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## 5 Growth accounting results

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

- all intangible and tangible assets
- all Australian Bureau of Statistics (ABS) national accounts assets (which includes all tangible assets and a subset of the intangible assets<sup>1</sup>)
- 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.<sup>2</sup> The other intangible investment and intangible capital services have been estimated as described in chapters 3 and 4.

### 5.1 Growth accounting components

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

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

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

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All published and unpublished national accounts data used in the growth accounting in this paper are from the dataset underlying ABS *Australian System of National Accounts, 2006-07* (Cat.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

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

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

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

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

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

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

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

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

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

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

Output growth becomes

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

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

And therefore in labour productivity terms

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

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

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

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

Intangible investment as a share of total output	•	$\left( \frac{\dot{N}}{L} \right)$	+	$\frac{Q'}{Q}$	•	$\left( \frac{\dot{Q}'}{L} \right)$	(5.6)
		Growth in intangible investment relative to labour		Other output as a share of total output		Growth in other output relative to labour	

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

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

Total capital deepening including intangible capital becomes

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

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

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

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The income shares  $s_R$  and  $s_K$  are

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

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

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

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

MFP growth as the residual is derived as

$$\dot{MFP} = \dot{LP} - \dot{KD} \quad (5.10)$$

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

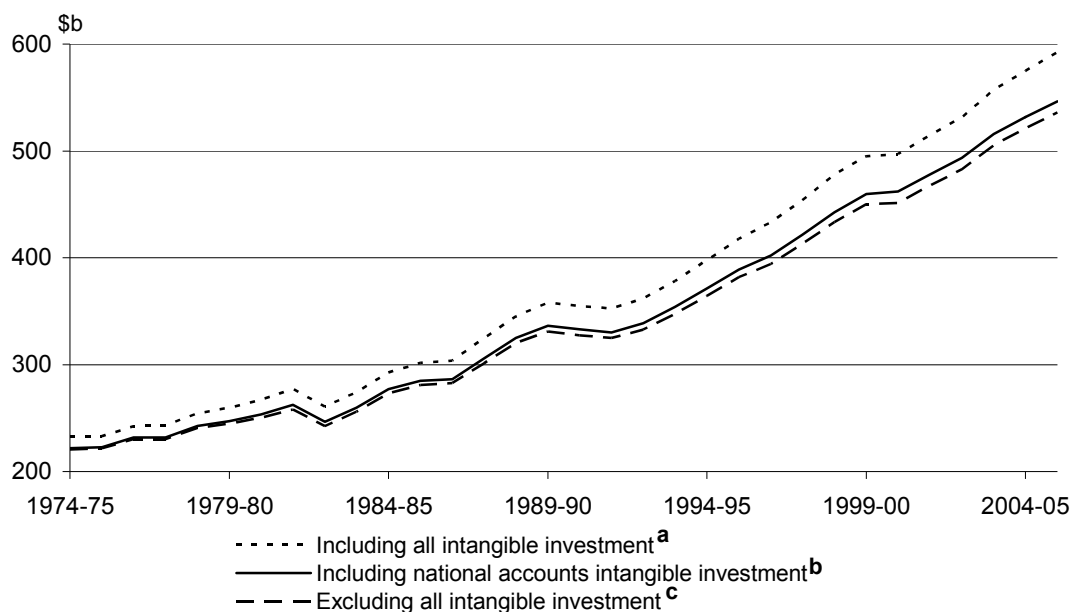
## Impact of intangibles on growth accounting components

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

### *Output*

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

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



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

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

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

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

Per cent per year<sup>a</sup>

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

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

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

### *Capital services*

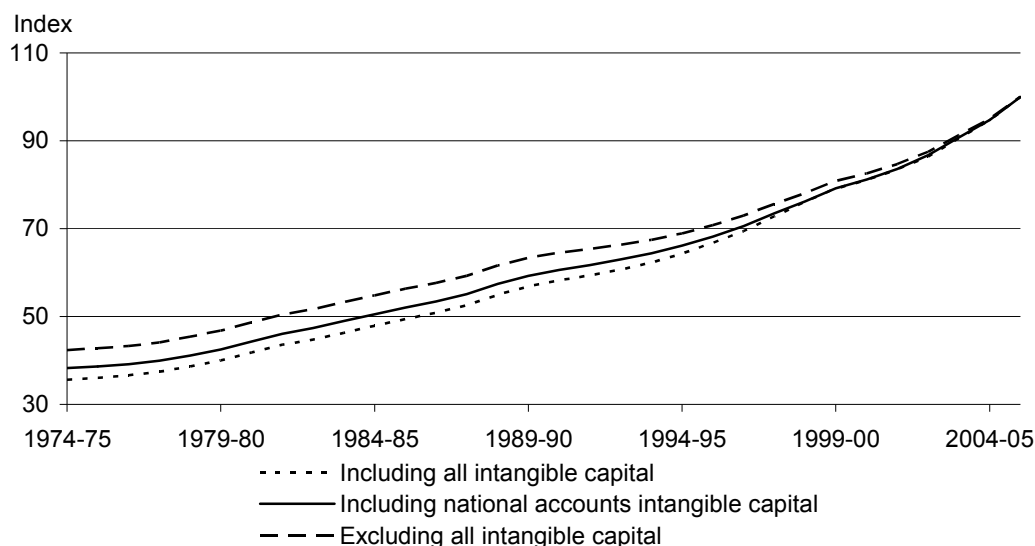
As discussed in chapter 4, aggregate capital services indexes are created using the volume index of the productive capital stock for each asset weighted using rental prices as weights.<sup>4</sup> The treatment of intangibles as capital will only increase the growth rate of the aggregate capital services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

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

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

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

Index 2005-06 = 100



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

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

### Factor income shares

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

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

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

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

**Table 5.2 Capital<sup>a</sup> and labour income shares, market sector**

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

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

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

## 5.2 Growth accounting results

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

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## Contribution of intangibles to labour productivity growth

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

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

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

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

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

**Table 5.3 Contributions to labour productivity growth<sup>a</sup>, market sector**

Per cent per year (Percentage share of total growth)

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

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

Source: Authors' estimates.

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

**Table 5.4 Contributions to capital deepening<sup>a</sup>, market sector**  
Per cent per year (Percentage share of total capital deepening)

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

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

Source: Authors' estimates.

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

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

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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<sup>7</sup>; and the rental prices for tangibles also changed.<sup>8</sup>

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

### **Comparing the impact of the new and existing intangibles**

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

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

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

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

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<sup>7</sup> 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.

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

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

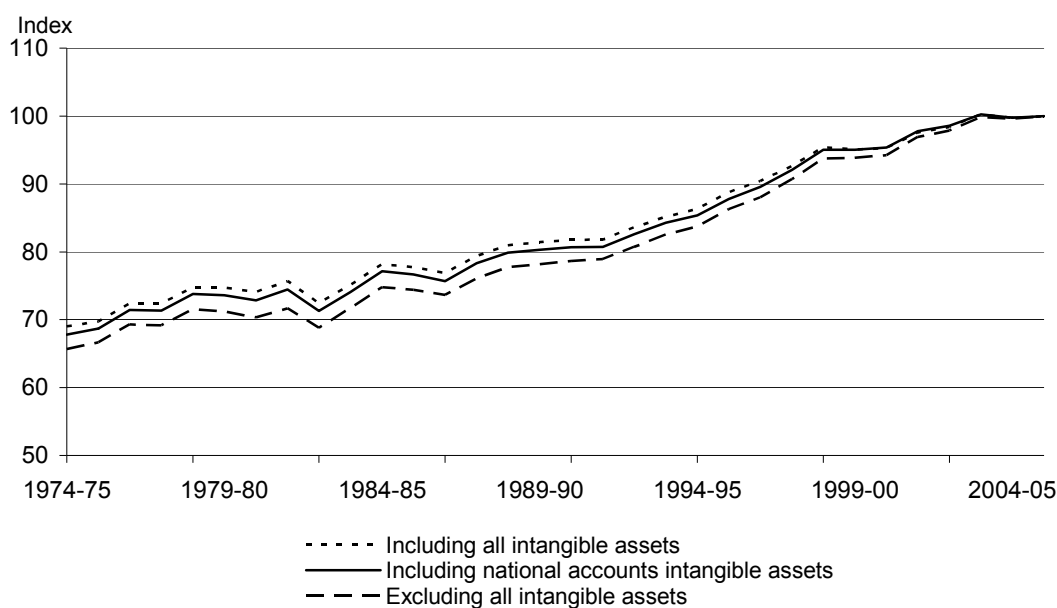
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## Growth accounting periods

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

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

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

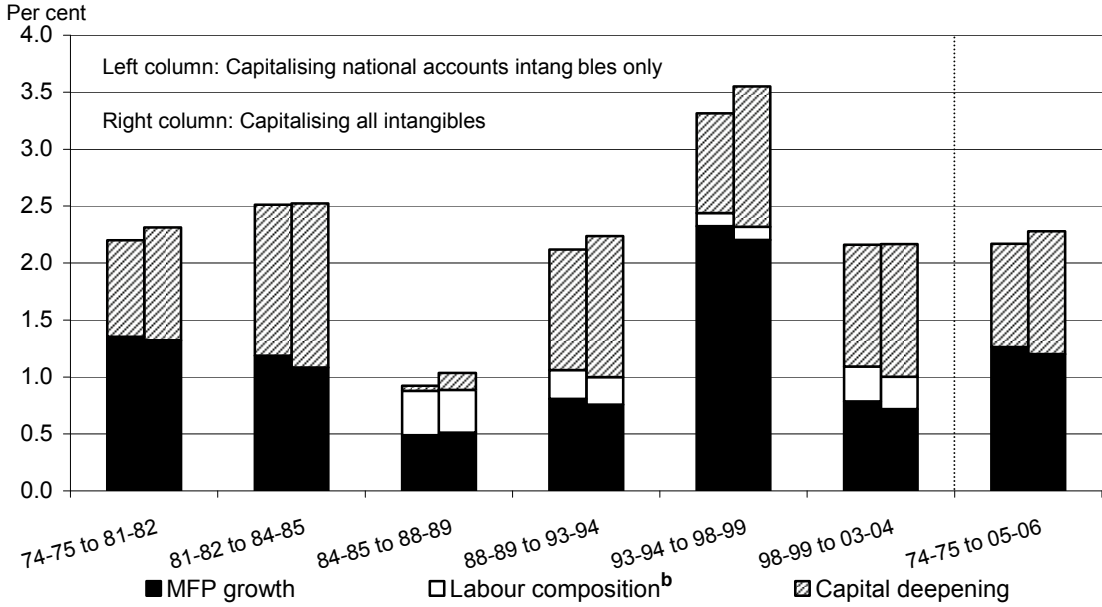


Data source: Authors' estimates.

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

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

**Figure 5.4 Contributions to labour productivity growth over MFP growth cycles<sup>a</sup>, market sector**  
Per cent per year



<sup>a</sup> 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. <sup>b</sup> Labour composition data are not available for the periods prior to 1984-85 to 1988-89 and therefore the full period 1974-75 to 2005-06. Labour composition change is captured in MFP growth where not separately identified.

Data source: Authors' estimates.

**Table 5.5 Productivity growth cycle analysis<sup>a</sup>, market sector**

Per cent per year

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

<sup>a</sup> MFP growth cycles. <sup>b</sup> Includes labour composition change for comparability across periods.

Source: Authors' estimates.

## Sensitivity testing results

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

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

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