment in architectural/engineering design investment (part of non-scientific R&D) at the market sector level as a result of methodological differences.

Baldwin et al. (2009) found intangibles to be prominent in both goods and services sectors of the Canadian economy, although the composition of that investment varied. A larger share of advertising and software expenditures were made by service sector industries and a larger share of purchased science and engineering were made by goods industries. R&D and own account other science were equally shared across the good and services sectors.

Ratio of intangible to tangible investment

There is also considerable variation in the ratio of intangible to tangible investment across countries (figure 4.2). The Australian ratio of intangible to tangible investment is higher in manufacturing than the service sector — this is the same as for the other countries shown. However, for Australia the ratio for manufacturing is much lower than the equivalent ratio for the United Kingdom and the Netherlands. For services, the Australian ratio is about the same as for Japan but around half that for the Netherlands and the United Kingdom. In addition to cross-country differences in intangible investment, strong growth in Australian tangible investment since 2001-02 may be part of the explanation for the lower ratios in Australia than the other countries. Tangible investment growth has generally not been as strong in the other countries.

Figure 4.2 **Ratio of intangible to tangible investment, by sector, by country**



a Based on different data for the United Kingdom to that used in the previous section — includes some revisions, but these were not reported on the detailed basis provided in the original paper used above.

Data sources: Author's estimates; Fukao et al. (2008, tables 2 and 5); van Rooijen-Horsten et al. (2008, table A5); Clayton et al. (2009, table 3).

For Japan, Fukao et al. (2008) suggest that the reason why firms in the service sector accumulate more tangible than intangible assets is that they are more dependent on debt finance (for which there are particular tangible collateral requirements in the Japanese financial system). For the United Kingdom it is perhaps unexpected that the ratio of intangibles to tangibles is so high in manufacturing, which might be expected to be reasonably intensive in tangible capital.

Baldwin et al. (2009) found that in Canada intangibles were more important than tangibles in several industries — Construction, Professional, scientific and technical services, Administrative support and waste management, Wholesale trade, Manufacturing, and Retail trade. The ratio of intangibles to tangibles investment for Manufacturing was around 1.6; while the other industries ranged from nearly 5.5 for Professional, scientific and technical services to around 1.3 for Retail trade. The ratio for the business sector as a whole was around 0.9.

4.2 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 early 2000s to 2005. Estimates for this period are available from all the country studies that have identified sectoral intangibles in growth accounting analysis.[6]

It should also be noted that the results for Australia presented in this chapter are for a different time period to those in chapter 3, in order to match the other countries. The period 1999-2000 to 2004-05 is not a growth cycle period for Australia and may be affected by the influences of business cycles.[7] This caveat may also apply to the periods reported from the other country studies.

Comparison of the importance of intangibles

There are limited growth accounting estimates available for international comparisons. Manufacturing sector estimates are available for all four countries discussed above but estimates for the service sector (as a whole) are only available

[6] For the Netherlands the full decomposition of labour productivity growth is not available, but MFP growth results are reported. Growth accounting results for earlier periods are reported in the country studies for the Netherlands and Japan.

[7] The closest peaks for Australia are 1998-99 and 2003-04. The MFP indexes for 1999-2000 and 2004-05 are lower than the nearest peaks for both sectors. But while not ideal the periods examined are at least not distorted by being peak to trough.

for Australia and Japan — for the Netherlands and the United Kingdom estimates for individual service industries are reported. Also, for the Netherlands and the United Kingdom there are differences in the basis on which the growth accounting estimates are reported, which affects comparability.[8] Therefore, the main comparisons discussed below are between Australia and Japan (results for the United Kingdom and the Netherlands are reported in the tables and figures where available).

Intangible capital deepening contributed around 25 per cent to Australian and Japanese labour productivity (LP) growth in manufacturing. This was more than half of the largest contributor, tangible capital deepening (at around 40 per cent) (table 4.3). The contribution of intangible capital deepening in the service sector was lower in both countries — 19 per cent in Australia and 14 per cent in Japan — with the MFP growth the largest contributor to LP growth (at around 45 per cent).

Although not providing directly comparable estimates, the Dutch paper found differences in the contribution of intangibles to output growth across industries. Intangibles made a smaller contribution to output growth in manufacturing than in a number of service industries (particularly Financial & business activities and Transport, storage & communication). In the case of Financial & business activities, intangible capital was as important as tangible capital as a driver of output growth. However, for manufacturing, van Rooijen-Horsten et al. (2008, p. 29) noted that "[a]lthough intangible investments in manufacturing are almost 14 per cent of value added (2005), intangibles' contribution to consolidated output growth is very small [0.0 in 2001–2005]. Apparently most intangible investments in manufacturing comprise replacements of older intangibles".

[8] For the Netherlands and the United Kingdom, a gross-output or KLEMS based approach is taken to MFP measurement, which differs to the value added approach taken in this paper and the Japanese study (Fukao et al. 2008). The value added approach relates value added to capital and labour as inputs, whereas the gross output approach relates gross output to capital, labour and intermediate inputs. These two methods will produce different estimates of MFP growth (the former will produce higher estimates than the latter), and the difference between them will be greater where intermediate inputs are a higher proportion of gross output (see OECD 2001b and Hulten 2009 for further discussion). While a gross-output approach has advantages for estimation at the industry level it has not been possible to employ this approach for the Australian estimates in this paper.

Table 4.3 **Productivity growth after accounting for all intangibles, by sector, by country**

Per cent per year

	Australia *(1999-2000 – 2004-05)*	*Japan* *(2000 – 2005)*	*UK*[a] *(2000 – 2005)*	*Netherlands*[b] *(2001 – 2005)*
Manufacturing				
All intangibles				
Labour productivity growth	2.99	4.26	3.73	na
	(100)	(100)	(100)	
Capital deepening	1.99	2.82	1.31	na
	(67)	(66)	(35)	
Intangible capital	0.72	0.96	0.97	na
	(24)	(23)	(26)	
Tangible capital	1.27	1.85	0.34	na
	(42)	(43)	(9)	
Intermediate input deepening	na	na	1.77	na
			(47)	
MFP growth/TFP growth[c]	0.99	1.44	0.66	0.6
	(34)	(34)	(18)	
Services[d]				
All intangibles				
Labour productivity growth	1.91	2.32		
	(100)	(100)		
Capital deepening	1.13	1.23		
	(59)	(53)		
Intangible capital	0.36	0.32		
	(19)	(14)		
Tangible capital	0.78	0.91		
	(41)	(39)		
Intermediate input deepening	na	na		
MFP growth/TFP growth[c]	0.78	1.09		
	(41)	(47)		

Components may not add to totals due to rounding. [a] These results for the United Kingdom are based on a revised version of the data used in earlier sections, but the detailed breakdown used earlier was not provided in Clayton et al. (2009). [b] A full LP growth decomposition is not reported in van Rooijen-Horsten et al. (2008). [c] Labour quality change has not been separately identified in the results for Australia and Japan. The labour quality change and TFP growth reported in the United Kingdom study have therefore been combined in this table for the purposes of comparison. [d] No service sector aggregate is available for the United Kingdom and the Netherlands. Individual service industry results for the United Kingdom are shown in figure 4.3.

Sources: Author's estimates; Fukao et al. (2008); Clayton et al. (2009); van Rooijen-Horsten et al. (2008).

This comparison with the other country results is affected to some extent by the use of an exogenous floor rate of return for the Australian capital services estimates — whereas the UK and Japanese studies use a purely endogenous rate of return and the study of the Netherlands uses a purely exogenous rate of return. The exogenous floor rate approach is used in this paper because it is used by the ABS in the Australian national accounts (see appendix B for details). But, as discussed in chapter 3, the Australian results were sensitivity tested to the rate of return assumptions. For manufacturing, the Australian results were virtually unchanged because the exogenous floor rate of return applied less often in the base case than in the service sector. For the service sector, using an endogenous rate of return increased the contribution of capital deepening to LP growth from 59 to 67 per cent, with MFP growth becoming correspondingly smaller (see appendix C). This increased the difference between the Australian and Japanese results.

Comparison of the effect of adding intangibles

As discussed in chapter 3, capitalising rather than expensing intangibles expenditure can result in a change to measured MFP growth. MFP growth can rise, fall or remain unchanged, 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 4.4 and figure 4.3 show growth accounting estimates for two definitions of capital — including no intangibles and including all intangibles. Again, directly comparable results for both sectors are only available for Australia and Japan. Some results on a different decomposition basis and for a different aggregation of industries are available for the United Kingdom. No results for the no intangibles case were reported in the study of the Netherlands.

The direction of the effect of including intangible capital was the same for Australia and for the United Kingdom — MFP growth fell (or was unchanged) in both manufacturing and services. In contrast, capitalising intangibles in Japan led to a rise in MFP growth in both sectors. Notably, for the service sector, this means that Japan's MFP growth ranking rises relative to Australia after capitalising intangibles. It is unchanged for manufacturing, for which Japan already had higher MFP growth than Australia. (The magnitude of the results for the United Kingdom is not directly comparable because the use of the gross output method gives a smaller MFP growth estimate than the method used for Australia and Japan).

Table 4.4 **Effect of intangibles on productivity growth, by country**

Per cent per year

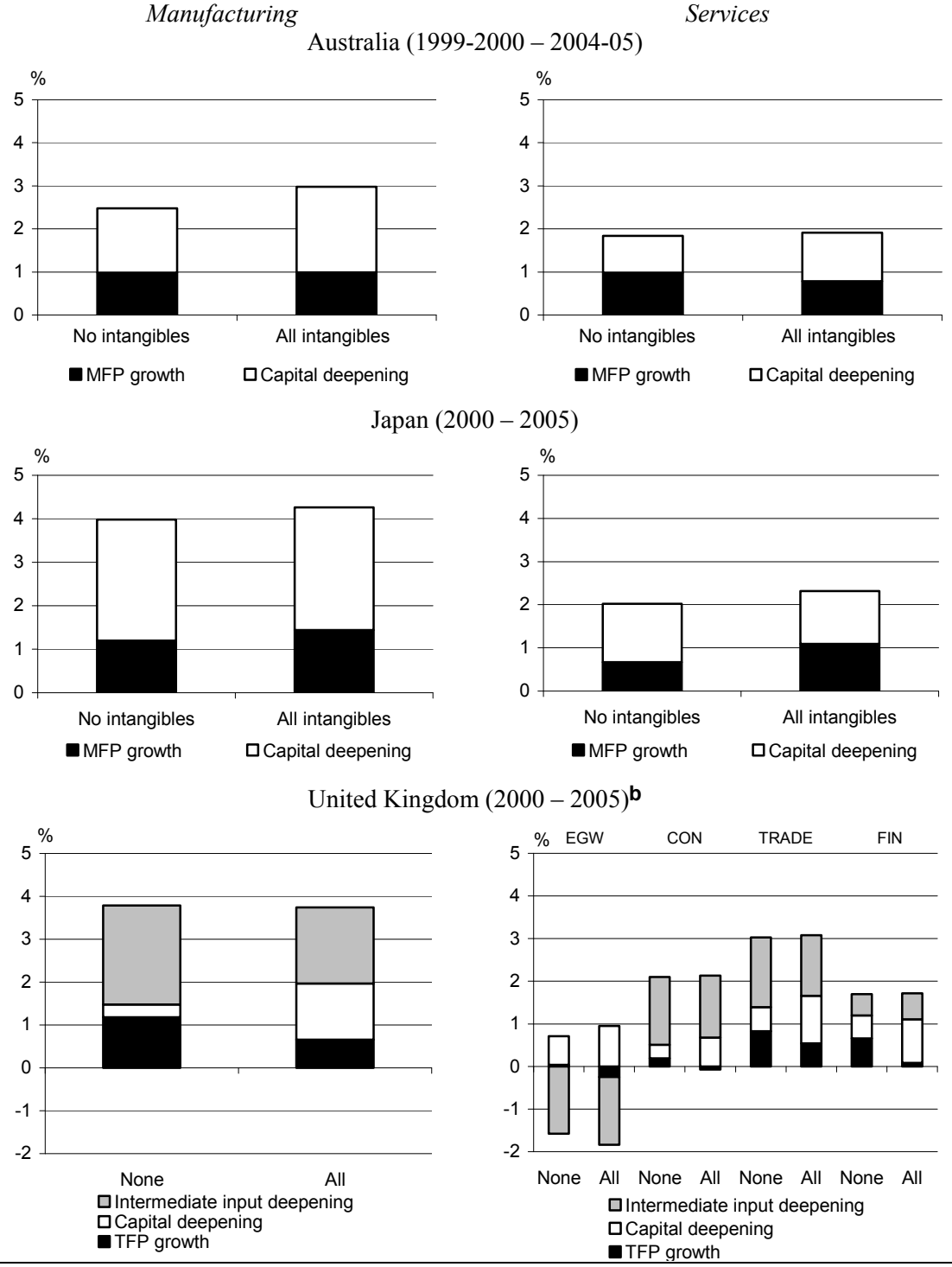
	Australia *(1999-2000 – 2004-05)*	*Japan* *(2000 – 2005)*	*UK*[a] *(2000 – 2005)*	*Netherlands*[b] *(2001 – 2005)*
Manufacturing				
No intangibles				
Labour productivity growth	2.49	3.98	3.79	na
	(100)	(100)	(100)	
Capital deepening	1.49	2.78	0.30	na
	(60)	(70)	(8)	
Intermediate input deepening	na	na	2.31	na
			(61)	
MFP growth/TFP growth[c]	0.99	1.20	1.18	na
	(40)	(30)	(31)	
All intangibles				
Labour productivity growth	2.99	4.26	3.73	na
	(100)	(100)	(100)	
Capital deepening	1.99	2.82	1.31	na
	(67)	(66)	(35)	
Intermediate input deepening[d]	na	na	1.77	na
			(47)	
MFP growth/TFP growth[c]	0.99	1.44	0.66	0.6
	(33)	(34)	(18)	
Services[e]				
No intangibles				
Labour productivity growth	1.84	2.02		
	(100)	(100)		
Capital deepening	0.85	1.35		
	(47)	(67)		
Intermediate input deepening	na	na		
MFP growth/TFP growth[c]	0.99	0.67		
	(54)	(33)		
All intangibles				
Labour productivity growth	1.91	2.32		
	(100)	(100)		
Capital deepening	1.13	1.23		
	(59)	(53)		
Intermediate input deepening	na	na		
MFP growth/TFP growth[c]	0.78	1.09		
	(41)	(47)		

Components may not add to totals due to rounding. [a] These results for the United Kingdom are based on a revised version of the data used in earlier sections, but the detailed breakdown used earlier was not provided in Clayton et al. (2009). [b] Results without intangibles and a full LP growth decomposition is not reported in van Rooijen-Horsten et al. (2008). [c] Labour quality change has not been separately identified in the results for Australia and Japan. The labour quality change and TFP growth reported in the United Kingdom study have therefore been combined in this table for the purposes of comparison. [d] The reclassification of intangible expenditure from intermediate input to capital obviously lowers the level of intermediate inputs and raises the level of capital. However, the effect on intermediate input deepening and capital deepening is ambiguous — it depends on the growth rates of intangible investment and intangible capital relative to other intermediates and tangible capital. [e] No service sector aggregate is available for the United Kingdom and the Netherlands. Individual service industry results are shown in figure 4.3.

Sources: Author's estimates; Fukao et al. (2008); Clayton et al. (2009); van Rooijen-Horsten et al. (2008).

Figure 4.3 **Decomposition of labour productivity growth, with and without intangibles, by sector/industry, by country[a]**

Per cent per year



a Equivalent data for the Netherlands are not available. **b** 'None' is no intangibles treated as capital; and 'All' is all intangibles treated as capital. TFP growth includes labour quality change for comparison purposes (labour quality change has not been separately identified in the results for Australia and Japan). EGW is Electricity, gas & water; CON is Construction; TRADE is Wholesale & retail trade, hotels & restaurants, transport & communications; FIN is Financial intermediation & business services.

Data sources: Author's estimates; Fukao et al. (2008); Clayton et al. (2009).

- In the Australian manufacturing sector, capital deepening rose by the same amount as LP growth, resulting in no change in MFP growth (which is derived as the residual). In services, capital deepening rose by more than the rate of LP growth, with a corresponding fall in MFP growth of 21 per cent (from 1.02 per cent a year to 0.81 per cent a year).
- In the United Kingdom, capitalising intangibles led to lower LP growth in the manufacturing sector and two of the service industries (as a result of slower growth in investment in intangibles than growth in other output). Combined with a rise in capital deepening, MFP growth fell by 44 per cent in manufacturing and by 2900 per cent in Electricity, gas & water and 200 per cent in Construction.[9] In the other two service industries, the rise in LP growth was outweighed by the rise in capital deepening with a corresponding fall in MFP growth of 47 per cent in Trade, hotels, etc and 141 per cent in Finance & business services.[10]
- The contrasting result for Japan, a rise in MFP growth in both sectors, was the result of a larger increase in LP growth than in capital deepening after capitalising intangibles. In the case of services, capital deepening actually declined. The rise in MFP growth was 20 per cent in manufacturing (from 1.20 to 1.44 per cent a year) and 63 per cent in services (0.67 to 1.09 per cent a year).

However, regardless of the direction of change in MFP growth, capitalising intangibles generally had a larger effect on the contribution of MFP growth to LP growth in services than manufacturing (the exceptions were Trade, hotels, etc and Construction in the United Kingdom).

- In manufacturing the largest change in the percentage contribution of MFP growth to LP growth was in the United Kingdom (-13 percentage points), followed by Australia (-7 percentage points) and Japan (+4 percentage points).
- In services, the change in the contribution of MFP growth to LP growth was of similar size (if different direction) in Australia (-13 percentage points) and Japan (+14 percentage points). Across the service industries in the United Kingdom, the change ranged from -10 percentage points in Trade, hotels, etc to -34 percentage points in Finance & business services.

Overall, capitalising intangibles therefore raised the importance of capital deepening and lowered the importance of MFP growth as sources of growth in

9 The very large percentage changes are from very small bases — the MFP growth rate fell from 0.01 to -0.28 per cent a year in Electricity, gas & water and from 0.13 to -0.13 per cent a year in Construction.

10 The large percentage changes are from small bases — the MFP growth rate fell from 0.61 to 0.32 per cent a year in Trade, hotels, etc and from 0.41 to -0.17 per cent a year in Finance & business services.

Australia and the United Kingdom in both manufacturing and services, but the reverse was the case in Japan (as illustrated in figure 4.3).

Effect on growth accounting results over shorter periods

The above results cover only one period but data for various shorter periods were examined in the Japanese study and the growth cycle periods were examined for Australia in chapter 3. Figure 4.4 presents these shorter period results. (The study of the Netherlands did include estimates for industries for two periods but did not compare the results after capitalising all intangibles with those without capitalising intangibles.)

The effect on MFP growth of capitalising intangibles expenditure is ambiguous a priori. It is therefore possible that the direction of this effect will differ across periods and, as Fukao et al. (2008) found for Japan, this can change the pattern of growth between periods — as shown in the circled periods in figure 4.4.

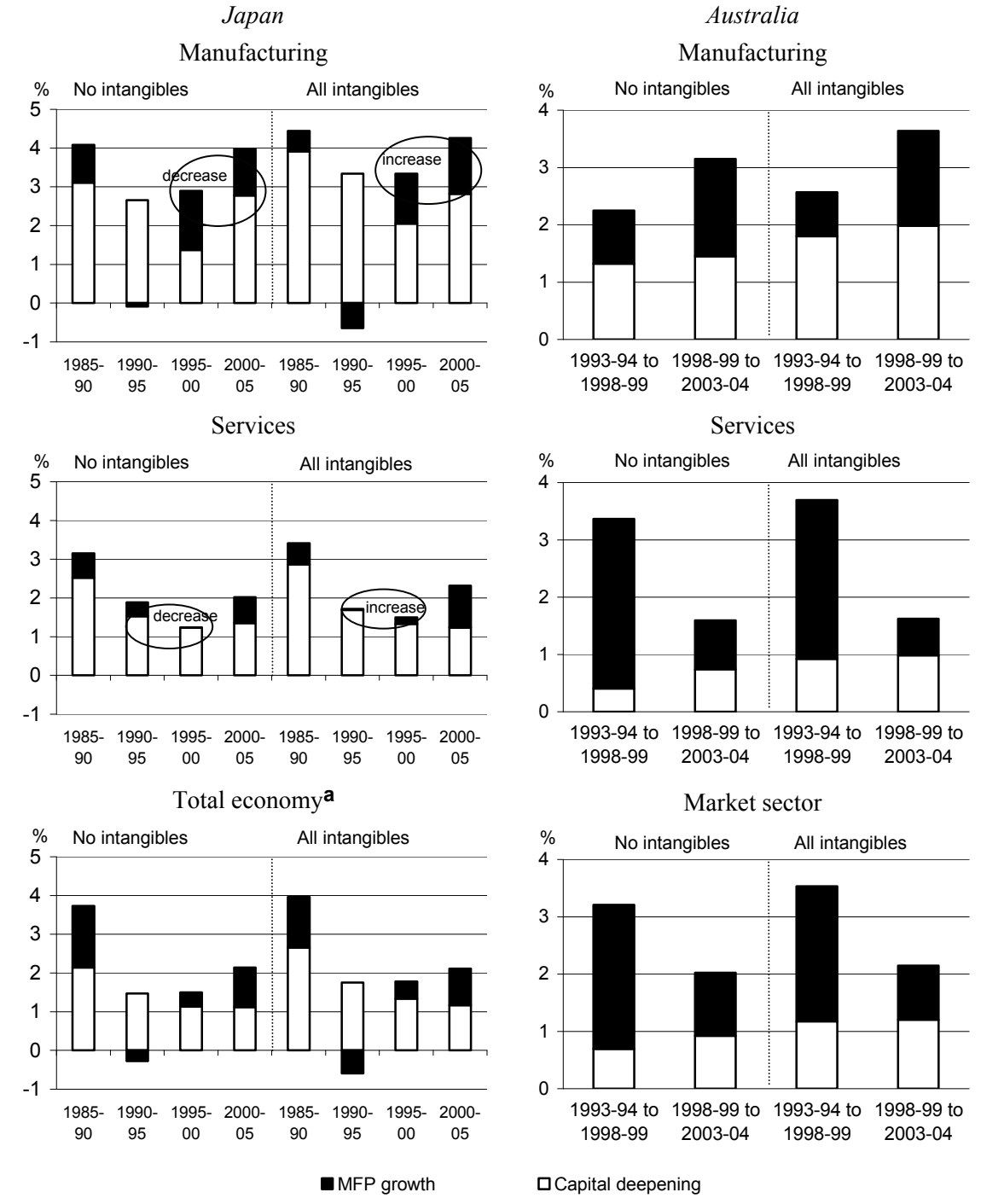
For Japan, treating intangibles as capital did reverse the pattern of MFP growth (in terms of a switch from an increase to a decrease in the MFP growth rate or vice versa between two time periods) in both manufacturing and services but in different time periods. And these different sectoral effects were offsetting so that the aggregate economy results showed no change in the pattern of MFP growth. For manufacturing a decrease in MFP growth between 1995–2000 and 2000–05 became an increase after capitalising intangibles. For services, capitalising intangibles changed a decrease in MFP growth between 1990–95 and 1995–2000 to an increase. The extent of this change in pattern (in percentage terms) was much larger in the service sector than in the manufacturing sector.

In contrast, the sectoral estimates for Australia show that capitalising intangibles did not change the pattern of MFP growth across the cycles, it only altered the extent of any increase/decrease in the MFP growth rate between periods. However, while the result estimated for the Australian manufacturing and service sectors is the same as that previously estimated for the market sector aggregate — that is, no change in the *pattern* of Australian MFP growth — the *size* of the effect on MFP growth does vary across sectors. For the market sector the decrease in the rate of MFP growth was slightly stronger after capitalising intangibles. This was also the case in services, with a slightly larger effect than in the market sector. But in manufacturing capitalising intangibles led to a considerably stronger increase in MFP growth — before capitalising intangibles the increase in MFP growth between cycles was 83 per cent of MFP growth in the first cycle but after capitalising intangibles the increase was 115 per cent. This is the opposite to the Japanese results in which the

effect of capitalising intangibles on the pattern of MFP growth was larger in services than manufacturing.

Figure 4.4 **Contributions to labour productivity growth over MFP growth cycles, by sector, by country**

Per cent per year



[a] In addition to Manufacturing and Services, the total economy includes Agriculture, forestry & fishing, Mining, Construction, and the Public sector (which together made up around 15 per cent of value added in 2005).

Data sources: Author's estimates; Fukao et al. (2008, tables 9.2, 9.3).

A Data sources and methodology for sectoral estimates of intangibles

This appendix describes the Australian data sources used in this paper. While the intent has been to follow the Corrado, Hulten and Sichel (CHS) methodology, data availability has led to some differences. This was also the approach taken in the study of intangibles at the market sector level in Australia (Barnes and McClure 2009). A more detailed discussion of data sources, methods and how the data sources compare with those used in other country studies can be found in appendix A to that study.

In this paper, the estimates of intangibles have been constructed for the manufacturing sector and the service sector. For the purposes of this paper, the service sector is defined those service industries within the market sector including: Electricity, gas & water; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Communication services; Finance & insurance; and Cultural and recreational services. The industries excluded are Property & business services, Government administration & defence, Education, Health & community services, and Personal & other services. All references to ABS ANZSIC (Australian Bureau of Statistics Australian and New Zealand Standard Industrial Classification) are to the ANZSIC 1993 edition. All published and unpublished national accounts data used in this paper are from the dataset underlying ABS, *Australian System of National Accounts, 2006-07* (Cat. no. 5204.0).

Table A.1 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.

Investment and capital stock estimates (for the 'new' intangibles) were constructed for the period 1989-90 to 2005-06. However, estimates are only reported from 1993-94 because additional assumptions made in the earlier years result in lower quality estimates. Investment estimates for these earlier years are only used in the construction of the initial capital stock estimate.

Table A.1 **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 expend. treated as investment*	*Deflator*	*Dep'n rate (%)*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
Computerised information	ABS national accounts (5204.0)	2006-1994 Gross fixed capital formation (GFCF) and productive capital stock (PKS) for computer software by industry	1	ABS computer software implicit price deflator (IPD)	24 (mfg) 23 (serv.)	817 (mfg) 6160 (serv.)	2530 (mfg) 18716 (serv.)
Business expenditure on R&D	ABS BERD survey (8104.0)	2006-1990 Business expenditure on R&D by industry (excluding R&D by the financial services industry)	1	Implied sector gross value added (GVA) deflator	20	4076 (mfg) 2105 (serv.)	16518 (mfg) 7173 (serv.)
Artistic originals (Service sector only)	ABS national accounts (5204.0)	2006-1994 GFCF and PKS for artistic originals	1	ABS artistic originals IPD	60	698 (serv.)	1102 (serv.)
New product development in financial industry (Service sector only)	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 1994-1990 Backcast using growth rate in intermediate usage of Financial & insurance from IO tables	1	Implied Finance & insurance industry GVA deflator	20	5591 (serv.)	27507 (serv.)

(continued on next page)

Table A.1 **(continued)**

Type of intangible	*Main data source*	*Time series (all refer to financial year ended)*	*Proportion of expend. treated as investment*	*Deflator*	*Dep'n rate (%)*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
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. 1994-1990 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 sector using sector intermediate usage as a share of Australian production of SUPC 43020 from SU tables back to 1995 (backcast using sector share of GVA).	1	Implied sector GVA deflator	20	1464 (mfg) 2141 (serv.)	5804 (mfg) 8319 (serv.)
Advertising	CEASA (2003, 2006, 2007)	2006-1990 Total advertising expenditure less expenditure on classifieds and directories. Multiplied by 2 to arrive at estimate including production costs. Scaled to sector using sector intermediate usage as a share of Australian production of advertising services (SUPC 43025 from SU tables back to 1995, backcast using sector share of GVA)	0.6	Implied sector GVA deflator	60	2152 (mfg) 4786 (serv.)	3604 (mfg) 7881 (serv.)

(continued on next page)

Table A.1 **(continued)**

Type of intangible	*Main data source*	*Time series (all refer to financial year ended)*	*Proportion of expend. treated as investment*	*Deflator*	*Dep'n rate (%)*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
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. 1992-1990 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 sector using sector intermediate usage as a share of Australian production of Other business services SUPC 43031 from SU tables back to 1995 (assumes this share is the same for market research services) (backcast using sector share of GVA).	0.6	Implied sector GVA deflator	60	260 (mfg) 723 (serv.)	406 (mfg) 1110 (serv.)

(continued on next page)

Table A.1 **(continued)**

Type of intangible	*Main data source*	*Time series (all refer to financial year ended)*	*Proportion of expend. treated as investment*	*Deflator*	*Dep'n rate (%)*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
Firm-specific human capital	ABS Training surveys (6353.0, 6278.0)	Based on estimates for the market sector from Barnes and McClure (2009). 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 2006 assumed hours per employee 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 1990 and 2003-2006. Resulting market sector nominal estimates split on the basis of sectoral share of market sector training hours.	1	Sector average weekly full-time ordinary earnings deflator	40	832 (mfg) 3062 (serv.)	2015 (mfg) 7308 (serv.)

(continued on next page)

Table A.1 **(continued)**

Type of intangible	*Main data source*	*Time series (all refer to financial year ended)*	*Proportion of expend. treated as investment*	*Deflator*	*Dep'n rate (%)*	*Investment 2006 ($m)*	*Stock 2006 ($m)*
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. 1994-1990 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 sector using 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 sector share of GVA).	0.8	Implied sector GVA deflator	40	2401 (mfg) 6669 (serv.)	5427 (mfg) 14704 (serv.)
Own account organisational capital	ABS Labour survey (6310.0)	2006-1998 20 per cent of earnings of sector employees classified as Managers & administrators (M&A) (excl. IT and farm mgrs). 1997-1990 Earnings backcast using growth rate in earnings of employees classified as M&A for the total economy. Assumes sector growth rate is the same as for the total economy. Employee numbers backcast using growth in total employed M&A for sector.	1	Implied sector GVA deflator	40	1608 (mfg) 3071 (serv.)	3607 (mfg) 6770 (serv.)

A.1 Nominal expenditure series

For each of the intangibles an expenditure series was compiled for 1989-90 to 2005-06 — which in most cases required backcasting based on related data.

Computerised information

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 for manufacturing and each of the service industries in the market sector are available for the full period 1993-94 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 smaller expenditures on database and own-account software development.

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. And mineral exploration is only relevant to Mining, which is a part of the market sector that is not examined in detail in this paper (see appendix A of Barnes and McClure 2009 for details of mineral exploration estimates).

It should also be noted that in December 2009, the ABS capitalised R&D in the Australian national accounts (ABS 2009). However, it was not possible to use these estimates in this paper — the ABS estimates are based on a different industry classification to that used in this paper and were also not available at the time the main analysis was undertaken. The estimates used in this paper were constructed using a methodology (discussed below) that is comparable with that used in the other CHS-type studies. While based on the same underlying data as the new ABS

estimates, the estimates in this paper are based on methodology that is less sophisticated.

Direct comparisons of the two sets of estimates are not possible because of the different industry classification. However, a comparison based on broadly similar groupings of industry divisions suggests that there is a similar general pattern of movements over time in the business R&D investment estimates for manufacturing and services in this paper and the ABS estimates. For manufacturing, the average annual growth rate for nominal business R&D investment over the period 1993-94 to 2005-06 is estimated at 7.5 per cent a year in this paper and 6.7 per cent using recent ABS-based estimates. For the service sector, the equivalent estimates are 14.1 per cent a year from estimates in this paper compared with 12.8 per cent using recent ABS-based estimates.

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 each industry was compiled for 1968-69 to 2002-03 by Shanks and Zheng (2006). For this paper these series[1] were updated and extended to 2005-06 using revised and updated data from the ABS Cat. no. 8104.0 and, in the case of the market sector service industries, aggregated to create a service sector series.

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 category 'business expenditure on R&D' includes 'R&D in social sciences and humanities' as well as scientific R&D undertaken by each sector.

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

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

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. The extent of any remaining duplication is discussed below.

Artistic originals

Artistic originals are already capitalised in the Australian national accounts and are allocated entirely to Cultural and recreational services, part of the service sector as defined 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)

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 — 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 1993-94 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). As this industry is part of the service sector, all new product development in the financial industry is allocated to that sector.

For this paper, a series for 20 per cent of total intermediate purchases[2] 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 1989-90 to 2005-06 — IO/SU data were not available for every year and missing years were interpolated/extrapolated (see appendix A of Barnes and McClure 2009 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 C).

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

To backcast the aggregate series of architectural and engineering services to 1989-90, 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

[2] 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.

relevant to each sector. This was done using the 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 1989-90 (and forecast to 2005-06) using growth in the 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. (A similar conclusion was drawn in the UK study — see MH (2006, p. 4) for further discussion.) 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 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 of Barnes and McClure 2009 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 C).

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). A reputation for reliability may persuade shoppers to try a new item for the first time.

There is some debate about whether advertising and marketing expenditure should be treated as investment. Aizcorbe et al. (2009, p. 17) notes that such expenditures may not alter the production function.

> First, some argue that advertising and marketing expenditures are in some sense unproductive, perhaps because advertising and brand equity are thought to affect the demand function instead of the production function. In contrast, spending on other intangibles directly affect the production function by either creating a better output or the same output using fewer inputs or better inputs. This issue is contentious, however; Hulten and Hao (2008) argue in favour of treating this type of spending as investment.

Hulten and Hao (2008) argue that the modern corporation is most often a complex organisation that develops, produces and markets a range of products and that characterising this process goes far beyond the simple production function framework. In an examination of the pharmaceutical industry they see marketing of a new drug as part of the innovation process.

> New drugs typically take time and effort to penetrate the market place, and some part of the marketing expenditure is a necessary coinvestment made in order to recoup the substantial up-front costs of product R&D. … These expenditure help establish a new drug in the market place, and, once established, the resulting brand equity is an asset to the firm. By implication, some fraction of these marketing expenditures should therefore be accorded the same treatment as R&D investment.[10](p. 13)

[10] This argument contrasts with the popular view that the marketing expenditures of pharmaceutical companies … are unproductive and merely serve to drive up the cost of drugs to the consumer. This rent-seeking view implicitly assumes that a good drug will sell itself, implying a rapid and costless dissemination of information. In fact, the up-take of new drugs is often far from rapid even when they turn out to be highly efficacious, despite considerable marketing efforts by the drug companies. The rationale for capitalizing some fraction of the marketing expenditures is based on the idea that a company will not undertake the cost to bring a new drug to market … unless there is the prospect of selling enough of the drug to cover the cost. Seen in this way, the marketing of a new drug is part of the innovation process.

Aizcorbe et al. (2009, p. 17) also raise the issue of advertising resulting in changes in a firm's market share rather than increasing aggregate output.

A separate issue is that cumulating advertising expenditures may increase a firm's output, but it does not follow that cumulating all firms' advertising expenditures increases aggregate output. Therefore, there is potentially a fallacy of composition problem involved in capitalizing these expenditures in the national accounts and calling them part of an aggregate capital stock.

These issues are not examined further here and for the purposes of comparability with CHS-type studies, brand equity is included as an intangible asset in this paper.

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 of Barnes and McClure 2009), the CEASA series has been doubled to account for production costs.

These estimates for the total Australian economy have been scaled down to sector estimates using 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 1989-90 (and forecast to 2005-06) using growth in the 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 of the market research industry was constructed for this paper using a number of data sources. (The CHS approach was followed for comparability purposes and in the absence of readily available alternative estimates of inhouse market research.) 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. The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05. 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 1989-90 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 each sector. This was done using the sector intermediate usage share for the closest available group of services (Other business services) from SU tables for 1994-95 to 2003-04. This share was backcast to 1989-90 (and forecast to 2005-06) using growth in the 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.

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.[3] 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.[4] 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.

[3] 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.

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

– It does not include education and unstructured on-the-job training. At the market sector level, Barnes and McClure (2009) was able to incorporate some of these broader elements of human capital into the growth accounting exercise through use of the ABS experimental quality-adjusted labour input series. However, quality-adjusted labour inputs are not available at the sectoral level.[5]

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). And data are even poorer at the sectoral level than the aggregate level. It was therefore necessary to split the market sector series for training expenditure from Barnes and McClure (2009) by simply using the sectoral shares of market sector training hours. This does not take account of any differences in costs of training across sectors or any difference in growth of costs across sectors. As such, the resulting series are extremely crude as this approximation is on top of those made to obtain the original market sector series. No single data source provides a time series of Australian employer-provided training expenditure and to construct the market sector series, several different sources were used, together with a number of assumptions (see appendix A of Barnes and McClure 2009). The sectoral series are therefore only broadly indicative and trends in them should be interpreted with caution.

The market sector series was constructed using a range of ABS data (see Barnes and McClure 2009 for full details). 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)

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

This series had been backcast and extended to 2005-06 using growth in a related series. No ideal series was available, but it was possible to construct an approximate series for total training hours and an exponential trend was used for expenditure per training hour. The resulting total nominal training expenditure for the market sector was apportioned across the manufacturing and service sectors according to sectoral shares of total training hours. The training hours series were constructed from ABS data from *Employer Training Expenditure, Australia* (Cat. no. 6353.0) for 1989-90, 1990-91, 1993-94 and 1996-97 and *Education and Training Experience* (Cat. no. 6278.0) for 1996-97, 2000-01 and 2004-05 and an assumption of linear growth in hours per employee for the missing years.[6]

In general, the firm-specific human capital series should be viewed as being affected by a number of measurement errors that may be compounded in growth rate calculations and all the growth rates should be interpreted cautiously. 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

[6] See appendix A of Barnes and McClure (2009) for further details on the construction of the market sector series. For 1989-90 and 1990-91 Cat. no. 6353.0 provided an industry breakdown of training hours per employee but not total employee numbers (which were available from labour force survey data in Cat. no. 6291.0).

- 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 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. 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 of Barnes and McClure 2009 for further details). This is examined as part of sensitivity testing in appendix C.

Data on revenue for ANZSIC industry classes are available from *Australian Industry* (ABS Cat. no. 8155.0) for 1998-99 to 2004-05. The 2005-06 estimate was made assuming that the growth rate for sales was the same as in 2004-05. The series for business management services was backcast from 1998-99 to 1993-94 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 each sector. This was done using the sector intermediate usage share for the closest available group of services (Other business services) from SU tables from 1994-95 to 2003-04. This share was backcast to 1989-90 (and forecast to 2005-06) using growth in the sector share of gross value added.

Own account

CHS estimate the own-account component of organisational capital as 20 per cent of the value of executive time using US Bureau of Labor Statistics 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, Chief Executive Officers).

The own account portion of organisational capital for Australia was estimated from average earnings of managers and the number of managers in each sector. The specific occupation group used is Managers & administrators[7] excluding, where possible, IT managers. The exclusion of IT managers is based on the reasoning used by MH (2006) — avoiding double counting with IT capital. 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, for each 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

[7] *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 of Barnes and McClure 2009).

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 of incorporated enterprises 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, and this provided data for only Managers & administrators for the total economy as a whole. Growth in average weekly earnings for this group of Managers & administrators was used to backcast each sector series from 1997 to 1990. For employee numbers in each sector, the sectoral series for number of Managers & administrators excluding IT managers was backcast from 1997 to 1990 using growth in total employed Managers & administrators in the sector. The growth rates were derived from Labour Force Survey data for employed Managers and administrators by industry (Cat. no. 6291.0.55.003).

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. For this paper, attempts were made to assess the appropriateness for the Australian context of this assumption (as discussed in box A.1). While it has not been possible to validate this assumption for the Australian context, the available literature suggest the CHS assumption is not an unreasonable 'placeholder' until other information becomes available. Therefore, for the purposes of comparability, and in the absence of alternative estimates of time spent, the same percentage is used in this paper.

Box A.1 **Managers' time use**

CHS (2005) assumed that managers spend 20 per cent of their time building organisational capital. They had little information available to them on which to base this assumption, and this also appears to be the case for Australia.

One of the seminal studies of managers' time use is Mintzberg (1973). His research was based on observation of five chief executives of large US organisations for 25 days. He categorised time use into desk work (which accounted for an average of 22 per cent of managers' time), telephone calls (6 per cent), scheduled meetings (59 per cent), unscheduled meetings (10 per cent) and tours (3 per cent). But his categorisation of time use is not particularly useful in identifying activities related to building organisational capital — which might be part of 'desk work' but might also be part of meetings. And the small sample is unlikely to be representative of all US managers.

Other early influential studies covered different levels of managers in different industries. Horne and Lupton (1965) surveyed 66 middle managers of UK firms and estimated that the time spent on 'formulating' — assessing the long and short term future, with defining objectives, and specifying the human and material means necessary to their attainment — ranged from around 15 to 30 per cent depending on type of manager. Penfield (1974) surveyed 204 lower level managers in a US public utility and estimated that they spent almost 20 per cent of their time 'planning'.

The approaches of Mintzberg and others have been applied in numerous countries and to various industries. Hales (1986) provides a survey of the scope, but not results, of such studies up to the mid-1980s. Oshagbemi (1995) reviewed the literature from 1981 to 1993 and found a relatively limited number of empirical studies. These studies found that managers on average spent 25–33 per cent of their time on desk work. But no relevant studies for Australia have been located. And it is likely that managers' time use has changed over time, particularly with the influence of IT. This limits the usefulness of studies prior to the widespread introduction of computers.

Most recently, Tengbland (2006) applied the Mintzberg approach to four Swedish executives and found a lower share of desk work (14 per cent) and a higher share for meetings (75 per cent) than Mintzberg. But the small sample, together with the possibility of differences between countries, makes it difficult to draw conclusions about changes in time use.

There is another stream of recent research on how leaders spend their time. A survey of 378 US senior executives examined how they allocated their time across five different roles — 'core job' (45 per cent); innovator (19 per cent); team (16 per cent); organisation (12 per cent); and career (8 per cent) (Welbourne 2006). Of these roles 'innovator' appears closest to the building of organisational capital as it is defined as 'work spent to develop new ideas, create new routines or improve on process'.

The available literature on managers' time use appears to provide little assistance in validating or improving upon the CHS assumption of 20 per cent. However, the available estimates, particularly those of Welbourne (2006), suggest that this assumption is not an unreasonable 'placeholder'.

A.2 How much of expenditure is investment

Column 4 of table A.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 in each sector. Sensitivity testing of the growth accounting results to investment size is reported in appendix C.

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.

As discussed in box A.2, there are two issues — does this expenditure build an asset and how long lived is it?

- 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.

Box A.2 **Durability of advertising benefits**

The question 'how long lived are the benefits of advertising' is a difficult one to answer. There are two issues — how much advertising builds an asset and how long lived is that asset? MH (2006, p. 8) suggests:

> 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.

Certain types of advertising expenditure have been excluded from advertising expenditure estimates in CHS-type studies because they are not considered to be asset building — for example, CHS (2005) included only national ads as they were considered to be those aimed at selling specific products rather than promoting sales at specific stores; and classified ads were excluded from the UK study (MH 2006) and Australian market sector study (Barnes and McClure 2009).

Further expenditure was then excluded because the ads had short-lived effects — that is, ads with a service life of less than one year would be an expense not an investment. CHS (2005) noted 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 40 per cent of the advertising expenditures considered to be asset building should be excluded from investment and this has been followed in other country studies.

The depreciation rate for the remaining advertising investment was then assumed to be 60 per cent. CHS (2006) 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.

These assumptions were particularly influenced by the work of Landes and Rosenfield (1994). They estimated that for 20 US industries the implied annual geometric rate of decay of advertising was: less than about 55 per cent for 7 industries (mainly manufacturing); 65-70 per cent for another 7 industries (some manufacturing and some service industries); and more than about 90 per cent for the remaining 6 industries (service industries).

Vakratas and Ambler (1999) provides a survey of empirical studies on how advertising works, including market response models. They note some technical issues that hamper estimation of the longevity of advertising and contribute to the wide range of results — for example, they cite studies that estimate that advertising effects dissipated after 16-32 weeks; 6-9 months; 3-15 months; and greater than 1 year. Nakamura (2005) suggests that the longevity of advertising varies by product, with advertising for repeat purchase and durable goods plausibly having a long life of over several years.

Wyatt (2008) notes there is a gap in the literature on the long-term effects of advertising expenditure. No Australia-specific studies that provide sufficient detail to arrive at an appropriate average depreciation rate for industry sectors have been identified. However, the literature cited above suggest that the CHS assumptions are not unreasonable 'placeholders'.

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.

A.3 Deflators

Column 5 of table A.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. 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 at the sectoral level is the implied sector gross value added (GVA) deflator, derived from current price and chain volume series in the Australian national accounts.[8] This deflator is used for all categories of intangible except for:

- computer software and artistic originals — ABS real gross fixed capital formation series are available for these intangible assets (based on asset-specific implicit price deflators)[9]
- financial product development — an implied Finance & insurance GVA deflator (derived from the Australian national accounts) was used. As discussed by Marrano, Haskel and Wallis (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 — as this intangible mainly comprises wage costs, a sectoral wage deflator (the average weekly ordinary time earnings for full-time adults) was used.

[8] For business R&D, this differs from the R&D deflator used by the ABS in its R&D estimates in the December 2009 Australian national accounts. As noted above, these data were not available at the time the main analysis for this paper was undertaken.

[9] 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.

A.4 Capital series

The 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).[10] 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[11], R_t is the intangible stock and N_t is the flow of investment (expenditure in constant prices) at time t.[12]

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. CHS (2006) assumed an initial stock of zero in a specific year for each asset (for example, 1928 for advertising). MHW (2007) assumed an initial stock of zero for all intangible assets in 1970. Fukao et al. (2008) 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 (1989-90 in this case) for which investment flow data are available. It does assume a constant rate of

10 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).

11 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).

12 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.

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 and the initial stock is largely depreciated by 1993-94 (the period from which the estimates are used in the analysis).

The investment flows (N_t) for each intangible were calculated as described above. The depreciation rates (δ) used for each new intangible in the PIM are those used in CHS (2006) to enable comparability (column 6 of table A.1).[13] 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 of Barnes and McClure 2009).[14] The average ABS depreciation rates for software and artistic originals are included for comparison.[15]

For this paper, an attempt was made to assess the appropriateness for the Australian context of the assumed depreciation rate for advertising (box A.2). While it has not been possible to validate this assumption for the Australian context, the available literature suggests the CHS assumption is not an unreasonable 'placeholder' until other information becomes available.

[13] 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.

[14] It should also be noted that the ABS has assumed a mean asset life of 11 years in its recent estimates of R&D capital, rather than a 10 year asset life which is consistent with a 20 per cent depreciation rate (as is used in this paper). (ABS Cat. no. 5310.0.55.002)

[15] These depreciation rates differ from those in the US study, which used 33 per cent for software and 20 per cent for 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 C.

B Growth accounting model with intangibles

This appendix describes the methodology and estimation process used in this paper to construct new growth accounting results for the manufacturing and service sectors. It is based on appendixes B and C of Barnes and McClure (2009), which provide further methodological details.

Section B.1 outlines the Corrado, Hulten and Sichel (CHS) model used for incorporating intangibles into conventional growth accounting. The remaining sections of the appendix provide details of the estimation of the various elements of the growth accounting equation including intangibles. Section B.2 details the methodology for constructing new capital services indexes 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 B.3 details changes to other terms in the production function. This includes output, labour inputs and the factor income shares.

B.1 Model

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). Their model outlined below is for the total economy but it is equally applicable to an individual industry sector.

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 $K_t \equiv I_t + (1-\delta_k)K_{t-1}$ 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]

$$P_{Q'_t} Q'_t \equiv P_{C_t} C_t + P_{I_t} I_t \equiv P_{L_t} L_t + P_{K_t} K_t \quad \text{(B.4)}$$

The conventional sources of growth (SOG) framework allocates the output growth to the share-weighted input growth and a residual, multifactor productivity (MFP) growth. This follows Solow (1957). The SOG equation is derived by logarithmic differentiation of (B.4):

$$\dot{Q}'_t = s'_{C_t} \dot{C}_t + s'_{I_t} \dot{I}_t \quad \text{(B.5)}$$

$$= s'_{L_t} \dot{L}_t + s'_{K_t} \dot{K}_t + \dot{MFP}'_t$$

where $\dot{x}_t$ denotes the rate of growth of variable x_t.

Rearranging (B.5) MFP growth[2] is therefore

$$\dot{MFP}'_t = \dot{Q}'_t - s'_{L_t} \dot{L}_t - s'_{K_t} \dot{K}_t \quad \text{(B.5a)}$$

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 $s'_{K_t} \equiv [P_{K_t} K_t]/[P_{L_t} L_t + P_{K_t} K_t]$

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.

2 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).

are assumed to be equal to the corresponding output elasticities. Intangible input and output do not appear in this SOG equation.

This can also be expressed in labour productivity (LP) terms (that is, growth in the level of output per unit of labour input) by rearranging (B.5), to provide the expression for a decomposition of LP growth into capital deepening (the capital income share weighted growth in capital inputs relative to labour) and MFP growth.

$$\dot{Q}' = s'_L \dot{L} + (1 - s'_L)\dot{K} + \dot{MFP}' \quad \text{where } s'_L + s'_K = 1$$

$$(\dot{Q}' - \dot{L}) = s'_L \dot{L} + (1 - s'_L)\dot{K} + \dot{MFP}' - \dot{L}$$

$$= (1 - s'_L)\dot{K} - (1 - s'_L)\dot{L} + \dot{MFP}'$$

$$(\dot{Q}'/L) = (1 - s'_L)(\dot{K}/L) + \dot{MFP}'$$

That is, $\dot{LP}' = \dot{KD}' + \dot{MFP}'$ (B.5b)

where capital deepening is $\dot{KD}' = (1 - s'_L)(\dot{K}/L) = s'_K(\dot{K}/L)$

Most of the growth accounting results presented in this paper are decompositions of labour productivity growth. 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 participation rate.

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 $N_t = F_N(L_{N_t}, K_{N_t}, R_{N_t}, t)$ $P_{N_t}N_t \equiv P_{L_t}L_{N_t} + P_{K_t}K_{N_t} + P_{R_t}R_{N_t}$ (B.6)

Tangible sector $I_t = F_I(L_{I_t}, K_{I_t}, R_{I_t}, t)$ $P_{I_t}I_t \equiv P_{L_t}L_{I_t} + P_{K_t}K_{I_t} + P_{R_t}R_{I_t}$ (B.7)

Consumption sector $C_t = F_C(L_{C_t}, K_{C_t}, R_{C_t}, t)$ $P_{C_t}C_t \equiv P_{L_t}L_{C_t} + P_{K_t}K_{C_t} + P_{R_t}R_{C_t}$ (B.8)

The balance equations are modified with $R \equiv R_I + R_C + R_N$ replacing $N \equiv N_I + N_C$.[3] 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).[4]

When intangible capital is treated in the same way as tangibles, the SOG equation becomes

$$\dot{Q}_t = s_{C_t} \dot{C}_t + s_{I_t} \dot{I}_t + s_{N_t} \dot{N}_t \quad \text{(B.10)}$$

$$= s_{L_t} \dot{L}_t + s_{K_t} \dot{K}_t + s_{R_t} \dot{R}_t + \dot{MFP}_t$$

where the expenditure shares are now

3 In this second case, CHS (2006) expand the technology of the intangible producing sector to use its own stock of accumulated intangibles.

4 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 section B.2). 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.

$s_{C_t} \equiv [P_{C_t} C_t]/[P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t]$, $s_{I_t} \equiv [P_{I_t} I_t]/[P_{C_t} C_t + P_{I_t} I_t + P_{N_t} N_t]$ 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

$s_{L_t} \equiv [P_{L_t} L_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t]$, $s_{K_t} \equiv [P_{K_t} K_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t]$ and
$s_{R_t} \equiv [P_{R_t} R_t]/[P_{L_t} L_t + P_{K_t} K_t + P_{R_t} R_t]$.

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.

Rearranging (B.10) MFP growth is therefore

$$\dot{MFP}_t = \dot{Q}_t - s_{L_t} \dot{L}_t - s_{K_t} \dot{K}_t - s_{R_t} \dot{R}_t \qquad \text{(B.10a)}$$

This can also be expressed in labour productivity (LP) terms by rearranging (B.10), to provide the expression for a decomposition of LP growth.

$\dot{Q} = s_L \dot{L} + (1 - s_L)(\dot{TK}) + \dot{MFP}$ where $TK \equiv K + R$ and $s_L + s_K + s_R = 1$

$(\dot{Q} - \dot{L}) = s_L \dot{L} + (1 - s_L)(\dot{TK}) + \dot{MFP} - \dot{L}$

$= (1 - s_L)(\dot{TK}) - (1 - s_L)\dot{L} + \dot{MFP}$

$(\dot{Q/L}) = (1 - s_L)(\dot{TK/L}) + \dot{MFP}$

That is, $\dot{LP} = \dot{KD} + \dot{MFP}$ (B.10b)

where capital deepening is $\dot{KD} = (1 - s_L)(\dot{TK/L})$ or $\dot{KD} = s_K(\dot{K/L}) + s_R(\dot{R/L})$

The relationship between LP growth with and without intangibles as capital can be derived as follows.

When intangibles are not capitalised

$LP' = (Q'/L)$ therefore $\dot{LP'} = \dot{Q'} - \dot{L}$

When intangibles are capitalised

$$LP = \frac{Q}{L} = \left(\frac{Q' + N}{L}\right) \text{ where } Q = Q' + N$$

therefore

$$\dot{LP} = (\dot{Q'} + \dot{N}) - \dot{L}$$

$$= \left(\frac{Q'}{Q' + N}\right)\dot{Q} + \left(\frac{N}{Q' + N}\right)\dot{N} - \dot{L}$$

$$= \mu \dot{Q'} + (1 - \mu)\dot{N} - \dot{L} \quad \text{where } \mu \equiv \frac{Q'}{Q' + N}$$

$$= \dot{LP'} + (1 - \mu)(\dot{N} - \dot{Q'})$$

B.2 Construction of capital services indexes

As discussed in chapter 3, capital services indexes have been calculated using three different definitions of capital. 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 (2006-07 issue), while the third definition of capital excludes all intangible assets.

To measure the impact of intangible investment on MFP growth, new estimates of capital services growth need to be constructed for the each of the industry sectors. 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.

The *productive capital stock* of an asset is the 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 economic capital stock (net capital stock) and the productive capital stock for new intangible assets are assumed to be equal.[5] The use of the net rather than productive capital stock means that the capital stock for intangible assets is understated.

5 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).

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 each sector[6] are formed by combining estimates of the productive capital stock and rental price for each asset type into a Tornqvist[7] index of aggregate capital services. For some asset types[8], capital is also split by industry and institutional sector — this is not shown for simplicity. The flow of aggregate capital services K is approximated by 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.

$$\dot{K} \cong \prod_j \left[\frac{K_j}{K_{j(t-1)}} \right]^{w_j} - 1 \qquad \text{(B.11)}$$

The rental price weight for each asset is based on its share of total sector capital rent. Capital rent is the rental price r_{jt} multiplied by the real productive capital stock K_j.

$$w_j = 0.5 * \left(\frac{r_j . K_j}{\sum_j r_j . K_{ij}} + \frac{r_{jt-1} . K_{jt-1}}{\sum_j r_{jt-1} . K_{jt-1}} \right) \qquad \text{(B.12)}$$

6 For the service sector, it should be noted that all assets in all service industries are aggregated in a single stage. This differs from the ABS methodology used to construct its market sector estimate. For the market sector, 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 service sector industry due to data limitations, so the single stage aggregation had to be used.

7 A Tornqvist index is the weighted geometric mean of the component growth rates.

8 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 institutional sector has not been possible due to data limitations.

Rental prices

The rental price of an asset is equivalent to the user cost of capital.[9] 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 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.

The rental price is derived using the following formula

$$r_j = T_j(i.p_j + d_j.p_j - p_j + p_{j(t-1)}) + p_j.x \qquad \text{(B.13)}$$

where for asset type j, the rental price r is a function of the income tax parameter T; the 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).[10]

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 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.

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9 The rental price formula used in this paper is based on that used in the ABS 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 (2001a, chapter 9).

10 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 C, have been performed on some parts of the rental price equation for the new intangibles.

In this paper, the depreciation rates used for the new intangible assets are those used in CHS (2006) and for the national accounts intangibles the ABS rates are used (table B.1). These depreciation rates are relatively high, which reflects the assumption that intangible capital has a relatively short productive life.

Table B.1 **Rental price components for intangible assets**
Average 1993-94 to 2005-06

	Depreciation rate[a] (%)		*Income tax parameter[b]*	
	Mfg	*Services*	*Mfg*	*Services*
Computerised information	24	23	1.23[c]	1.23[c]
Business R&D	20	20	0.85[c]	0.85[c]
Artistic originals	-	60	-	0.99[c]
Financial product development	20	20	1.00	1.00
New architectural and engineering designs	20	20	1.00	1.00
Advertising	60	60	1.00	1.00
Market research	60	60	1.00	1.00
Firm specific human capital	40	40	1.00	1.00
Purchased organisational capital	40	40	1.00	1.00
Own account organisational capital	40	40	1.00	1.00

[a] Depreciation rates are constant for the new intangibles and vary over time for the intangibles already capitalised in the national accounts (software and artistic originals). [b] The income tax parameter is defined as $T_t = (1 - u_t z_t - a_t z_t)/(1 - u_t)$ where u_t is the corporate tax rate; z_t is the depreciation rate; and a_t is the additional allowance rate. These tax parameters for the new intangibles are those used in the sensitivity testing (rather than the base case) for the market sector analysis in Barnes and McClure (2009). [c] Averages of the annual parameters from 1993-94 to 2005-06.

Sources: CHS (2006); author's 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 B.1). For the national accounts intangibles this parameter is calculated by the ABS. For most of the new intangible assets it has been assumed that the income tax parameter is one, because expenditure on (most) intangibles is deductible (in full) for tax purposes. 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.

The deflator used for most intangible assets is the implicit price deflator (IPD) for sector gross value added — this differs between the manufacturing and service sectors. For financial product development investment, the Finance & insurance gross value added IPD has been used. For firm-specific human capital a sectoral 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 2.

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 sector by the total capital stock.[11] The non-income tax parameter is therefore the same for every asset. Total taxes will not change after the inclusion of intangible assets but the total 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 institutional 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. This is because rental prices for the unincorporated sector are invariably lower as a result of the method of calculation used by the ABS in which they are derived as a function of corporate rental prices.

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 are allocated to the corporate sector.

[11] Currently the ABS uses productive capital stock in the rental price equation (ABS 2000, para. 27.60) and net capital stock in the calculation of the non-income tax rate (ABS 2000, para. 27.72). However, for the purposes of this paper, productive capital stock is used in the calculation of the non-income tax rate (x). This avoids the distortionary effect that results from x being calculated using net capital stock but then being multiplied by the productive capital stock (which is generally larger). The extent of the distortion is affected by whether or not intangibles are capitalised, since the total of non-income tax is distributed across a different sized pool of assets depending on whether intangibles are included. Therefore this change in method has been implemented in order to clarify the real effect of capitalising intangibles on the average rate of return.

ABS (2007b, 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 in rental price calculations and has noted that it will consider changing its approach in the future.

Rate of return

Standard growth accounting uses the Jorgenson-Griliches methodology for estimating the rate of return as a common rate across all assets. 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 (see CHS 2006, p. 26 for further discussion). This approach has been followed in this paper.

The Jorgenson-Griliches methodology makes no adjustment to the rate of return for different types of assets carrying different degrees of riskiness. The OECD manual on measuring capital (OECD 2009, p. 67) notes that assets are not used in isolation but they are combined with other assets and other factors of production in economic units. The rate of return, therefore, concerns the business operation as a whole and it is unclear how one would measure each asset's rate of return when multiple assets are used jointly.

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 sector assets.[12]

The capitalisation of intangibles requires the equalising endogenous rate of return on all assets (tangible and intangible) in each sector 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.

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 manufacturing sector and the service sector. The rate of return for the each 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.

12 This differs from CHS (2006), which uses a purely endogenous rate. The effects of this difference and the sensitivity of the results to the rate of return assumption are discussed in appendix C.

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 (Y_K).[13]

$$Y_K = \sum_j r_j.K_j \tag{B.14}$$

summed across assets j

Using this assumption, calculating the endogenous rates of return[14] is simply a case of reorganising the rental price equation to include capital income and the productive capital stock.

$$i = \frac{Y_K - \sum_j K_j(T_j(d_j.p_j - p_j + p_{j(t-1)}) + p_j.x)}{\sum_j K_j.T_j.p_j} \tag{B.15}$$

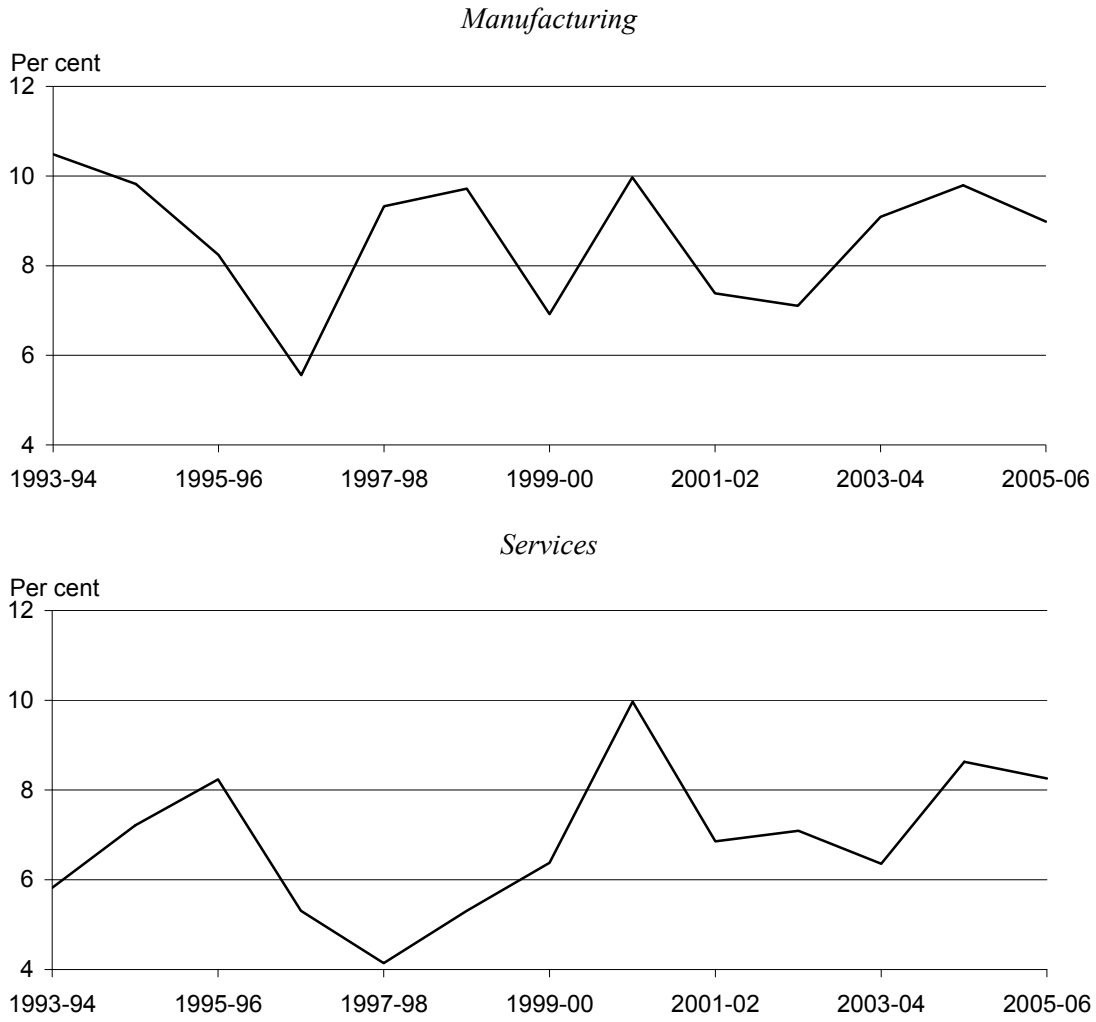
where Y_K is capital income (including non-income taxes attributed to capital) and K is the real productive capital stock.

This paper follows the ABS method of using the hybrid rate of return (figure B.1). In practice the rate of return when all intangibles are capitalised fell below this exogenous floor rate in two years for the manufacturing sector and all but three years for the service sector. Therefore, the rate of return used in this paper is often exogenous (as shown in chapter 2). 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 C.

13 Provided all the endogenous rental prices are positive, as a negative rental price forced to zero would also affect the total capital income.

14 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.

Figure B.1 **Rate of return[a], all intangibles treated as capital, by sector**



a Using the ABS hybrid methodology, which is an endogenous rate with a floor of the CPI growth plus 4 per cent.

Data sources: Author's estimates; ABS unpublished national accounts data.

Effect of capitalising intangibles on the rate of return

As discussed in chapter 2, capitalising intangibles can increase or decrease the measured rate of return. In its simplest sense, the endogenous rate of return on capital is capital income divided by the capital stock. Expensing rather than capitalising intangibles understates the capital stock and this could result in an overstatement of the rate of return on tangible capital. But expensing rather than capitalising intangibles also understates capital income. With both the numerator and denominator of the rate of return calculation affected by capitalising intangibles, the rate of return can potentially rise or fall. The rate of return including a group of intangibles will be greater than the rate of return excluding those

intangibles if intangible investment as a proportion of the intangible capital stock is greater than the rate of return if those intangibles are not capitalised.

But, as shown above, the calculation of rate of return as used in growth accounting also takes account of other factors such as depreciation, revaluation of the capital stock and differences in tax treatment. The condition for whether the rate of return rises or falls is therefore more complex, as derived below.

As shown in equation (B.15), the endogenous (or internal) rate of return before capitalising intangibles is:

$$i = \frac{Y_K - \sum_j K_j (T_j (d_j.p_j - p_j + p_{j(t-1)}) + p_j.x)}{\sum_j K_j.T_j.p_j}$$

or in simplified terms

$$i = \frac{Y_K - AK}{\alpha K} \tag{B.16}$$

After capitalising intangibles the equation for the endogenous rate of return becomes

$$i' = \frac{Y_K + I - \sum_j K_j (T_j (d_j.p_j - p_j + p_{j(t-1)}) + p_j.x) - \sum_j R_j (T_j (d_j.p_j - p_j + p_{j(t-1)}))}{\sum_j K_j.T_j.p_j + \sum_j R_j.T_j.p_j}$$

where K is tangible capital and I is intangible investment and R is intangible capital, or in simplified terms

$$i' = \frac{Y_K - AK + I - BR}{\alpha K + \beta R}$$

which can be rearranged as

$$i' = \left(\frac{\alpha K}{\alpha K + \beta R}\right)\left(\frac{Y_K - AK}{\alpha K}\right) + \left(\frac{\beta R}{\alpha K + \beta R}\right)\left(\frac{I - BR}{\beta R}\right)$$

$$= \left(1 - \frac{\beta R}{\alpha K + \beta R}\right)\left(\frac{Y_K - AK}{\alpha K}\right) + \left(\frac{\beta R}{\alpha K + \beta R}\right)\left(\frac{I - BR}{\beta R}\right)$$

$$= \left(\frac{Y_K - AK}{\alpha K}\right) - \left(\frac{\beta R}{\alpha K + \beta R}\right)\left(\frac{Y_K - AK}{\alpha K}\right) + \left(\frac{\beta R}{\alpha K + \beta R}\right)\left(\frac{I - BR}{\beta R}\right)$$

$$= \left(\frac{Y_K - AK}{\alpha K}\right) + \left(\frac{\beta R}{\alpha K + \beta R}\right)\left[\left(\frac{I - BR}{\beta R}\right) - \left(\frac{Y_K - AK}{\alpha K}\right)\right]$$

Together with equation (B.16), this implies that the rate of return after capitalising intangibles, i', will be greater than the rate of return before capitalising intangibles, i, if and only if

$$\left(\frac{I - BR}{\beta R}\right) > \left(\frac{Y_K - AK}{\alpha K}\right)$$

The right-hand side of this inequality is the endogenous rate of return before capitalising intangibles.

Rental price estimates

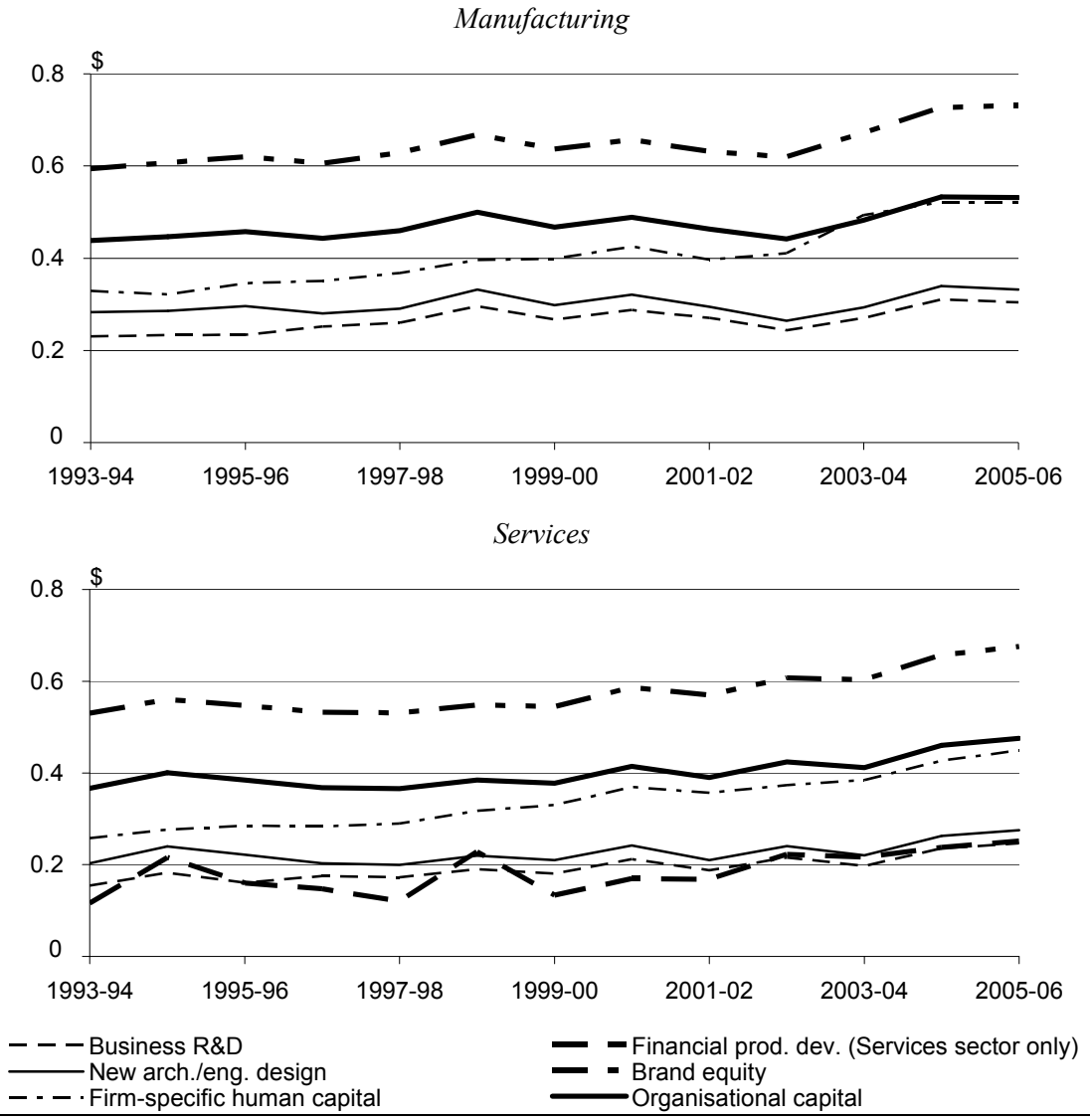
Figure B.2 shows the rental prices used for the new intangibles for each sector — there are considerable differences in the level of and trends across some assets. The growth in the capital stock of an asset with a higher rental price will carry a higher weight in the aggregate capital services index.

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 (as listed in table B.1) is assumed to be constant.

The differences in rental prices for a given asset type between industry sectors are a result of those parameters that are sector specific — the deflators (implied sectoral gross value added deflators, not asset price deflators) and the rate of return. The rental prices for assets in manufacturing are all higher than the equivalents in services largely because of manufacturing having a higher rate of return than services for several years within the series.

Figure B.2 **Rental prices by intangible asset type, by sector, 1993-94 to 2005-06**
Dollars



Data source: Author's estimates.

B.3 Other growth accounting components

This section details the methodology and data sources used for the other (non-capital) parameters in the growth accounting framework for each of the manufacturing and service sectors.

Output

For the manufacturing sector, output including only the existing national accounts intangible assets is equal to manufacturing sector gross value added (GVA) as currently measured in the national accounts and supplied by the ABS. For the service sector, ABS GVA data for each of the service industries within the market sector were aggregated.

For the all intangibles case, where expenditure on new intangibles is treated as investment, sector output is equal to the existing sector GVA plus sectoral investment in the new intangible assets. New intangible expenditure series were constructed for each sector (as described in chapter 2) and these expenditure series were then used to calculate an investment series for intangible assets. For each sector a new chain volume measure of value added was calculated using current price intangible investment series and ABS sector GVA together with the implied sector GVA IPD and individual price deflators for each intangible asset.

Sectoral output excluding all intangible assets was constructed by deducting current price investment in the existing intangible assets from existing sector GVA.[15] The result was then deflated using a sector IPD.

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 section B.1.

Total factor income, for each industry, 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) (income of the unincorporated sector) 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.

15 Current price gross fixed capital formation (GFCF) by sector for the existing national accounts intangible assets (computer software and artistic originals) was used as the sectoral investment estimate for the national accounts intangibles.

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.

Sectoral capital income for the three capital definitions are as follows.

- For the case including all intangible assets, capital income is equal to sectoral national accounts capital income (GOS adjusted for GMI and taxes) plus sectoral investment in new intangibles.
- For the existing national accounts definition of capital, capital income is sectoral GOS adjusted for GMI and taxes (as outlined above).
- For the case excluding all intangible assets, capital income is equal to sectoral national accounts capital income minus sectoral GFCF in the national accounts intangible assets.

As detailed in section B.1, treating intangibles as capital 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 derived from the hours worked by industry series from the ABS national accounts.

C Sensitivity testing

This appendix details the sensitivity testing undertaken on the growth accounting results from chapter 3. The appendix is split into two sections. The first section tests the results using a different methodology for calculating the rate of return for the capital stock. The second section tests the growth accounting results with different investment estimates for the new intangible assets.

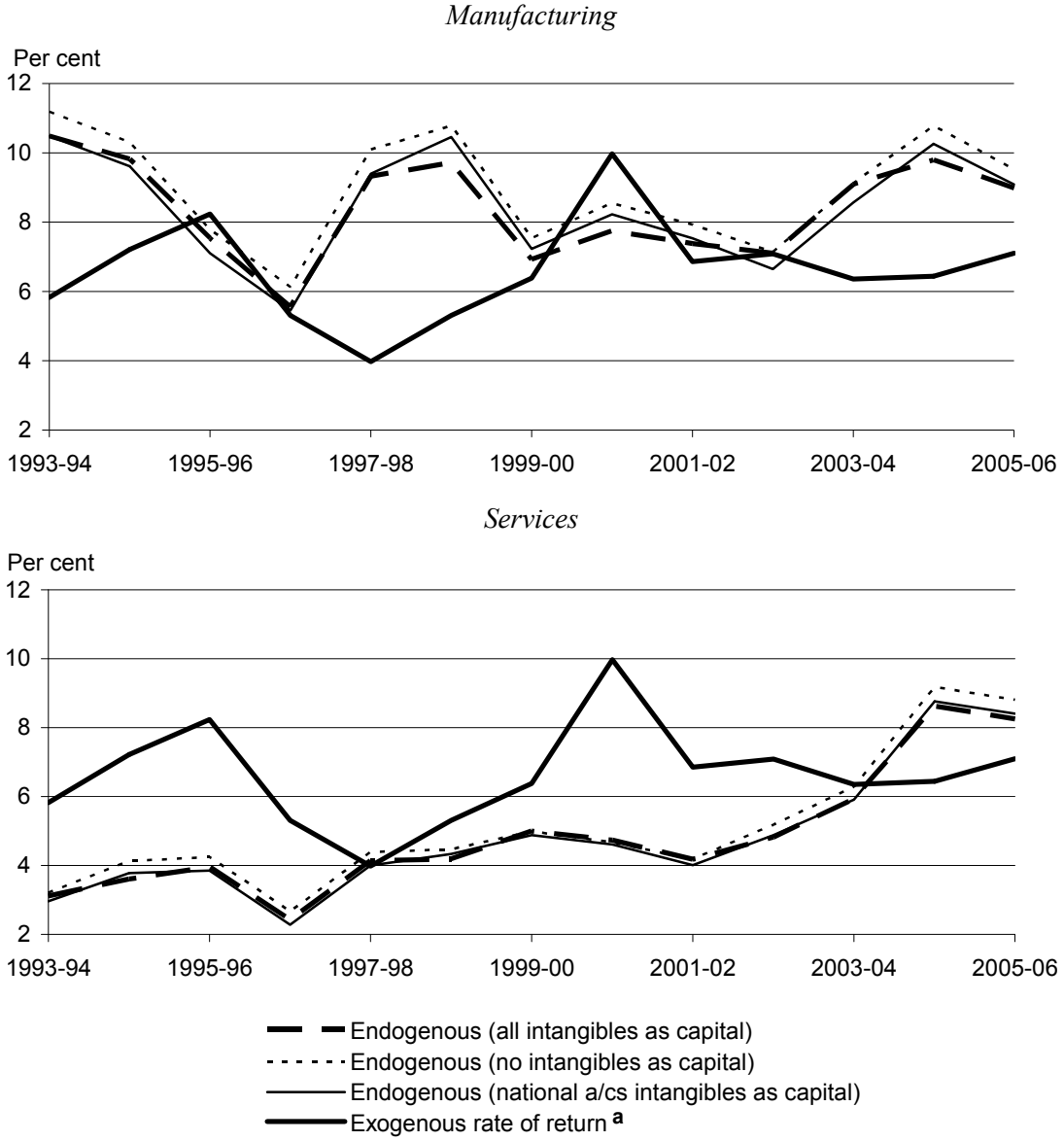
C.1 Rate of return

As discussed in chapter 2, this paper applies the hybrid Australian Bureau of Statistics (ABS) methodology for calculating the rate of return on capital. The methodology uses an endogenous rate of return unless the rate falls below an exogenous floor rate equal to consumer price index (CPI) growth plus 4 per cent.[1] 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 within a sector, fell below this mark in most years when calculated for the service sector and in only a few years for the manufacturing sector (figure C.1).

Because this differs from some of the other country studies, which used a purely endogenous rate of return, the Australian results have been re-estimated with a purely endogenous rate of return for the purposes of international comparison. This section compares the Australian growth accounting results with a purely endogenous rate of return with those using the ABS hybrid method (as reported in chapters 3 and 4).

[1] It should be noted that the 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.

Figure C.1 **Comparison of endogenous and exogenous rates of return, by sector**



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: Author's estimates; ABS unpublished national accounts data.

There is a considerable difference between the exogenous and endogenous rates of return (figure C.1). But the difference between the endogenous rates of return for the three definitions of capital is relatively small. Because the stock of intangibles is small relative to tangibles (and intangible investment is a small share of total capital

income), the capitalising of intangibles has only a small effect on the equalising endogenous rate of return across all assets.[2]

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.

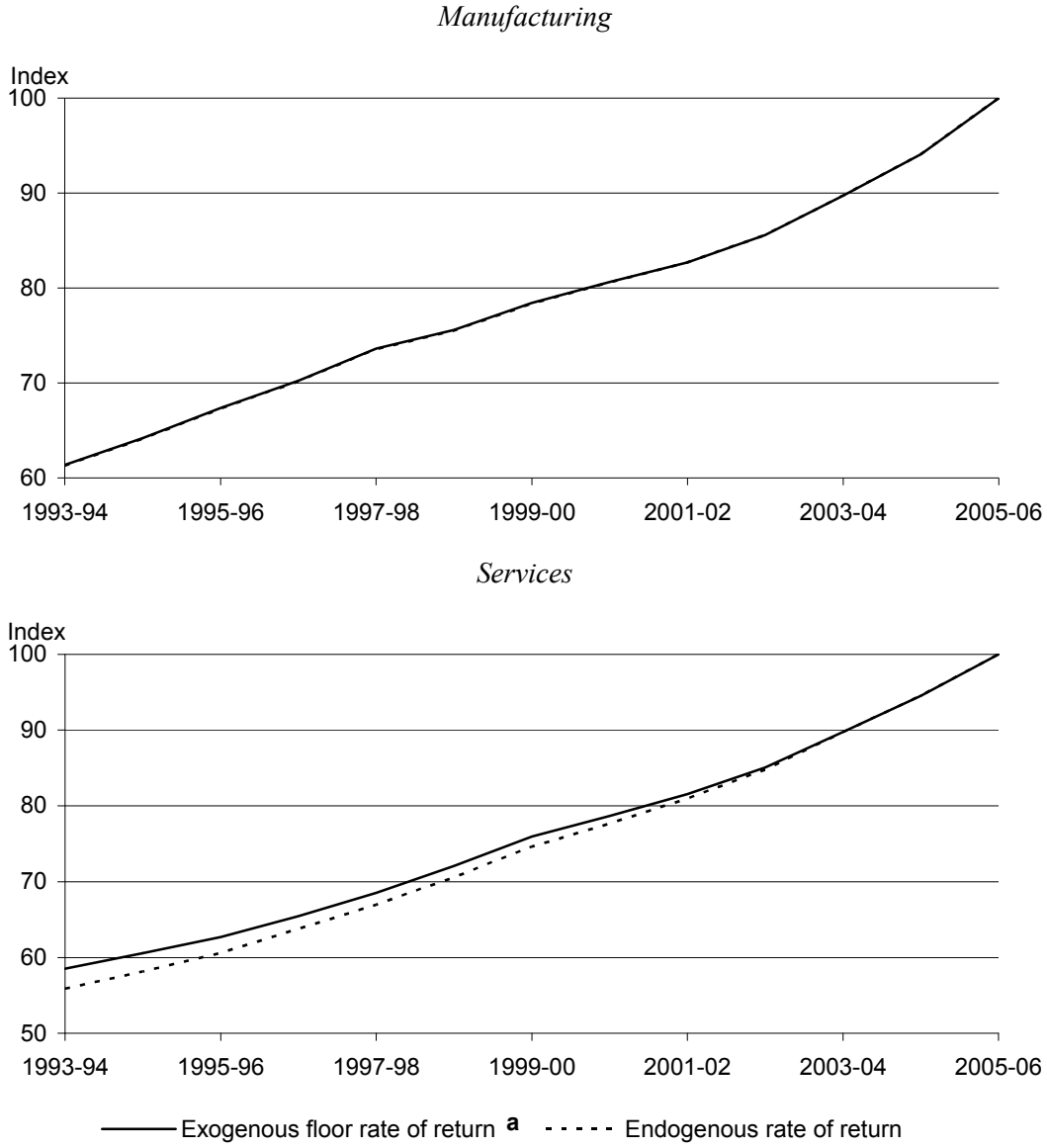
Figure C.2 shows a comparison of capital services indexes using a purely endogenous rate of return and an endogenous rate of return subject to an exogenous floor rate of return. Using the endogenous rate of return increases the growth in the capital services for the all intangibles case by an average of around 0.01 of a percentage point a year in manufacturing and 0.4 of a percentage point a year in services. There is little difference for manufacturing because the exogenous floor rate of return has been used less often in the base case result.

The main reason a change in the rental price weights increases the growth in capital services, when an exogenous floor rate is replaced with an endogenous rate, is that the use of the endogenous rate lowers the rental price for all assets by an equivalent amount. 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.

[2] This is consistent with the findings of CHS (2006, table 4), which reported that capitalising intangibles changed the equalising rate of return for all assets by only a small amount, slightly changing income accruing to tangible capital.

Figure C.2 **Capital services, alternative rates of return, by sector, all intangibles treated as capital**

Index 2005-06 = 100



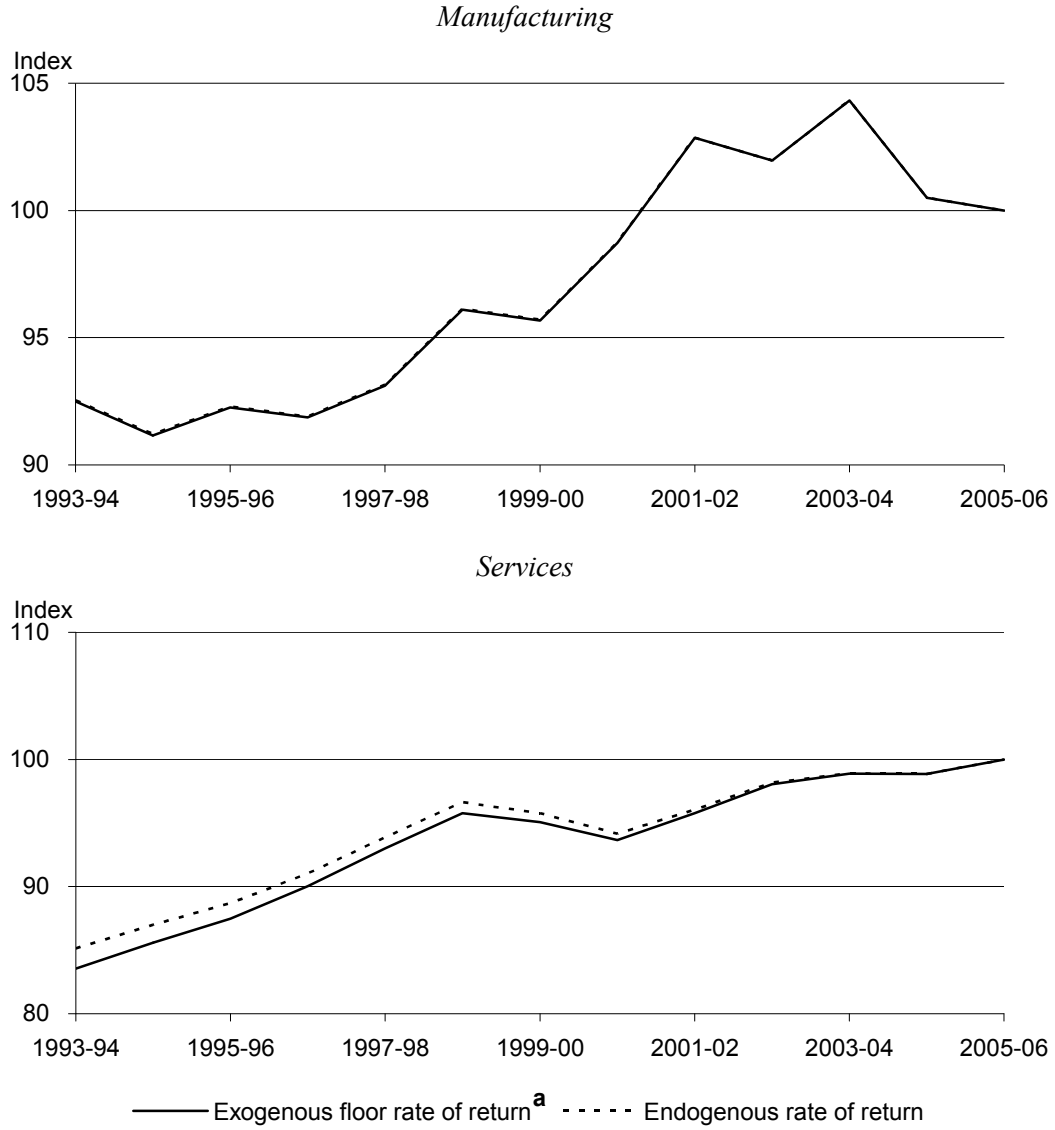
a The ABS hybrid methodology has been used, which is an endogenous rate with an exogenous floor of the CPI growth plus 4 per cent.

Data sources: Author's estimates; ABS unpublished national accounts data.

Using the purely endogenous rate of return increased the growth rate of the capital services index more in services than manufacturing (figure C.2), which had a corresponding downward effect on the multifactor productivity (MFP) growth estimates. For the case including all intangibles as capital, the decrease in MFP growth over the entire period was 11 per cent in services and 1 per cent in manufacturing using the endogenous rate of return approach (figure C.3). The use of the endogenous rate did not change the productivity growth cycles.

Figure C.3 **MFP using alternate rates of return, by sector, 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.

Data sources: Published and unpublished ABS national accounts data; author's estimates.

Under all three capital definitions, the rate of MFP growth in services fell considerably using the purely endogenous rate of return, but was relatively unaffected in manufacturing, and capital deepening increased by an equivalent amount (table C.1). As noted above, there is little difference for manufacturing because the endogenous rate fell below the exogenous floor rate of return less often.

Table C.1 **Comparison of MFP growth rates using alternative rates of return, 1993-94 to 2005-06**

Per cent per year

	Manufacturing	*Services*
Including all intangibles assets		
Exogenous floor	0.65	1.51
Endogenous	0.65	1.35
Including national accounts intangible assets		
Exogenous floor	0.64	1.58
Endogenous	0.63	1.42
Excluding all intangible assets		
Exogenous floor	0.69	1.70
Endogenous	0.69	1.58

Source: Author's estimates.

As mentioned in chapter 3, the reason for testing the results using a purely endogenous rate of return is for comparability with the other country studies. At the sectoral level, comparable growth accounting estimates are available for only Japan and the Netherlands — and the Netherlands uses an exogenous rate of return. Table C.2 therefore shows the Australian and Japanese estimates.

The comparison of the manufacturing sector results for Australia and Japan is virtually unchanged when a purely endogenous rate of return is applied, because this has little effect on the Australian results. However, for the service sector, the use of a purely endogenous rate of return increases the difference between the Australian and Japanese results after intangibles are capitalised, as a result of the decrease in Australian MFP growth.

Table C.2 **International comparisons using endogenous rate of return**

Per cent per year (Percentage share of total growth)

	Australia (exog. floor)[a]	*Australia (endog.)*[b]	*Japan (endog.)*
	1999-2000 – 2004-05	*1999-2000 – 2004-05*	*2000–2005*
Manufacturing			
All intangible assets			
Labour productivity growth	2.99	2.99	4.26
	(100)	(100)	(100)
Decomposition:			
Capital deepening	1.99	2.00	2.82
	(67)	(67)	(66)
Intangible	0.72	0.72	0.96
	(24)	(24)	(23)
Tangible	1.27	1.28	1.85
	(42)	(43)	(43)
MFP growth	0.99	0.98	1.44
	(33)	(33)	(33)
No intangible assets			
Labour productivity growth	2.49	2.49	3.98
	(100)	(100)	(100)
Decomposition:			
Capital deepening	1.49	1.50	2.78
	(60)	(60)	(70)
MFP growth	0.99	0.98	1.20
	(40)	(40)	(30)
Services			
All intangible assets			
Labour productivity growth	1.91	1.91	2.32
	(100)	(100)	(100)
Decomposition:			
Capital deepening	1.13	1.28	1.23
	(59)	(67)	(53)
Intangible	0.36	0.39	0.32
	(19)	(20)	(14)
Tangible	0.78	0.89	0.91
	(41)	(46)	(39)
MFP growth	0.78	0.64	1.09
	(41)	(33)	(47)
No intangible assets			
Labour productivity growth	1.84	1.84	2.02
	(100)	(100)	(100)
Decomposition:			
Capital deepening	0.85	1.00	1.35
	(47)	(54)	(67)
MFP growth	0.99	0.85	0.67
	(54)	(46)	(33)

[a] Using an exogenous floor rate of return (as in chapters 3 and 4). [b] Using a purely endogenous rate of return.

Sources: Author's estimates; Fukao et al. (2008).

C.2 Investment and capital stock size

As detailed in chapter 2, 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 — increasing it by 50 per cent and decreasing it by 50 per cent[3]
- reducing the investment estimates for specific new intangibles (financial R&D for services, and architectural/engineering designs and purchased organisational capital for both manufacturing and services) based on alternative data sources and assumptions[4] to create 'lower bound estimates' for the new intangibles
- doubling the depreciation rate for all new intangibles[5] (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 for each sector is shown in figure C.4. In both sectors, uniformly 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). The opposite is the case for uniform increases in the new intangibles. The use of the lower bound estimates for selected new intangibles raises the growth rate in total intangible investment in services but lowers it in manufacturing. This difference is due to the change in financial R&D only affecting the service sector — financial R&D investment is decreased, giving a lower weight to its particularly low growth rate in the calculation of the total intangible investment growth rate.

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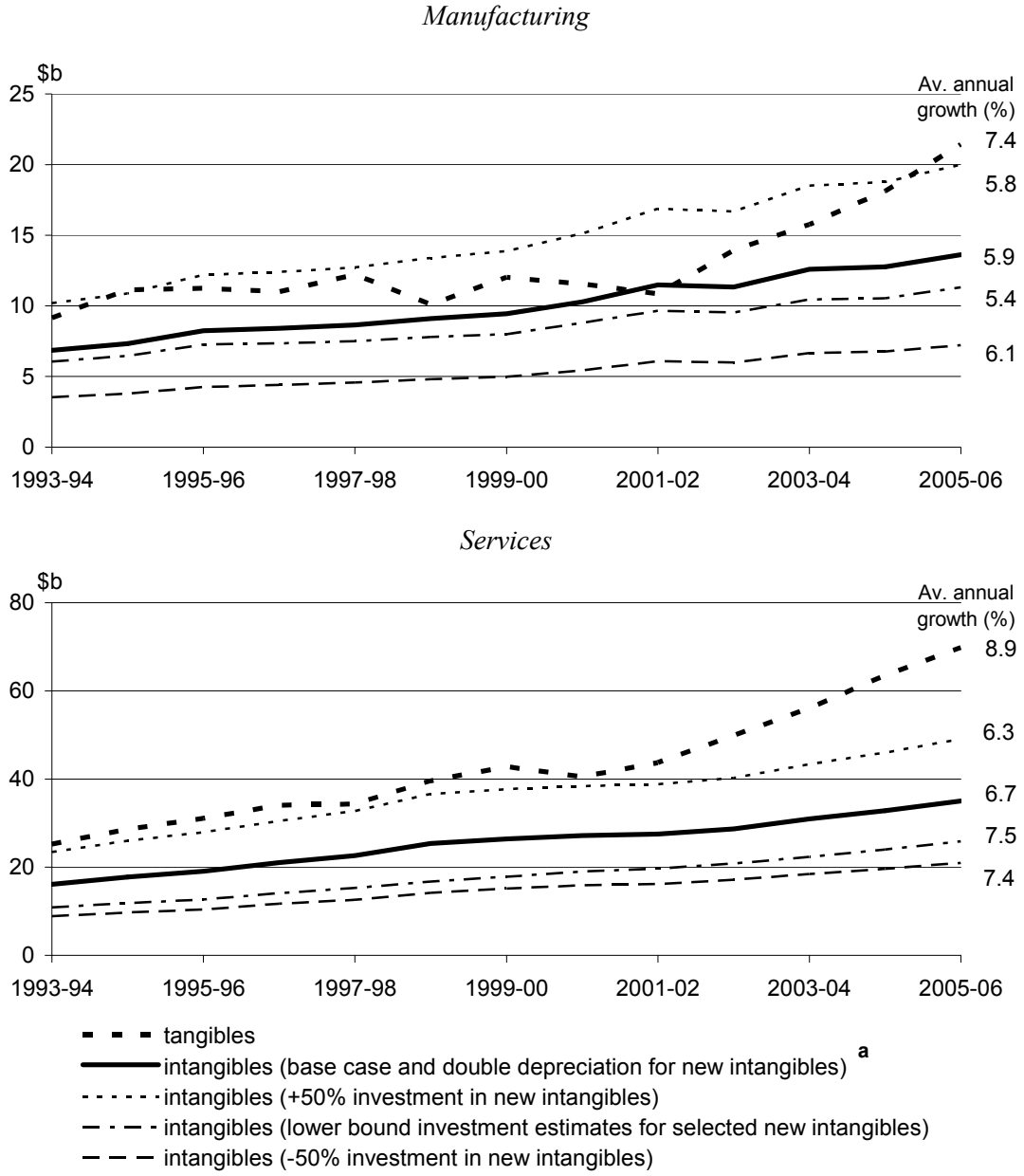
3 This alternative can be thought of in two ways: testing underestimation or overestimation of intangible expenditure and therefore investment or, in the case of reducing investment by 50 per cent, halving the proportion of expenditure on intangibles that is assumed to be investment (as listed in table 2.1).

4 The specific adjustments are detailed below in the sub-section 'Lower bound testing for selected new intangibles'.

5 For brand equity the base case depreciation rate was 60 per cent so this was not doubled but instead increased to 90 per cent.

Figure C.4 **Real investment, alternative estimates for new intangibles, by sector, 1993-94 to 2005-06**

2005-06 dollars, chain volume measures



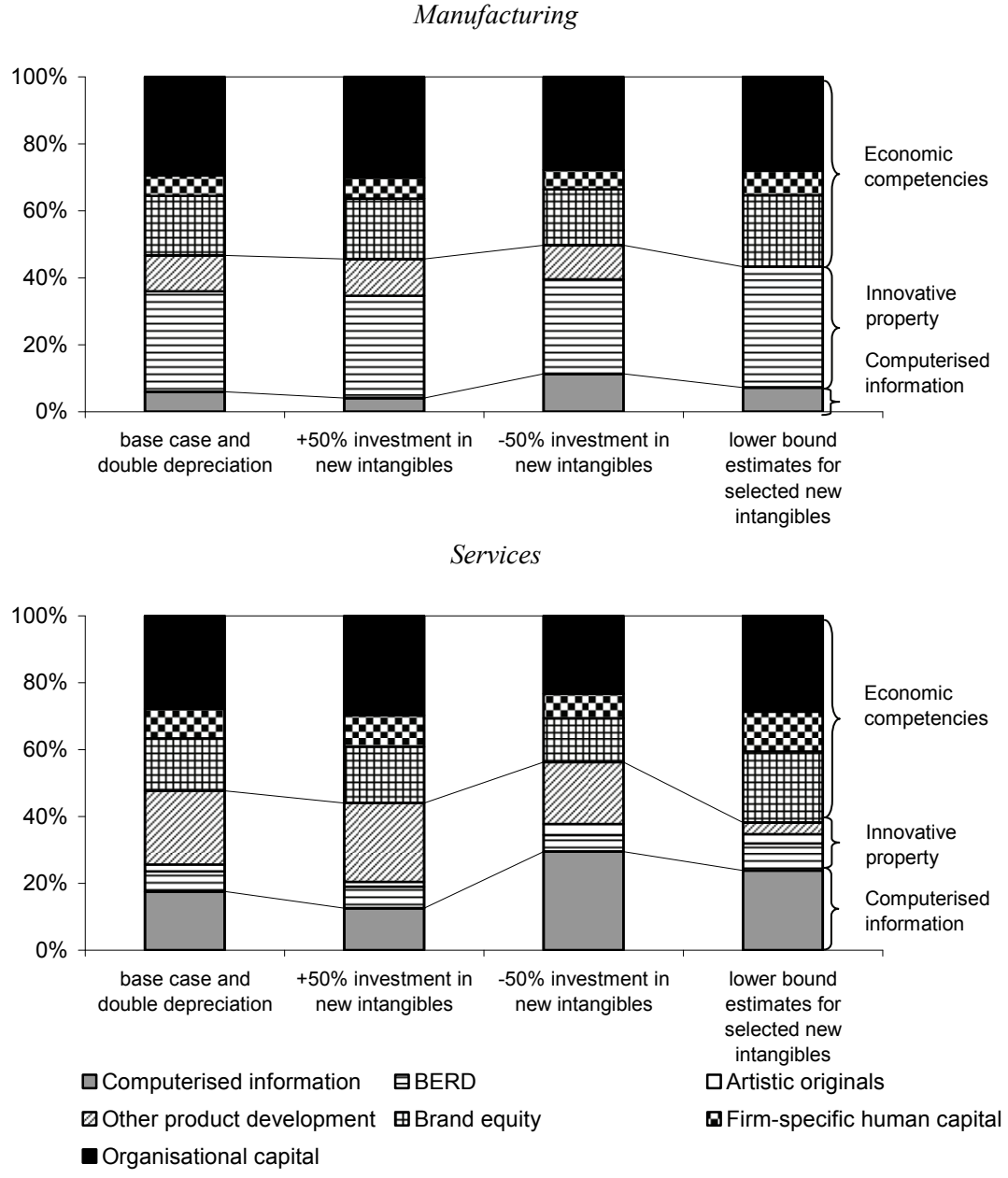
a The investment level is obviously unaffected by the depreciation rate, which affects the capital stock.

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

Alternative estimates for investment in the new intangibles will obviously affect the ratio of total investment (including all intangibles) to output (shown in figure 2.5). However, for each of these alternative estimates the upward trend in the ratio of national accounts investment to output is increased to some extent by the inclusion of investment in new intangibles.

The alternative estimates for investment in new intangibles also change the composition of investment in *total intangibles* (figure C.5). For both sectors, 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.

Figure C.5 **Shares of nominal total intangible investment, by asset type, by sector, alternative estimates for new intangibles, 2005-06**
Per cent

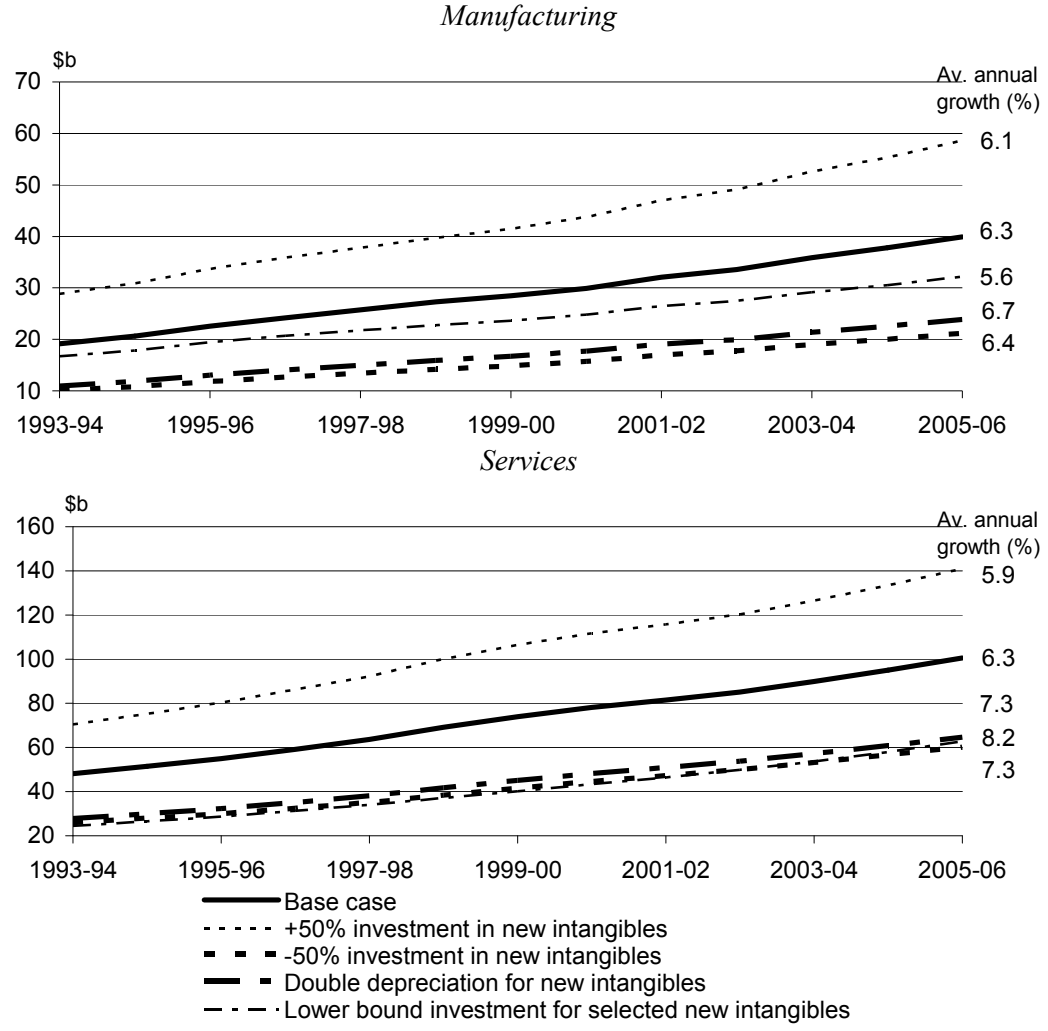


Data source: Author's estimates.

The opposite is the case for decreasing investment in new intangibles 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 C.6 shows the effect on the *total intangible* capital stock of the alternative investment estimates and depreciation rates for the new intangibles. Double depreciation has a similar effect on the capital stock to the 50 per cent decrease in investment. The largest change in growth rate is for the 'lower bound' set of estimates and is larger in services than manufacturing (because of the effect of financial R&D on services only, as noted above).

Figure C.6 **Total intangibles capital stock, alternative estimates for new intangibles, by sector, 1993-94 to 2005-06**
2005-06 dollars, chain volume measure



Data source: Author's estimates.

Figure C.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 for both sectors. The opposite is the case for the decrease in investment. The lower bound estimates shift the capital service flow composition away from innovative property in services in particular, because of the lower estimate for financial R&D. Doubling the depreciation rate for the new intangibles has relatively little effect on the composition of capital services because the lower capital stock is partially offset by increases in the rental prices.

The results of all these sensitivity tests on the components of the growth accounting for the period 1993-94 to 2005-06 are summarised in table C.3. 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 labour productivity growth is increased, measured capital deepening is increased and measured MFP growth is decreased for services and increased for manufacturing.

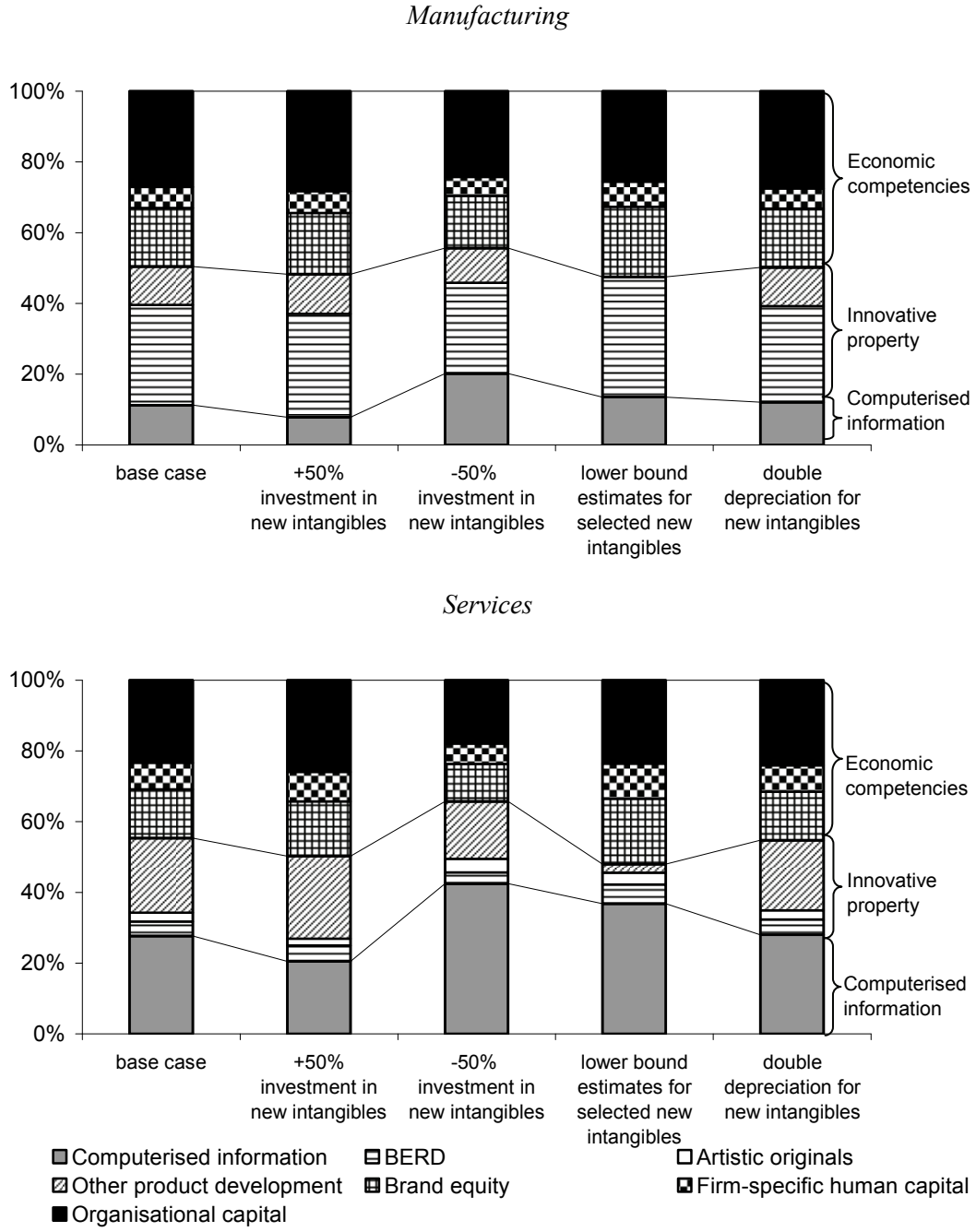
As expected, the magnitude of these changes is affected by the estimated size of the investment and capital stock for the new intangibles. This is mainly because changes in the level of investment/capital stock for the new intangibles relative to the level of other outputs/inputs affects the weighting together of growth rates in the new intangibles and the other outputs/inputs.[6] However, within the bounds for which the estimates are varied, the magnitude of the change in 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.

Sensitivity testing of the estimates in other country studies shows similar results (see, for example, MHW 2007 and Fukao et al. 2008). Corrado (as reported in National Research Council 2009) noted that while the assumptions used in the CHS framework affected the levels of investment and capital, sensitivity testing suggested that many of the assumptions had little impact on estimates of patterns of growth and productivity (for example, depreciation rate assumptions and some of the arbitrary assumptions used to estimate economic competencies).

6 In most cases, the alternative investment/stock estimates for each new intangibles had relatively little effect on the growth rate for that intangible because the alternative estimates were based on uniform percentage changes over time.

Figure C.7 **Composition of total intangible capital services, by sector, alternative estimates for new intangibles, 2005-06**

Per cent



Data source: Author's estimates.

Table C.3 **Comparison of investment and capital size sensitivity testing results, all intangibles treated as capital, 1993-94 to 2005-06**

Per cent per year

	Manufacturing	*Services*
Labour productivity growth		
Base case – nat. a/cs intangibles treated as capital[a]	2.32	2.48
Base case – all intangibles treated as capital[a]	2.69	2.54
50 per cent increase in new intangibles[b]	2.85	2.57
50 per cent decrease in new intangibles[c]	2.51	2.51
Lower bound for selected new intangibles[d]	2.59	2.55
Double depreciation for all new intangibles[e]	2.69	2.54
MFP growth		
Base case – nat. a/cs intangibles treated as capital[a]	0.64	1.58
Base case – all intangibles treated as capital[a]	0.65	1.51
50 per cent increase in new intangibles[b]	0.66	1.48
50 per cent decrease in new intangibles[c]	0.65	1.54
Lower bound for selected new intangibles[d]	0.65	1.54
Double depreciation for all new intangibles[e]	0.68	1.50
Capital deepening		
Base case – nat. a/cs intangibles treated as capital[a]	1.69	0.88
Base case – all intangibles treated as capital[a]	2.04	1.02
50 per cent increase in new intangibles[b]	2.19	1.08
50 per cent decrease in new intangibles[c]	1.87	0.96
Lower bound for selected new intangibles[d]	1.94	0.99
Double depreciation for all new intangibles[e]	2.01	1.02

Components may not add to totals due to rounding. [a] These series are the main results as presented in chapter 3. [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 (see details below).[e] Doubled all depreciation rates for all new intangible assets except brand equity, which has been increased from 60 to 90 per cent.

Source: Author's estimates.

Lower bound testing for selected new intangibles

The specific variations for the lower bound estimates are:

- for financial product development (which is included for the service sector only), 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 in each sector, 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 in each sector, 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 15 per cent in manufacturing (12 per cent in 1993-94 and 18 per cent in 2005-06) and 35 per cent in services (37 per cent in 1993-94 and 33 per cent in 2005-06). The difference between sectors largely reflects the adjustment to financial product development that only affects the service sector.
- Financial product development investment in the service sector is reduced by an average of around 90 per cent (a range of 96 to 84 per cent between 1993-94 and 2005-06).
- Architectural and engineering designs investment (as separately identified) is reduced by 100 per cent in each year (to zero) in each sector. 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 in each sector (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 in services and virtually nothing in manufacturing (table C.4). In services, compared with the base case including all intangibles, the rate of MFP growth falls from 1.70 per cent a year when excluding all intangible assets, to 1.54 per cent a year rather than 1.51 per cent (a 2 per cent difference). In manufacturing there is virtually no change.

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 C.4 **Comparison of MFP and capital services growth rates using lower bound intangible estimates, by sector, 1993-94 to 2005-06**

Per cent per year

	Manufacturing	*Services*
MFP growth		
All intangible assets (base case)	0.65	1.51
All intangible assets ('lower bound')	0.65	1.54
No intangible assets	0.69	1.70
Total capital services growth		
All intangible assets (base case)	4.2	4.6
All intangible assets ('lower bound')	4.0	4.6
No intangible assets	3.5	3.9

Source: Author's estimates.

Adjusting investment sizes for all new intangibles

Increasing investment by 50 per cent for the new intangibles resulted in a 0.14 of a percentage point increase in capital services growth (for the all intangibles case) in manufacturing and a 0.03 of a percentage point increase in services. This is a result of a higher weighting of intangibles, which grew faster than tangible assets, in the aggregate capital services indexes. Decreasing investment in intangibles by the same amount had the reverse effect (-0.18 of a percentage point in manufacturing and -0.04 of a percentage point in services).

Table C.5 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 26 to 35 per cent in manufacturing and from 17 to 24 per cent in services. Capital deepening attributable to all intangibles also increases, from 34 to 41 per cent in manufacturing and from 44 to 48 per cent in services. When new intangibles investment is decreased by 50 per cent, in manufacturing capital deepening attributable to new intangibles falls to 15 per cent and total capital deepening attributable to all intangibles falls to 24 per cent. In services capital deepening attributable to new intangibles falls to 10 per cent and total capital deepening attributable to all intangibles falls to 38 per cent.

Table C.5 Contributions to capital deepening, all intangibles treated as capital, 1993-94 to 2005-06

Per cent per year (Percentage share of total capital deepening)

	Base case[a]	*50 per cent increase in new intangibles*[b]	*50 per cent decrease in new intangibles*[c]
Manufacturing			
All intangibles	0.69	0.90	0.44
	(34)	(41)	(24)
National accounts intangibles	0.15	0.14	0.16
	(7)	(7)	(9)
New intangibles	0.54	0.77	0.28
	(26)	(35)	(15)
Tangibles	1.35	1.29	1.43
	(66)	(59)	(76)
Total capital deepening	**2.04**	**2.19**	**1.87**
	(100)	**(100)**	**(100)**
Services			
All intangibles	0.44	0.51	0.36
	(44)	(48)	(38)
National accounts intangibles	0.26	0.26	0.27
	(26)	(24)	(28)
New intangibles	0.18	0.26	0.09
	(17)	(24)	(10)
Tangibles	0.59	0.57	0.60
	(57)	(53)	(62)
Total capital deepening	**1.02**	**1.08**	**0.96**
	(100)	**(100)**	**(100)**

Components may not add to totals due to rounding. [a] These series are the main results as presented in chapter 3. [b] Increased investment in new intangibles by 50 per cent. [c] Decreased investment in new intangibles by 50 per cent.

Source: Author's estimates.

The effects on manufacturing MFP growth were very small. When new intangibles investment was increased by 50 per cent, MFP growth increased by 0.01 of a percentage point, or 1.5 per cent (an average of 0.66 per cent a year, up from 0.65 per cent for the all intangibles case). Decreasing new intangibles investment left MFP growth virtually unchanged (table C.3).

For services, the effects on MFP growth were larger. When investment in new intangibles was increased by 50 per cent, MFP growth decreased by 0.03 of a percentage point, or 2 per cent (an average of 1.48 per cent a year, down from 1.51 per cent for the all intangibles case). Decreasing intangibles investment increased MFP growth by a 0.03 (or 2 per cent) (table C.3).

In both sectors, 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 the MFP growth effect (compared with the results in chapter 3). The reverse is true for a 50 per cent decrease. However, in both cases, this ignores the issue of potential complementarities between intangibles and other capital and labour inputs.

Increased depreciation rates

The growth accounting results are very robust to doubling depreciation rates for the new intangibles. This is because smaller capital stocks[7], 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.

[7] For 2005-06, in manufacturing the estimated real net capital stock of intangibles is $40 billion for the base case and $24 billion when the depreciation rates for new intangibles are doubled. In services the equivalent stocks are $101 billion and $65 billion (figure C.6).

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