4 Services from intangible capital

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

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

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

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

4.1 Intangible capital stocks

Perpetual inventory method

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Capital stock estimates

Current capital stock

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

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

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

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

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

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

a Net capital stock.

Sources: Authors' estimates; ABS national accounts data.

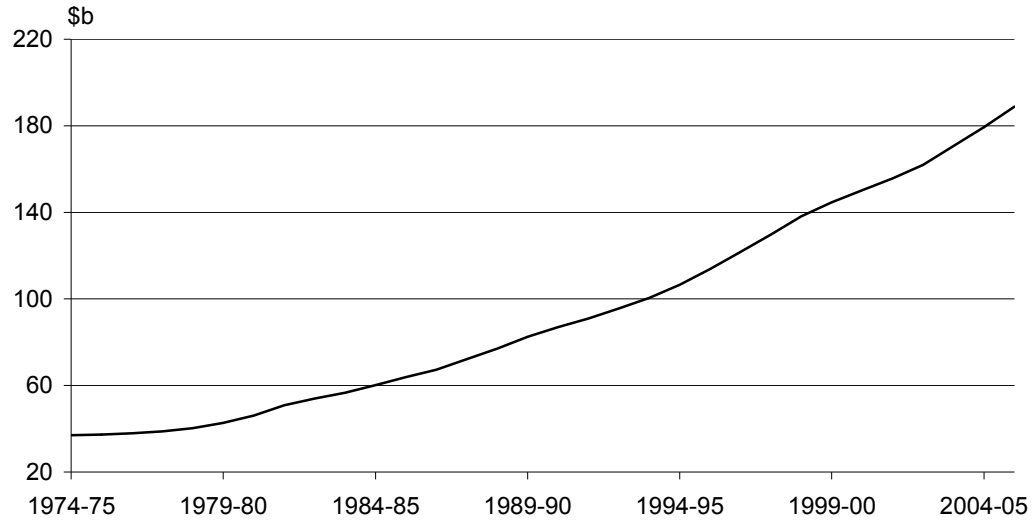
Growth in the capital stock

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

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

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

2005-06 dollars, chain volume measure



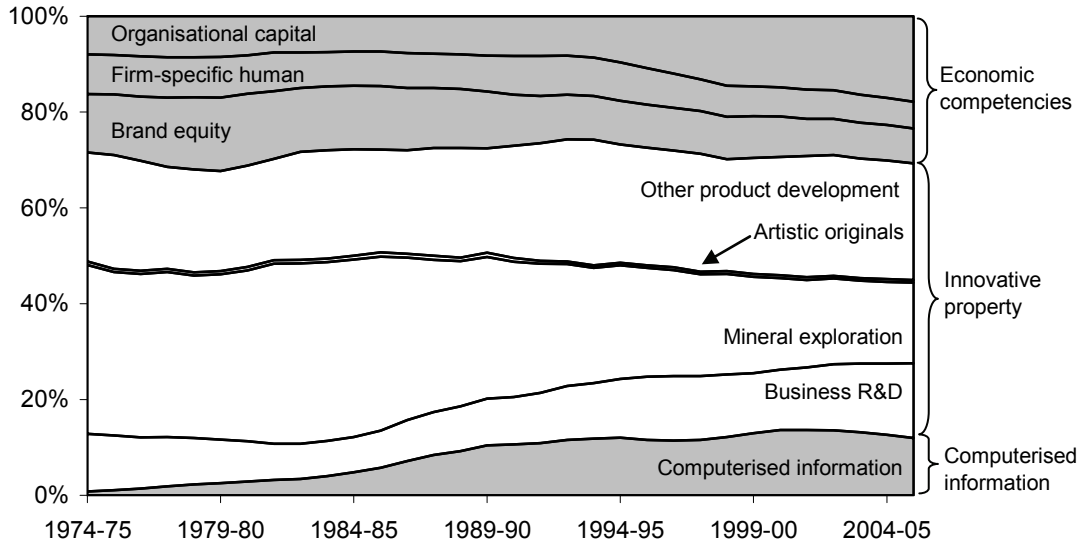
a For sensitivity of the intangible capital stock to some of the assumptions in its compilation, see appendix D.

Data source: Authors' estimates.

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

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

Per cent



Data source: Authors' estimates.

4.2 Capital services

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

Rental prices

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

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

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

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

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

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

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

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

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

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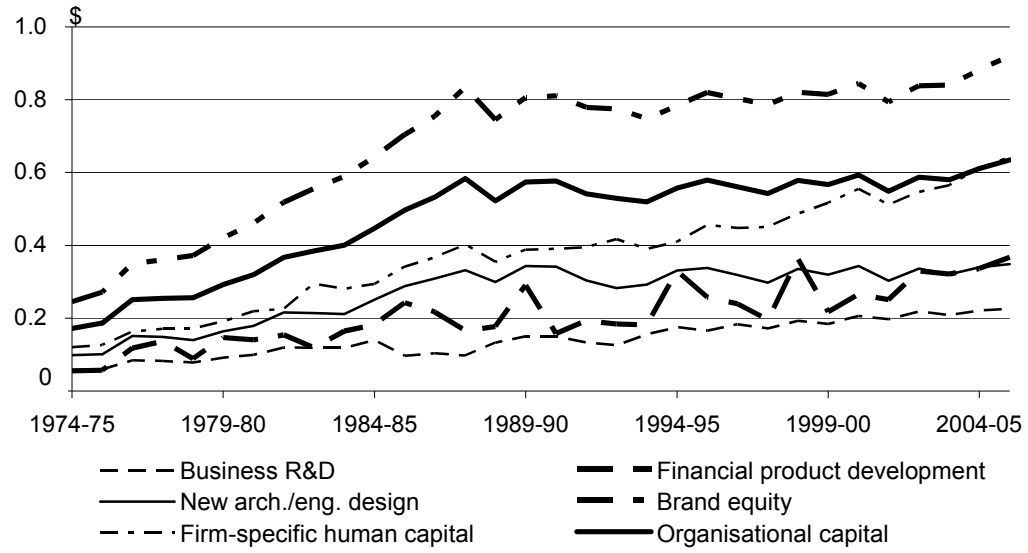
8 The inclusion of the tax parameters in the rental price removes some of the distortions to the rental price due to different tax allowances for different capital items and industries over time (ABS 2000, para. 27.61).

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

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



Data source: Authors' estimates.

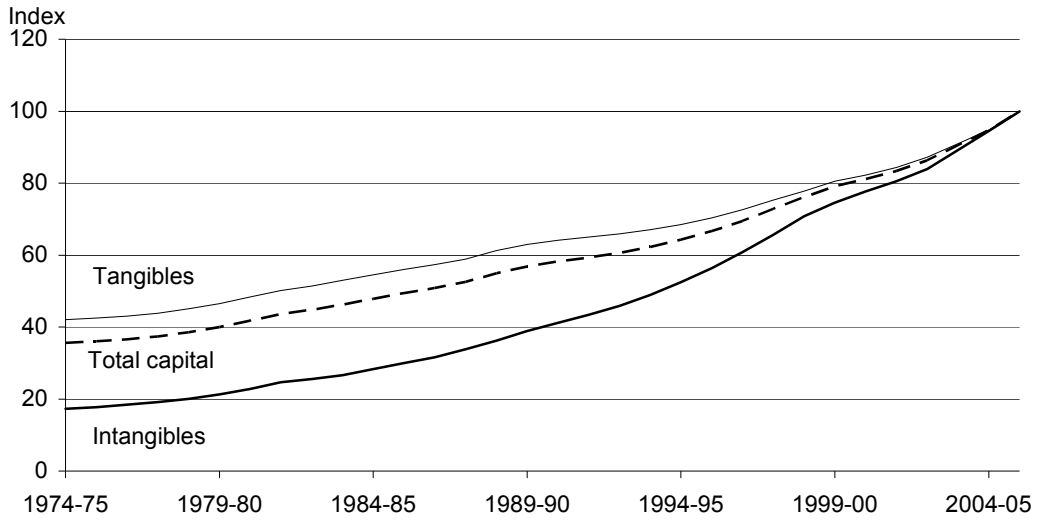
Capital services indexes

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

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

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

Index 2005-06 = 100



Data source: Authors' estimates.

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

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

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

Per cent per year (percentage contribution to total growth)

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

[a] Share of capital income.

Source: Authors' estimates.

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

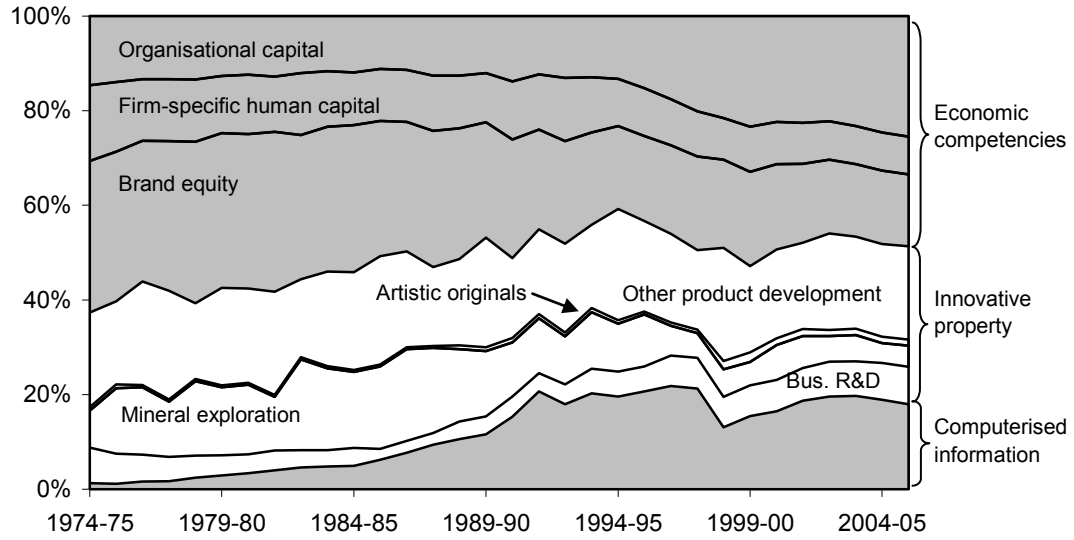
- Computerised information had the fastest growth rate in each period (except for purchased organisational capital in the third period) and, although the rate declined in each successive period, the contribution to total capital services growth increased (from 4 to 15 per cent between the first two periods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

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

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

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

Per cent



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

Data source: Authors' estimates.