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Experimental Estimates of Industry Multifactor Productivity

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Experimental Estimates of Industry Multifactor Productivity

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PREFACE

This information paper provides experimental estimates of industry level multifactor productivity (MFP). It is an extension of the ABS's research into productivity that began back in the 1980s. Estimates of MFP for the market sector were first published in 1985. Since that time, there has been growing interest in productivity measurement, particularly in the productivity performance of individual industries. The ABS commenced research into industry level MFP estimates in 2002. To assist this work the ABS established a Productivity Measurement Reference Group to advise on conceptual and practical issues involving productivity measurement. This paper has benefited from discussions with the Reference Group.

There are a number of conceptual and data issues surrounding productivity measurement. Statistical agencies and others involved in the field are still gaining experience in their compilation. As such, the industry level estimates contained in this paper should be considered experimental.

The paper discusses the general concepts and methodology for measuring MFP and then presents a brief summary of results. Much of the paper is centred around individual industry analyses of the estimates. Future directions are outlined at the end of the paper. The indexes that comprise the industry estimates are available on the ABS website at www.abs.gov.au in a spreadsheet format (cat. no. 5260.0.55.001).

The ABS plans to publish industry MFP estimates on an annual basis and is seeking user feedback regarding the estimates and the methodology used in their calculation. Please forward any comments to Paul Roberts (paul.roberts@abs.gov.au).

Brian Pink
Australian Statistician

INTRODUCTION

INTRODUCTION

The ABS has been producing multifactor productivity (MFP) estimates for approximately 20 years. Considerable development work took place during the 1980s leading to the publication of the first estimates of MFP in 1985. Since then, MFP estimates for the market sector as a whole have been produced each year and released in conjunction with the annual national accounts.

Over recent years, interest in productivity measurement has increased significantly with particular interest in the productivity performance of individual industries and the Australian economy relative to other countries. In response to this, the ABS commenced a project in 2002 aimed at developing industry level estimates of MFP. Estimates were released in a research paper in 2005 (Zheng 2005) and confirmed that while there were some limitations to the available data, meaningful estimates could be developed. Since then research has been undertaken to further develop and extend the estimates.

The focus of this paper is to present experimental estimates of MFP for the 12 industries that comprise the market sector. The paper presents an analysis and discussion of the results for each of the industries. The estimates of industry MFP presented in the paper use the same basic data that underlie the estimates of market sector productivity published in the *Australian System of National Accounts, 2005–06* (cat. no. 5204.0). However, one difference of note between the industry level estimates and the aggregate market sector estimates is the treatment of taxes on products (sales tax, excise tax and GST). These are excluded from the individual industry estimates but accounted for in the published aggregate.

In developing these industry estimates a number of matters were identified as requiring further research. These research topics are identified in the industry chapters and summarised in Chapter 15 together with other general research topics. These topics provide a basis for future ABS work in this field.

The results presented in this paper should be interpreted with care, particularly with regard to short term movements. The methodology used in compiling the estimates implicitly assumes that the proportion of capital stock used in production (capital utilisation) does not change, therefore any real world change in the extent to which capital is utilised in production will be recorded as a change in productivity. The methodology further assumes that each hour of labour input is fully utilised in production. Further, improvements in output due to a firm's ability to produce more output as a result of their size, that is, economies of scale, will also appear as a measured productivity improvement.

The paper is structured as follows. The general concepts and methodology for measuring MFP are discussed in Chapter 1. Chapter 2 presents a brief summary of results comparing the industry estimates to the published market sector estimates, as well as comparing gross output based MFP estimates to value added based MFP estimates. The following chapters contain the individual industry analyses. The final chapter provides

INTRODUCTION *continued*

some concluding remarks, as well as identifying areas for future research. Appendix 1 provides further details on the methodology and data. Appendix 2 presents a sensitivity analysis on possible methodological approaches to estimating capital services.

The ABS plans to publish industry MFP estimates on an annual basis and is seeking user feedback regarding the estimates and their methodology.

CHAPTER 1 METHODOLOGY AND INTERPRETATION

The primary aim of productivity analysis is to understand the drivers of growth in output. Growth in output can occur from the application of more inputs, by utilising inputs more efficiently or from a combination of both. At a basic level, productivity growth occurs when the volume of output rises faster than the volume of inputs, but beyond this simple notion a range of conceptual and measurement issues arise. In the first instance, productivity growth can be defined in relation to a single input (for example, labour) or to a combination of inputs (for example, labour and capital). Also, output growth might be defined in relation to total sales or it might be defined as growth in value added, that is, output less intermediate costs. This section outlines the measurement choices made in the compilation of the current round of industry MFP estimates.

MULTIFACTOR PRODUCTIVITY THEORY

The three measures of productivity that the ABS currently publishes for the market sector[1] of the economy are:

- labour productivity (LP), estimated by dividing an index of the volume of value added (VA) by an index of labour input (L), that is, $LP = VA / L$
- capital productivity (KP), estimated by dividing an index of the volume of value added by an index of capital inputs (K), that is, $KP = VA / K$
- multifactor productivity (MFP), estimated by dividing an index of the volume of value added by a combined index of labour and capital inputs, that is, $MFP = VA / (I_{KL})$.

These can also be calculated at an industry level.

There is also a gross output measure of MFP, estimated by:

- dividing an index of the volume of gross output (GO) by a combined index of labour, capital and intermediate inputs (I), that is, $MFP = GO / (I_{KLI})$.

Labour and capital productivity measures are partial productivity measures and provide a measure of growth in output to growth in one of the factor inputs, either capital or labour. The most obvious limitation of labour and capital productivity measures is that they attribute to one factor of production – labour or capital – changes in output attributable to all factors of production. For example, the effects of technical progress, improvements in management practices and economies of scale, could affect measures of both capital and labour productivity. Also, a labour productivity measure takes no account of the amount of capital available to labour, or how this amount changes over

1 There are 17 industries under the current ANZSIC classification system. The market sector comprises Agriculture, forestry & fishing; Mining; Manufacturing; Electricity, gas & water; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Communication services; Finance & insurance; and Cultural & recreational services. The non-market sector includes Property & business services; Government administration & defence; Education; Health & community services; and Personal & other services. Industry MFP estimates are available for the 12 market sector industries only.

MULTIFACTOR PRODUCTIVITY THEORY *continued*

time. A change in the amount of capital available per unit of labour is reflected in the concept of capital deepening.

The limitations of partial productivity measures gives rise to the development of MFP, which is a more comprehensive productivity measure. MFP measures the ratio of growth in output to growth in two or more factor inputs and represents that part of the change in output that cannot be explained by changes in the inputs. The ABS approach to measuring MFP is based on neoclassical economic theory using a translog production function in conjunction with two assumptions, constant returns to scale and that marginal products of capital and labour are equal to their respective real market prices. This forms the basis of the growth accounting approach to estimating MFP.

However, these assumptions may not hold in practice. If there are scale efficiencies then this will also be captured as an increase in MFP. This possibility is likely as there would be many firms operating in an environment of increasing returns to scale, especially over short periods. The assumption that the marginal products of capital and labour are equal to their market price, is based on perfect competition existing in factor markets. As a result, growth in MFP may contain the impact of various phenomena in addition to disembodied technological change, such as economies of scale and scope, and efficiency gains relating to changes in resource allocation. That is, resources such as capital and labour may shift between or within industries, which would affect measured MFP growth.

For the market sector as a whole, the ABS compares MFP growth rates over productivity cycles, which involves identifying and dividing the data into peaks in MFP growth. The reason for this is it is assumed that these peaks represent similar levels of capacity utilisation. One important issue that arises is that individual industries will not necessarily have the same cycles as either the market sector or each other. The industry average MFP growth estimates contained in this paper are not calculated on a peak to peak basis. The ABS will conduct further research on this issue.

INDEX NUMBER CHOICE

There are numerous choices as to which form of index number to use in measuring outputs and inputs. The following index numbers are used for the analysis presented in this paper:

- The industry value added, gross output and intermediate inputs indexes are chained Laspeyres indexes, as they are consistent with published aggregate market sector output and GDP
- The industry capital services index is a Tornqvist index based on weighted changes in productive capital stock derived using the perpetual inventory method
- The labour input index is a simple elemental index based on hours worked data from the Labour Force Survey (LFS), which is a household survey providing hours worked by industry.

The interpretation of growth in MFP is generally not affected by the choice of index number form, although the results can vary slightly.

The combined input indexes required for MFP estimation are constructed by using the respective income shares of capital and labour for value added, and the respective cost shares for capital, labour and intermediate inputs for gross output. The input indexes are combined to form an aggregate input index using a Tornqvist methodology. These income shares are derived from total industry income. The calculation of MFP is then the

INDEX NUMBER CHOICE *continued*

output index (gross output or value added) divided by its corresponding combined input index.

OUTPUT

As identified above, there are two different measures for industry output, value added and gross output. Gross output is the total value of all products produced by all firms operating in an industry, while value added is the total value of products produced in an industry minus the value of intermediate inputs used during the production process.

Gross output and value added are obtained from the ABS supply-use tables. Data from the supply-use tables are available from 1994–95. While gross output data are only available from this date, industry value added data are available from 1974–75. MFP estimates based on value added are available from 1985–86 as this is the earliest available data for industry level hours worked.

QUALITY ADJUSTED OUTPUT

The measurement of output for the service industries poses some particular problems in relation to changes in quality. Identifying and capturing changes in the quality of services is difficult in both concept and practice. Although some adjustments for quality are captured in the price data used to deflate the current price estimates, the difficulties involved are such that the final measure of industry output may not adequately capture all quality changes.

It is particularly difficult to perform accurate quality adjustment for service industries, as change in the quality of service is very difficult to measure in an objective way. Techniques such as analysing component change, overlapping sales or hedonic regression analysis, which are the normal methods for quality adjustment, may be ineffective at providing an accurate adjustment level because of the intangible nature of the product and the data required. If the extent of quality change is not completely captured in the data, output growth and MFP may be understated.

MEASURING GROSS OUTPUT AND VALUE ADDED MFP

There are a number of issues to consider in the choice of output measure for estimating industry level MFP. With regard to interpretation, gross output based MFP estimate is intended to measure the 'Hicks neutral technological progress in an industry' whereas the value added based MFP growth reflects

> '...the industry's capacity to translate technological change into income and into contributions to final demand' (OECD 2001a).

Ideally MFP measures disembodied technical change attributable to improved use of factor inputs. In the case of gross output this efficiency can be attributed to improvements in not only the use of primary inputs, capital and labour, but also in the use of intermediate inputs. The value added measure of MFP removes the value of intermediate inputs, which has the effect of attributing productivity improvements gained through the more efficient use of intermediate inputs to capital and labour. For this reason the value added measure of MFP shares drawbacks associated with the partial productivity measures, as it does not account for all factor inputs. This is the case for any approach that does not measure every single input separately.

MEASURING GROSS OUTPUT AND VALUE ADDED MFP *continued*

Further, the exclusion of intermediate inputs from value added based MFP presents problems when there are changes in the proportion of intermediate inputs relative to primary inputs. On the other hand, gross output based MFP estimates would be less sensitive to events such as an increase in outsourcing.

An advantage of the value added MFP measure is its ease of aggregation across industries and the conceptual link between industry-level and aggregate MFP growth (OECD 2001a). Value added is derived directly from national accounts data and is available earlier than gross output and for a longer time series.

Overall, these two measures can complement each other to reflect an industry's performance. For this reason, the paper provides both estimates for each industry.

Equations 1 and 2 show how the two measures of MFP are calculated.

$$\textit{Value added based MFP} = A_{VA} = \frac{(Y_{GO} - I)}{(I_{KL})} \quad (1)$$

$$\textit{Gross output based MFP} = A_{GO} = \frac{Y_{GO}}{(I_{KLI})} \quad (2)$$

Where:

Y_{GO} is gross output

I is intermediate inputs

L and K are labour and capital inputs

I_{KL} is a combined index of capital and labour

I_{KLI} is a combined index of capital, labour and intermediate inputs.

When estimating productivity growth rates the gross output MFP estimates will be flatter than the value added MFP estimates (Equations 3 and 4) since the contribution of intermediate inputs in the gross output measure will reduce the MFP growth estimate.

Equations 3 and 4 calculate growth in value added and gross output MFP, with all factor inputs remaining constant.

$$\hat{A}_{VA} = \frac{(Y + \Delta Y - I)/(L + K)}{(Y - I)/(L + K)} = \frac{(Y + \Delta Y - I)}{(Y - I)} = 1 + \frac{\Delta Y}{Y - I} \quad (3)$$

$$\hat{A}_{GO} = \frac{(Y + \Delta Y)/(I + L + K)}{Y/(I + L + K)} = \frac{(Y + \Delta Y)}{Y} = 1 + \frac{\Delta Y}{Y} \quad (4)$$

Where:

$\hat{}$ represents growth.

A different way to express the difference between the two measures is that gross output MFP is equal to value added MFP multiplied by the ratio of nominal value added to nominal gross output. Since the ratio is smaller than one, growth in gross output MFP is flatter than growth in value added MFP. Equation 5 shows this relationship.

$$\hat{MFP}_{GO} = \hat{MFP}_{VA}\,(Y_{VA} / Y_{GO}) \quad (5)$$

SECTORAL OUTPUT

For the purposes of measuring MFP growth at the industry level there is a further measure of output that is relevant, the concept of sectoral output. Sectoral output is the value of gross output minus the net value of intra-industry transfers, that is, sectoral output is the value of all goods and services produced within an industry for use outside the industry. The issue of intra-industry intermediate inputs is particularly relevant for industries with vertically integrated supply chains such as Manufacturing and

SECTORAL OUTPUT *continued*

Construction, where there is a high degree of intra-industry transfers inherent in the production process. The exclusion of intra-industry intermediate inputs removes the problems associated with overstatement of intermediate inputs due to fragmentation, which occurs when a vertically integrated firm splits into two or more smaller entities, and increases measured industry gross output without a change in industry sectoral output. Due to the structure of the ABS supply-use benchmarking system, sectoral output estimates are not currently produced for individual industries. This could present problems for the interpretation of gross output MFP in those industries that have a high degree of intra-industry transfers.

Gross output MFP growth based on sectoral output would be the preferred measure for analysing growth in MFP, as it captures underlying gains in technical efficiency without distortions caused by changes to intermediate inputs or fragmentation. However, the gross output MFP growth estimates published in this paper are not of this type as data for intra-industry transfers are not available.

TAXES AND BASIC PRICES

Taxes and subsidies on products are usually payable on goods and services when they are produced, delivered, sold, transferred or otherwise disposed of by their producers. They include taxes and duties on imports that become payable when goods enter the economic territory or when services are delivered by non-resident units. For more information on taxes and subsides on products and their treatment in the national accounts refer to Chapters 4 and 21 of the *Australian System of National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0).

In the Australian System of National Accounts, Gross Domestic Product (GDP) is obtained by summing the value added of all industries and then adding taxes less subsidies on products. The difference between gross value added at basic prices, and GDP at market (or purchaser's) prices, is the value of taxes less subsidies on products.

Published market sector MFP estimates currently include all taxes and subsidies on products. The industry estimates in this paper do not include these taxes. That is, industry output is valued at basic prices. One reason for this is essentially practical, as there is no industry detail available to accurately allocate the amount of taxes paid. Besides the practical aspect, another reason is that in some sense taxes at the industry level are arbitrary and distort gross output and value added relativities. Further, it is only volumes that are of interest in productivity measurement, and, conceptually at least, taxes should affect only prices.

INPUTS

Labour inputs

The productivity measures use hours worked by industry based on data from the household Labour Force Survey (LFS). The total hours worked estimates by industry are the product of industry employment and average hours worked per person by industry.

Using the LFS for industry hours worked has some strong advantages. The LFS records hours worked and employment information for employees and the self-employed while business surveys tend only to have employment data for employees and tend not to record hours worked information. Since the self-employed constitute around 15% of the Australian work force and have different patterns of work than employees their inclusion is a significant benefit of LFS data over business surveys. The LFS also has a consistent

Labour inputs continued

uninterrupted time series and if the ABS were to use business surveys a hybrid of two different data sources would be needed.

There has been some research using alternative sources of employment data, such as the Economic Activity Survey (EAS) / Tax data and the Survey of Employment and Earnings (SEE) to compare with the LFS. The results showed that while there were no significant differences in the industry distribution of employment between the LFS and the alternative sources, the patterns of growth were different in some industries. Overall, the data quality of the alternative sources is not yet considered sufficiently high and therefore in these productivity estimates the LFS data are used.

One area for further research is to adjust the industry hours worked estimates for changes in labour composition. When compiling productivity estimates, increases in aggregate labour composition, such as increased experience and higher qualifications, will not be reflected as increases in labour inputs, but will be reflected in MFP. An aggregate market sector adjustment has been developed but no industry level adjustments are possible at this stage.

Further details on labour inputs are discussed in Appendix 1.

Capital inputs

The other input used in measuring value added based MFP is capital services. Capital services are a flow measure based on the productive capacity of capital. The capital services produced by an asset over its life are directly proportional to the productive capital value of the asset. The productive capital stock estimates are derived on the basis of an asset's pattern of decline in efficiency due to age. There are many possibilities for defining the 'age-efficiency profile', but a lack of data makes it difficult to determine the precise profile of each asset and hence, general assumptions are used. The ABS uses hyperbolic functions to describe the age-efficiency profiles. A hyperbolic function means that the efficiency of an asset declines by a small amount at first and the rate of decline increases as the asset ages. Age-efficiency profiles are distinct from, but related to, rates of financial depreciation of assets, which are linked to age-price profiles. That is, the productive efficiency of an asset will not necessarily decline at the same rate as its economic value.

The productive capital stock is estimated by applying a perpetual inventory method (PIM) to volume estimates of investment (gross fixed capital formation) at a detailed level in conjunction with age-efficiency profiles. Briefly, for each asset type the PIM adds the current year's investment to previous years' investments, which are multiplied by suitable scalars[2] to give a productive capital stock for each asset. An index of capital services is then defined by aggregating the changes in the productive capital stock for each asset using their respective rental price as weights. Rental prices are also called the user cost of capital and are defined as the price per unit of capital and are considered to be the cost of financing an asset (OECD 2001a). For further details on capital inputs see Appendix 2.

2 The scalars take into account age-efficiency profiles and retirement distribution patterns. The scalar in the year the investment is made is equal to one. To represent the decline in the capital service that occurs over time the scalar in subsequent years is less than one. The scalars are different for each asset and change each year of the asset's life.

Capital inputs continued

There are a number of assumptions required to estimate capital services. These assumptions relate to the rate of return, the asset price deflator, and the mean asset life. For the estimates presented in the industry analyses in Chapters 4 to 15, there is no change to previous ABS methodology for estimating industry level capital services. Appendix 2 highlights that different methodological choices have little impact on capital services estimates at an industry level, and as such do not affect interpretation of the industry MFP estimates. For further details on the sensitivity analysis of the methodological options, see Appendix 2.

The ABS classifies the use of capital as an intermediate input when the capital is leased or rented from a firm primarily operating in another industry. If the proportion of the capital that is leased is changing it can affect value added productivity growth estimates. A reduction in the percentage of capital held within an industry over time, such as when a firm leases rather than purchases capital, would understate growth in the capital service index, which would have the effect of overstating value added MFP growth. The treatment of capital as an intermediate input only applies to operating leases, as capital held under a long term finance lease is treated as capital and included in productive capital stock estimates (ABS 2000).

Intermediate inputs

Gross output based MFP requires estimates of intermediate inputs. Intermediate inputs are sourced from the supply-use tables and are formed into a chain-volume Laspeyres index using appropriate price deflators. Intermediate inputs consist of the value of goods and services consumed as inputs into the production process. The goods and services may be either transformed, or completely used up in the process of producing outputs.

In addition to goods and services used directly in the production process, intermediate inputs include the value of all goods and services used as inputs into ancillary activities. Ancillary activities include purchasing, sales, marketing, accounting, data processing, transportation, storage, and security. The output of an ancillary activity is not intended for use outside of the enterprise.

INCOME AND COST SHARES

Total industry income is the sum of the gross operating surplus (GOS) of corporations and government, gross mixed income (GMI) and compensation of employees (COE). Gross mixed income includes both capital and labour components, and these are split in order to obtain capital and labour income shares. These income shares are used to weight capital and labour inputs when measuring value added based MFP. The capital income share is given by the sum of GOS and proprietor's capital income (capital's share of GMI) divided by total income. Labour's income share is then the residual, but more precisely it is the sum of COE and proprietor's labour income (labour's share of GMI) divided by total income.

For measuring gross output based MFP it is more relevant to use total industry cost. That is in order to measure a combined inputs index of capital, labour and intermediate inputs a cost share is required for intermediate inputs, capital and labour. The intermediate inputs cost share is based on the current price value of the intermediate inputs. Capital and labour income as derived above form their respective cost shares.

ADDITIONAL INFORMATION

For more detail about these conceptual and measurement issues readers should refer to the *Australian National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0, Ch 27) or Zheng (2005) *Estimating Industry-Level Multifactor Productivity for the Market Sector Industries in Australia: Methods and Experimental Results*. Both are available on the ABS web site.

CHAPTER 2 SUMMARY OF RESULTS

SUMMARY OF RESULTS

This chapter presents a summary of the industry estimates, including a comparison between value added based MFP and gross output based MFP estimates. The estimates in tables 2.1 and 2.14 show that the industries are sensitive to the span of years chosen for estimating growth rates. This is because the industries will not necessarily have the same productivity growth cycles (for a short discussion on productivity growth cycles see Chapter 1).

GROWTH IN MFP

Value added based MFP

Periods of five years have been chosen to present the results in table 2.1. Table 2.1 shows that between 1985–86 and 2005–06 the industries with strongest growth in MFP were the Communication services and Agriculture, forestry & fishing industries. Finance & insurance also had high growth, particularly up until 2000–01. Other industries with MFP growth faster than the market sector over the last twenty years were Transport & storage, Wholesale trade and Electricity, gas & water. Cultural & recreational services had the weakest MFP growth.

Mining, Electricity, gas & water and Finance & insurance industries showed relatively strong MFP growth over the early periods with growth slowing in later periods. Construction and Accommodation, cafes & restaurants had stronger MFP growth between 2000–01 and 2005–06 compared to earlier periods.

2.1 COMPOUND ANNUAL PERCENTAGE CHANGE IN VALUE ADDED BASED MFP, Market sector industries

	1985–86 to 1990–91	*1990–91 to 1995–96*	*1995–96 to 2000–01*	*2000–01 to 2005–06*	*1985–86 to 2005–06*
High					
Communication services	4.7	4.7	2.2	2.7	3.6
Agriculture, forestry & fishing	2.3	1.8	5.3	2.5	3.0
Finance & insurance	3.1	2.0	2.0	0.2	1.8
Medium					
Transport & storage	0.7	2.9	1.7	1.6	1.7
Wholesale trade	–1.8	3.9	2.9	1.3	1.5
Electricity, gas & water	6.0	2.6	0.5	–3.2	1.4
Low					
Retail trade	–1.0	1.1	2.2	0.7	0.7
Manufacturing	0.9	0.5	1.1	0.4	0.7
Construction	–1.8	0.2	—	4.5	0.7
Mining	3.5	2.3	1.1	–5.9	0.2
Accommodation, cafes & restaurants	–3.8	—	1.4	2.5	—
Cultural & recreational services	–0.9	–2.2	0.8	–0.2	–0.6
Market sector	**0.8**	**1.6**	**1.6**	**0.8**	**1.2**

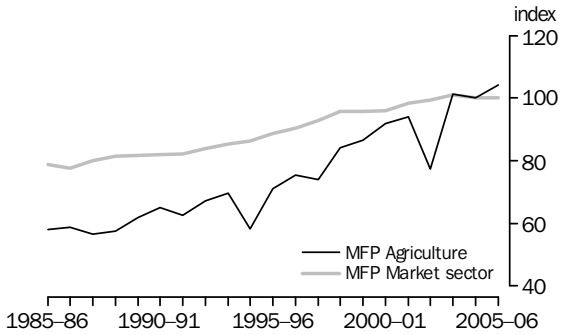
— nil or rounded to zero (including null cells)

Value added based MFP continued

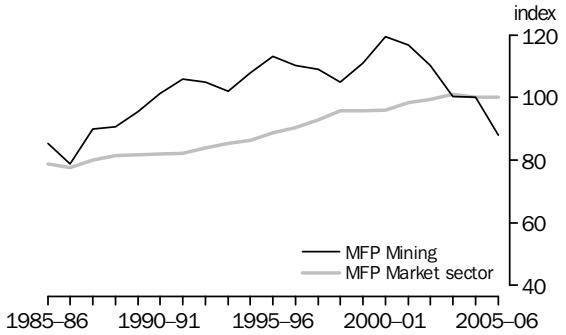
Figures 2.2 to 2.13 presents value added based MFP growth for the market sector industries. They compare industry MFP growth to the market sector MFP growth. MFP growth for Agriculture, forestry & fishing, Wholesale trade, Transport and storage and Communication services on average exceeded market sector MFP growth over the last 20 years. The Retail trade industry had a similar pattern of MFP growth to that of the market sector.

Value added based MFP for the market sector industries (2004–05 = 100)

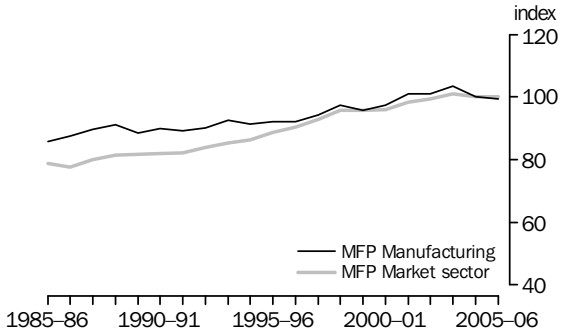
2.2 AGRICULTURE, FORESTRY & FISHING



2.3 MINING

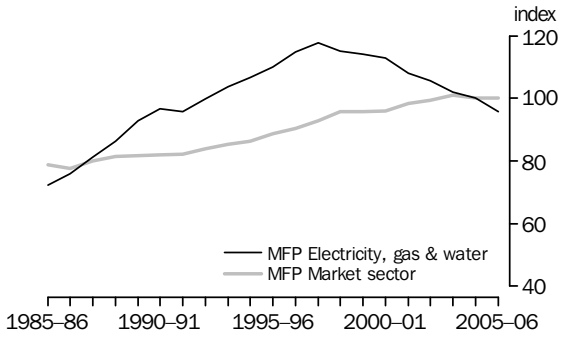


2.4 MANUFACTURING

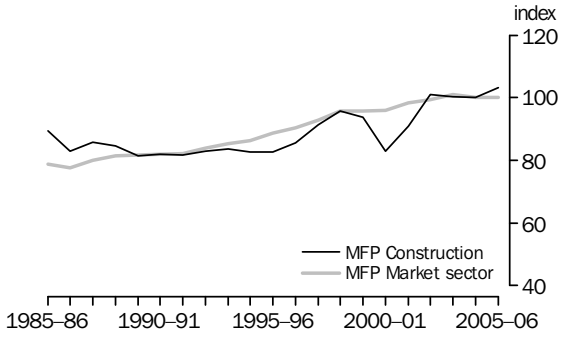


Value added based MFP for the market sector industries (2004–05 = 100) continued

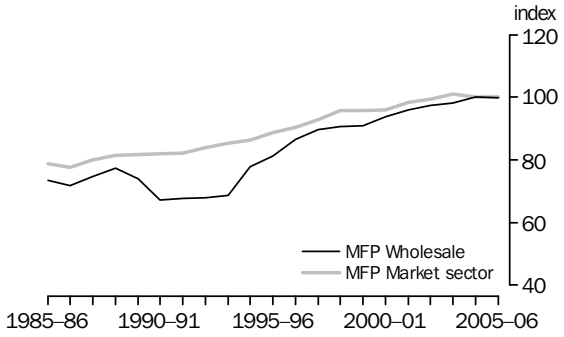
2.5 ELECTRICITY, GAS & WATER



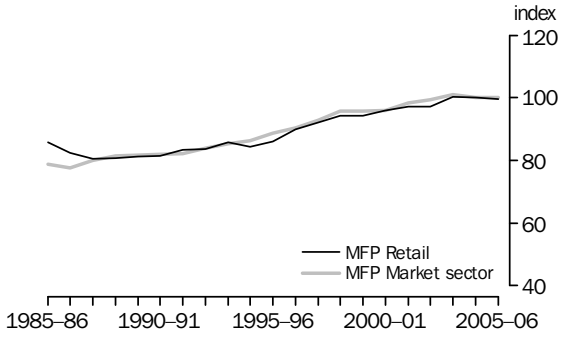
2.6 CONSTRUCTION



2.7 WHOLESALE TRADE

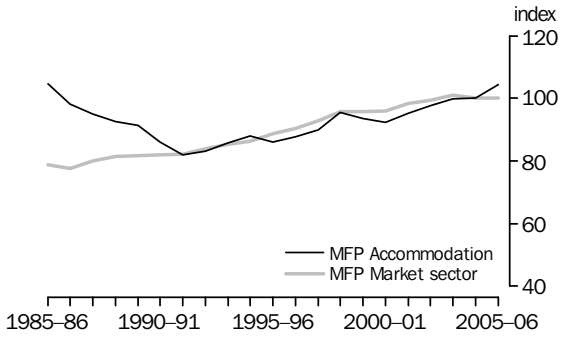


2.8 RETAIL TRADE

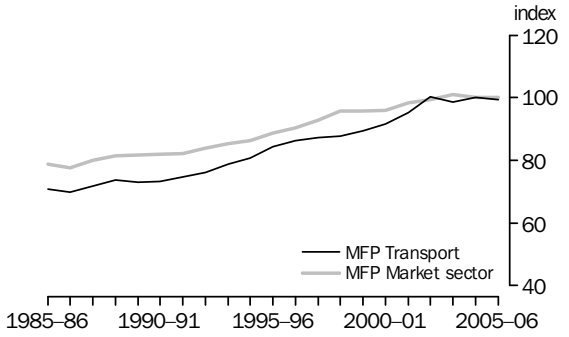


Value added based MFP for the market sector industries (2004–05 = 100) continued

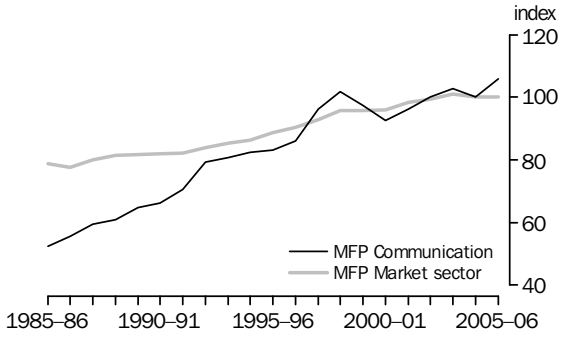
2.9 ACCOMMODATION, CAFES & RESTAURANTS



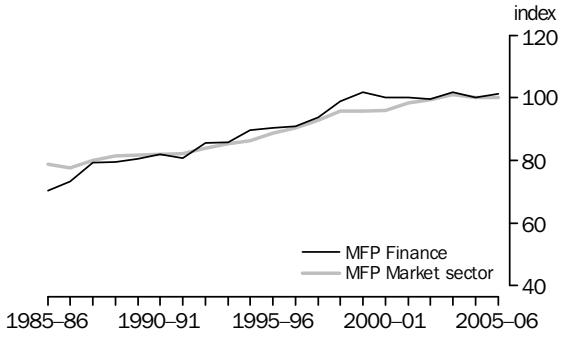
2.10 TRANSPORT & STORAGE



2.11 COMMUNICATION SERVICES

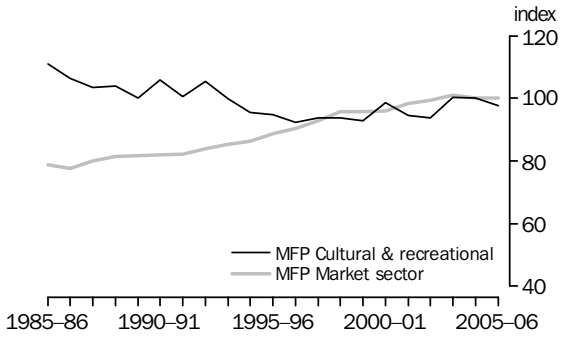


2.12 FINANCE & INSURANCE



Value added based MFP for the market sector industries (2004–05 = 100) continued

2.13 CULTURAL & RECREATIONAL SERVICES



COMPARISON BETWEEN VALUE ADDED BASED MFP AND GROSS OUTPUT BASED MFP

Table 2.14 presents a comparison between gross output based MFP growth and value added based MFP growth. The conceptual differences between the two sets of estimates are discussed in Chapter 1. The table shows gross output based MFP growth tends to be flatter, which is to be expected because of the relationship between value added and gross output.

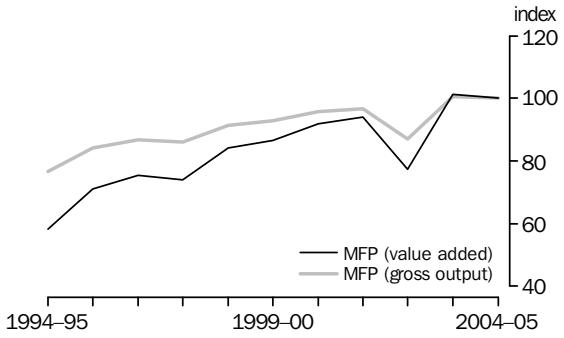
2.14 COMPOUND ANNUAL PERCENTAGE CHANGE IN GROSS OUTPUT AND VALUE ADDED BASED MFP, Market sector industries

	MFP (VALUE ADDED)			MFP (GROSS OUTPUT)		
	1994–95 to 1999–00	*1999–00 to 2004–05*	*1994–95 to 2004–05*	*1994–95 to 1999–00*	*1999–00 to 2004–05*	*1994–95 to 2004–05*
Agriculture, forestry & fishing	8.2	2.9	5.5	3.9	1.5	2.7
Mining	0.6	–2.1	–0.8	0.3	–1.2	–0.5
Manufacturing	0.9	0.9	0.9	0.4	0.3	0.3
Electricity, gas & water	1.4	–2.6	–0.6	0.9	–1.4	–0.3
Construction	2.5	1.3	1.9	0.7	0.5	0.6
Wholesale trade	3.1	1.9	2.5	1.4	0.8	1.1
Retail trade	2.3	1.2	1.7	1.1	0.6	0.8
Accommodation, cafes & restaurants	1.2	1.4	1.3	0.7	0.5	0.6
Transport & storage	2.1	2.2	2.2	0.8	1.1	1.0
Communication services	3.4	0.5	1.9	1.8	0.3	1.1
Finance & insurance	2.6	–0.4	1.1	1.9	–0.1	0.9
Cultural & recreational services	–0.6	1.5	0.5	–0.1	0.9	0.4

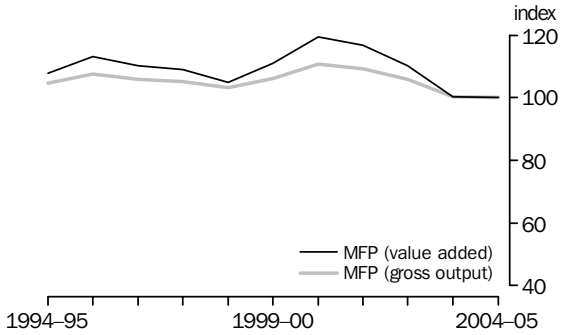
Figures 2.15 to 2.26 show the pattern of value added and gross output MFP growth across the various market sector industries is similar, although the magnitude of growth differs. This indicates that the analysis underlying the estimates, which is presented in the industry chapters, will be applicable to both sets of MFP estimates.

MFP for the market sector industries (2004–05 = 100)

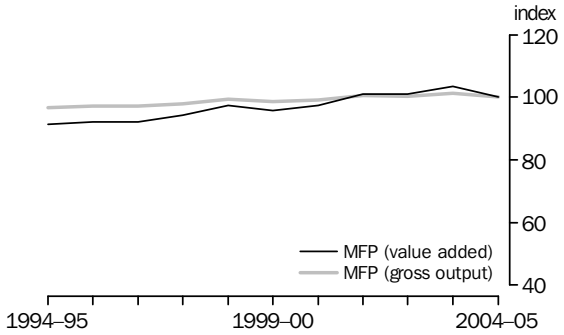
2.15 AGRICULTURE, FORESTRY & FISHING



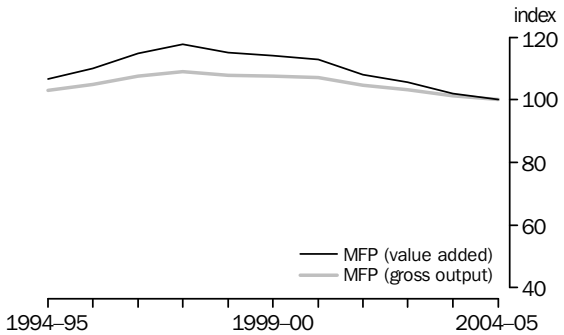
2.16 MINING



2.17 MANUFACTURING

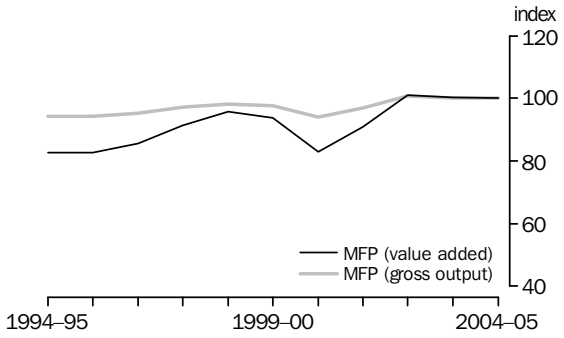


2.18 ELECTRICITY, GAS & WATER

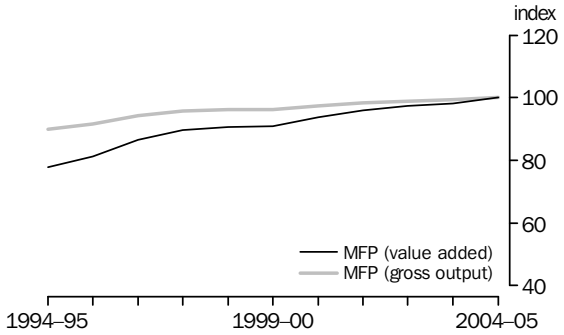


MFP for the market sector industries (2004–05 = 100) continued

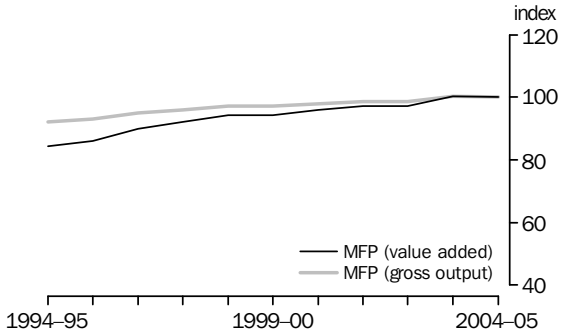
2.19 CONSTRUCTION



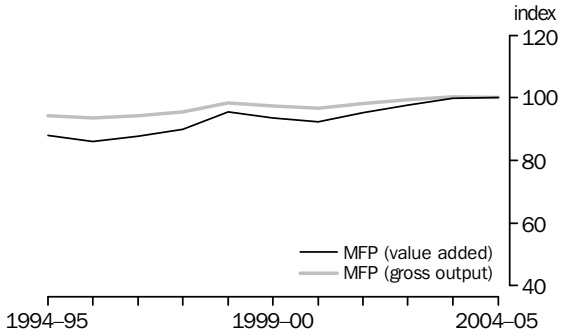
2.20 WHOLESALE TRADE



2.21 RETAIL TRADE

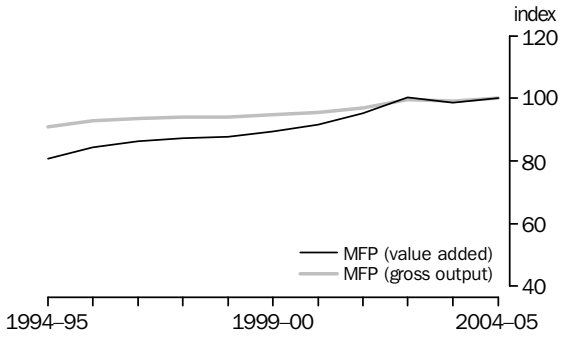


2.22 ACCOMMODATION, CAFES & RESTAURANTS

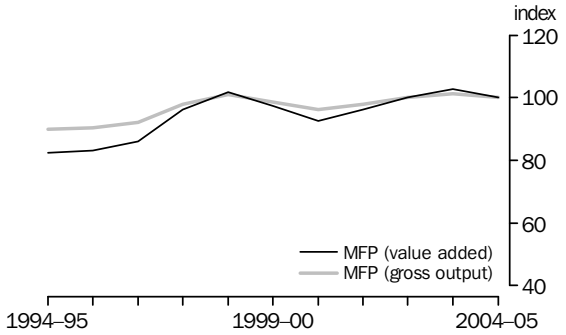


MFP for the market sector industries (2004–05 = 100) continued

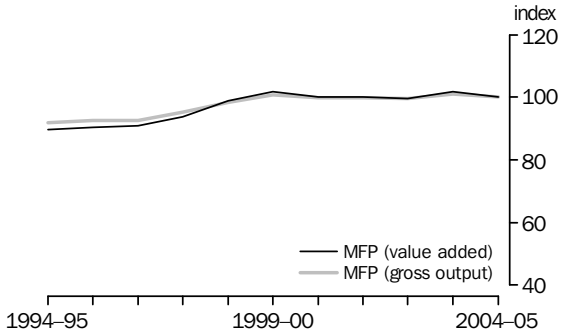
2.23 TRANSPORT & STORAGE



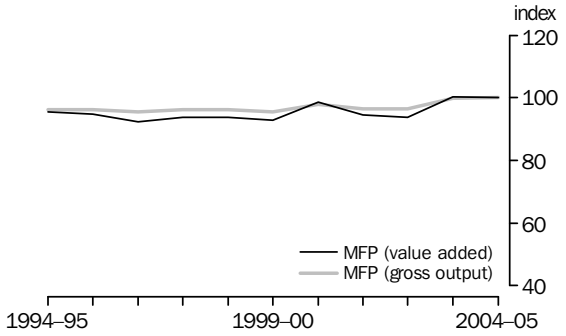
2.24 COMMUNICATION SERVICES



2.25 FINANCE & INSURANCE



2.26 CULTURAL & RECREATIONAL SERVICES



GROWTH ACCOUNTING

Value added

Table 2.27 presents a growth accounting analysis for the market sector industries for the period 1985–86 to 2005–06, that is, the contributions to value added growth from growth in MFP and growth in inputs. The table shows that for Agriculture, forestry & fishing and Electricity, gas & water MFP growth was the largest contributor to their value added growth. To a lesser extent MFP growth was a significant contributor to value added growth in Wholesale trade, Transport & storage and Communication services.

For Mining, growth in capital services was the biggest contributor to its value added growth. Capital services contributed positively to value added growth in all industries. While for Cultural & recreational services, Accommodation, cafes & restaurants, Retail trade and Construction, hours worked was the biggest contributor to value added growth.

2.27 GROWTH ACCOUNTING ANALYSIS, Contributions to value added growth—1985–86 to 2005–06

	Value added	*Capital services*	*Hours worked*	*MFP*
	%	% pts	% pts	% pts
Agriculture, forestry & fishing	2.6	0.2	–0.6	3.0
Mining	3.5	3.0	0.4	0.2
Manufacturing	1.7	1.1	–0.1	0.7
Electricity, gas & water	2.0	1.2	–0.6	1.4
Construction	3.9	1.0	2.3	0.7
Wholesale trade	3.6	1.5	0.5	1.5
Retail trade	3.1	1.1	1.3	0.7
Accommodation, cafes & restaurants	3.8	1.4	2.5	—
Transport & storage	3.7	1.1	0.8	1.7
Communication services	7.7	3.6	0.5	3.6
Finance & insurance	4.6	1.9	0.9	1.8
Cultural & recreational services	3.2	1.7	2.2	–0.6
Market sector	**3.3**	**1.4**	**0.7**	**1.2**

— nil or rounded to zero (including null cells)

Note: Contributions may not add due to rounding.

Gross output

The contributions to growth in gross output from growth in MFP and growth in inputs are presented in table 2.28 and are for the period 1994–95 to 2004–05. Agriculture, forestry & fishing showed the highest relative contribution to output growth from MFP. Other industries with relatively high contributions to output growth from MFP were Wholesale trade, Retail trade and Transport & storage. The capital services contribution to growth in gross output for Mining was much stronger than in any other industry. Accommodation, cafes & restaurants and Retail trade had the strongest contributions of hours worked growth to gross output growth. With the exceptions of Agriculture, forestry & fishing and Mining, intermediate inputs contributed the most to the industries' growth in gross output.

Gross output continued

2.28 GROWTH ACCOUNTING ANALYSIS, Contributions to gross output growth—1994–95 to 2004–05

	Gross output growth	*Capital services*	*Hours worked*	*Intermediate inputs*	*MFP*
	% pts	% pts	% pts	% pts	% pts
Agriculture, forestry & fishing	4.8	0.1	–0.3	2.1	2.7
Mining	2.4	1.8	0.2	1.0	–0.5
Manufacturing	1.6	0.5	–0.1	1.0	0.3
Electricity, gas & water	1.7	1.0	—	1.1	–0.3
Construction	5.5	0.3	0.7	3.9	0.6
Wholesale trade	4.0	0.7	—	2.3	1.1
Retail trade	3.8	0.6	0.6	1.7	0.8
Accommodation, cafes & restaurants	4.2	0.5	0.8	2.2	0.6
Transport & storage	4.4	0.5	0.4	2.6	1.0
Communication services	6.6	2.1	0.4	3.2	1.1
Finance & insurance	5.2	1.3	0.5	2.5	0.9
Cultural & recreational services	4.2	0.7	0.6	2.5	0.4

— nil or rounded to zero (including null cells)

Note: Contributions may not add due to rounding.

INCOME SHARES

Value added based

Table 2.29 presents capital income and labour income shares for the three years, 1985–86, 1995–96 and 2005–06. In Electricity, gas & water, Construction and Finance & insurance there were significant increases in capital income shares between 1985–86 and 2005–06. Between 1995–96 and 2005–06 Mining and Accommodation, cafes & restaurants also had strong increases in their capital income shares. Manufacturing, Retail trade and Wholesale trade capital and labour income shares remained relatively stable across the three years.

2.29 CAPITAL AND LABOUR INCOME SHARE OF VALUE ADDED

	CAPITAL			LABOUR		
	1985–86	*1995–96*	*2005–06*	*1985–86*	*1995–96*	*2005–06*
	%	%	%	%	%	%
Agriculture, forestry & fishing	65	59	62	35	41	38
Mining	70	71	81	30	29	19
Manufacturing	37	37	38	63	63	62
Electricity, gas & water	51	69	69	49	31	31
Construction	16	23	32	84	77	68
Wholesale trade	35	34	37	65	66	63
Retail trade	23	28	24	77	72	76
Accommodation, cafes & restaurants	24	25	30	76	75	70
Transport & storage	35	39	39	65	61	61
Communication services	49	60	61	51	40	39
Finance & insurance	19	36	50	81	64	50
Cultural & recreational services	30	27	32	70	73	68
Market sector	**38**	**40**	**44**	**62**	**60**	**56**

COST SHARES

Gross output based

For gross output based estimates of MFP it is more relevant to use cost shares, albeit with the absolute values remaining the same for capital and labour. Much of the pattern experienced in the income shares is repeated for the gross output cost shares.

Table 2.30 shows the capital, labour and intermediate inputs cost shares for gross output for 1994–95 and 2004–05. Over the last decade Mining and Finance & insurance both had their capital cost share increase by more than 10 percentage points, with their labour and intermediate inputs cost shares both falling. Between 1994–95 and 2004–05, Wholesale trade had the largest labour cost share increase. Manufacturing and Electricity, gas & water had the highest increase in their intermediate input cost shares for the same period.

2.30 CAPITAL, LABOUR AND INTERMEDIATE INPUTS COST SHARES OF GROSS OUTPUT

	CAPITAL		LABOUR		INTERMEDIATE INPUTS	
	1994–95	*2004–05*	*1994–95*	*2004–05*	*1994–95*	*2004–05*
	%	%	%	%	%	%
Agriculture, forestry & fishing	29	35	19	21	52	44
Mining	40	52	16	12	43	36
Manufacturing	15	14	26	22	59	64
Electricity, gas & water	40	38	18	17	42	46
Construction	6	10	22	21	71	70
Wholesale trade	15	17	29	28	56	55
Retail trade	13	12	34	39	53	49
Accommodation, cafes & restaurants	11	15	34	35	55	50
Transport & storage	16	15	25	24	59	61
Communication services	33	32	22	20	45	47
Finance & insurance	22	33	40	34	37	33
Cultural & recreational services	10	14	28	29	62	58

OUTLINE OF THE INDUSTRY CHAPTERS

The following chapters provide productivity results and analyses for each market sector industry. The industry analyses are structured around the following topics:

- Outline – provides a brief overview on the size of the industry and some general industry specific issues
- Productivity – examines labour productivity, capital productivity and MFP growth trends
- Output – examines value added and gross output estimates
- Labour inputs – presents hours worked with some discussion on the composition of industry employment. Some industry specific issues associated with labour are also examined
- Capital inputs – presents capital services with some analysis on the productive capital stock and rental prices
- Income shares – highlights changes to the capital and labour income shares.

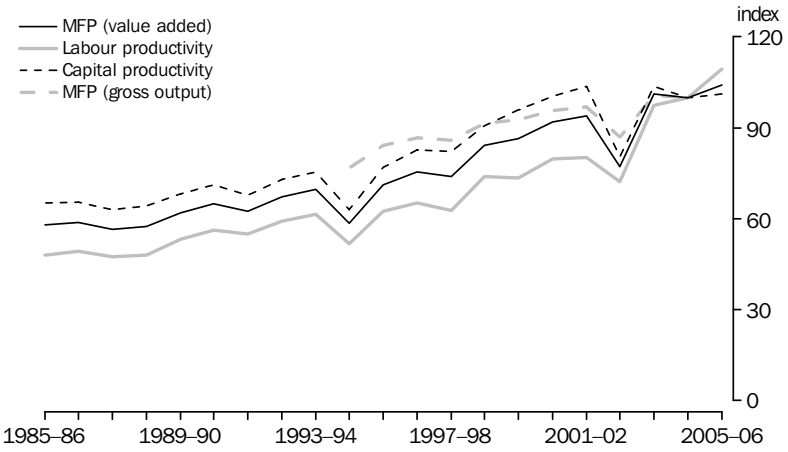
CHAPTER 3 AGRICULTURE, FORESTRY AND FISHING

The Agriculture, forestry & fishing industry contributes around 3% to GDP. Historically, the contribution of this industry to the Australian economy has been trending down, though the absolute size of the industry continues to grow. The industry is dominated by agriculture, with forestry and fishing making up only around 10% of industry output.

PRODUCTIVITY

Figure 3.1 presents indexes of labour productivity, capital productivity and MFP between 1985–86 and 2005–06. MFP has steadily increased in the Agriculture, forestry & fishing industry over the last 20 years. Average annual MFP growth on a value added basis over this period was around 3% per year, which was far stronger than average annual MFP growth for the market sector of 1.2% per year. However, there are some notable exceptions to this trend growth over the last 20 years, with productivity falling in a number of years, most notably in 1994–95 and in 2002–03.

3.1 AGRICULTURAL MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)



Given agriculture's susceptibility to variations in rainfall, it is not surprising that the story of Australian droughts manifests itself strongly in the labour productivity and MFP data presented in this chapter. Indeed, the marked falls in the various productivity measures in 1994–95 and 2002–03 relate directly to the droughts that occurred at those times.

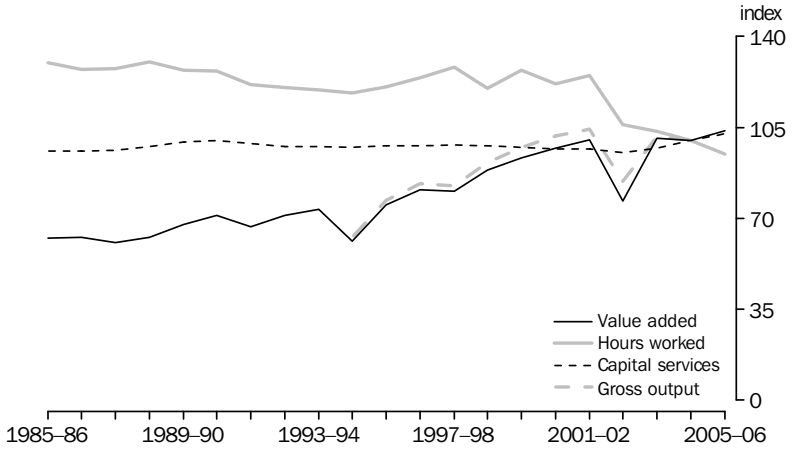
OUTPUT

Value added for this industry has been trending upward, although this has been volatile (figure 3.2). The reason for this volatility is mainly due to variations in the weather. The impact of drought is evident for both the value added and gross output series. The drought in 1994–95 affected cropping production across much of eastern and southern Australia. Some parts of Queensland and northern New South Wales experienced difficult

OUTPUT *continued*

conditions in the four years prior to 1994–95 and were already recording low levels of output. In 1994–95, the volume of farm output fell by around 20% (ABS 2006a).

3.2 AGRICULTURE FORESTRY & FISHING OUTPUTS AND INPUTS (2004-05 = 100)



Eight years later, the 2002–03 drought was regarded as the most widespread since the 1982–83 drought. The volume of output from grain crops fell by over 50%, which considerably lowered total output from the industry. The fall in total volume of farm output from the 2002–03 drought was around 26%, which was greater than the decline during the 1994–95 drought (ABS 2006a).

As Figure 3.2 highlights, these droughts brought about significant declines in gross output and value added in 1994–95 and in 2002–03. However, there was an immediate recovery in output following both periods.

LABOUR INPUTS

Figure 3.2 presents the labour input measure used to calculate the productivity measures in Figure 3.1. The most notable aspect is the difference in the response of the labour input index (total hours worked) to the two droughts. In 1994–95, there was a negligible change in total hours worked, which suggests that there was little labour shedding at the time. However, in 2002–03, total hours worked fell significantly. Moreover, unlike output, total hours worked did not recover in the period immediately after the 2002–03 drought. In fact, total hours worked continued to decline, albeit at a reduced rate. It appears this decline in total hours worked is largely responsible for the strength of the recovery in labour productivity and MFP in 2003–04 evident in Figure 3.1.

Perhaps the simplest explanation relates to the broader economic conditions of the time. In 2002–03, Australia's unemployment rate was significantly lower than in 1995–96. Workers in the agriculture sector may have been more easily able to find work in other sectors in 2002–03 – especially given the growing demand for similar types of labour in other industries such as Construction, Mining and Transport & storage. As a consequence, typically mobile agricultural workers may have been less inclined to accept any reduction in income from working in a temporarily depressed agricultural industry and, instead, have shifted to the booming construction and mining industries.

LABOUR INPUTS *continued*

The decline in employment in 2002–03 occurred in all four employment types (figure 3.3). The biggest fall was in employees, which was against trend. The self employed farmers also declined faster in 2002–03, but it had been trending down for some time.

3.3 AGRICULTURE, FORESTRY & FISHING STATUS IN EMPLOYMENT

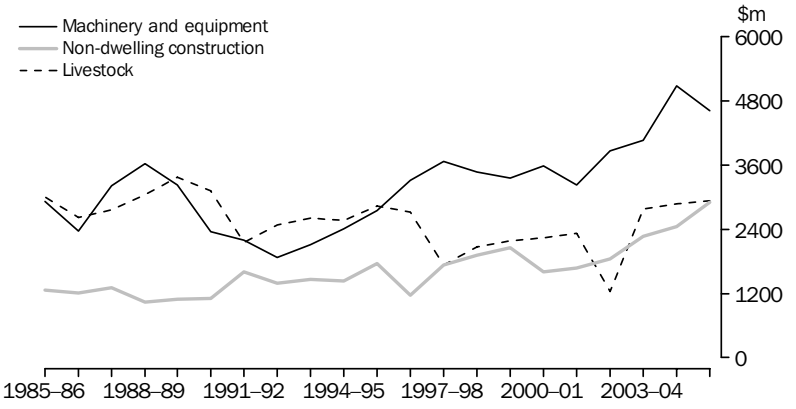
Source: - Labour Force, Australia, Detailed, Quarterly, Feb 2007 (Cat. no. 6291.0.55.003).

CAPITAL INPUTS

The 2002–03 drought also appears to have been something of a catalyst for structural change in the input mix. While total hours worked was falling at unprecedented rates, average annual growth in capital services over the three years following the 2002–03 drought was greater than in any previous year. This suggests that the 2002–03 drought, coupled with an increasingly competitive labour market, may have prompted firms to substitute labour with new capital.

Figure 3.4 further supports the proposition that capital formation was a feature of the industry in the years following the 2002–03 drought. Gross fixed capital formation in the years following the 2002–03 drought was unusually high. While new investment in livestock was a notable feature of this upturn, it was also concentrated in machinery and equipment and there was a continued upward trend from before the drought in non-dwelling construction.

3.4 AGRICULTURE, FORESTRY & FISHERIES GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)



(a) Reference year for chain volume measures is 2004-05.

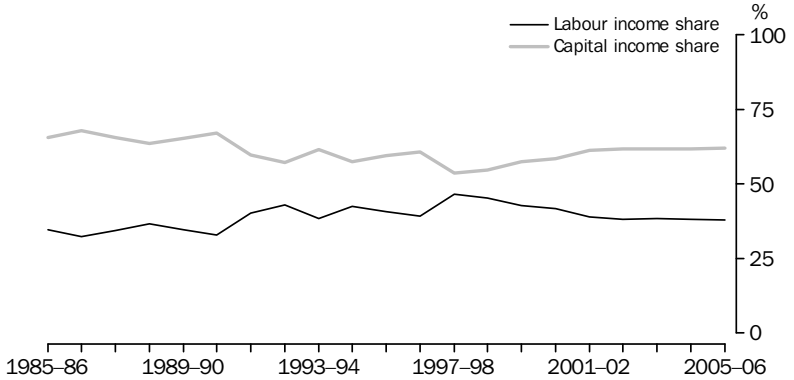
INCOME SHARES

Figure 3.5 demonstrates that there was also an increasing capital share of income from the late 1990s onwards. The increasing income share of capital meant that capital was weighted as an increasingly important component of the input. This, coupled with the greater flow of capital services relative to labour inputs (figure 3.2), meant that there was a significant increase in the input index over the last few years.

The Agriculture, forestry & fishing industry has a notable complication in the calculation of the capital and labour shares of income because it has such a large unincorporated sector. Unincorporated enterprises contribute a significant proportion of the industry's income. The complication arises because it is unclear how income from this sector as measured by gross mixed income (GMI) should be attributed between a return to labour and a return to capital. This has been done by estimating implicit labour and capital income using average compensation per hour received by wage and salary earners and the corporate rental price respectively. For more details see *Australian System of National Accounts: Concepts Sources and Methods*, (cat. no. 5216.0) and Appendix 1.

There is a further complication in the calculation of the capital services index that is of particular relevance to the Agriculture, forestry & fishing industry. This complication arises because of the dominance of land as an asset in the productive capital stock for the industry. The appendix at the end of this chapter details how land can complicate the calculation of the capital services index (and observed MFP) in the Agriculture, forestry & fishing industry.

3.5 AGRICULTURE, FORESTRY & FISHING LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

MFP estimates for the Agriculture, forestry & fishing industry are heavily influenced by weather patterns. Despite this volatility, average annual MFP growth for the industry has been higher than the market sector as whole. Following 2002–03 there appears to be a structural change in the input mix where total hours worked declined more rapidly while capital services grew.

APPENDIX: *Implications of land on Agriculture*

A more intricate statistical issue is embedded within the capital story of this industry. Land is a significant component of the capital stock in the Agriculture, forestry and fishing industry, averaging around 60% of total net capital stock. This has an important implication for the calculation of capital services in this industry. This is because the

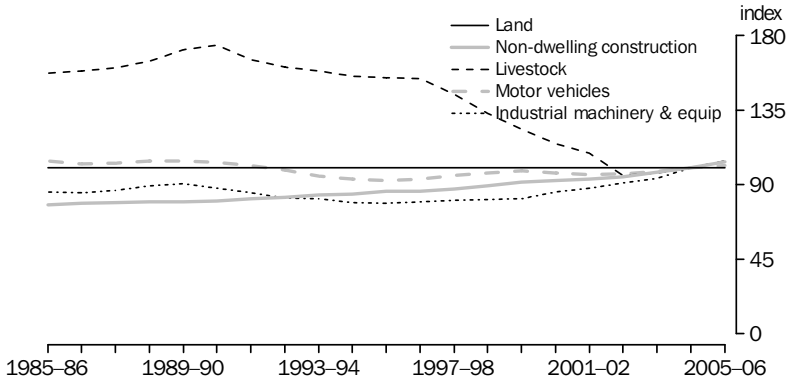
Implications of land on Agriculture continued

productive capital stock volumes multiplied by their rental price are used to form the rental price weights for each asset.

This would pass without comment were it not for the dominance of the land in the productive capital stock and the necessity for occasionally constraining rental prices on this asset type in the calculation of capital services. An exogenous constraint is occasionally necessary because the annual endogenous calculation of rental prices on land sometimes results in a negative number. In these years, the rental price on land is constrained to 0.001 – an insignificantly small number to ensure that rental prices are always positive. Positive rental prices are required to form positive weights.

The weighting of different assets in the calculation of capital services varies based on the rental value of those assets. Given that the stock of land is very large and constant through time, that is, zero growth in the productive capital stock of land (figure 3.6), there will be very little change in the capital services indicator during normal periods when rents from land are sufficiently greater than zero. However, during periods of downturn, the rental price on land may approach zero and hence services flowing from other assets will make up a greater proportion of the capital services index. If there is a notable change in these other asset types (for instance, the accumulation of livestock or equipment), then the change in capital services as a whole will be more pronounced than if the rental price on land were normal. Further, it is unlikely that the assumption that the productive stock of land is unchanging over time holds true due to unmeasureed quality improvements to the land.

3.6 AGRICULTURE, FORESTRY & FISHING PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)

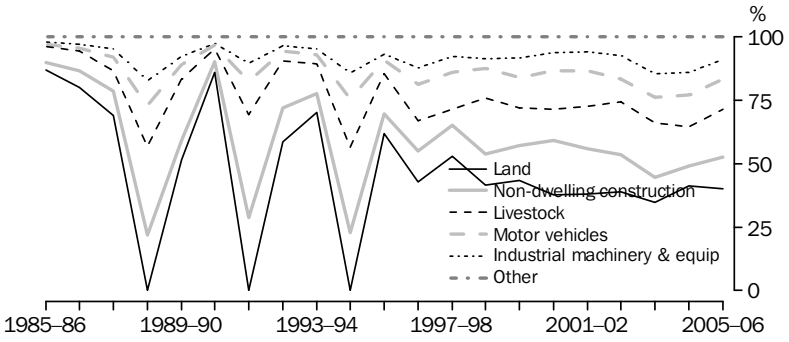


This variation in the importance of the land has implications for the reported MFP estimates. For instance, during periods where rental prices on land are very low and where there is a greater than normal accumulation of other types of assets, the growth in the capital services index will be larger than had the rental price on land been sufficient for land to dominate the indicator (figure 3.7). This will mean that the combined input index will also be larger than otherwise and that MFP will be reported as less than otherwise. Conversely, the dominance of the land in the stock of capital also means that during periods when normal land rents are occurring and greater than normal accumulation of other asset types (such as machinery and livestock), the growth in

Implications of land on Agriculture continued

capital services will be more muted. In turn, any change in MFP as a result of a change in output (from the application of the new capital) will be more pronounced.

3.7 AGRICULTURE, FORESTRY & FISHING RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

Gross mixed income

As noted, the estimation of capital and labour shares of income is complicated in the Agriculture, forestry & fishing industry by the large unincorporated sector. This sector's output is measured as a combination of income from capital and labour (gross mixed income) and must be split into its two components to create factor shares of income.

The exogenous constraint on the rental price of land outlined above has an implication in the calculation of the capital rent component of gross mixed income. When the rental price is constrained, the capital share of income will be higher than otherwise (because capital income from the unincorporated sector will not decline linearly with GOS when a non-negativity constraint is applied to rental prices). This understates the growth in the input index used to calculate MFP and, consequently, to overstate growth in MFP itself.

CHAPTER 4 MINING

The Mining industry is an important part of the Australian economy. Mining accounts for approximately 5% of GDP, although this jumped to 7.5% in 2005–06. Over the last 5 years the volume of output produced by the industry has not changed to any significant extent, even though its income has grown by more than 85%. Mining exports account for a significant proportion of Australia's total exports, around 38% in value terms in 2005–06.

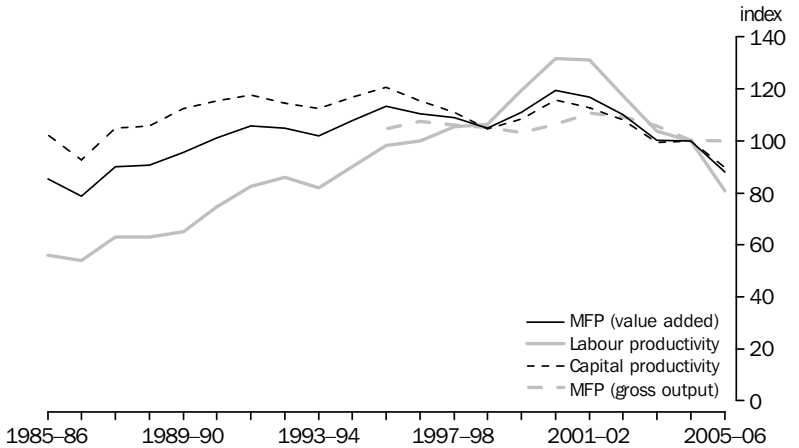
PRODUCTIVITY

The strong growth in Mining income in recent years might suggest that industry multifactor productivity (MFP) is also growing strongly. However, the estimates indicate otherwise. MFP, capital productivity and labour productivity indexes for this industry have been in decline since their last peak in 2000–01 (figure 4.1). Figure 4.1 shows the gross output based measure of MFP following a similar pattern to the value added based measure of MFP. The figure shows that the decline in MFP since 2000–01 using gross output is slower than the value added based measure of MFP. This is due to the relationship between gross output and value added that was discussed in Chapter 1.

Value added based MFP for Mining grew by 0.2% per year between 1985–86 and 2005–06, which is slower than market sector MFP growth for this period. However, as noted MFP growth for Mining has been negative since 2000–01. For the period prior to 2000–01 MFP growth for Mining was faster than market sector MFP growth.

The strong prices for commodities may have meant that less productive mines have become economically viable. The opening of these mines would reduce the average productivity of the industry.

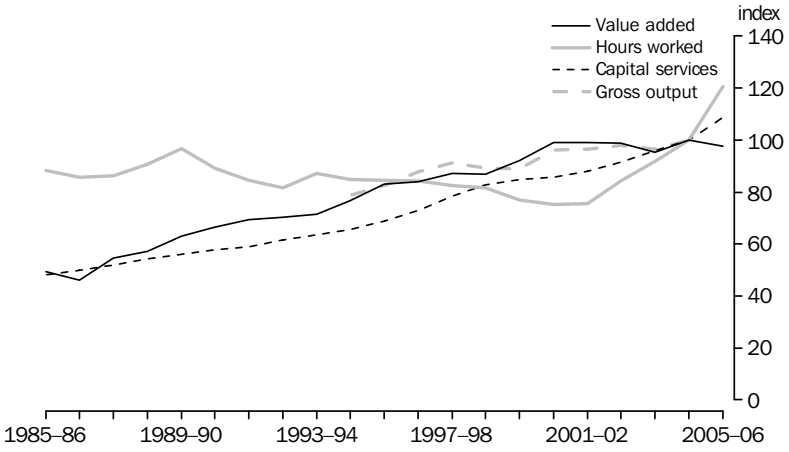
4.1 MINING MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)



OUTPUT

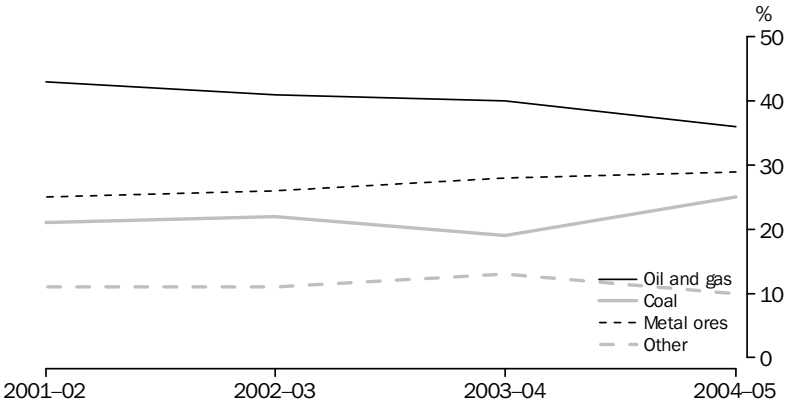
Figure 4.2 shows the growth in value added for Mining. The chart shows that between 1985–86 and 2000–01, value added in volume terms had steady upward growth. From 2000–01 though, there was no growth for value added in volume terms. Figure 4.2 also shows gross output for Mining, which shows a similar pattern to value added, although there are some minor differences.

4.2 MINING OUTPUTS AND INPUTS, (2004-05 = 100)



The low growth in value added since 2000–01 is associated with compositional change within the industry. While there was a decline in the output of oil and gas there was a strong increase in the production of other minerals. Figure 4.3 shows Mining subdivision shares of current price value added reflecting these compositional shifts in output.

4.3 MINING CURRENT PRICE VALUE ADDED SHARES BY SUBDIVISION



Source: ABS 2006b, Mining Operations, Australia, 2004-05 (cat. no. 8415.0).

The production volumes of crude oil and condensate have been falling from around 2000–01. The main reason for this drop in volumes is due to depletion of the mature oil fields in the Gippsland basin and the Timor Sea (ABARE 2003). In addition, during 2005–06 the disruption by cyclones in the Northwest Shelf was also a contributor to the decline in oil production (ABARE 2006). The effect is significant, as oil and gas has

OUTPUT *continued*

contributed up to 43% of industry value added (ABS 2006b). However, this proportion has been falling since 2001–02, to 36% in 2004–05.

The reason that oil and gas has a significant proportion of industry value added relative to output is because of its relatively low intermediate usage. Oil and gas uses around 10% of the industry's intermediate inputs, but it generates between 25 to 30% of Mining's gross output.

One other possibility that may be constraining output growth is upstream and downstream production bottlenecks. One possible downstream constraint on output growth is port capacity. If ores cannot be exported out of the country, then mines may not extract the ore out of the ground because of limited storage facilities at ports. While intermediate products are not an output issue, the availability of replacement parts may be an upstream factor constraining output growth. For instance, large truck tyres are in short supply globally (Treasury 2005).

LABOUR INPUTS

The increase in total hours worked has also contributed to the decline in MFP since the beginning of this decade. Total hours worked have increased on average almost 10% per year since 2000–01, with an increase of over 20% in 2005–06. This growth in hours worked has been generated by a significant growth in employment in the industry. These new workers may not be as productive as incumbent workers and their output could be lower. Hence, measured productivity might also be lower.

There is a possibility that a high proportion of these additional employees are involved in the construction of new mines, or extending existing ones, rather than in mining type activity. The strong growth in the non-dwelling construction component of gross fixed capital formation in respect of the Mining industry would tend to support this hypothesis. It can be difficult to adequately capture this type of activity in the output measures.

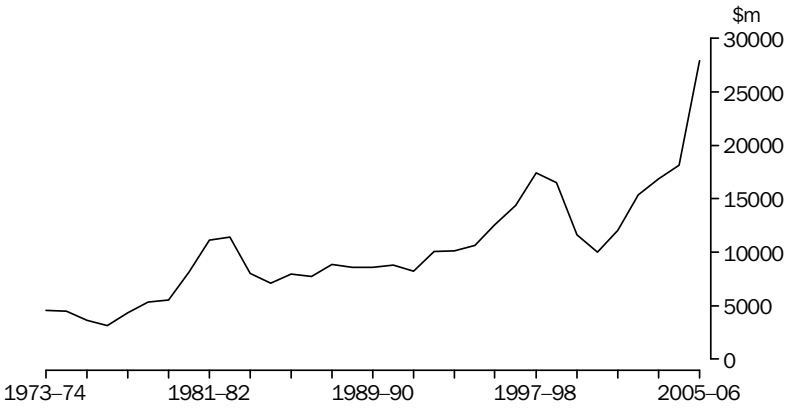
CAPITAL INPUTS

The significant increases in income for the Mining industry might be expected to flow through to increased investment in order to exploit the returns available. This expectation seems to be reflected in the gross fixed capital formation (GFCF) estimates for the industry (figure 4.4). Figure 4.4 also shows this pattern occurring around the mining boom of the late 1970s, where a significant rise in investment occurred in the early 1980s.

CAPITAL INPUTS

continued

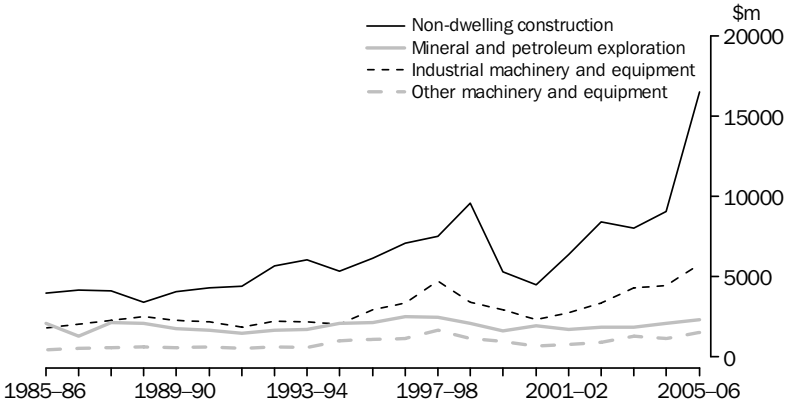
4.4 MINING GROSS FIXED CAPITAL FORMATION, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

The slowdown in the growth in capital services in 1999–00 was due to a significant fall in investment (GFCF) in that year. However, it has since rebounded, although in volume terms this rebound seems to have returned the series to the trend growth rate that occurred over the 1990s (see figure 4.2). The volume of investment jumped significantly in 2005–06, especially in non-dwelling construction (figure 4.5).

4.5 MINING GROSS FIXED CAPITAL FORMATION, BY ASSET, Chain volume measures (a)



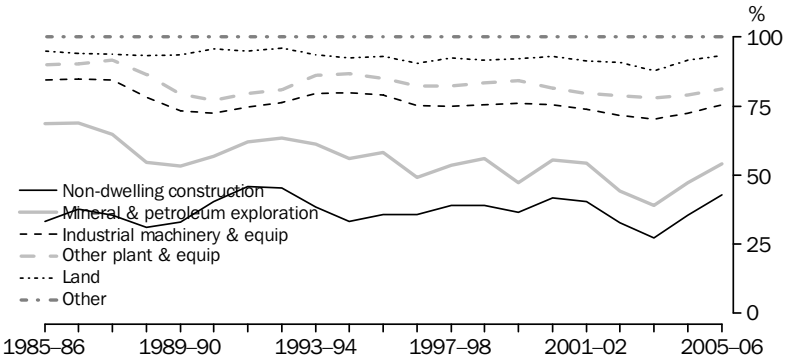
(a) Reference year for chain volume measures is 2004-05.

In the last few years the two assets with the fastest growth in GFCF, non-dwelling construction and industrial machinery, also increased their contribution to capital services, which is a product of the rental price weights in figure 4.6 and the growth in the productive capital stock in figure 4.7.

CAPITAL INPUTS

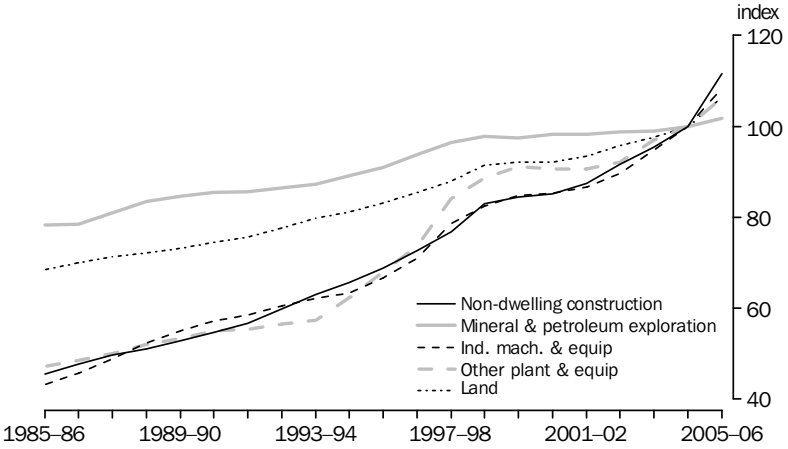
continued

4.6 MINING RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

4.7 MINING PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)



The changes in the industry composition discussed above may also indicate that the capital-labour mix required has changed. Figure 4.8 shows a move from more capital intensive (oil and gas) to more labour intensive activities. Despite the changes to the capital-labour ratio, Mining remains a very capital intensive industry, and has one of the highest levels of capital to labour of any Australian industry at $1.35 million of net capital stock per person employed in 2005–06. This is also reflected in the fact that capital's share of income is on average 70%, although in recent years this has risen to 80%.

CAPITAL INPUTS

continued

4.8 MINING CAPITAL-LABOUR RATIO, (2004-05 = 100)

The capital-labour ratio is defined as the ratio of capital services to hours worked.

There are a number of issues to consider when examining how the changes in capital impact on the MFP estimates. For instance, while investment has been increasing in recent years it may be that there is a lag preceding the use of the asset in production. This may be another reason that might explain the slowdown in productivity. Another possible issue with capital services measurement is that the fall in oil production is not mirrored by a fall in the associated capital services. That is, the current capital services measure assumes that oil rigs are operating at a constant level of capacity even though this level of capacity utilisation may be falling, given declining oil and gas volumes. See the appendix at the end of this chapter for more details.

Two further issues to consider when examining capital services for Mining are the scope of assets and the treatment of mineral exploration. Subsoil assets are not included in the capital services measure for Mining at present and further work in this area is required. The second issue is the treatment of the efficiency decline for mineral exploration. The ABS treatment is such that it is assumed that there is no decline in the efficiency of mineral exploration, that is, the asset delivers the same level of capital service throughout its life. The assumption is that there is no decline in exploration knowledge or obsolescence. If the efficiency of exploration knowledge did decline over time then the growth in capital services would be slower than is currently measured. This is because there would be less capital services being delivered to the owner from mineral exploration.

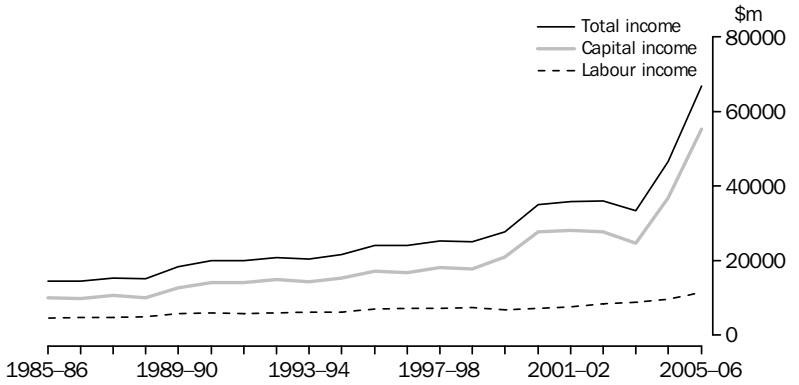
INCOME SHARES

During the last five years the prices paid for Mining outputs have grown strongly, due to the so-called 'commodity price boom' (RBA 2005). This strong growth in prices is reflected in the strong growth in the profits of the Mining industry as recorded in the gross operating surplus estimates published in the *Australian System of National Accounts* (cat. no. 5204.0) and is evident in figure 4.9.

INCOME SHARES

continued

4.9 MINING LABOUR AND CAPITAL INCOME



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

Even with the increases in employment, the labour income share for Mining has continued its decline since the late 1990s (figure 4.10). However, investment volumes also increased rapidly at the same time as labour inputs, and as such any change in the labour income share has only a minimal impact on MFP estimates. This is because growth in labour contributes around 20% to growth in total inputs.

4.10 MINING LABOUR AND CAPITAL INCOME SHARES

Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

There is no necessary reason why Mining MFP should have increased because incomes have increased. The evidence points to MFP declining or having very little growth. There was no growth in output accompanying the growth in both inputs. There is also the possibility that lags in new investment becoming productive is part of the reason why productivity is declining, but this requires further investigation.

A number of measurement issues need further research and should be taken into consideration when interpreting the Mining productivity estimates. These areas include capacity utilisation and the impact of possible compositional changes.

SUMMARY *continued*

There are also two other areas for further research that may improve the estimates. The first is examining the scope of assets, primarily as subsoil assets are not included in the capital services measure for Mining. The other issue that requires further investigation relates to the possibility that the full extent of the construction activity, that is mine development, is not being fully captured in the output estimates of the industry.

APPENDIX:

Capital measurement issues

Investment in the Mining industry has been increasing in recent years. However, there may be a lag until there is any subsequent increase in production. This may be a reason that might explain the slowdown in productivity. That is, inputs are growing but without any growth in output.

In the process of constructing the mine, the company's expenditure is recorded as gross fixed capital formation, which forms part of the industry's productive capital stock. The assumption for measuring MFP is that the rate of capacity utilisation is assumed to remain relatively constant in production. This would not be the case until the building of the mine has finished. What this means for productivity measurement is that growth in capital services may be overstated during periods of strong investment growth, and MFP growth understated. The issue of capacity utilisation in the Mining industry is an area for further research.

Another possible issue with capital services measurement is that the observed fall in oil production may also change the rate of capacity utilisation. That is, the current capital services measure assumes that oil rigs are operating at a constant rate of capacity utilisation even though this rate may be declining, given oil field maturity. This would affect measured productivity because the capital services inputs are not adjusted to take into account any changes in the rate of capacity utilisation of assets, hence growth in capital services is being overestimated while MFP growth is underestimated. At the same time this assumes that these assets have not been fully depreciated or retired out of the perpetual inventory model. However, the converse may be the case; that is, oil rigs in use in the 1960s may be providing capital services, if they are still in use, but they may have been retired out of the model. Thus the overall measurement effect is unclear. The extent that the oil production facilities were being less than fully utilised is an area for further research. Any peak-to-peak analysis is also problematic, as the Bass Strait oil fields are not likely to again be able to achieve earlier levels of capacity utilisation.

CHAPTER 5 MANUFACTURING

The Manufacturing industry has historically been the largest industry in Australia. However, the percentage contribution of Manufacturing to GDP has been decreasing over the past three decades. In the early 1970s Manufacturing value added contributed almost 25% to GDP, while in 2005–06 the Manufacturing industry contributed 11% to GDP, with the Property & business service industry being the largest, contributing 12.4% to GDP. However, the Manufacturing industry remains the largest industry in the market sector. Although the Manufacturing industry contributes less to GDP today than it did twenty years ago, output in the industry has had an upward trend over the same time period.

PRODUCTIVITY

Figure 5.1 presents indexes of labour productivity, capital productivity and MFP between 1985–86 and 2005–06. Over the period 1985–86 to 2005–06, the Manufacturing industry has experienced average annual growth in value added based multifactor productivity (MFP) of about 0.7% per year (figure 5.1), although this growth has been declining in recent years. Overall, MFP in the Manufacturing industry follows a similar trend to MFP in the market sector. Labour productivity has followed a similar pattern to MFP, with growth of 1.9% per year. Capital productivity declined by 1.2% per year between 1985–86 and 2005–06.

5.1 MANUFACTURING MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

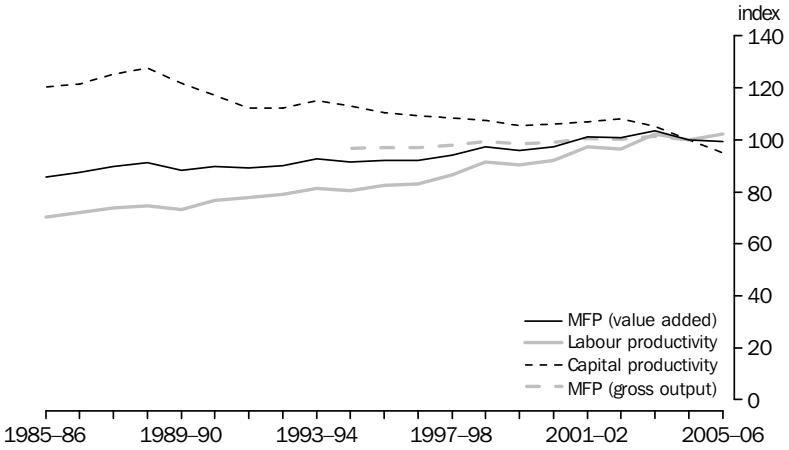


Figure 5.1 also shows the gross output based measure of MFP. As expected the figure shows that the growth in MFP using gross output is slower than the value added based measure of MFP.

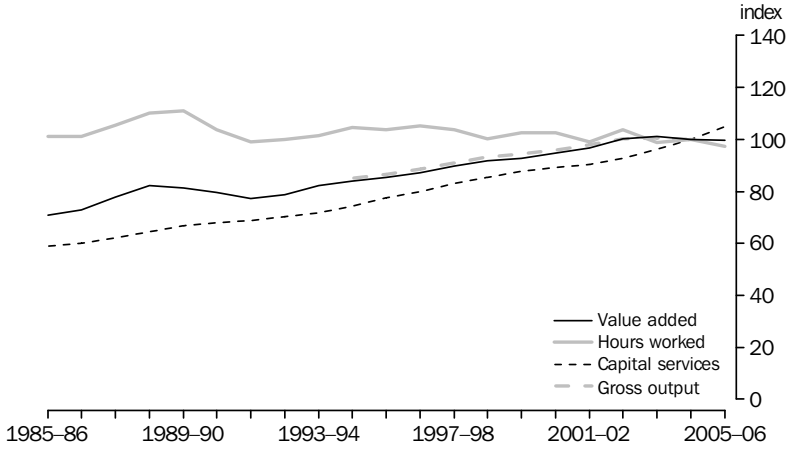
OUTPUT

Growth in Manufacturing value added is shown in figure 5.2. It shows a steady increase since the early 1990s, but has declined slightly since 2003–04.

Figure 5.2 also shows growth in gross output for Manufacturing, and it follows a similar pattern to value added, with its growth slightly slower than value added. Given the small differences between value added and gross output, the differences between the value added based MFP growth and gross output based MFP growth come from the combined inputs index, with intermediate inputs having the largest influence.

Based on current price shares of value added, Food, beverage & tobacco is the largest subdivision in the Manufacturing industry followed by the Machinery & equipment subdivision, and the Metal Products subdivision. Growth in value added for each of these subdivisions has a similar trend to the Manufacturing industry as a whole.

5.2 MANUFACTURING OUTPUTS AND INPUTS, (2004-05 = 100)



LABOUR INPUTS

Labour input as measured by hours worked (figure 5.2) has been decreasing since 1989–90. The decline in hours worked is largely due to the fact that less people are employed in the Manufacturing industry while average hours worked per employed person has been stable over the period. This is because total hours worked is estimated by multiplying average hours worked per person by total employment.

One issue to note is that a different employment series is used for the Manufacturing industry in this paper compared to previously published estimates in *Australian System of National Accounts, 2005–06* (cat.no.5204.0). The hours worked estimates published in cat. no. 5204.0 are based on employment from Manufacturing survey and census data for the years prior to 2000–01 (from 2000–01 Labour Force Survey data is used). This paper bases its hours worked series on Labour Force Survey (LFS) data for the entire series. This means that the estimates for hours worked and labour productivity in this paper are different from those published in cat. no. 5204.0. For further details see the appendix at the end of this chapter.

CAPITAL INPUTS

Capital services estimates for the Manufacturing industry have a continual upward trend for the period 1985–86 to 2005–06 (figure 5.2). The growth in capital services over the period 1985–85 to 2005–06 has been driven by the additional capital stock available for use in production.

CAPITAL INPUTS
continued

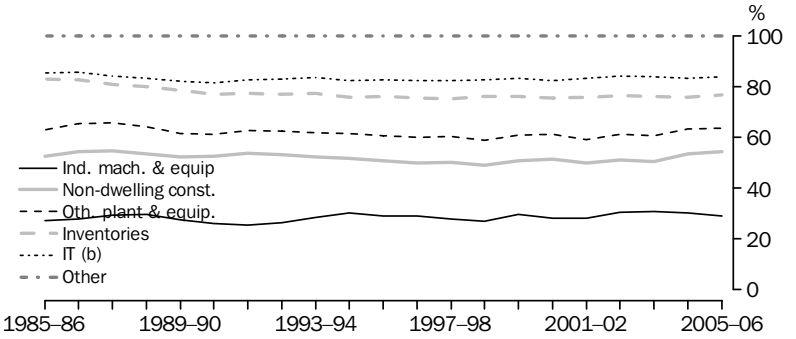
Investment (as measured by gross fixed capital formation (GFCF)) drives the increases in the productive capital stock. There were large increases in GFCF for both industrial machinery and equipment and non-dwelling construction in recent years (figure 5.3).

5.3 MANUFACTURING GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

(a) Reference year for chain volume measures is 2004-05.

The additional industrial machinery and non-dwelling construction contribute 50% in terms of rental price weights (figure 5.4). For instance, in 2005–06 these two assets contributed 3.1 percentage points to the 4.8% growth in the industry's capital services.

5.4 MANUFACTURING RENTAL PRICE WEIGHTS (a)



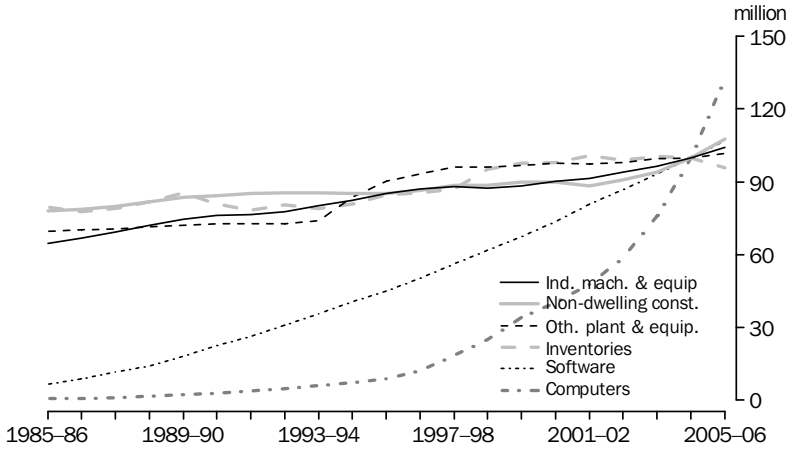
(a) Chart lines are cumulative shares.
(b) IT includes software and computers and peripherals.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

These increases in GFCF are also reflected in figure 5.5, where growth in the productive capital stock appears to have accelerated in recent years. In particular there has been a rapid rise in the productive capital stock of computers and software.

CAPITAL INPUTS

continued

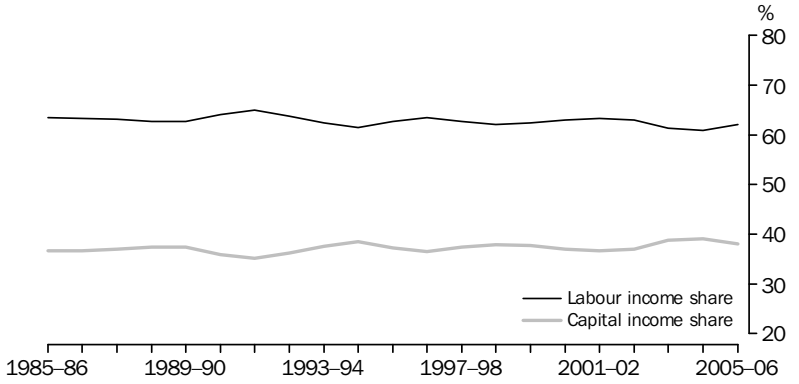
5.5 MANUFACTURING PRODUCTIVE CAPITAL STOCK (2004-05 = 100)



INCOME SHARES

Figure 5.6 shows that both the labour and capital income shares have remained fairly constant over the period 1985–86 to 2005–06. The labour income share averages around 63% for the majority of the period.

5.6 MANUFACTURING LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

Given the income distribution between capital and labour shares the changes in the capital and labour inputs have offset each other. The result is that the combined input series for capital and labour has been relatively flat between 1985–86 and 2005–06.

SUMMARY

Manufacturing MFP growth has generally trended upward over the last twenty years, although it has fallen over the last two. This fall is due to both to an acceleration in the growth in capital services, due to an increase in GFCF, but also a slowing in output growth.

APPENDIX:

Details on hours worked

The *Australian System of National Accounts* published estimates of hours worked for the Manufacturing industry have been based on a different source compared to all other industries. For the years 1986–87 to 2000–01, the employment estimates for the Manufacturing industry have been obtained from the annual census/survey of

Details on hours worked continued

Manufacturing establishments and the average hours worked comes from the Labour Force Survey. For the remaining years, employment data are not available from the manufacturing surveys so all labour input data have been sourced from the Labour Force Survey.

Figure 5.7 compares the hours worked series based on the combination of the annual survey/census of manufacturing establishments and the Labour Force Survey, and the hours worked series based solely on the Labour Force Survey. The hours worked series based solely on the Labour Force data decreases at a slower rate than the hours worked series currently used in the National Accounts. Growth in MFP would be faster in the years up to 2000–01 if the Manufacturing survey and census data were used.

The main reason for the difference in hours worked is that the two series are based on different employment estimates prior to 2000–01. The average hours worked series is based on research work that was implemented in *Australian System of National Accounts, 2005–06*. The methodology is outlined in the information paper, *Implementing New Estimates of Hours Worked into the Australian National Accounts, 2006* (cat. no. 5204.0.55.003). However, there are negligible differences in the movements between the two series average hours worked.

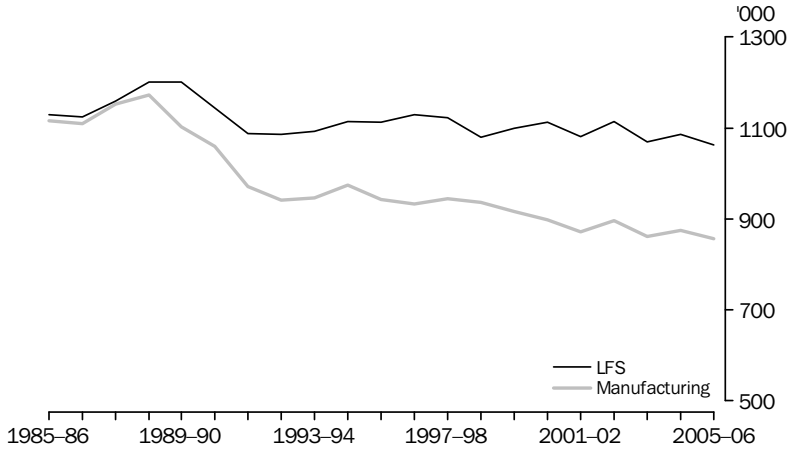
5.7 MANUFACTURING HOURS WORKED, (2004-05 = 100)

The main difference in the employment series occurs in 1989–90, where the census/survey data showed a decline in employment of 6% while the LFS data showed no change. Comparisons of employment estimates (figure 5.8) to the 1991 Population Census suggest similar results to the Manufacturing census/survey data (ABS 1994) in terms of levels. However, there were some methodological changes occurring around this time which affected the interpretation of the movement in employment from the Manufacturing survey. The main change was to the definition of units within Manufacturing that began implementation in 1988–89 and was completed in 1990–91 (ABS 1994). The LFS estimates are considered to provide better measures of movements in labour inputs, and as such are used in this paper for the entire time series.

Details on hours worked

continued

5.8 MANUFACTURING EMPLOYMENT



CHAPTER 6 ELECTRICITY, GAS AND WATER

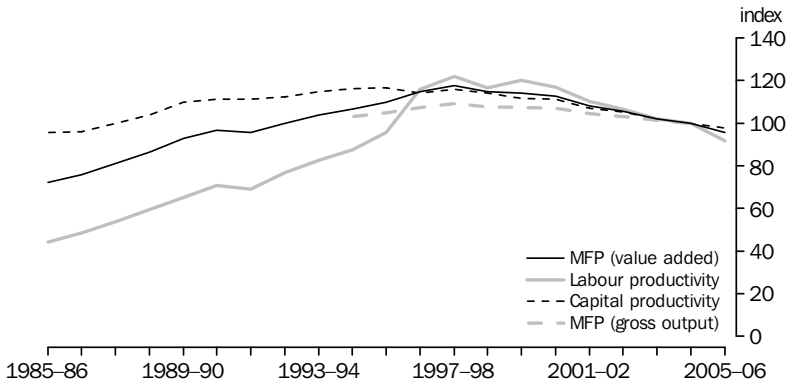
The Electricity, gas & water industry contributed 2.8% to GDP in 2005–06. Electricity is the largest part of this industry and contributes 65% to industry value added. Water, sewerage and drainage's share of value added is 29% and Gas is just 6%. Prior to 1990, the industry was highly regulated, and most utilities operated as monopolies. The electricity industry was vertically integrated in most, if not all jurisdictions, with single companies responsible for generation, transmission, distribution and retail. Significant reforms occurred in the three sectors over the 1990s (SCNPMGTE 1997). However, different jurisdictions approached deregulation on different time frames. Some of the reforms included corporatisation, privatisation, and the structural separation of electricity utilities. These reforms have continued in this decade.

PRODUCTIVITY

Over the period 1985–86 to 1997–98 there was strong growth in multifactor productivity (MFP) on a value added basis (figure 6.1). However, since 1997–98 MFP growth has been negative. Despite this fall, value added based MFP growth averaged 1.4% per year between 1985–86 and 2005–06, which was higher than the market sector average of 1.2% per year. Figure 6.1 also shows strong growth in labour productivity and capital productivity up until 1997–98, although capital productivity increases were more moderate.

The gross output based MFP measure for the period 1994–95 to 2004–05 is also highlighted in figure 6.1. The figure shows gross output based MFP declining more slowly than value added based MFP.

6.1 ELECTRICITY, GAS & WATER MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

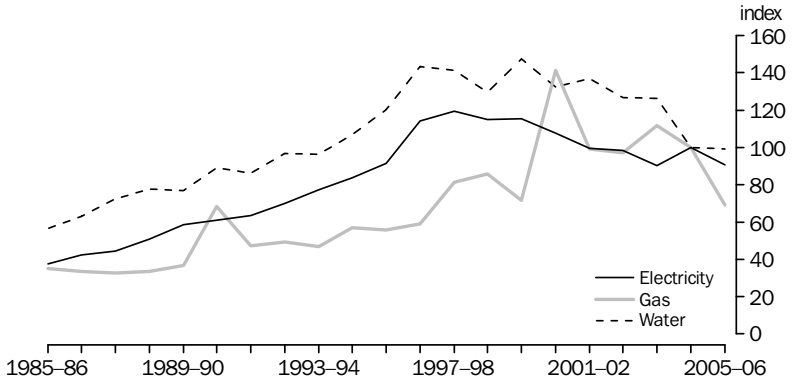


PRODUCTIVITY *continued*

Figure 6.2 presents labour productivity for the three subdivisions between 1985–86 and 2005–06. Labour productivity grew strongly in the Electricity industry up until 1997–98. However, since then it has declined due to slower output growth and the faster growth in hours worked[3].

Water, sewerage and drainage labour productivity increased strongly during the 1990s, then declined from 2000–01. Gas industry labour productivity trended upward up until the late 1990s, although with some volatility. The recent fall in productivity for the Gas industry was due to a large increase in hours worked relative to the change in value added.

6.2 ELECTRICITY, GAS & WATER LABOUR PRODUCTIVITY, (2004-05 = 100)



OUTPUT

Between 1985–86 and 2005–06 value added in volume terms grew by 2.0% per year (figure 6.3). Growth has been relatively steady over this period, although it was slightly stronger in the latter half of the 1980s and weaker since the late 1990s.

Figure 6.3 also shows gross output over the period 1994–95 to 2004–05. Gross output shows a similar pattern of growth to value added.

3 The Energy Reform Implementation Group (ERIG 2007) also shows declines in labour productivity for electricity generation in NSW and Victoria, these two states have large electricity generation with output shares of 33% and 26% respectively. NSW also experienced declines in labour productivity for transmission.

OUTPUT *continued*

6.3 ELECTRICITY, GAS & WATER OUTPUTS AND INPUTS, (2004-05 = 100)

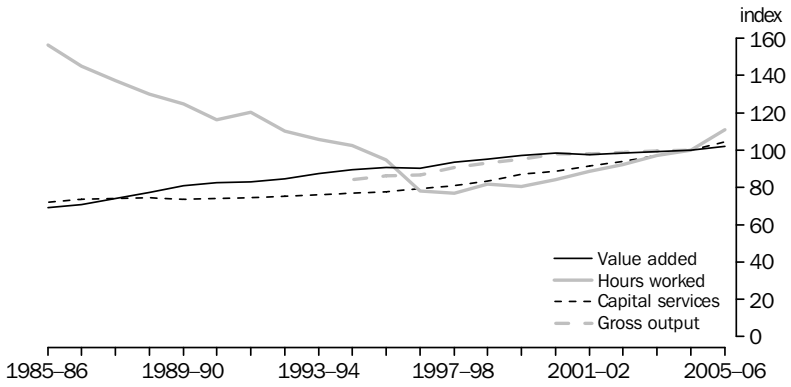


Figure 6.4 shows value added data by subdivision. Electricity industry value added grew on average by 2.7% per year in volume terms between 1985–86 and 2005–06. Over the 1990s Electricity value added growth slowed somewhat, with the slowdown more pronounced from 2000–01. Growth in value added picked up in 2005–06. No output data are available on the specific segments of Electricity industry (generation, transmission or distribution).

Between 1985–86 and 2005–06, Water, sewerage and drainage value added grew by 0.6% per year. However, since 2001–02 value added has fallen. The dry conditions and lower water levels affected output, with lower demand due to water restrictions in most States.

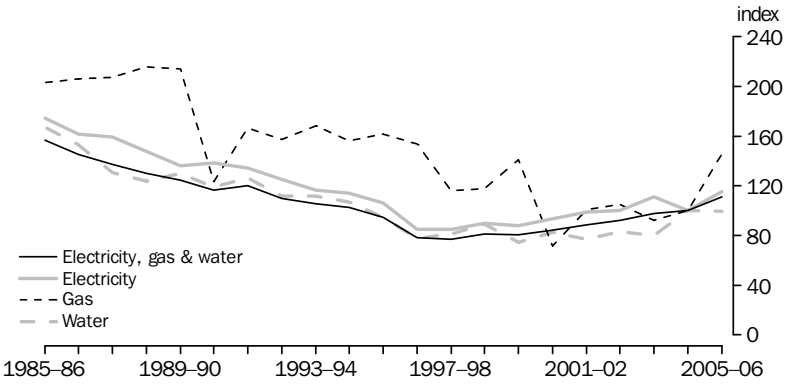
Gas industry value added growth was on average 2.4% per year between 1985–86 and 2005–06. However, over recent years this growth also slowed.

6.4 ELECTRICITY, GAS & WATER VALUE ADDED BY SUBDIVISION, (2004-05 = 100)

LABOUR INPUTS

Figure 6.5 shows total hours worked for the Electricity, gas & water industry between 1985–86 and 2005–06. The chart shows that there was a marked decline in total hours worked between 1985–86 and 1997–98, with positive growth since. Total hours worked for the three subdivisions are also shown in figure 6.5. All three subdivisions show a similar pattern of decline between 1985–86 and 1997–98. Gas industry growth is more volatile due to the smaller size of its workforce.

6.5 ELECTRICITY, GAS & WATER HOURS WORKED, (2004-05 = 100)



The fall in hours worked in the Electricity, gas & water industry between 1985–86 and 1997–98 was due to falls in employment across the three sub-industries (figure 6.6). However, since 1997–98 employment levels have been stable, and even increasing in recent years. There is evidence that some Electricity utilities may be conducting own-account capital work, and this is a possible reason for the increase in employment. However, own-account capital work will also be reflected in the output of the industry.

There are a number of possible reasons based on anecdotal evidence as to the recent increase in employment. For instance:

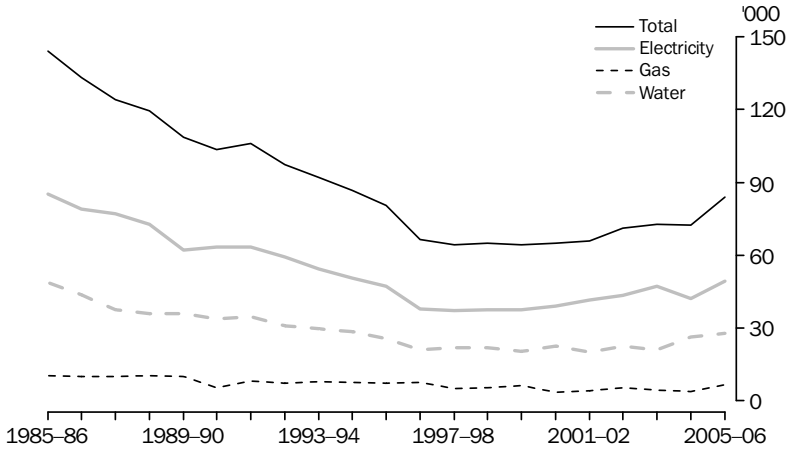
- with the separation of functions in the Electricity industry, there would be the need to replicate head office staff
- with the advent of the National Electricity Market there has been an increase in retail activity, which may require increases in employment through expanded marketing outlets
- capital equipment in this industry has been rundown, and employment is required to perform maintenance and/or replacement work
- for the Water industry, the utilities may require more labour to supply water to households and industries as a result of the latest drought.

Over the last 20 years there has been a decline in full-time employment while there has been strong growth in part-time employment. The main occupations in Electricity, gas & water are tradespersons, professionals, clerical and service workers. Across all occupations there were declines up to 2000–01. This was followed by a strong pickup in tradespersons and professionals from 2001–02.

LABOUR INPUTS

continued

6.6 ELECTRICITY, GAS & WATER EMPLOYMENT



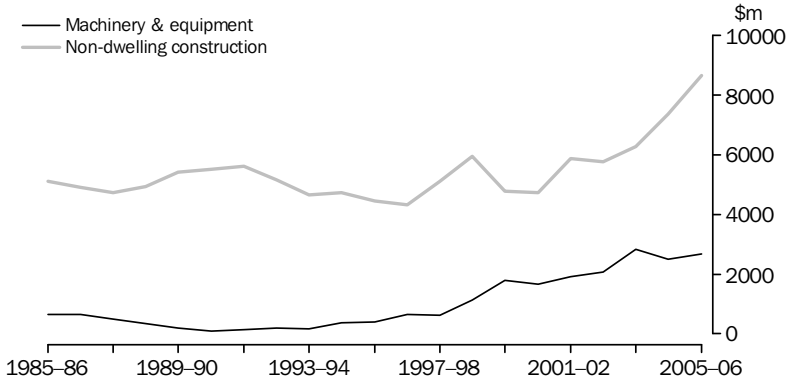
CAPITAL INPUTS

Figure 6.7 presents gross fixed capital formation (GFCF) since 1985–86. GFCF growth steadily declined between 1985–86 and 1993–94, but has grown strongly from 1994–95. This strong growth occurred in both non-dwelling construction and machinery and equipment.

ERIG (2007) indicates that a number of utilities have been investing to increase their base load capacity. In addition, the report also indicates some utilities may be increasing their peak capacity. The issue of peak capacity is that it is maintained in a 'semi-reserve' status to be brought online at peak demand. Given that no adjustment is made for capacity utilisation, the current approach to measuring capital services may overstate the capital services flow.

Determining the level of investment based upon type of investment (e.g. peak load capacity and base load capacity) is problematic, because GFCF data cannot differentiate investment by purpose at the detailed level.

6.7 ELECTRICITY, GAS & WATER GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

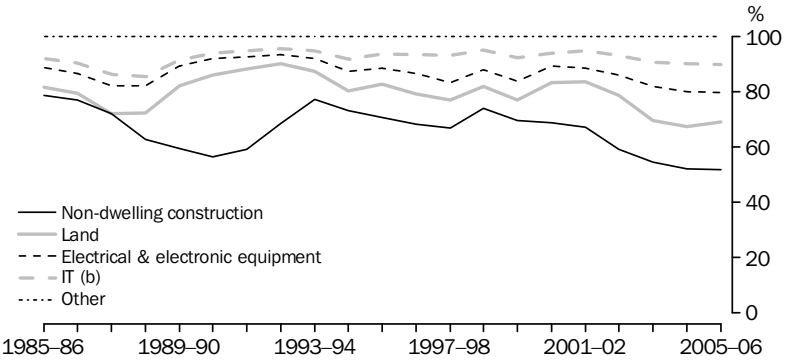


(a) Reference year for chain volume measures is 2004-05.

CAPITAL INPUTS *continued*

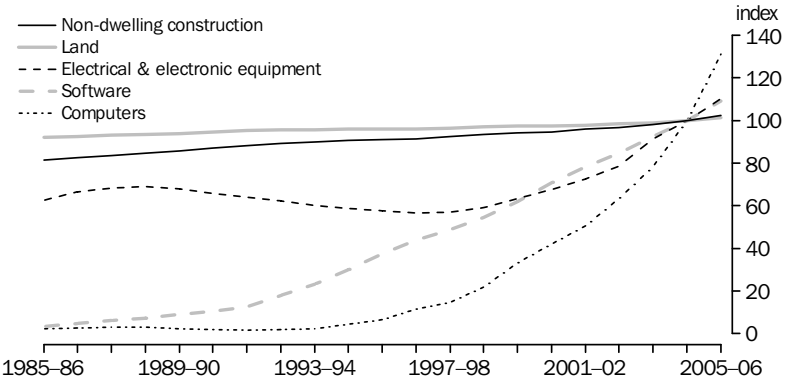
Figure 6.8 provides a breakdown of rental price weights for the major assets of the Electricity, gas & water industry. The figure shows the non-dwelling construction rental price weight (the asset's share of capital rent) declining due to slower growth in its productive capital stock (figure 6.9). However, non-dwelling construction still has the largest rental price weight. The rental price weights for computers, software and electrical and electronic equipment grew strongly in recent years.

6.8 ELECTRICITY, GAS & WATER RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares. (b) IT combines computers and computer software. Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

6.9 ELECTRICITY, GAS & WATER PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)



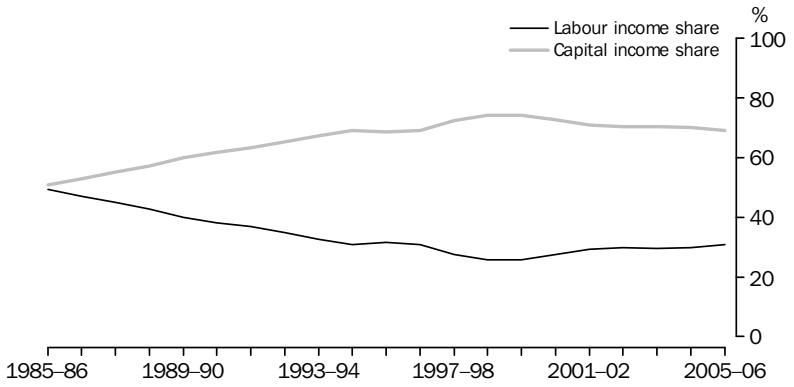
INCOME SHARES

Figure 6.10 highlights the capital and labour income shares for Electricity, gas & water. The capital income share increased rapidly from 51% in 1985–86 to 74% in 1999–00. This reflects the decline in employment that occurred over this period. Since then there has been minimal change in the capital income share.

INCOME SHARES

continued

6.10 ELECTRICITY, GAS & WATER LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

In analysing what drives productivity growth for the Electricity, gas & water industry it is necessary to examine each sub-industry separately. Further, there is also the issue of what is occurring at the state level, especially in regards to timing of reforms and their subsequent effect on productivity. Results from this industry are consistent with the ERIG (2007) report, which indicates that there has been minimal productivity growth since the beginning of the decade.

CHAPTER 7 CONSTRUCTION

Construction is the fifth largest industry in the Australian economy, contributing around 7% to GDP in 2005–06. Construction industry value added in volume terms grew on average by 3.9% per year between 1985–86 and 2005–06. The industry consists of two sub-divisions, General construction and Construction trade services. Within General construction are two groups – building, and non-building construction. Construction trade services consist of five groups, site preparation services, building structure services, installation trade services, building completion services and other construction services. The building construction group is dominated by the private sector. Non-building construction is undertaken by both the private and public sectors, with some major public infrastructure projects increasingly delivered through a process of private-public partnerships (PPP) arrangements. PPPs are generally a partnership-type contractual arrangement between the Government and private sector for the delivery of public infrastructure.

PRODUCTIVITY

Multifactor productivity (MFP) growth for the industry on a value added basis averaged 0.7% per year between 1985–86 and 2005–06, which is below the market sector MFP growth of 1.2% per year. MFP growth picked up in the mid 1990s, although there was a temporary dip in 2000–01, which is partly due to a timing anomaly associated with the introduction of the GST.

Figure 7.1 presents MFP, labour productivity and capital productivity measures for the Construction industry. Labour productivity and MFP show similar patterns of growth, growing slowly over most of the period from 1985–86. Capital productivity at first declined in the late 1980s, then increased to 2005–06. The decline of all three measures in 2000–01 was due to the introduction of the GST, which influenced the time at which construction activity was undertaken leading to weaker output in 2000–01.

The gross output based MFP measure for the period 1994–95 to 2004–05 is also shown in figure 7.1. The figure shows growth in gross output based MFP being flat, except in 2000–01. The decline in gross output based MFP in 2000–01 was not as much as value added based MFP due to the significant contribution intermediate inputs makes to gross output MFP. The intermediate inputs cost share of total inputs was approximately 70% in 2005–06 with intra-industry transfers accounting for 37% of this. The reason for this high proportion of intra-industry transfers is due to the large number of sub-contractors working in this industry.

PRODUCTIVITY

continued

7.1 CONSTRUCTION MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

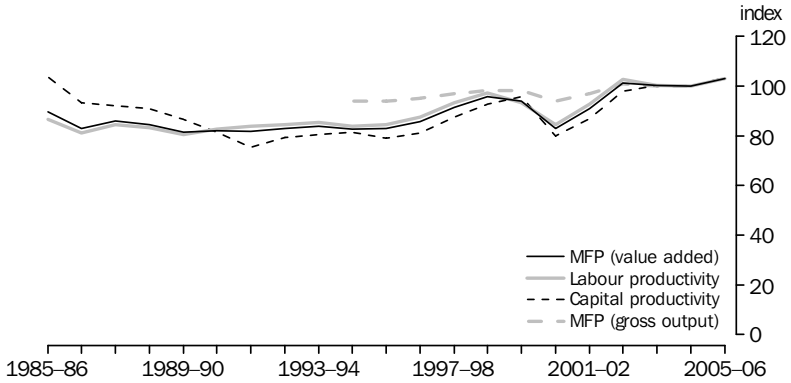
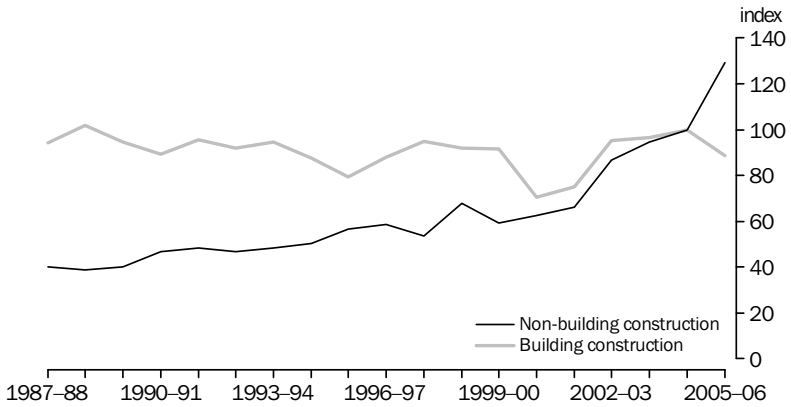


Figure 7.2 shows that value of work done per hour worked in the non-building construction industry has trended upwards from 1987–88 to 2005–06. The value of the work done includes costs of materials, labour etc., and is closer in concept to turnover, rather than value added. The building construction industry's value of work done per hour worked has been relatively flat for much of this period, although since 2001–02 there has been some growth.

The estimates in figure 7.2 are not fully comparable to the industry division estimates in figure 7.1 because the value of work done (output measure) is not the same as value added. Further, the hours worked excludes construction trade services, which has a significant employment share. However, it indicates that the modest growth rate in labour productivity of 0.9% per year for the industry as a whole is held back by a longer term decline in building construction value of work done per hour worked.

7.2 VALUE OF WORK DONE PER HOUR WORKED, Building construction and Non-building construction (a) (2004-05 = 100)



(a) Based on Value of work done.

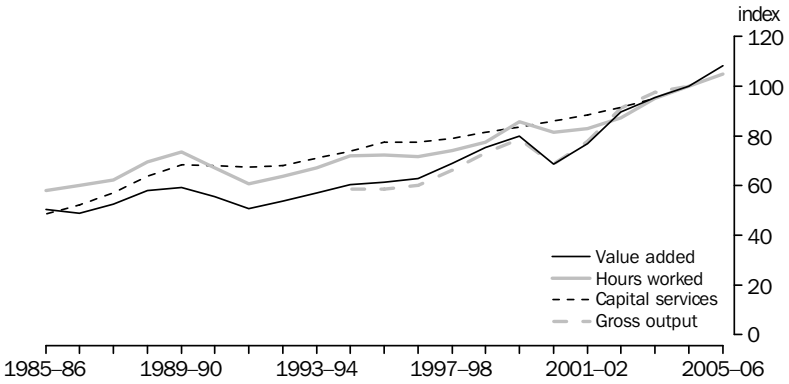
PRODUCTIVITY
continued

Another issue that may affect productivity growth in the Construction industry is changes over time in the geographic locations where engineering and non-building construction are undertaken. The higher intermediate input cost associated with major construction projects in remote areas may cause gross output measures of productivity to be lower.

OUTPUT

Over the last 20 years, value added in volume terms grew on average by 3.9% per year. Some peaks and troughs are evident in the data. This may have been due to factors such as changing interest rates, property speculation and the early 1990s recession. The easing of interest rates in the latter half of the 1990s and building activity associated with the Sydney Olympics may have contributed to stronger growth in Construction output. The fall in output in 2000–01 was substantially due to building activity being brought forward to counter the introduction of the GST. When the GST was introduced value added fell by 14%. Since 2001–02 value added has grown strongly (figure 7.3).

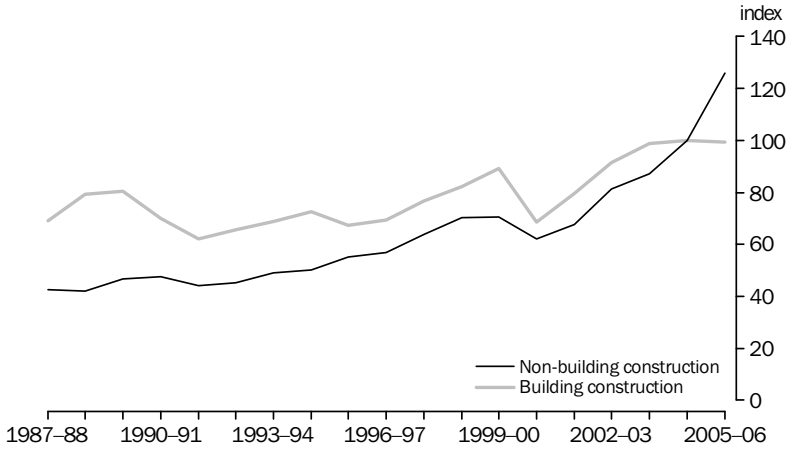
7.3 CONSTRUCTION OUTPUTS AND INPUTS, (2004-05 = 100)



The growth in the value of work done in volume terms for building construction and non-building construction is presented in figure 7.4. The figure shows non-building construction value of work done increasing gradually over the 1990s, with growth accelerating from 2001–02. The value of work done for the building construction industry grew more moderately with no growth over the last few years. In terms of relative size, the respective current price shares of the two industries were 66% for building construction and 34% for non-building construction in 1987–88. In 2005–06 these shares had changed to 59% for building construction and 41% for non-building construction.

OUTPUT *continued*

7.4 VALUE OF WORK DONE IN BUILDING CONSTRUCTION AND NON-BUILDING CONSTRUCTION, (2004-05 = 100)

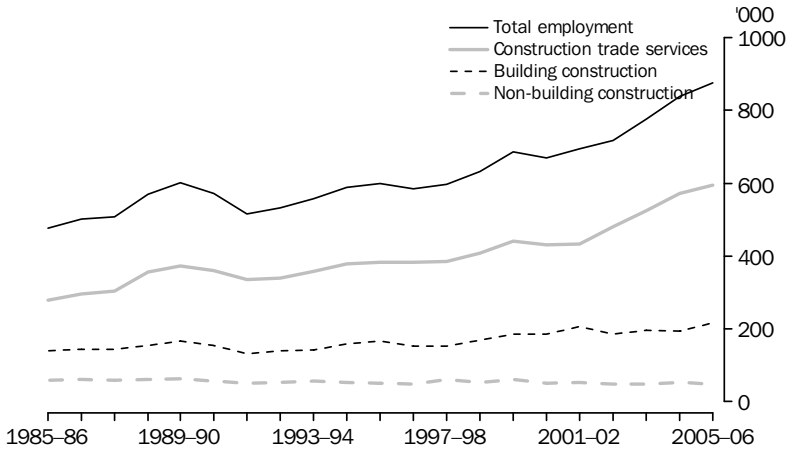


LABOUR INPUTS

Between 1985–86 and 2005–06 hours worked growth averaged 3.0% per year (figure 7.3) with significant increases in the periods leading up to 1989–90 and 1999–00. These changes occurred in employment rather than in average hours worked. Growth in the late 1980s coincides with the property speculation boom. Growth in the late 1990s relates to building work being completed prior to the introduction of the GST.

Much of the employment growth over the 1990s came from construction trade services while non-building construction employment declined slightly (figure 7.5). The construction trade services' employment share increased from 59% in 1985–86 to 68% in 2005–06. Over the same period, building construction's employment share declined from 29% to 25%, with non-building construction falling from 12% to 7%.

7.5 CONSTRUCTION EMPLOYMENT



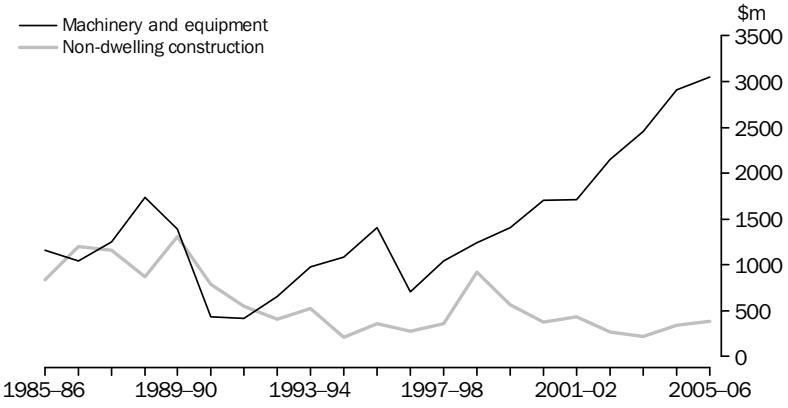
CAPITAL INPUTS

Between 1985–86 and 2005–06 growth in capital services averaged 3.9% per year. Capital services grew strongly between 1985–86 and 1989–90, and then slowed over the first half of the 1990s. Figure 7.3 shows that growth in capital services accelerated from the beginning of the decade.

CAPITAL INPUTS
continued

Capital services are predominantly driven by investment in machinery and equipment. Growth in the volume of total gross fixed capital formation (GFCF) fluctuated between 1985–86 and 1996–97 (figure 7.6). After 1996–97, GFCF growth was very strong. The bulk of this investment came from machinery and equipment.

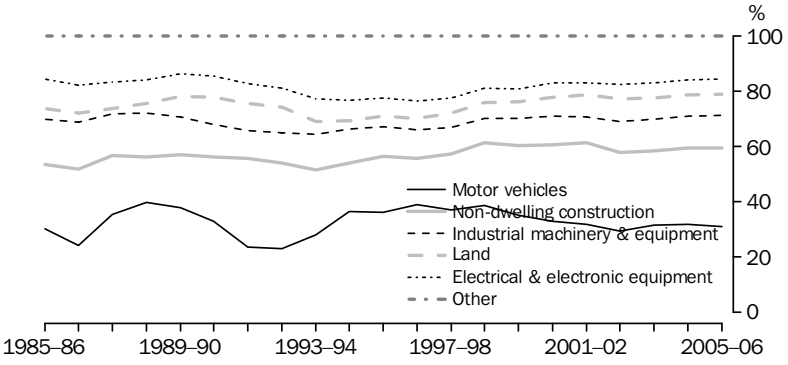
7.6 CONSTRUCTION GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)



(a) Reference year for chain volume measures is 2004-05.

Further to the growth in GFCF, rental price weights also influence capital services. Figure 7.7 shows assets with relatively large rental price weights are motor vehicles, non-dwelling construction and industrial machinery and equipment. The reason non-dwelling construction has such a large weight is due to the realised rate of return being higher than expected.

7.7 CONSTRUCTION RENTAL PRICE WEIGHTS (a)



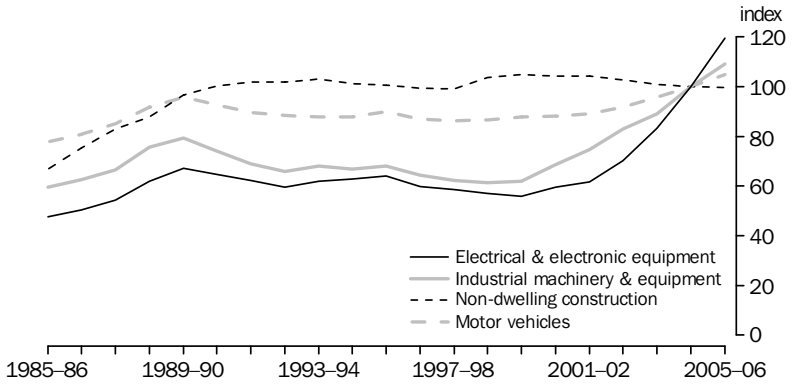
(a) Chart lines are cumulative shares.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

Figure 7.8 shows motor vehicles and non-dwelling construction productive capital stock increased strongly over the second half of the 1980s with no growth since then. Growth in electrical and electronic equipment and industrial machinery and equipment stock accelerated from 1997–98 onwards.

CAPITAL INPUTS

continued

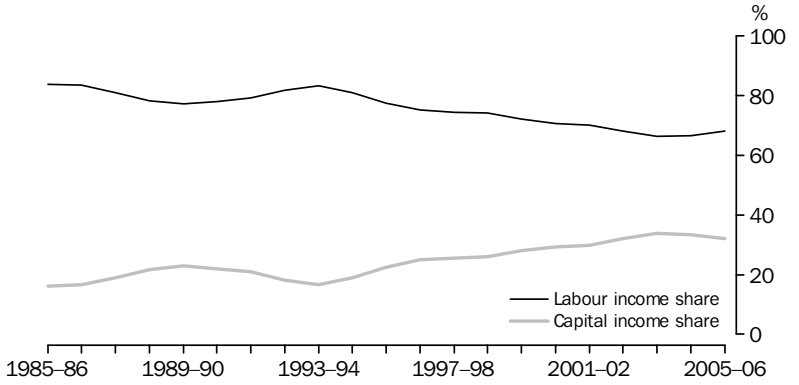
7.8 CONSTRUCTION PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)



INCOME SHARES

Figure 7.9 presents the capital and labour income shares for the Construction industry. The figure shows that the gap between capital and labour income shares is narrowing. The capital income share increased from 16% in 1985–86 to 31% in 2005–06. The Construction industry has a notable complication in the calculation of the capital and labour income shares because it has a large unincorporated sector. In 2005–06 gross mixed income was approximately 33% of Construction industry's total factor income.

7.9 CONSTRUCTION LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

Growth in MFP for the Construction industry averaged 0.7% per year over the past two decades. Construction industry MFP growth was lower than market sector MFP growth. This relatively low growth in MFP could be in part due to changes in the composition of the industry.

CHAPTER 8 WHOLESALE TRADE

The Wholesale trade industry contributes approximately 5% to Australia's GDP. The industry consists of Basic material wholesaling, Machinery and motor vehicle wholesaling, which includes computer wholesaling, and Personal and household good wholesaling. In 2004–05 the largest subdivision was Machinery and motor vehicle wholesaling, which contributed around 41% to the industry's value added, followed by Personal and household goods wholesaling contributing 37% and Basic material wholesaling contributing 22%. The 1990s saw strong growth in industry value added. This increase in value added came from substantial rationalisation within the industry, a wider uptake of technology amongst firms, and the increased use of new inventory management techniques, such as 'just-in-time' processing (Johnson et al 2000).

PRODUCTIVITY

The 1990s saw strong value added based multifactor productivity (MFP) growth in the Wholesale trade industry relative to the market sector. This was due not only to strong growth in outputs, but also to slower growth in inputs. Over the 1990s the Wholesale industry had one of the fastest growth rates in MFP, but since 2000–01 MFP growth has slowed. Between 1985–86 and 2005–06 MFP grew at 1.5% per year. This was faster than the market sector as a whole, which grew at 1.2% per year.

Figure 8.1 shows MFP, labour productivity and capital productivity for the Wholesale industry. The figure shows that MFP and labour productivity follow a similar pattern, with little growth in MFP and labour productivity over the second half of the 1980s and the early 1990s. From 1993-94 growth in MFP increased and this growth rate began slowing in 1997–98. There was no growth in MFP over the last year.

PRODUCTIVITY

continued

8.1 WHOLESALE MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

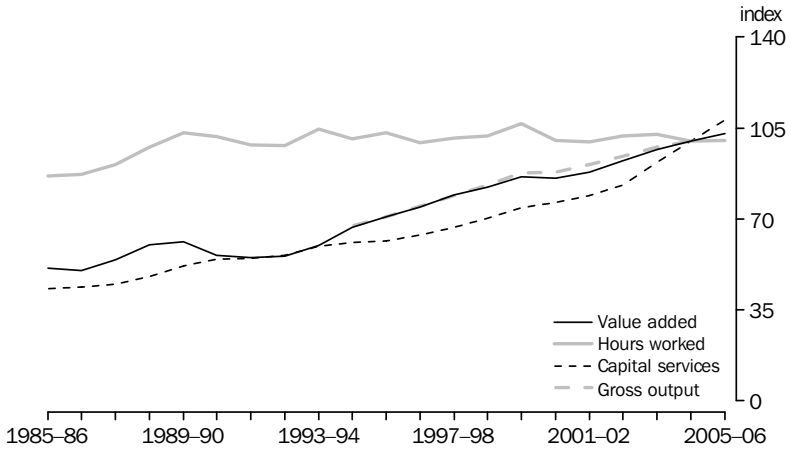
Figure 8.1 also includes gross output based MFP growth. The chart shows that gross output based MFP is growing more slowly than value added MFP, which is to be expected. The measures of value added and gross output have grown at similar rates over the last ten years (figure 8.2). However, the slower rate of growth in the gross output based measure of MFP is due to the inclusion of intermediate inputs in the equation. Intermediate inputs have a strong influence on gross output based MFP growth because they account for on average around 57% of the combined inputs. Intermediate inputs grew at approximately the same rate as gross output over the period 1994–95 to 2004–05. This means that the combined inputs index, which includes labour, capital and intermediate inputs grew twice as fast as the combined labour capital index (figure 8.3).

Capital productivity has followed a different pattern to MFP and labour productivity. The capital productivity series shows a decline between 1985–86 and 2005–06. However, there was a short increase in growth in capital productivity between 1993–94 and 1997–98. Growth in capital services slowed relative to growth in output over this period.

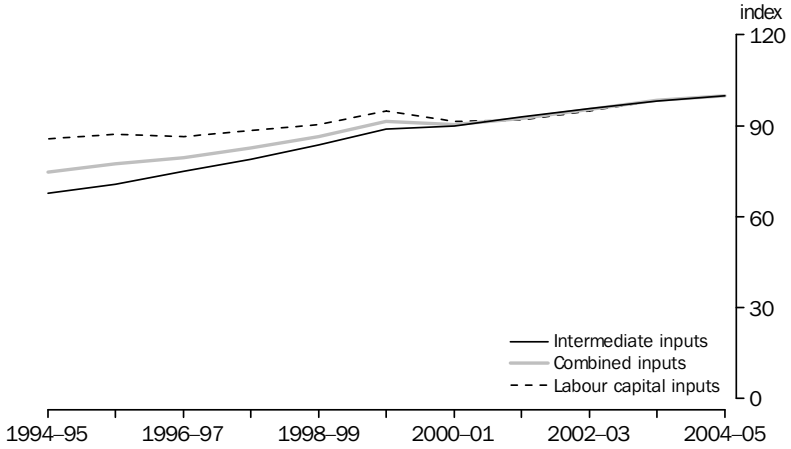
The increase in MFP over the 1990s came from increases in output without any commensurate increases in inputs, especially labour. Figure 8.2 shows the output and input components used in measuring MFP. While there was slower growth in capital services over the 1990s it was the hours worked that influenced the combined inputs index. This was because the labour income share is approximately 65 per cent of total factor income.

OUTPUT

8.2 WHOLESALE OUTPUTS AND INPUTS, (2004-05 = 100)



8.3 WHOLESALE INTERMEDIATE INPUTS, COMBINED INPUTS AND LABOUR AND CAPITAL INPUTS, (2004-05 = 100)



The growth in gross valued added, especially over the 1990s, was caused by both supply side and demand side factors. Supply side factors involved the advent of new technologies and a greater uptake of existing technologies that enabled productivity improvements. Demand side factors related to improved overall economic conditions as consumers increased their purchases.

LABOUR INPUTS

Total hours worked has shown very little growth over the period 1985–86 to 2005–06 (figure 8.2). This is mainly because total employment grew minimally, with the nearly all the growth occurring over the second half of the 1980s.

CAPITAL INPUTS

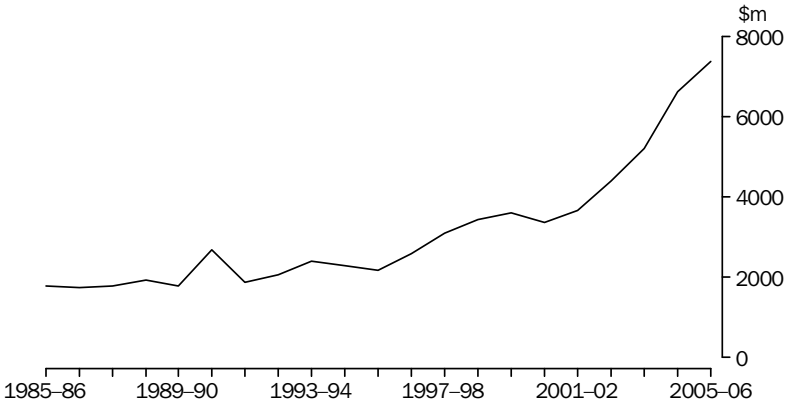
The slowdown in productivity growth in recent years has not been caused by any significant slowdown in output growth, but due to an increase in the growth in capital services. Figure 8.2 highlights the growth in capital services that has occurred since the late 1990s. One possible anecdotal explanation contributing to the increase since 2002–03 could be the centralisation of distribution centres occurring over recent years, which would involve significant new investment. For example, Woolworths is reducing

CAPITAL INPUTS
continued

its distribution centres down from 31 to 9 larger regional distribution centres(Woolworths 2006, p. 19).

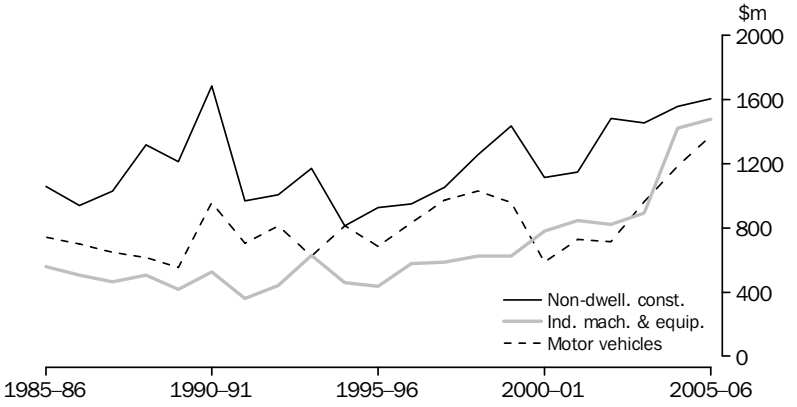
Figure 8.4 highlights the significant growth in gross fixed capital formation (GFCF) since the late 1990s. Figure 8.5 shows this strong growth was in motor vehicles and industry machinery and equipment. Over the last three years, there was also growth in GFCF from electrical and electronic equipment, and computers (figure 8.6).

8.4 WHOLESALE GROSS FIXED CAPITAL FORMATION, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

8.5 WHOLESALE GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

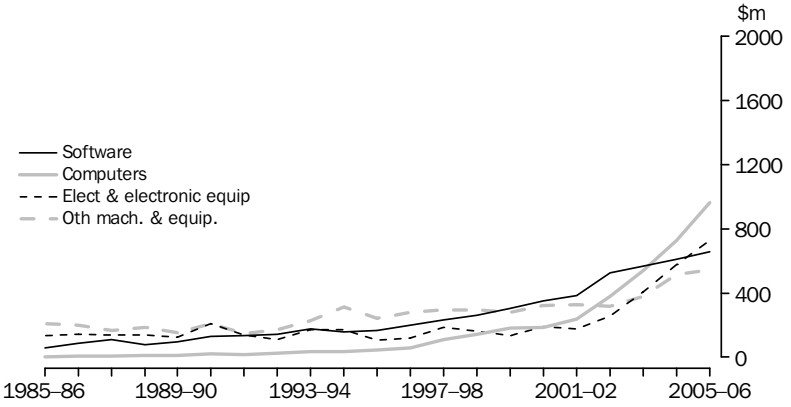


(a) Reference year for chain volume measures is 2004-05.

CAPITAL INPUTS

continued

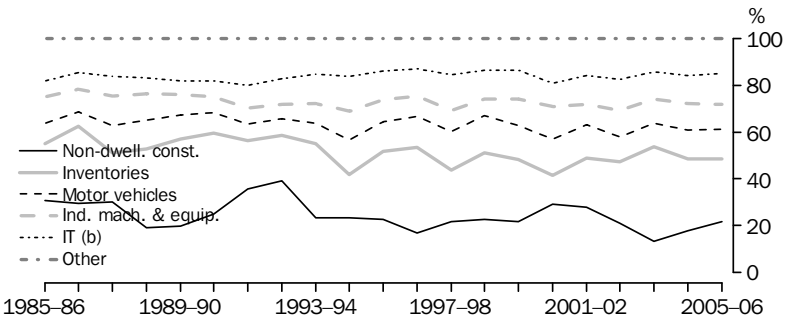
8.6 WHOLESALE GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)



(a) Reference year for chain volume measures is 2004-05.

Besides the growth in GFCF, rental price weights also influence capital services. One asset that is not covered by GFCF data is inventories. From figure 8.6 it can be seen that inventories has a significant impact on capital services, with its high rental price weight. However, the inventories proportion of total capital rent has been relatively volatile, fluctuating from a 12% rental price weight to 40%. Other assets with relatively large rental price weights are non-dwelling construction, motor vehicles, and industrial machinery and equipment. Computers and software have been increasing their respective shares over the last two decades (figure 8.7).

8.7 WHOLESALE RENTAL PRICE WEIGHTS (a)

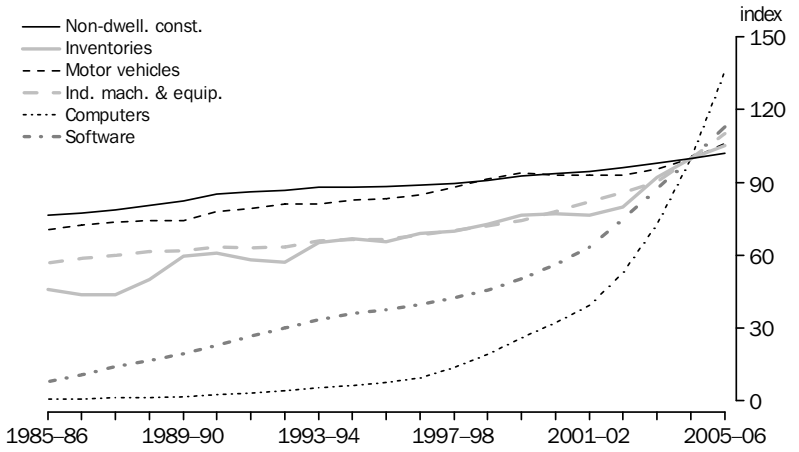


(a) Chart lines are cumulative shares.
(b) IT includes software, and computers and peripherals.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

CAPITAL INPUTS

continued

8.8 WHOLESALE PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)

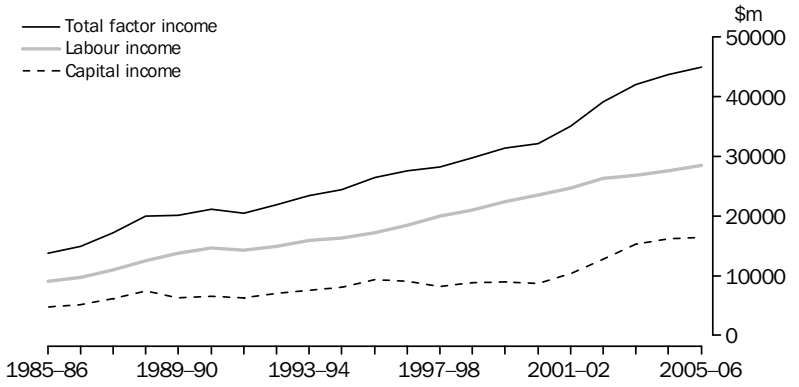


Even though there has been strong growth in GFCF for motor vehicles in recent years, there has been little change to the trend pattern of growth in its productive capital stock (figure 8.8). Figure 8.8 also shows inventories, computers and software as accelerating their growth in productive capital stock since 2002–03.

INCOME SHARES

Figure 8.9 shows that there has been significant growth in total factor income since the late 1990s and the early part of this decade. The increase comes predominantly from growth in gross operating surplus (GOS). The increase saw the capital income share rise from under 30 per cent in 1999–00, to almost 36 per cent in 2005–06 (figure 8.10). This means that the faster growth that occurred in capital inputs over this period also received a greater share when estimating total inputs for productivity measurement, and as such, MFP growth slows.

8.9 WHOLESALE LABOUR AND CAPITAL INCOME

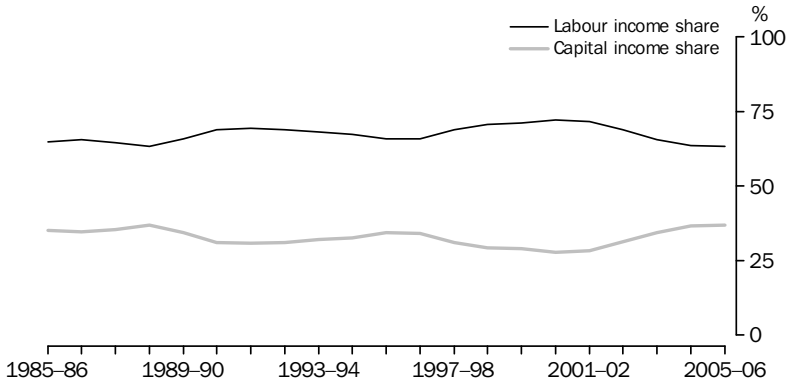


Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

INCOME SHARES

continued

8.10 WHOLESALE LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital income of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

The Wholesale trade industry experienced rapid growth in MFP over the 1990s. This growth has slowed since 2000, and has shown no growth over the last two years. The main reason behind this is the high growth in inputs, especially capital services.

CHAPTER 9 RETAIL TRADE

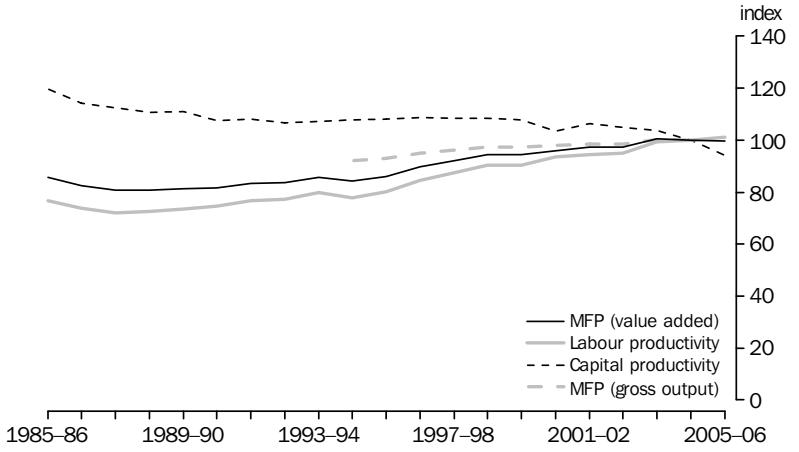
Retail trade is one of the larger industries in Australia, contributing around 7% to GDP. The industry comprises Food retailing, Personal and household goods retailing and Motor vehicle retailing and services. In 2004–05 Personal and household goods retailing was the largest contributor in terms of value added at 47%, followed by Food retailing at 31% and Motor vehicle retailing at 22%. Retail trade is a labour intensive industry, and the average labour income share of 75% reflects this. The link between the deregulation of shopping hours and measured hours worked is one of the key issues affecting productivity in this industry.

PRODUCTIVITY

While there has been growth in productivity in Retail trade it did not enjoy the high growth rates that occurred in some industries over the 1990s, such as Wholesale trade and Communications. However, there have been significant changes in the industry since the late 1980s that affected measured productivity.

Figure 9.1 presents the productivity performance for Retail trade. The chart shows an upward trend in MFP growth on a value added basis. The annual average rate for the period 1985–86 to 2005–06 was relatively low at 0.7% per year. This rate is below the market sector for this period, which grew at 1.2%. The fastest growing period for the Retail trade sector was during the 1990s. Prior to this MFP growth was relatively flat, and since the late 1990s MFP growth has again slowed.

9.1 RETAIL MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY (2004-05 = 100)



Gross output based MFP estimates are also presented in Figure 9.1. The figure shows that the gross output based MFP grew more slowly than value added based MFP, which is to be expected.

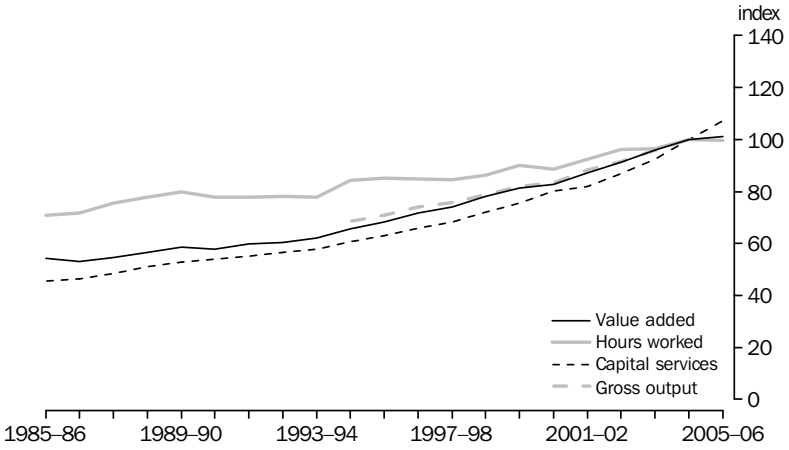
PRODUCTIVITY *continued*

Figure 9.1 also presents labour productivity and capital productivity. Labour productivity has grown more strongly than MFP, but capital productivity has trended down for much of last twenty years.

OUTPUT

Figure 9.2 shows growth in output in Retail trade. The chart shows that there has been a steady increase in Retail output since 1985–86. Growth picked up in the latter half of the 1990s, when consumer confidence was relatively high. Associated with this rising consumer confidence were rising incomes, low inflation and low interest rates. This might indicate that consumer demand is driving changes in Retail output and that this demand is driven by relatively buoyant conditions in the Australian economy.

9.2 RETAIL OUTPUTS AND INPUTS, (2004-05 = 100)



Retail output is not solely demand driven as there were a number of supply side factors that also affected the industry. For instance, there was an increase in competition in the industry, due to in part the deregulation of trading hours but also due to the introduction of 'category killers' in certain segments of the Retail market. Category killers are large retail stores that specialise in particular products, such as hardware (Bunnings), toys (Toys-R-Us) or sporting goods (Rebel Sport).

Another aspect that affects Retail is the deregulation of shopping hours. While deregulation may have led to an increase in competition, there might not have been any significant increases in output, as measured by volume of goods traded. However, this raises the issue of how improved convenience for shoppers should be factored into a quality adjustment for Retail output.

Value added has been steadily increasing, at approximately 3.1% per year over the last two decades. The main component of Retail output is gross margins. The margins in current price terms are the difference between sales and cost of goods sold. The change in the volume of Retail industry output is based on the quantity of goods sold.

LABOUR INPUTS

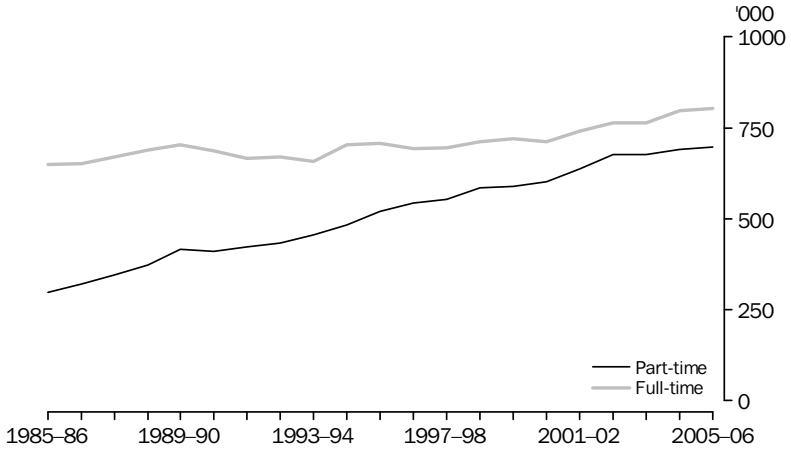
Figure 9.2 shows the movements in total hours worked for the Retail industry between 1985–86 and 2005–06. Average annual growth for this period was 1.7% per year.

LABOUR INPUTS *continued*

The figure shows significant increases in total hours worked in 1994–95, 1999–00 and 2003–04. The biggest increase in hours worked occurring in 1994–95 where growth was 8.1%. This increase was driven by increases in both full-time (7%) and part-time (5.9%) employment (figure 9.3). In addition average weekly hours worked increased 1.4% in 1994–95. To some extent this increase may have been driven by the deregulation of shopping hours in some of the bigger eastern states, particularly in the early 1990s. Other evidence that supports this is that the big increases occurred in the Food retailing and Personal and household goods segments of the industry.

Figure 9.3 also shows a shift in employment patterns from full-time to part-time work. Part-time employment increased from 30% of total employment in 1985–86 to almost 50% in 2005–06, with part-time employment growing by 4.3% per year for the last two decades (figure 9.3). This shift to part-time employment has also meant average weekly hours have tended to fall over this period, from 34.4 hours per week in 1985–86 to 29.9 hours per week in 2005–06.

9.3 RETAIL EMPLOYMENT



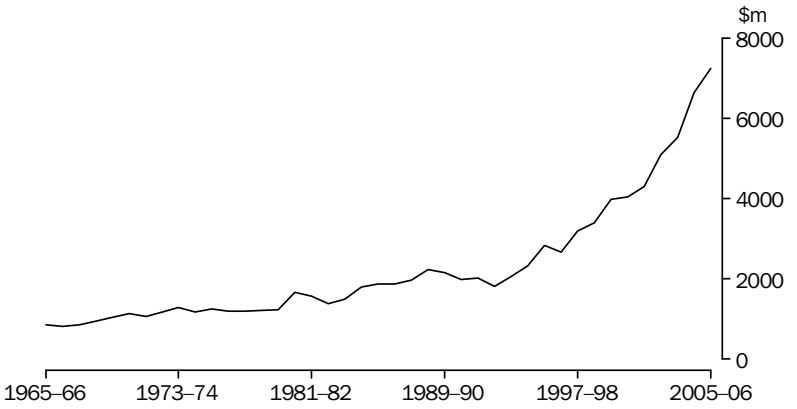
CAPITAL INPUTS

There was strong growth in capital services for Retail trade since the late 1990s (figure 9.2). This increase was driven by the rapid growth in gross fixed capital formation (GFCF) that has occurred since the mid 1990s (figure 9.4). Much of this growth is driven by the growth in computer hardware, which has grown at just over 30% per year for the last decade.

CAPITAL INPUTS

continued

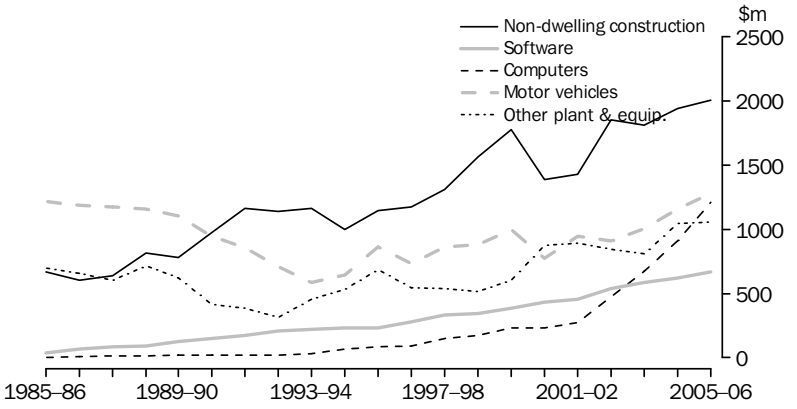
9.4 RETAIL GROSS FIXED CAPITAL FORMATION, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

Figure 9.5 shows the increases in GFCF for each asset in volume terms that occurred between 1985–86 and 2005–06. The chart shows a significant increase in computer hardware GFCF, which relates to the increased use of scanning technology, EFTPOS facilities and computerised inventory management. Over the latter half of the 1990s non-dwelling construction GFCF grew rapidly, which outside of computers and software, was the fastest growing asset.

9.5 RETAIL GROSS FIXED CAPITAL FORMATION BY ASSET, Chain volume measures (a)



(a) Reference year for chain volume measures is 2004-05.

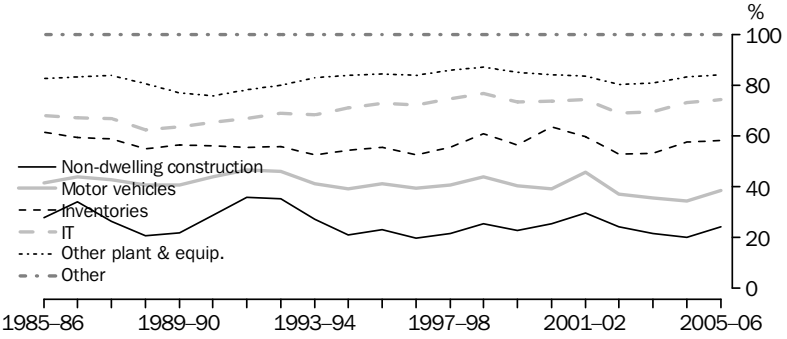
While there have been significant changes in GFCF, there have been only minimal changes in the rental price weights of the assets used to construct the industry's capital services estimate (figure 9.6). The large increase in computers' GFCF has led to only a 2% increase in its rental price weight. On the other hand the increase in motor vehicle investment has not translated into an increase in its rental price weight. This is because other assets have grown relatively faster than motor vehicles. Another aspect is the inclusion of land and inventories in estimating the industry's capital services.

CAPITAL INPUTS
continued

Inventories form a significant component of Retail trade's capital services, which is unlike most other industries. The rental price weight for inventories has shown some volatility, but has averaged 16% over the last twenty years (figure 9.6). The productive capital stock of inventories grew by 1.8% per year between 1985–86 and 2005–06, although as figure 9.7 shows, most of this increase occurred over the last ten years.

One other issue in the measurement of capital services relates to deregulation of trading hours. As stores are opening longer hours this means they are obtaining greater capital services from their existing stock of assets compared to previously, that is, there appears to be an increase in capacity utilisation. The current measures for capital services do not account for this. The impact of trading hours on capital services requires further investigation.

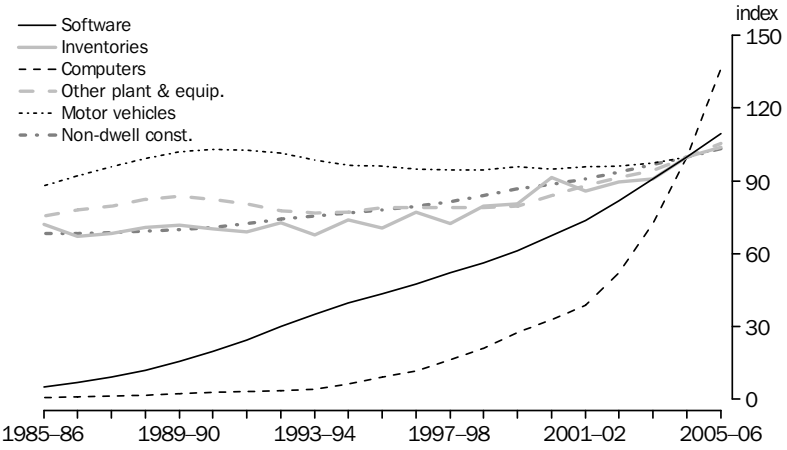
9.6 RETAIL RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
(b) IT includes software, and computers and peripherals.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

Figure 9.7 shows the growth in the productive capital stock for those assets that have relatively larger rental price weights. The impact of information technology on Retail trade capital services is further reflected in this chart, as there was significant growth in both these assets since the mid 1990s.

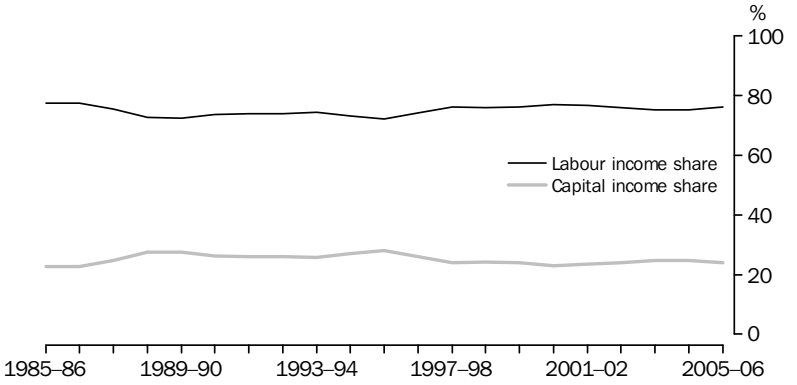
9.7 RETAIL PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)



INCOME SHARES

Despite the growth in capital services, the Retail industry is labour intensive, which is seen in the returns to capital and labour income shares in figure 9.8. The figure shows the there has been little change over the last twenty years with the capital income share at approximately 25%. However, the gap between labour and capital income appears to have widened somewhat in recent years.

9.8 RETAIL LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

Growth in MFP for Retail was relatively slow compared to other market sector industries. This is despite there being increases in competition and increases in the use of technology. Deregulation of shopping hours and the greater use of technology were some of the changes affecting this industry. However, these changes have not translated into an increase in MFP growth.

CHAPTER 10 ACCOMMODATION, CAFES AND RESTAURANTS ....

The Accommodation, cafes & restaurants industry consists of firms primarily engaged in the provision of hospitality services. This includes accommodation; clubs; pubs, taverns and bars along with cafes and restaurants. The industry is the third smallest in the economy, contributing between 1.9% and 2.5% to GDP over the period 1985–86 to 2005–06. While the contribution of the industry to GDP has remained small over this period, the actual output of the industry, measured by value added, has increased significantly, growing at 3.8% per year. The largest proportion of value added in this industry is from pubs and clubs, while the largest employer is cafes and restaurants.

PRODUCTIVITY

10.1 ACCOMODATION, CAFES & RESTAURANTS MFP, LABOUR AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

Multifactor productivity (MFP) measured on a value added basis in the Accommodation, cafes & restaurants industry decreased over the latter half of the 1980s, but from 1991–92 MFP has trended upwards (figure 10.1). There was zero average MFP growth from 1985–86 to 2005–06, and hence was considerably below the market sector average of 1.2% per year. A comparison of the gross output based MFP series to the value added based MFP series shows value added based MFP growing at a higher rate.

Growth in labour productivity shows a similar pattern to MFP over the period 1985–86 to 2005–06. There was a long decline from 1985–86 to 1991–92 followed by growth from 1991–92 to 2005–06 (figure 10.1). Overall, labour productivity increased at an average rate of 0.5% per year between 1985–86 and 2005–06.

PRODUCTIVITY *continued*

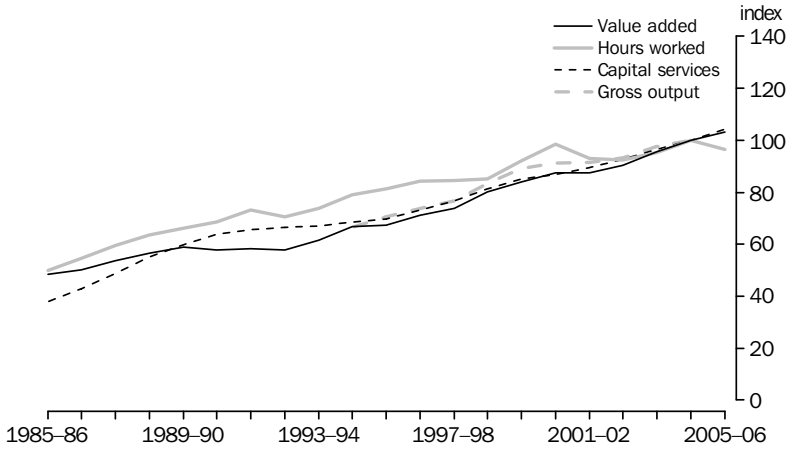
Capital productivity in Accommodation, cafes & restaurants shows a similar pattern to labour productivity and MFP, with a significant decline from 1985–86 to 1991–92 followed by a period of solid growth from 1992–93 to 1994–95. Capital productivity has been relatively flat since 1994–95 (figure 10.1). Capital and labour inputs show a similar pattern of growth (figure 10.2), indicating that there is no significant level of capital-labour substitution in this industry. This may explain the similar movements in capital and labour productivity growth.

In Australia there has historically been minimal productivity growth in this industry. This is consistent with international results which show that among a significant number of developed economies there has been little productivity growth in this industry (Wölfl, 2003).

OUTPUT

Figure 10.2 shows output from Accommodation, cafes & restaurants. There has been relatively steady growth in value added between 1985–86 and 2005–06. The value added and gross output measures display similar growth between 1994–95 and 2004–05. Despite the falls in productivity between 1985–86 and 1989–90, value added continued to increase.

10.2 ACCOMODATION, CAFES & RESTAURANTS OUTPUTS AND INPUTS, (2004-05 = 100)



The measurement of output for Accommodation, cafes & restaurants poses some particular problems in relation to changes in the quality of service. This is because the quality of service may have improved significantly since 1985–86, and this may not have been completely captured in the output estimates.

LABOUR INPUTS

There was a steady increase in hours worked in Accommodation, cafes & restaurants between 1985–86 and 2005–06, although falls were recorded in 1991–92, 2000–01 and 2005–06 (figure 10.2). Changes in the number of hours worked is due mostly to changes in the level of total employment as average hours worked per employed person remained relatively stable. The fall in total employment in 1992–93 followed a period where employment in this industry continued to grow even though output began to decline in 1990–91. This is consistent with observations showing that there can be a lagged relationship between output and employment (ABS 2005). There was a further

LABOUR INPUTS
continued

decline after 2000–01, which followed an expansion in the level of employment, possibly linked to the Sydney Olympics and the associated increase in hospitality services in New South Wales. The bulk of employment in this industry is in the cafes and restaurants subdivision, with around 49% of all employees.

Another observation is that there have been less significant changes in the ratio of full-time to part-time employees in this industry between 1985–86 and 2005–06 than in other service industries such as Retail trade. The percentage of employees in this industry identified as working part-time has increased from 44% in 1985–86 to 49% in 2005–06.

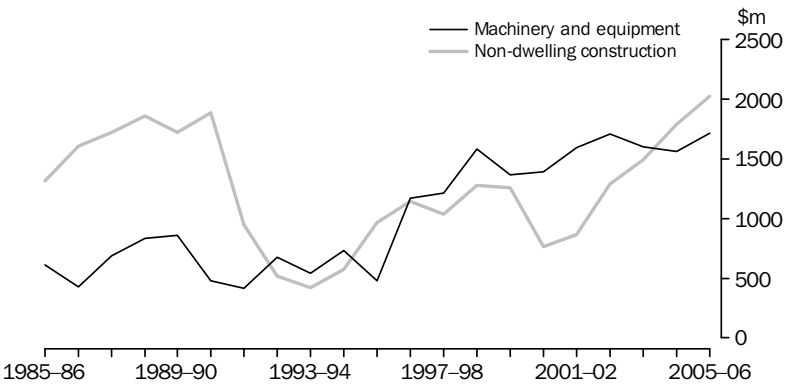
CAPITAL INPUTS

An analysis of tourist accommodation data shows that there was significant growth in the stock of available tourist accommodation (measured in available bed nights) from 1985–86 to 1991–92, which aligns with the significant growth of gross fixed capital formation (GFCF) in non-dwelling construction during this period (figure 10.3). The data show growth in available accommodation between 5 and 10% per year between 1985–86 and 1991–92. During the same period average room occupancy rates declined from approximately 70% in 1985–86 to 50% in 1991–92 (ABS 2006d). After 1991–92 there was very little growth in the stock of available tourist accommodation until 1994–95, which aligns with the significant decline in GFCF during this period. Occupancy rates increased from 1991–92 to 1994–95, indicating that spare capacity was beginning to be utilised.

The rapid decline in productivity from 1985–86 to 1991–92 may be related to the drop in occupancy rates. The level of output in this industry was still growing at a steady rate during this period but it was being exceeded by growth in investment and employment, associated with the significant increase in available accommodation.

In this industry, leased and rented capital in the form of non-dwelling construction represents a significant proportion of intermediate inputs. It is likely the bulk of cafes and restaurants along with a significant proportion of pubs and clubs lease rather than own their property. Any change in this proportion would have an impact on capital inputs in this industry, and thus affect value added based productivity estimates.

10.3 ACCOMODATION, CAFES & RESTAURANTS GROSS FIXED CAPITAL FORMATION, Chain volume measure (a)



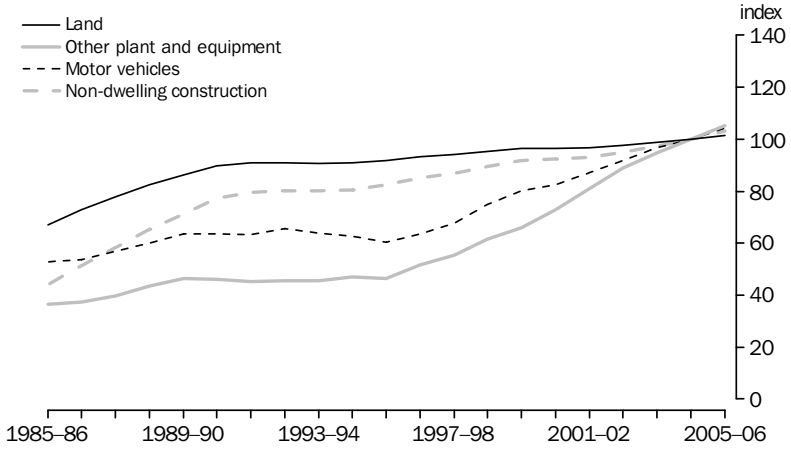
(a) Reference year for chain volume measures is 2004-05.

CAPITAL INPUTS
continued

There has been a significant increase in gross fixed capital formation for both machinery and equipment and non-dwelling construction since the mid 1990s (figure 10.3). This followed a period of very low investment during the early 1990s.

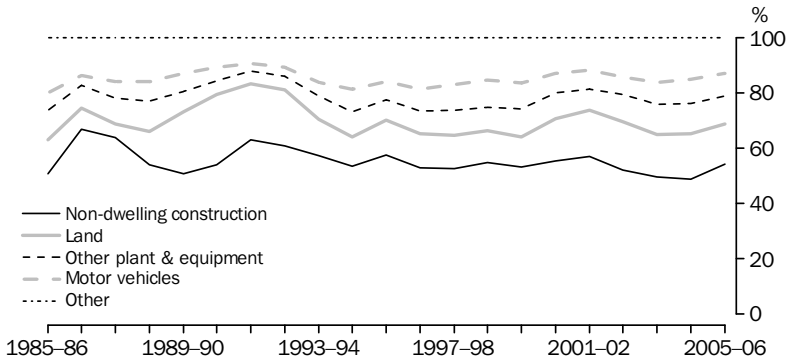
There was a significant increase in the productive capital stock of land and non-dwelling construction during the late 1980s (figure 10.4). The very high growth in machinery and equipment gross fixed capital formation after 1995–96 is also clear. The majority of machinery and equipment in this industry consists of motor vehicles and other plant and equipment.

10.4 ACCOMMODATION, CAFES & RESTAURANTS, PRODUCTIVE CAPITAL STOCK BY ASSET, (2004-05 = 100)



An analysis of the rental price weights since 1985–86 shows that non-dwelling construction contributes the bulk of capital in this industry (figure 10.5). The stock of land and investment in non-dwelling construction increased during the late 1980s and early 1990s, with the demand for land likely to be closely linked to non-dwelling construction. The rental price weights have remained relatively stable since 1994–95.

10.5 ACCOMMODATION, CAFES & RESTAURANTS RENTAL PRICE WEIGHTS (a)

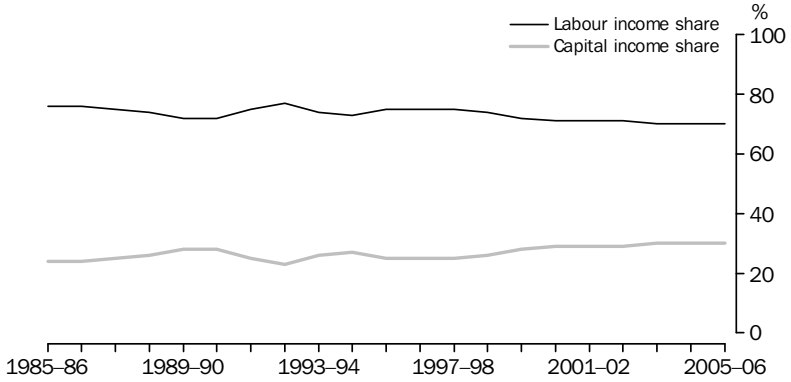


(a) Chart lines are cumulative shares.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

INCOME SHARES

The labour and capital income shares shows that the capital income share has increased from 24% to 30% between 1985–86 and 2005–06 (figure 10.6). The only deviation from this trend was during the period of high capital formation between 1988–89 and 1991–92, where the capital share of income increased.

10.6 ACCOMODATION, CAFES & RESTAURANTS LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

The data suggests that changes in MFP within this industry may be related to capacity utilisation and therefore only partly reflect underlying gains or falls in technical efficiency. The tourist accommodation data appears to suggest that movements in capacity utilisation have the greatest impact on productivity figures for the accommodation subdivision. Further research is required to analyse the impact of capital as an intermediate input as well as the role and composition of capital in this industry. There is also a need for more research into the quality adjustment of output volumes and prices.

CHAPTER 11 TRANSPORT AND STORAGE

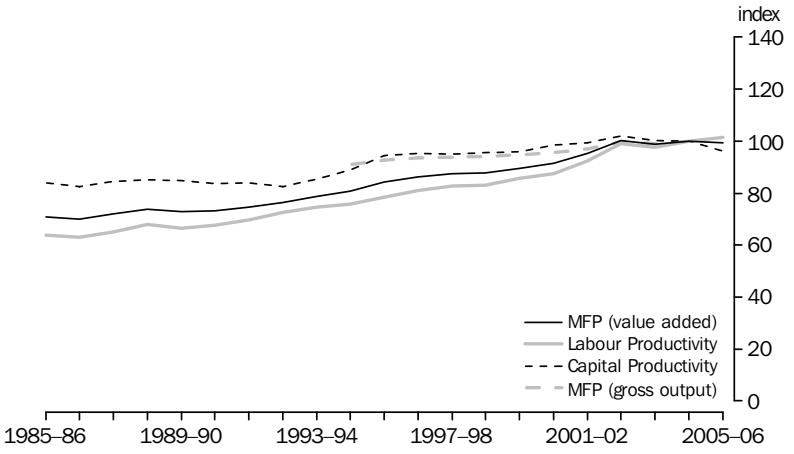
The Transport & storage industry includes businesses primarily engaged in the provision of passenger and freight transport and associated services. This industry includes most forms of road, air, sea and rail transport; services to transport such as stevedoring, airport operations and travel agencies; pipeline transport; grain storage and general warehousing services. The contribution of the Transport & storage industry to total GDP has been relatively constant at around 5%. Value added growth in the Transport & storage sector was 3.7% per year between 1985–86 and 2005–06, and has generally followed a similar pattern to GDP growth.

PRODUCTIVITY

Growth in value added based multifactor productivity (MFP) in the Transport & storage industry averaged 1.7% per year between 1985–86 and 2005–06 (figure 11.1), compared to 1.2% per year MFP growth for the market sector. MFP has been flat since 2002–03.

A comparison between value added MFP growth and gross output MFP growth shows that value added MFP grew at a much higher rate (figure 11.1). Intermediate inputs contribute around 60% of all inputs into this industry, leading to the lower growth rate of gross output MFP relative to value added MFP. Both gross output MFP and value added MFP peaked in 2002–03, displaying insignificant growth since then.

11.1 TRANSPORT & STORAGE MFP, LABOUR AND CAPITAL PRODUCTIVITY, (2004-05 = 100)

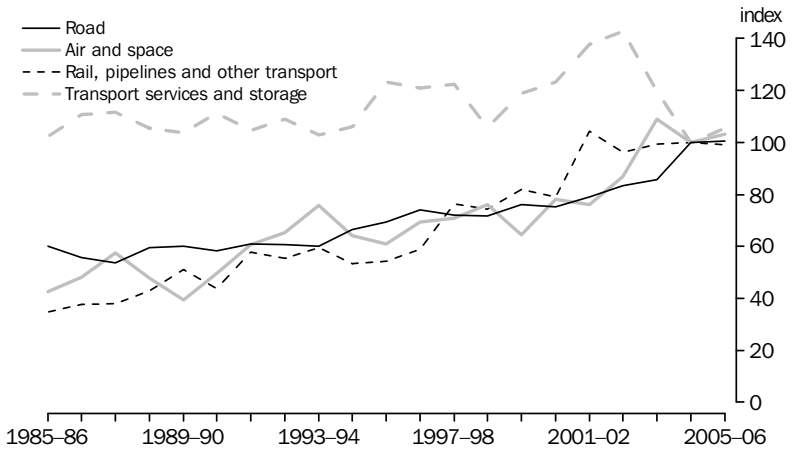


Labour productivity has moved in a similar pattern to MFP. Between 1989–90 and 2002–03 labour productivity grew at a rate of 3.1% per year. Since 2002–03 labour productivity has grown at 0.8% per year.

PRODUCTIVITY

continued

11.2 TRANSPORT & STORAGE LABOUR PRODUCTIVITY BY SUB-INDUSTRY, (2004-05 = 100)

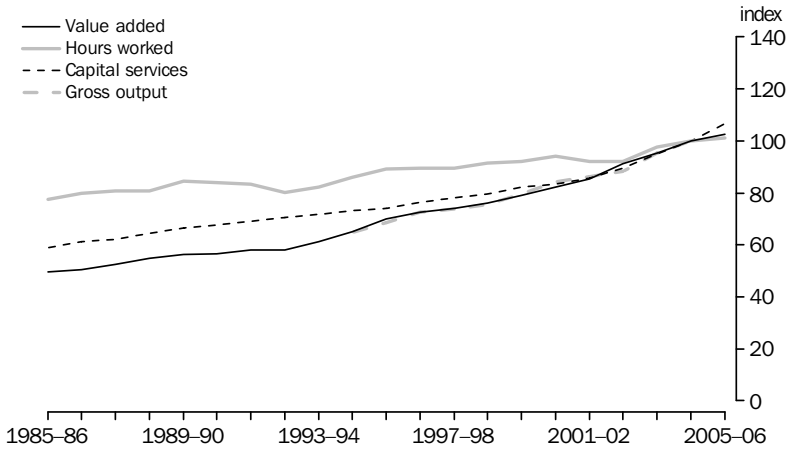


The three major transport sub-industries of Road, Air and space, and Rail, pipelines and other transport have all displayed significant labour productivity growth (figure 11.2). There were significant rises in labour productivity for transport services and storage during the mid to late 1990s, but a fall of almost 40% since 2001–02 was due to employment levels growing significantly faster than output.

OUTPUT

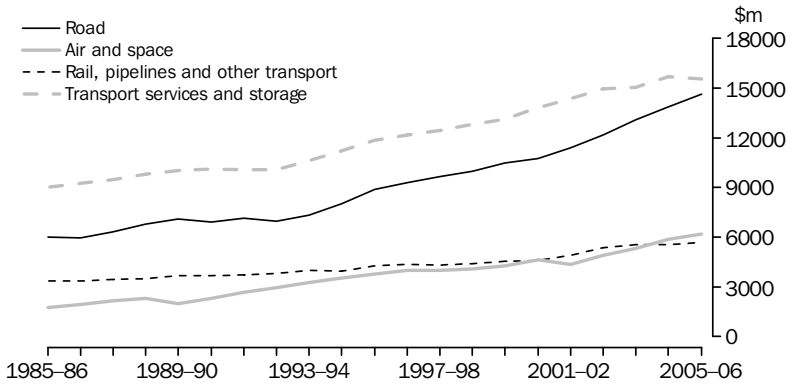
Growth in value added exceeded growth in capital services and total hours worked from 1985–86 to 2002–03 (figure 11.3) but since 2002–03 growth in both capital and labour inputs increased significantly, matching the rate of output growth.

11.3 TRANSPORT & STORAGE OUTPUTS AND INPUTS, (2004-05 = 100)



OUTPUT *continued*

11.4 TRANSPORT & STORAGE VALUE ADDED BY SUB-INDUSTRY, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

Value added by sub-industry (figure 11.4) shows that road transport and transport and storage services contribute the bulk of output and hence the bulk of growth in this industry. Road transport has shown the strongest growth and rail, pipeline and other transport the lowest.

LABOUR INPUTS

11.5 TRANSPORT & STORAGE TOTAL EMPLOYMENT

Total employment in this industry has shown an upward trend between 1985–86 and 2005–06, with employment growth accelerating significantly since 2002–03 (figure 11.5). There has been substantial employment growth in storage and increases in part-time employment across all divisions. The increase in employment in the storage sector has been particularly significant, with employee numbers doubling between 2002–03 and 2005–06.

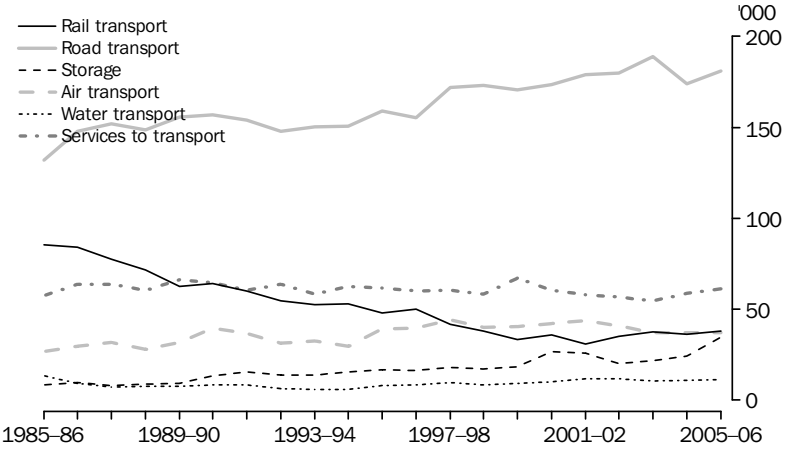
The trend towards lower average working hours per employee in many Australian industries has not occurred to any significant extent in the Transport & storage industry (ABS 2007a). However, the industry does have one of the lowest percentages of part time employees, although this percentage has increased. Part-time employees represented just 2% of the workforce in 1985–86, increasing to 8% by 2005–06. The

LABOUR INPUTS
continued

compositional effect of an increase in part-time employees was offset by an increase in average working hours for full-time employees. Average hours per week for all employees increased marginally from 38 to 38.7.

Between 1985–86 and 2005–06 there were changes in the composition of employment at the industry subdivision level. The proportion of persons employed in rail transport decreased, while the proportion of persons employed by the road transport subdivision increased (figure 11.6). There has also been a significant increase in employment in the storage subdivision. These changes in employment may have an effect on overall productivity growth as different subdivisions will have different levels of productivity.

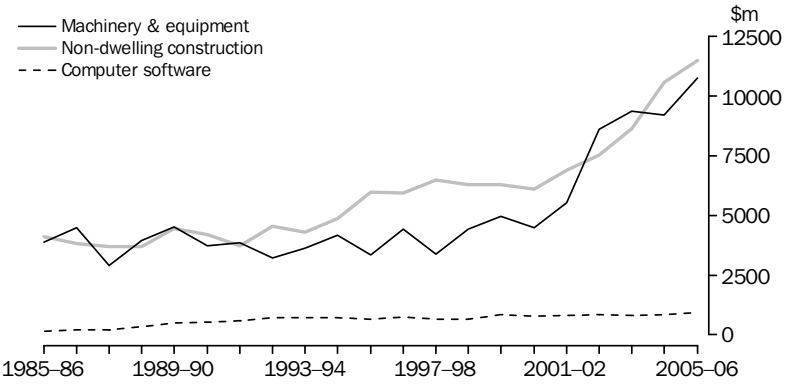
11.6 TRANSPORT & STORAGE EMPLOYMENT BY SUBDIVISION



CAPITAL INPUTS

Growth in capital services in Transport & storage accelerated from 2002–03 (figure 11.3). This is linked to the significant increase in gross fixed capital formation (GFCF) since 2001–02. The increase in GFCF has been driven by a significant increase in both investment in machinery and equipment and non-dwelling construction (figure 11.7).

11.7 TRANSPORT & STORAGE GROSS FIXED CAPITAL FORMATION BY ASSET TYPE, Chain volume measure (a)

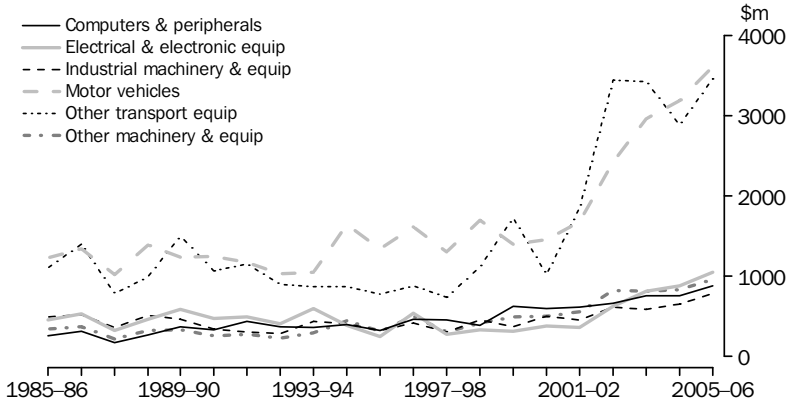


(a) Reference year for chain volume measures is 2004-05.

CAPITAL INPUTS
continued

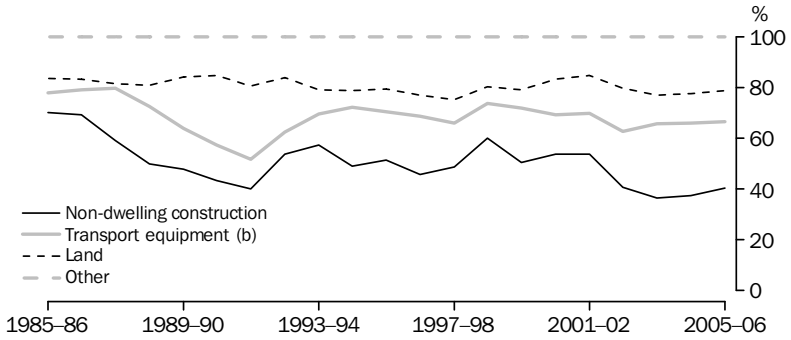
In 2005–06, non-dwelling construction and machinery and equipment each represented around half of total GFCF. Figure 11.8 shows GFCF for different assets in machinery and equipment. The figure shows the bulk of investment is in motor vehicles and other transport equipment. This is consistent with data that shows above average growth in commercial vehicle sales (ABS 2007b) along with a significant increase in commercial aircraft investment (Qantas 2003–2006, Virgin 2005). A significant proportion of capital in this industry is leased, but is classified as a finance lease and therefore placed within Transport & storage capital inputs and not as an intermediate input. A significant proportion of commercial aircraft, motor vehicles and other transport equipment would be classified in this manner.

11.8 TRANSPORT & STORAGE MACHINERY AND EQUIPMENT GROSS FIXED CAPITAL FORMATION, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

11.9 TRANSPORT & STORAGE, RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
(b) Transport equipment includes road vehicles and other transport equipment
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

Figure 11.9 shows the rental price weights used to aggregate the component capital services series in respect of the Transport & storage industry. Since 2001–02 there has been an increase in the weight for other transport equipment. This increase reflects the fact that the prices of these types of assets have been falling over this period while the prices of the other assets have remained steady or have been increasing. In the user cost

CAPITAL INPUTS
continued

formulation used to model rental prices of assets, a relative decline in the price of an asset translates into a relative increase in its rental price.

11.10 TRANSPORT & STORAGE PRODUCTIVE CAPITAL STOCK BY ASSET

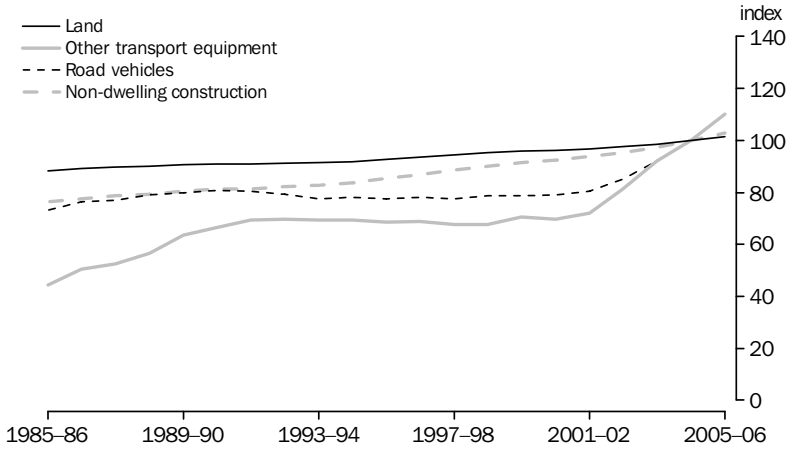
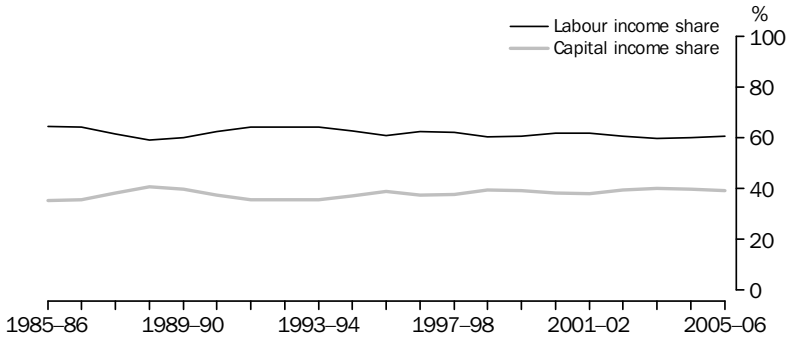


Figure 11.10 shows the significant increase in the productive capital stock for both road vehicles and other transport equipment since 2001–02. Growth in the productive capital stock of non-dwelling construction has not changed significantly, despite the large increase in GFCF for this asset type.

INCOME

11.11 TRANSPORT & STORAGE, LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

There has been a slow but noticeable change in the capital and labour shares of income. The labour share of income has decreased from 66% to 60% from 1985–86 to 2005–06 (figure 11.11). Most of the fluctuations in the capital and labour shares are being driven by changes in labour inputs.

SUMMARY

The fall in Transport & storage productivity growth since 2002–03 is linked to a big increase in investment and employment as output growth remained relatively constant. These changes have come from the significant increase in employment in the storage subdivision and increases in capital formation, mainly in the form of commercial aircraft and motor vehicles. Also, the compositional change occurring within the industry is affecting productivity levels and in turn productivity growth. More research is also required to analyse the relationship between Transport & storage and the Wholesale trade industry, and how this might be affecting productivity growth.

CHAPTER 12 COMMUNICATION SERVICES

In 2005–06 the Communication services industry contributed 2.7% to GDP, down from 3.3% in 1993–94. The industry consists of firms providing postal, courier and telecommunications services. Conventional wired telephony services, internet services and the provision of mobile telephone services are included in telecommunications services and postal services includes pick up and delivery for postal, package and courier items. Bulk transport of postal items is usually classified as part of the Transport & storage industry. Multifactor productivity (MFP) growth in this industry has averaged 3.6% per year between 1985–86 and 2005–06, well above market sector MFP growth as a whole. There have been significant structural changes within the industry over the last 20 years. In 1985–86 the industry was almost exclusively publicly owned and controlled through two major government bodies, the Australian Telecommunications Commission trading as Telecom, and the Australian Postal Commission trading as Australia Post. Since that time the industry has been substantially deregulated and privatised. The changes within the industry alongside significant changes in technology would have affected productivity growth. Deregulation of the telecommunications industry saw competition initially entering the industry in 1992 and 1993, followed by a larger number of mostly service re-sellers after further deregulation in 1997.

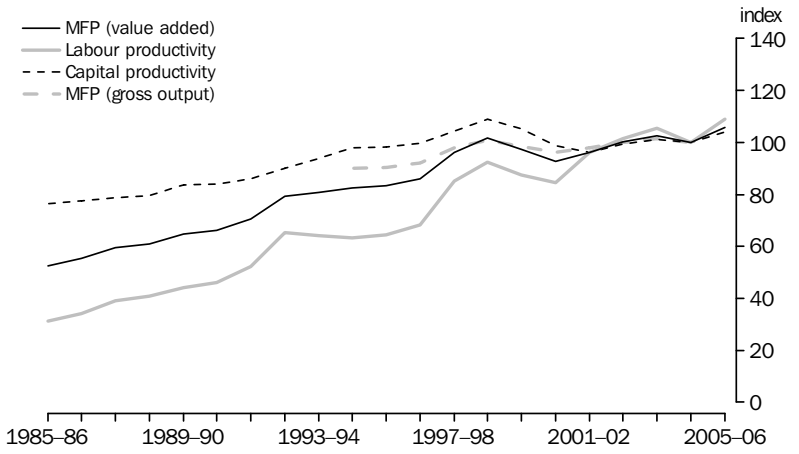
PRODUCTIVITY

Value added based MFP growth trended upward from 1985–86 to 1998–99. In 1999–00 there was a significant fall in MFP as inputs continued to rise while output slowed, with growth resuming an upward trend in 2001–02. The 1990s saw a series of changes within the industry such as corporatisation, deregulation and extra competition in the market, which are likely to have affected productivity growth. Changes to output composition, such as the introduction of the internet and mobile telephone services, are also likely to have affected productivity growth. A comparison between gross output MFP and value added MFP shows that value added MFP has been growing at a faster rate than gross output MFP measure, but in a similar pattern (figure 12.1).

PRODUCTIVITY

continued

12.1 COMMUNICATION SERVICES MFP, LABOUR AND CAPITAL PRODUCTIVITY, (2004-05 = 100)



Labour productivity in the Communications industry displays significant growth (figure 12.1). Labour productivity growth from 1985–86 to 2005–06 averaged 6.5% per year, significantly higher than the market sector average. This was due to high growth in value added and slow growth in employment, with employment growth averaging around 1% per year from 1985–86 to 2005–06.

Capital productivity displayed slower growth when compared to labour productivity and MFP, although it had a similar pattern. Capital productivity displayed the same peak in 1999–00 followed by a significant decline.

OUTPUT

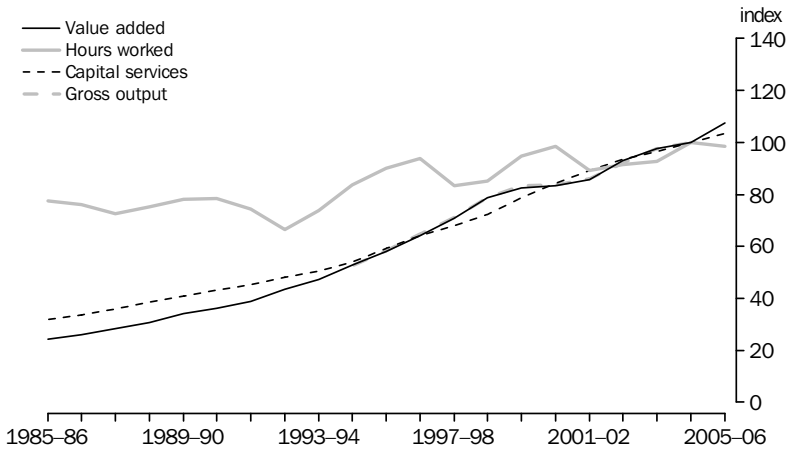
Value added in Communication services has displayed significant volume growth, averaging approximately 8% per year since 1985–86 (figure 12.2). Value added growth has been positive for the entire period between 1985–86 and 2005–06. Growth slowed slightly between 1998–99 and 2001–02, but still continued to grow at over 3% per year.

Despite the strong growth in output volumes in the Communications services industry, its contribution to GDP in current prices has fallen from 3.3% in 1993–94 to 2.7% in 2005–06, indicating that there has been a rapid fall in output prices. Information and communications technologies form a significant component of the assets used by this industry as capital inputs and it is likely that the large fall in the price level for these assets is likely to have significantly reduced marginal costs within the industry. The fall in marginal costs will have contributed to a reduction in the output price level.

There have been significant changes in the services provided by this industry. In 1985–86 the two major outputs were traditional wired telephony services and postal services. By 2005–06 the industry also offered mobile telephone services, satellite communications and the provision of both wired and wireless internet services. Postal services have also represented a declining a share of industry output. Compositional change can have an effect on productivity measurement because of different requirements for labour, capital and intermediate inputs of each product.

OUTPUT *continued*

12.2 COMMUNICATION SERVICES OUTPUTS AND INPUTS, (2004-05 = 100)



LABOUR INPUTS

There have been two notable periods of decline in the number of hours worked in the industry during the 1990s (figure 12.2). These coincide with restructuring among larger firms in the industry that occurred immediately prior to the major stages of deregulation in 1992 and 1997 (PC 2001). A third period of decline in the early 2000s coincides with a period of consolidation and a small number of high profile failures in the market, with the majority of the falls in employment among elementary sales, service and clerical positions and transport workers.

The structural shifts in this industry, such as the changing output composition and the declining income share of postal & courier services, have had a significant impact on labour force composition. Overall this industry has seen a move away from elementary sales & clerical staff and labourers towards a higher proportion of managers, advanced clerical staff and professionals.

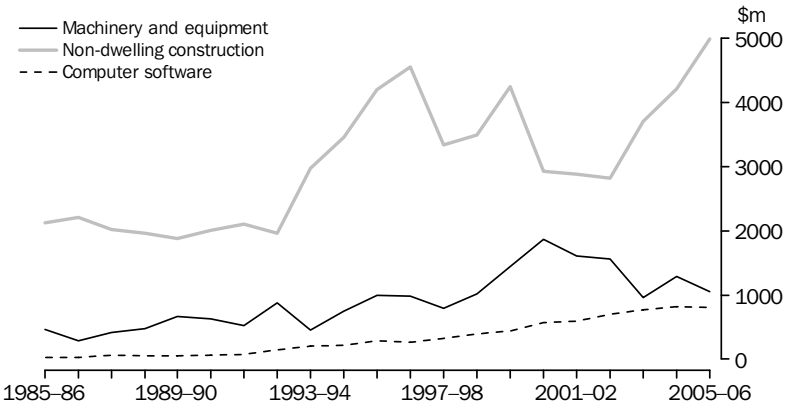
CAPITAL INPUTS

The level of gross fixed capital formation (GFCF) in machinery and equipment in this industry was high between 1999–00 and 2002–03, with a significant decline since then. This investment coincided with the entry of new firms into the industry and likely contributed to the lower productivity growth during that period. The growth in capital inputs has been driven by computer equipment, electrical equipment and computer software capital formation (figure 12.3). GFCF is highest in non-dwelling construction but investment in ICT equipment has also had a significant impact on capital services.

CAPITAL INPUTS

continued

12.3 COMMUNICATION SERVICES GROSS FIXED CAPITAL FORMATION BY ASSET TYPE, Chain volume measure (a)



(a) Reference year for chain volume measures is 2004-05.

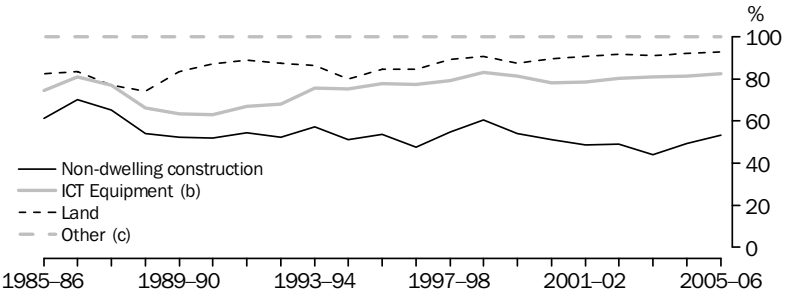
GFCF in this industry follows technological advancements, with a cyclical profile coinciding with the introduction of new technologies. This is particularly true for non-dwelling construction, as investment in new physical networks is not a regular occurrence and usually follows significant technological advancements, whereas ICT equipment is more likely to be upgraded on a regular basis (PC 2001). The peaks in capital formation after 1997 were most likely related to the rollout of mobile phone and internet services by the larger providers; rather than as a result of new, smaller firms entering the market. It was during this time that the penetration of internet services began accelerating with the introduction of ADSL services to households in 2000.

The majority of machinery and equipment investment in this industry is in information & communications technology (ICT) equipment, such as computers & peripherals and electrical & electronic equipment. The price level of ICT equipment declined significantly between 1985–86 and 2005–06, with the price level of electrical & electronic equipment declining by 2.2% per year and computer software declining by 3.4% per year. Computer equipment declined in price by nearly 16% per year over the same period. Although the rental price of ICT equipment fell significantly due to the decline in price level of these assets, the rental price weight of this equipment increased significantly from 1985–86 to 2005–06, indicating that large volume increases are the main contributing factor to the increase in the rental price weight (Figure 12.4). The productive capital stock of ICT equipment increased significantly faster than either non-dwelling construction or land, which are the two other main assets held in this industry (Figure 12.5).

CAPITAL INPUTS

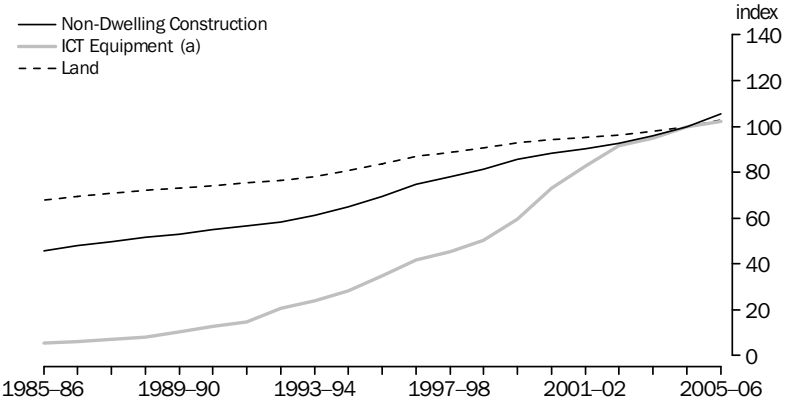
continued

12.4 COMMUNICATION SERVICES RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
(b) 'ICT Equipment' includes computers, electrical & electronic equipment and computer software.
(c) 'Other' includes motor vehicles, other transport equipment, industrial machinery & equipment and other plant & equipment.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

12.5 COMMUNICATION SERVICES PRODUCTIVE CAPITAL STOCK BY ASSET, (2004-05 = 100)



(a) 'ICT Equipment' includes computers, electrical & electronic equipment and computer software.

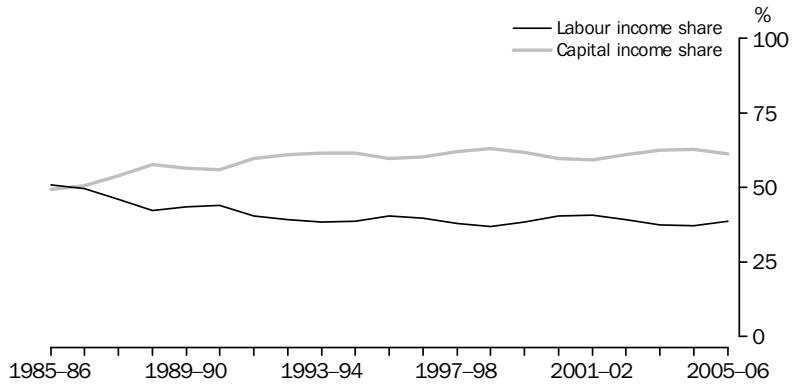
INCOME SHARES

The capital share of income increased on average 1% per year between 1985–86 and 2005–06 (figure 12.6). The increase in the capital share of income is likely to have been driven by the relative decline in employment levels. This is a reflection of the change in the composition of the industry away from labour intensive postal and telephone services into capital intensive information technology services.

INCOME SHARES

continued

12.6 COMMUNICATION SERVICES LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

Analysis of productivity growth in Communication services over an extended time period is difficult due to changes in the composition of industry output as the products and services that make up industry output changed considerably between 1985–86 and 2005–06. The growth in internet and mobile telephone services and the relative decline of postal services will have had an affect on measured productivity as each new activity would have different labour and capital requirements to traditional telephone and postal services. It is difficult to separate the impact of structural change from the impact of compositional changes in output when analysing MFP growth and any analysis of productivity growth in this industry should take this into consideration.

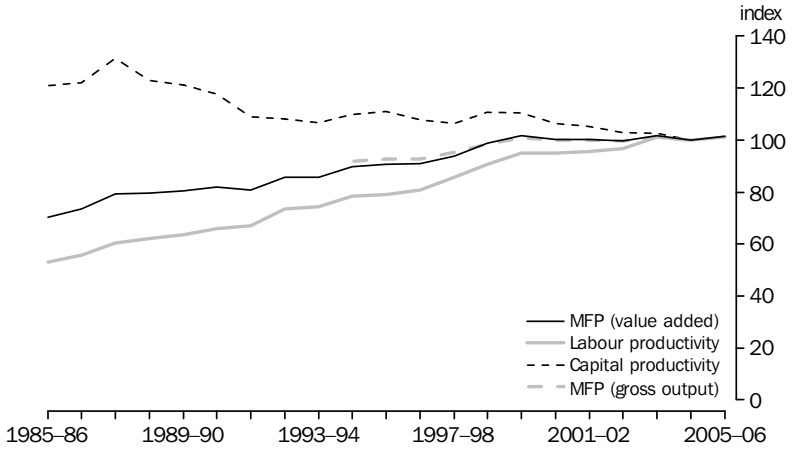
CHAPTER 13 FINANCE AND INSURANCE

The Finance & insurance industry contributes just over 7% to GDP. The industry's contribution to the total economy grew significantly through the 1980s, which likely reflects the deregulation that was undertaken over that period. Since the early 1990s, the proportion of the economy that is the Finance & insurance industry has remained stable.

PRODUCTIVITY

Between 1985–86 and 2005–06 average annual MFP growth on a value added basis was around 1.8% per year, which is stronger than average annual market sector MFP growth over this period (1.2% per year). While there was a relatively strong increase in MFP up to 1999–00, it has levelled out since then. Labour productivity has also trended upwards (figure 13.1) since 1985–86, although the pace has slowed since 1999–00. Capital productivity has followed a downward trend since 1988–89.

13.1 FINANCE & INSURANCE MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)



Underlying the changes in the productivity estimates are the changes in output and the factors of production. Figure 13.2 presents the series for these indicators. The labour index has increased slowly since the early 1990s following a fall from the peak in 1989–90[4]. The output and capital input series both increased at roughly the same rate through the course of the last 20 years.

4 The higher labour index in recent years reflects a combination of an increase in average hours worked and employment, though employment is still just below the peak recorded in 1989–90.

PRODUCTIVITY
continued

There is little difference between the gross output and gross valued added measures of MFP. Growth in intermediate inputs through the latter part of the 1990s slowed growth in gross output based MFP relative to the gross value added measure. The fact that there is only a small difference in growth is unsurprising given the relatively low use of intermediate inputs by this industry, at 35% of total input cost in 2004–05.

OUTPUT

There are a range of conceptual issues underlying the output indicators in the Finance & insurance industry. First and foremost is identifying what it is that should be measured as output in the Finance & insurance industry and measuring the volume of this output.

The Finance & insurance industry provides a set of relatively intangible services. In the Finance segment of the industry the range of services includes providing a place to deposit money, providing access to credit, and providing financial advice and management services. The prudential services of the Insurance industry are equally hard to quantify. Moreover, the services across the industry are not homogenous nor directly comparable (though they may be more homogenous than the services of some other industries such as Cultural & recreational services).

13.2 FINANCE & INSURANCE OUTPUTS AND INPUTS, (2004-05 = 100)

Gross output in the Finance industry is derived as the sum of financial intermediation services indirectly measured (FISIM), explicit service charges and gross rents of banks and other finance institutions. FISIM is basically calculated as the earnings by financial firms from the differential between the interest paid on deposits held at the firm and the interest earned on loans provided by the firm. Output in the Insurance industry is derived as the sum of premiums collected and investment income earned by insurance companies less claims paid. In both cases, value added is derived by deducting intermediate consumption from gross output.

While these definitions are useful for describing the value of output, there remains a lack of clarity in the description of the volume of output from the Finance & insurance industry. Whereas it is generally feasible to measure the value of the output in current prices, deflating the indirectly measured components of this output to a volume measure is problematic because a price change between the two periods is not readily

OUTPUT *continued*

identifiable(more information can be obtained from *Australian System of National Accounts: Concepts, Sources and Methods*, chapter 10, cat.no. 5216.0).

The period around 1989–90 was a period of significant transition and readjustment for the Finance & insurance industry. During this period, the banking industry experienced losses that were equivalent to 2.3% of GDP in 1989–90 (Gizycki and Lowe 2000). In volume terms value added growth slowed in 1990–91 and fell in 1991–92 by 3.8%. This decline in output had followed a period of significant deregulation in the 1980s that had intensified competition in the Australian finance industry. Through this period, a property price bubble was also expanding quickly. However, the recession of the early 1990s saw a significant slowdown in housing market activity, resulting in an associated fall in Finance & insurance industry value added.[5]

One of the most notable changes in the Finance & insurance industry in more recent years has been the introduction of new electronic banking and finance services. Compared to twenty years ago when withdrawals and deposits were usually done through a teller, today they are frequently made electronically through an ATM, over the internet, or at the point of sale using EFTPOS. Also, twenty years ago bank transfers were carried out in a branch, whereas today they can be carried out over the internet. In addition, specialised brokers generally facilitated trading in shares twenty years ago, today people are able to quickly and easily access the market through the internet. Technological changes may have enabled banks to achieve both economies of scale and scope, although much of the evidence is anecdotal.

LABOUR INPUTS

Changes in the industry are also evident in the hours worked data presented in figure 13.2. Labour flowed into the industry following the period of deregulation as firms sought to expand in the newly liberalised marketplace. The increase in service provision, partly associated with the significant increase in commercial lending for property investment saw value added also increase strongly in the years leading up to 1989–90. However, both value added and labour fell significantly, as parts of the industry had record losses.

There has been some changes in the employment patterns within the Finance & insurance industry. The industry has seen a small shift to part-time employment over the last twenty years, most notably in Insurance (14% to 19% of total employment) and the Services to Finance and Insurance (19% to 26% of total employment). The other aspect of employment that is changing relates to changes in occupations employed within the industry. The main occupations in the Finance & insurance industry are managers, professionals, clerical, sales and service workers. However, the number of clerical, sales and service workers declined over the last 20 years while managers and professionals have increased.

CAPITAL INPUTS

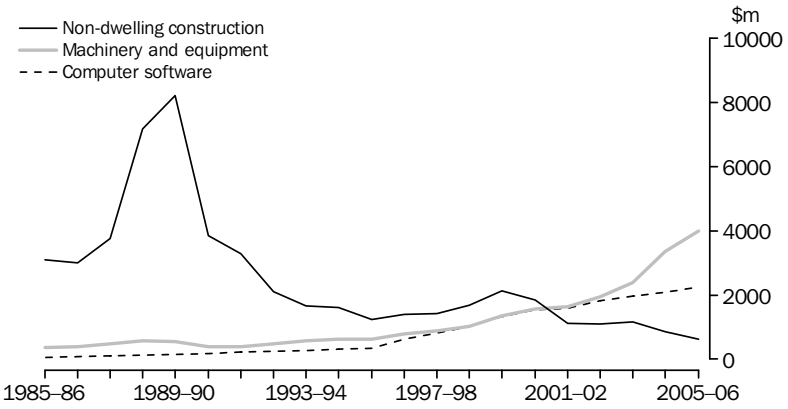
The introduction of new banking and finance services drove the increase in GFCF in the sector that began in the mid 1990s (figure 13.3). The disaggregation of GFCF demonstrates that firms began to invest heavily in computers and computer software in the late 1990s (figure 13.4) and that this investment continued to grow strongly through to the mid 2000s. GFCF in software, electrical and electronic equipment, and computers drove the growth in GFCF in the industry.

5 Gross operating surplus in current prices fell by around 25 per cent in 1989–90.

CAPITAL INPUTS

continued

13.3 FINANCE & INSURANCE GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

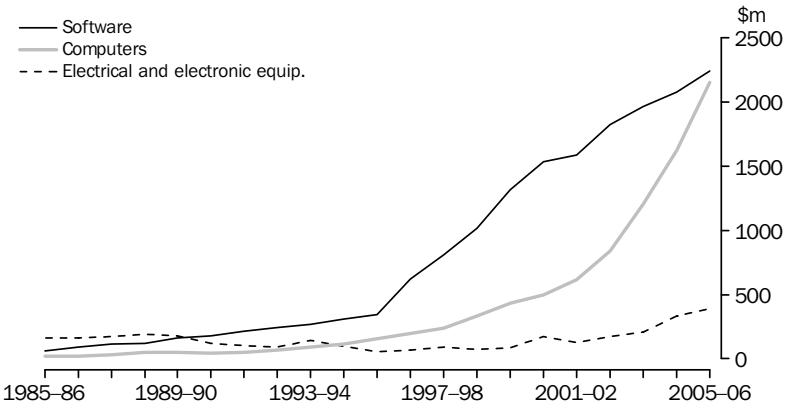


(a) Reference year for chain volume measures is 2004-05.

This changing nature in the delivery of financial services also suggests that fewer branches (buildings) may have been required to house the delivery of face-to-face services. Anecdotally this can be seen through the reduction in the number of branches, which is consistent with the decline in in non-dwelling construction through the early 2000s (figure 13.3). Non-dwelling construction's impact on capital services, as measured by the rental price weight, has declined from 60% in 1985–86 to 52% in 2005–06. Conversely, software has increased its rental price weight (figure 13.5) because of large volume increases in its productive capital stock.

From 1989–90 to 1997–98, average annual growth in capital services was around 3.7% per year. From 1997–98 to 2005–06, average annual growth in capital services accelerated to around 5% per year.

13.4 FINANCE & INSURANCE GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

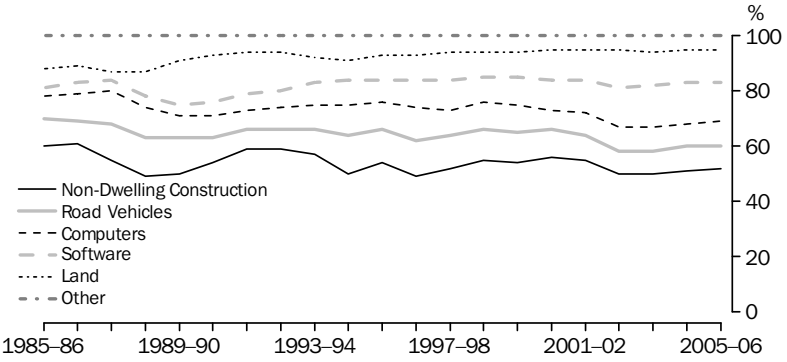


(a) Reference for chain volume measures is 2004-05.

CAPITAL INPUTS *continued*

Much of the story in the growth in capital services is attributable to changes in the composition of GFCF, principally because of the short service lives of the types of assets increasingly purchased, particularly for computers and computer software. This contrasts with long lived assets, like land and some forms of construction, which deliver services proportionate to their stock over a far longer period. Growth in productive capital stock in figure 13.6 also reflects this. Figure 13.6 shows little growth in productive capital stock for most assets since the early 1990s, with the exception of the two technology assets. Changes in productive capital stock and asset rental price weight determine the industry capital services index.

13.5 FINANCE & INSURANCE RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
Rental price weights are formed from capital rents for each asset. Capital rent is defined as the rental price multiplied by the productive capital stock.

13.6 FINANCE & INSURANCE PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)

INCOME SHARES

The capital share of income grew significantly over the 1990s (figure 13.7). This means that capital services were weighted more heavily in the input index, and consequently, the input index grew strongly because of the strong growth in capital services. Even though value added was continuing to maintain its trend growth, the strong growth in the input index meant that MFP growth levelled off from the beginning of the 2000s. Unusually strong capital deepening in the form of investment in new electronic methods

INCOME SHARES
continued

of service delivery was having an impact on short-run MFP growth that could be expected.

13.7 FINANCE & INSURANCE LABOUR AND CAPITAL INCOME SHARES

Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is the compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

Reforms, changes in technology and changes in the nature of service delivery in this industry were reflected in growth in productivity over the 1980s and 1990s. Since the beginning of this decade there has been minimal productivity growth. This is mainly due to the strong growth in capital services, especially technological assets. However, there are a number of issues relating to the measurement of output that could impact on this result and will need further research. Key amongst these is understanding what is being captured in the measurement of output, and adequately capturing the change in the nature of service delivery. Part of this is also accurately measuring volume of output with appropriate price deflators.

CHAPTER 14 CULTURAL AND RECREATIONAL SERVICES

Cultural & recreational services is the smallest industry in the Australian economy, contributing approximately 1.6% to GDP in 2005–06. The industry comprises libraries, museums, parks and gardens, sporting facilities, gambling services, radio and television services, production, distribution and exhibition of film. In terms of employment, the largest subdivision within this industry is sport and recreation, with an employment share of 54% in 2005–06. This is followed by libraries, museums and the arts with 28% and motion picture, radio and television services with 18% of employment. Since 1985–86, the employment share of motion picture, radio and television services has declined, with the other two subdivisions increasing. The output of Cultural & recreational services includes a sizeable public sector component. In 2005–06, the public sector share of value added was approximately 15%. The public sector outputs are mainly non-market activities such as, libraries, museums, parks and gardens.

PRODUCTIVITY

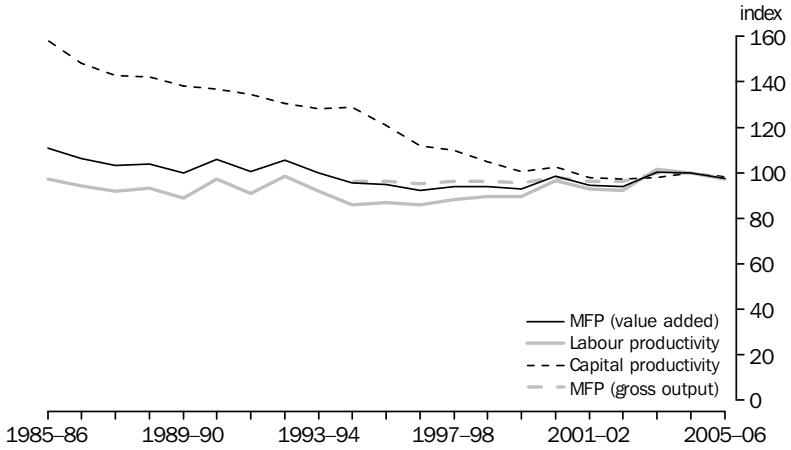
Figure 14.1 presents labour productivity, capital productivity and multifactor productivity (MFP) measures for Cultural & recreational services. Between 1985–86 and 2005–06 there was no growth in labour productivity, while MFP on a value added basis recorded, on average, negative growth of 0.6% per year, compared to market sector MFP growth of 1.2% per year. Capital productivity also declined, falling 2.4% per year between 1985–86 and 2005–06.

The gross output based measure of MFP for the period 1994–95 to 2004–05 is also shown in figure 14.1. The figure shows little difference in the two MFP measures, except that the gross output based MFP growth was flatter reflecting the influence of intermediate inputs.

PRODUCTIVITY

continued

14.1 CULTURE & RECREATIONAL SERVICES MFP, LABOUR PRODUCTIVITY AND CAPITAL PRODUCTIVITY, (2004-05 = 100)



OUTPUT

Value added in volume terms grew by 3.2% per year on average between 1985–86 and 2005–06 (figure 14.2). In 2000–01 value added was boosted by the Sydney 2000 Olympics, with growth of 7.0%.

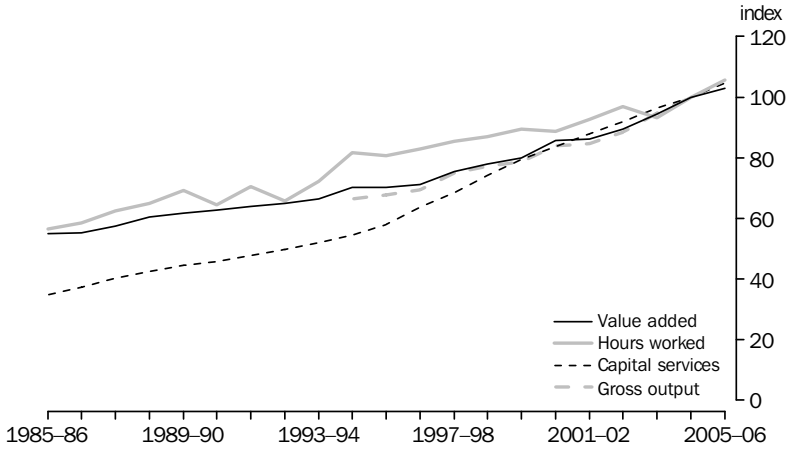
Data for the public and private sectors for this industry come from two different sources. For private sector, output is based on sales of goods and services from the ABS Quarterly Business Indicators Survey. This survey covers services such as, gambling, sport and recreational, cultural and entertainment and broadcasting. The public sector data is based on Government financial reporting records and contains a significant non-market element which is valued at cost.

The diversity of activities within this industry means that obtaining appropriate volume measures is problematic. Rather than using output prices for the deflators, a number of proxies are used, such as the CPI and labour cost indexes. In addition, volume estimates are unlikely to capture all aspects of quality change.

Growth in value added accelerated in the mid 1990s, coinciding with higher incomes, which may have influenced demand for these activities. That is, an increase in affluence may mean that individuals were able to spend more on cultural and recreational activities.

OUTPUT *continued*

14.2 CULTURE & RECREATIONAL SERVICES OUTPUTS AND INPUTS, (2004-05 = 100)



LABOUR INPUTS

Hours worked in this industry increased by an average of 3.2% per year between 1985–86 and 2005–06 (figure 14.2). There was particularly strong growth in hours worked over the two years 1993–94 and 1994–95, following the recession. This was due to a significant increase in employment as average hours worked remained relatively stable.

To some extent it appears that this industry might provide an example of 'Baumol's cost disease'. Baumol and Bowen (1966) point out that the same number of musicians are needed to play in a string quartet today as in the 1800s. The inference is that it may be difficult to obtain any productivity improvement because output will be constant as there is no quality adjustment to be made. Labour will also remain constant, and that all that changes are costs. On the other hand, there may be some areas at the industry level where productivity improvements might occur. For instance, industry output is recorded for a whole year of the string quartet and not just one performance. Travelling time between performances has improved since the 1800s, thus making it possible to give more concerts, without any substantial increase in inputs.

The composition of labour in the Cultural & recreational services industry has changed since 1985–86. The share of employment in libraries, museums and the arts subdivision has grown from 23% in 1985–86 to 28% in 2005–06. The subdivision covering motion picture, radio and television services has declined from 25% to 18%, while sport and recreation increased moderately.

There has also been a shift towards more part-time employment in the industry. Since 1985–86, part-time employment grew strongly in sports and recreation, and the libraries, museums and the arts sub-divisions.

CAPITAL INPUTS

Capital services recorded strong growth, averaging 5.7% per year between 1985–86 and 2005–06 (figure 14.2). This is almost twice as fast as value added growth. Capital services are affected by changes in gross fixed capital formation (GFCF) and this drives growth in the productive capital stock.

CAPITAL INPUTS *continued*

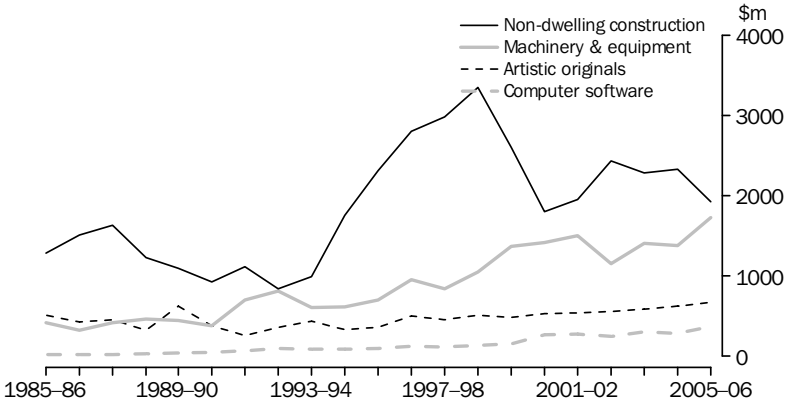
Figure 14.3 shows GFCF for Cultural & recreational services. Between 1993–94 and 1998–99, there was rapid growth in GFCF. This growth appears to be a level shift in investment as growth prior to 1993–94 and post 1998–99 are both relatively flat. This shift is also reflected in the capital services series, which shows a change in growth around 1996–97 (figure 14.2). One possible reason for this short period of strong growth is due to the increase in non-dwelling construction GFCF as a result of the announcement of the hosting the Olympics (figure 14.4).

The growth of non-dwelling construction GFCF is important because capacity utilisation may be an issue that requires further consideration. Capacity utilisation of Cultural & recreational facilities such as concert halls and sports stadium are likely to vary significantly in the short term. However, it would be difficult to ascertain whether the rate of capacity utilisation changes over the long term.

14.3 CULTURAL & RECREATIONAL SERVICES GROSS FIXED CAPITAL FORMATION, Chain volume measures (a)

(a) Reference year for chain volume measures is 2004-05.

14.4 CULTURE & RECREATIONAL SERVICES GFCF BY ASSET, Chain volume measures (a)

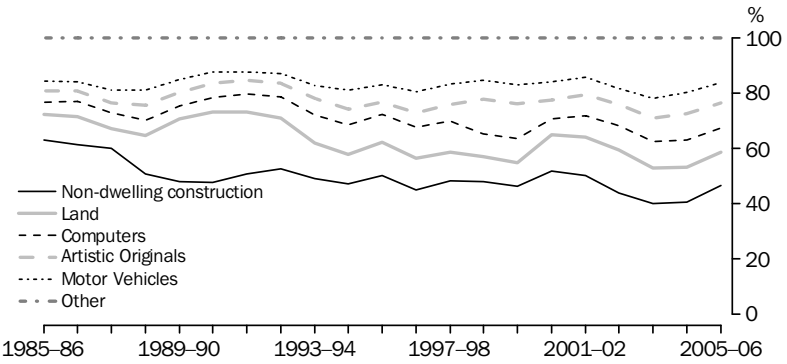


(a) Reference year for chain volume measures is 2004-05.

CAPITAL INPUTS *continued*

In addition to GFCF, rental price weights (figure 14.5) also influence capital services. Since 1985–86 rental price weights for non-dwelling construction declined. This was due to slower growth in the productive capital stock for non-dwelling construction compared to other assets (figure 14.6). Other assets with relatively large rental price weights are land, artistic originals, electrical and electronic equipment and motor vehicles, which all increased their respective shares over the last 20 years.

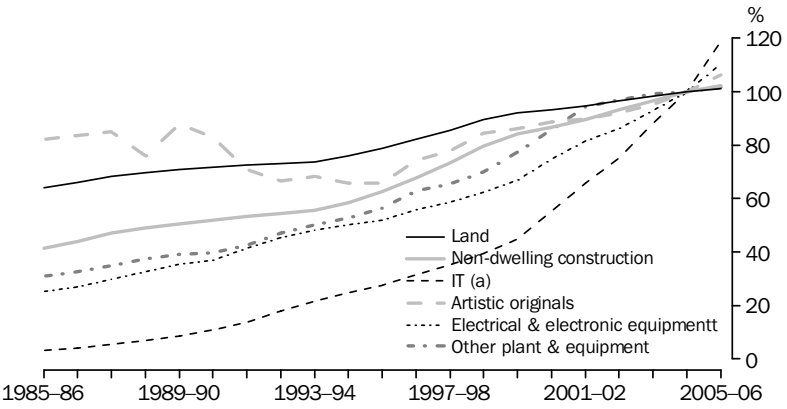
14.5 CULTURE & RECREATIONAL SERVICES RENTAL PRICE WEIGHTS (a)



(a) Chart lines are cumulative shares.
Rental price weights are the asset's share of capital rent. Capital rent is the product of the asset's rental price and productive capital stock.

Figure 14.6 shows strong growth in productive capital stock between 1993–94 and 1998–99 for non-dwelling construction. However, most other assets experienced even stronger growth over the later half of the 1990s, such as electrical and electronic equipment and other plant and equipment.

14.6 CULTURE & RECREATIONAL SERVICES PRODUCTIVE CAPITAL STOCK, (2004-05 = 100)



(a) IT includes computers and computer software.

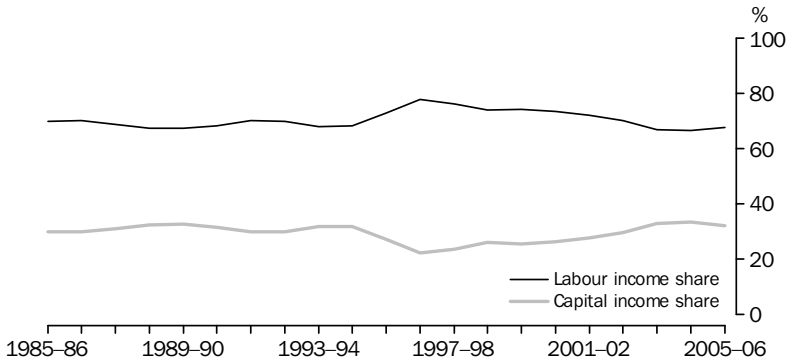
INCOME SHARES

Figure 14.7 highlights the capital and labour income shares for the Cultural & recreational services industry. Between 1985–86 and 2005–06 capital and labour income shares averaged 29% and 71% respectively. Despite the rapid growth in capital services, labour continues to dominate total inputs.

INCOME SHARES

continued

14.7 CULTURE & RECREATIONAL SERVICES LABOUR AND CAPITAL INCOME SHARES



Capital income is gross operating surplus plus the capital proportion of gross mixed income. Labour income is compensation of employees plus the labour proportion of gross mixed income.

SUMMARY

Growth in MFP for Cultural & recreational services has been gradually declining compared to market sector MFP growth. Difficulties associated with capturing quality change, especially considering the heterogeneous nature of the industry output should be taken into account when assessing these results.

CHAPTER 15 FUTURE DIRECTIONS

FUTURE DIRECTIONS

While the ABS has been producing multifactor productivity (MFP) estimates for the market sector as a whole for many years, the estimates contained in this paper are the first estimates presented for individual industries within the market sector by the ABS. The estimates represent the results of a significant body of work undertaken within the ABS over the last five years. The paper provides an in-depth analysis of each industry, discussing the validity of the results as well as the data used in construction of the estimates. While the industry analyses indicate plausible results, there are some difficult conceptual and measurement issues at the industry level that are less problematic or do not exist at all at the total market sector level. Because of the difficult measurement issues involved, the ABS qualifies these initial estimates of industry productivity by labelling them as 'experimental'.

The first updated estimates are expected to be released in November 2007, shortly after the release of the annual publication – *Australian System of National Accounts* (cat. no. 5204.0). Aggregate market sector estimates will still be published in *Australian System of National Accounts*.

The ABS invites comments on the estimates from readers. After considering comments received on these initial estimates, the ABS will incorporate any necessary adjustments to the estimation of industry level productivity estimates.

This research has identified a number of areas of productivity measurement that require further work. These are summarised below. Although the ABS remains keen to extend and improve the quality of the estimates as quickly as possible, some of the areas flagged for future research are considered longer term projects. Measurement issues such as adjusting for quality change in service industry outputs have been the subject of discussions for many years by national accountants and price statisticians. Any resolutions of these and other outstanding measurement issues will flow through to quality improvements in productivity statistics.

For the most part, the methodology and data underlying the industry level MFP estimates are the same as those used to estimate annual market sector MFP currently published in cat. no. 5204.0, and the labour productivity estimates published in the quarterly national accounts. The main difference is that market sector MFP includes taxes less subsidies on products, whereas the industry level MFP estimates do not. To achieve consistency with aggregated industry estimates, a possible change might be to remove taxes less subsidies on products for the market sector. This would mean that market sector MFP would be presented in basic prices rather than in purchasers' prices (the current treatment). Any such changes would be discussed with users prior to implementation.

Output

More research needs to be conducted on output volume estimates to gauge the possible impact on MFP estimates of changes to industry output composition over time. Likewise, the potential impacts on MFP of quality change that might not be fully captured in industry output volumes could be better assessed. While this applies to all industries, it is particularly relevant to some service industries where the nature of outputs have changed rapidly over time. Adding to this difficulty is the heterogeneous nature of the output for many industries. The measurement of output volumes for services is made particularly difficult by the intangible nature of most services, making quality change particularly difficult to quantify. The Communications industry is a particular example where the product mix produced within the industry has changed significantly between 1985–86 and 2005–06.

Capital inputs

Further sensitivity analysis on various aspects of capital services measurement, specifically the assumptions surrounding capital estimation at the industry level is to be undertaken. Although considerable work of this nature has already been undertaken to produce the estimates in this paper, future work would extend this to look at other components of the user cost of capital equation such as the rate of depreciation and the effect of capital gains. Based on the outcome of research to date, further work is to be conducted on the use of a mix of asset price deflators and the CPI as the price deflator in the user cost equation, with the idea being to form a better ex ante measure of producer's asset inflation expectations across all industries. The other assumptions used to produce capital estimates, including depreciation and age-efficiency profiles could also be subject to further research.

One of the main methodological challenges is linked to the problem of negative rental prices. Despite the testing of various options for the rental price equation, no single approach eliminated the occurrence of negative rental prices in all cases. Possible solutions that will be assessed include replacing the current endogenous methodology for the rate of return with an exogenous rate of return e.g. the long term bond rate, or smoothing endogenous rates of return. Another possible area of research relates to volatility of asset prices and how this is best handled in the model.

At a specific industry level there are a number of areas for further research. For instance, in the Mining industry, the services of subsoil assets are not currently included in the capital services measure for Mining. Also, the age-efficiency profile for the mineral exploration asset could be reviewed (currently the assumption is made that mineral exploration assets yield constant capital services throughout their service life). Another area that requires further analysis is the assumption of fixed estimates of productive capital stock of land in the Agriculture, forestry & fishing industry.

The impact of capacity utilisation is another topic for further research. The neo-classical assumptions that underpin MFP estimation assume that capacity utilisation is either constant or at least at full capacity at the peak of the cycle. More investigation is needed into the potential impact of changes in capacity utilisation on MFP for some industries. Of the industries studied, only Accommodation, cafes & restaurants has an indicator which may show a change in capacity utilisation, through room occupancy data, but this measure is at best limited in its usability. Given the difficulties of adjusting for capacity utilisation, further investigations could be undertaken into the impacts of measuring

Capital inputs continued

MFP between cycle peaks at the individual industry level, and particularly for those industries that are capital intensive.

Labour inputs

There are a number of areas for further investigation in relation to labour inputs. For instance, a Tornqvist index using compensation of employees to weight hours worked could be developed. The current hours worked index is a simple index, which has an implicit assumption that the marginal product of labour is the same across all industries.

Another area for further research is to adjust the industry hours worked estimates for changes in labour composition. When compiling productivity estimates, increases in aggregate labour composition, such as increased experience and higher qualifications, will not be reflected as increases in labour inputs, but will be reflected in MFP. An aggregate market sector adjustment has been developed and results are published in cat. no. 5204.0, but no industry level adjustments are possible at this stage.

Aggregation

Concurrent with measuring industry level MFP, the ABS will continue to estimate aggregate market sector MFP. This aggregate measure can be estimated directly or by summing the individual industry MFP estimates, but different results would be obtained. If the ABS is to publish industry level MFP estimates then the issue of consistency between the current method and any alternative set of results needs to be addressed since compiling the industry level estimates would naturally raise analytical questions as to their contributions to aggregate MFP growth. Future research will be undertaken to evaluate methods for estimating aggregate and industry level MFP for both value added and gross output measures.

Changes to the national accounts

The national accounts will be subject to a number of changes as a result of the future implementation of ANZSIC 2006 and the revision of the 1993 SNA. These new classifications and standards are expected to be first implemented in the annual national accounts for 2008–09 and the September quarter 2009 quarterly national accounts. These changes will also impact on the industry and total market sector MFP estimates at that time. A considerable amount of data development and analysis will be required to incorporate these changes in the MFP estimates.

APPENDIX 1 DETAILS ON METHODOLOGY

This appendix provides additional details on methodology and data sources that were discussed in Chapter 1 and Appendix 2.

CONCEPTS

Productivity is generally defined as the ratio of a measure of the volume output to a volume measure of input. Multifactor productivity (MFP) is defined as the ratio of output to two or more inputs, which is a relatively simple definition. However, the measurement of productivity is not straightforward. There are various complex issues involved in the measurement of output, input and other components used for deriving the MFP estimates. In fact, the reliability of an aggregate MFP measure for the whole economy is determined by how well the aggregate output, capital and labour and factor incomes are measured. These aggregates in turn depend on almost every aspect of the national accounts.

Moreover, there are various frameworks under which the MFP measure can be obtained. The same productivity measure under different approaches often uses different assumptions, and may give rise to different interpretations. Therefore there are two closely related issues involved in MFP estimation - the measurement issues and the issue of applying the appropriate method.

This appendix focuses on the methodology and the data sources used at the industry level, including measurement issues. The appendix will not present in detail the theoretical framework underpinning the methodology, or the issue of applying the appropriate method. For a treatment of the theoretical framework see *Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth*, OECD Manual (OECD 2001a), *Estimating Industry-level Multifactor Productivity for the Market-Sector Industries in Australia: Methods and Experimental Results* (Zheng 2005), and *Estimates of Multifactor Productivity, Australia* (Aspden 1990).

The approach taken in this paper is based on the growth accounting framework established by Solow (1957). This provides for a derivation of the MFP measure based on an aggregate production function. This aggregate production function includes only one output and two types of aggregate input (although this could be extended to include intermediate inputs), capital and labour, with technology as an additional variable shifting over time.

MFP takes account of several factor inputs at the same time and is largely a measure of the effects of technical progress, improvements in the workforce, improvements in management practices, economies of scale and so on. MFP can also be affected in the short term to medium term by other factors such as weather and by variations in capacity utilisation. Strictly speaking MFP growth occurs when there is an upward shift in the production function.

This aggregate production function implies that all firms within the same industry have the same production function. Further, MFP in this framework measures disembodied technological change. That is, embodied technological change is captured in capital inputs and or intermediate inputs.

To estimate industry level MFP, indexes for volume measures of output, and primary and intermediate inputs are required, along with data on industry-level factor incomes. There are number of difficulties and measurement problems associated with industry-level MFP estimation. Some of these issues are addressed in this appendix.

OUTPUT AND INTERMEDIATE INPUTS

The gross outputs for each market sector industry in both volume and current price terms are obtained from the ABS supply-use tables that contain both market and non-market sector industries and more than two hundred commodity groups. Since 1994–95, the ABS has been compiling annual supply-use tables in both current price and volume terms. Thus, industry-level gross output MFP can be estimated from that period.

In the Australian supply-use framework, the current price gross output and value added are valued at basic prices. They exclude taxes payable and any transport charges paid separately by the producer, but include subsidies received, as a consequence of production or sale. The basic price is intended to measure the amount actually retained by the producer, the price most relevant to the decision-making process, and is therefore the price most appropriate for valuing output in productivity analysis.

The volume measures of gross output and intermediate inputs in the supply-use tables are derived from aggregation of supply and use commodities at constant prices. The volume supply and use commodities are estimated by deflating the nominal value of each commodity by the corresponding output and input price index. Thus, the corresponding volume measure of value added is based on the procedure of double deflation.

The series for industry level value added is much longer than that for gross output, although for years prior to 1994–95 the estimates were derived without using the supply-use framework.

To estimate value added for the years prior to 1994–95 it is assumed (for all industries other than Agriculture, forestry and fishing) that the volume measure of value added grows at the same rate as the volume measure of output (the output indicator method).

It is, therefore, implicitly assumed that gross output and intermediate inputs have the same growth rate. That is, there is no change in the efficiency of use of intermediate inputs in the production process. However, the efficiency of use of capital and labour will change.

For more details on how output is derived for individual industries see *Australian System of National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0, ABS 2000).

CAPITAL INPUT

Capital services produced by an asset over its life are directly proportional to the productive capital value of the asset. By weighting together volume indexes of the productive capital stock of different assets using their rental prices as weights, an aggregate index of capital services is produced.

Estimates of productive capital stock for the following asset types have been used in the ABS estimation of MFP:

- six types of machinery and equipment: computers and computer peripherals; electronic and electrical machinery and communications equipment; industrial machinery and equipment; motor vehicles; other transport equipment; and other plant and equipment
- buildings and structures other than dwellings
- livestock
- three types of intangible fixed assets: artistic originals; mineral exploration; and computer software
- inventories
- land.

CAPITAL INPUT *continued*

Chapter 16 of *Australian System of National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0) provides a full description of the method used to derive the capital stock measures for the relevant components of gross fixed capital formation (that is, for all assets listed above except inventories and land). The method used to derive productive capital stock using age-efficiency profiles is also described.

Volume estimates for inventory items are obtained for all the market sector industries other than Communications, Finance and insurance; and Cultural and recreational services.

A benchmark estimate of agricultural land is obtained from the balance sheet, where the value for the reference period is chosen. The stock of agricultural land is treated as a non-depreciable asset and in volume terms the productive capital stock of agricultural land is assumed to remain constant over time.

For non-agricultural land, estimates for each industry are calculated by taking the balance sheet value for the reference year as a benchmark, and assuming that the growth rate is half that of the productive capital stock of non-dwelling construction. This approach recognises that changes in the capital services provided by land can accrue due to changes in the value of the building on it, but disproportionately so.

An index of aggregate capital services is compiled in the form of a Tornqvist index (that is, the weighted geometric mean of the component growth rates). The growth rates of productive capital stocks of each asset type are weighted together using estimates of the rental prices. Rental prices are generally unobservable because, for most capital, the owner is also the user, and are estimated using the user cost of capital equation (see Appendix 2 for details).

LABOUR INPUT

Indexes of hours worked are used to estimate labour input. The hours worked estimates are derived as the product of employment and average hours worked. Using an index of hours worked provides a better measure of labour input than using employment, because hours worked captures changes in paid and unpaid overtime worked, standard weekly hours, leave taken, and changes in the proportion of part-time employees. However, changes in the skill level of the labour force are not captured in hours worked, and as such are reflected in the industry productivity estimates. To obtain a measure of productivity that excluded the effect of changing skill levels, it would be necessary to adjust hours worked for changes in the composition of the labour force.

To adjust for changes in the composition of the labour force it would be necessary to examine factors that might cause changes to the labour inputs. For instance, changes in labour inputs could be due to such factors as changes in the level of educational attainment or the age distribution of the work force. However, these are difficult to quantify. At present, the ABS does not attempt to make such adjustments at the industry level.

EMPLOYMENT ESTIMATES

The employment estimates used to derive hours worked comprises all labour engaged in the production of goods and services, and include not only wage and salary earners but also:

- employers
- self-employed persons
- persons working one hour or more without pay in a family business or on a farm.

The annual figures are simple averages based on the available observations of employment levels during the year.

Industry estimates should be compiled with the objective of ensuring full consistency between estimates of industry employment and gross value added (ideally both sets of estimates would be derived from the same source for each industry). However industry employment data from business surveys are not considered of sufficient quality for use in

EMPLOYMENT ESTIMATES *continued*

production analysis. Consequently the labour force survey (LFS) employment estimates are used. These are compiled from *The Labour Force, Australia* (cat. no. 6203.0) and relate to the mid-month of the quarter, as there are no industry estimates for the first and last month of each quarter.

HOURS WORKED

Total annual hours worked are based on estimates of actual hours worked from the LFS. Total hours actually worked are observed in the LFS during the two week reference period of each month. However, the design of the LFS means that this two week reference period is only representative of 'one week' of each month. So, each reference period is assigned to one calendar week of the month. This provides 12 weeks of the year where total hours worked are observed.

Total hours worked in the remaining unobserved weeks of the year are imputed by interpolating linearly between the 12 observed weeks. Interpolation of the weeks at the beginning of January and at the end of December requires information on hours worked in the observed weeks of the previous December and the following January respectively.

Before total hours worked in a LFS reference period can be assigned to a calendar week, or be used as the basis of linear interpolation, they must be corrected for events such as public and school holidays. These non-random holidays tend to affect hours worked during the week containing the holiday rather than neighbouring weeks. Hours worked during a reference period affected by a non-random holiday may not be representative of hours actually worked in the assigned calendar week, nor will they be a good indicator of hours worked in neighbouring weeks. An estimate of the hours lost due to each observed non-random holiday can be made using intervention analysis.

Regression-ARIMA (Autoregressive Integrated Moving Average) intervention analysis is a technique that can be applied to estimate the effect of a known event on a regular time series. The parameter estimates from this type of analysis can be used to create a holiday corrected time series which excludes the impact of non-random holidays. Once these hours are appropriately accounted for, the holiday corrected estimates provide an appropriate basis for linear interpolation.

The corrected hours worked estimates still contain the effects of seasonal changes to hours worked from factors such as sick leave, annual leave and periods when hours worked tend to be high. The effects of seasonal factors on hours worked tend to be similar in neighbouring weeks, rather than being specific to one particular week.

The interpolation procedure results in an estimate of holiday-corrected total hours worked in each week of a year. To be representative of total hours actually worked in each week of the year, the hours lost due to non-random holidays need to be accounted for. For non-random holidays, which are regularly observed in the LFS reference periods, the holiday correction obtained from intervention analysis can be weighted to be used to estimate the hours lost in each observed week. Hours lost from unobserved holidays are based on similar observed holidays. For example, the correction for Christmas is based on the observed correction for Easter.

The estimates of total hours actually worked in each week of the year are summed to create an estimate of monthly, quarterly or annual total hours worked. If the period does not start on a Monday, or end on a Sunday, total hours worked in the start, and/or end, week are apportioned to reflect this.

In order to obtain annual hours worked by industry it is necessary to make some simplifying assumptions, recalling that industry detail in the LFS is only available at the mid-quarter months. This mid-quarter month information is used to estimate the proportion of total hours worked by people employed in each industry in each of these four months. These quarterly proportions are weighted together to provide an annual proportion of total hours worked for each industry. Applying this proportion to total

HOURS WORKED *continued*

annual hours worked by all employed people gives an annual hours worked estimate for each industry. This method implicitly assumes that the effects of holidays and other seasonal factors are constant across all industries. The ABS intends to investigate ways to improve this aspect of the methodology.

For more details on the hours worked methodology see *Information Paper: Implementing New Estimates of Hours Worked into the Australian National Accounts* (cat. no. 5204.0.55.003).

FACTOR INCOMES

Estimates of factor incomes are required to derive the shares of labour and capital input used to measure MFP on a value added basis. For MFP on a gross output basis, estimates of cost shares for labour, capital and intermediate inputs are required. The share of intermediate inputs in gross output can be directly obtained by the current price measures of gross output and intermediate inputs in the supply-use tables. This is, however, not the case for capital and labour, because there are various other expenditure/income items in the current price measure of value added. As an accounting identity value added at basic prices is the same as total factor income plus taxes less subsidies on production and imports. Total factor income consists of compensation of employees, gross operating surplus and gross mixed income.

In most work on MFP estimation, the measures of factor income are often used to directly derive the relevant factor income shares. To do this, gross mixed income needs to be allocated to capital and labour. Gross mixed income is the income that accrues to unincorporated enterprises owned by members of household, that is, to self-employed persons. Gross mixed income consists of two major components, wages, salaries and supplements of unincorporated enterprises and the gross operating surplus of unincorporated enterprises. However, this split is not readily identifiable in the data, and has to be apportioned appropriately.

GROSS MIXED INCOME

For the household sector, the labour and capital shares of income earned by unincorporated enterprises are subsumed into one national accounts aggregate: gross mixed income. The following procedure has been used to impute the labour and capital shares of this aggregate for each industry in the market sector.

An initial estimate of labour income is imputed by assigning to proprietors and unpaid helpers the same average compensation per hour received by wage and salary earners. An initial estimate of proprietors' capital income is derived by multiplying the household productive capital stocks for each industry and asset type by corporate rental prices. An implicit value of proprietors' gross mixed income is obtained by summing these two products:

$$\hat{Y}_{ui} = (e_{ci}.H_{ui}) + \sum_{j} (r_{cij}.K_{uij})$$

where

$\hat{Y}_{ui}$ = the implicit value of proprietors' gross mixed income in industry i

e_{ci} = the corporate average hourly compensation rate for wage and salary earners, industry i

H_{ui} = total proprietors' hours worked

r_{cij} = the corporate rental price rate for industry i, asset type j

K_{uij} = household sectors' productive capital stock for industry i, asset type j

Final estimates are obtained by multiplying the average compensation per hour and the rental price component of by a scaling factor. This factor equates the sum of proprietors' capital and labour incomes to actual gross mixed income:

$$Y_{ui} = (S_i.e_{ci}.H_{ui}) + \sum_{j} (S_i.r_{cij}.K_{uij})$$

GROSS MIXED INCOME

continued

where the scaling factor S_i is:

$$S_i = \frac{Y_{ui}}{\hat{Y}_{ui}}$$

and Y_{ui} is actual gross mixed income.

Proprietors' capital income for industry i is given by:
$Y_{ki} = \sum_j (S_i . r_{cij} . K_{uij})$

Proprietors' labour income is given by:
$(S_i . e_{ci} . H_{ui})$

The proprietor's labour and capital income are added to the corporate sector's labour and capital income respectively to form total labour and capital income for the industry.

APPENDIX 2 SENSITIVITY ANALYSIS OF CAPITAL INPUTS

SENSITIVITY ANALYSIS OF CAPITAL INPUTS

The measure of capital input required for the calculation of MFP creates particular difficulty for the statistician. In principle there is a requirement to measure the volume of capital utilised in delivering output. In much of the productivity literature these flows of capital are described as capital services. However, neither the value nor volume of these services are directly available from business accounts. Therefore it is necessary to estimate these flows indirectly using modelling approaches.

The method used by the ABS to estimate capital inputs involves the use of a perpetual inventory model. This model involves the accumulation, by industry and asset type, of the additions to the capital stock as recorded by the Gross Fixed Capital Formation (GFCF) estimates recorded in the *Australian System of National Accounts* (ASNA). These additions to the stock are adjusted to account for retirements and other removals from the capital stock. As there is little direct empirical information available in relation to these withdrawals from the capital stock it is necessary to make some assumptions about how long each asset will remain in production.

GFCF is recorded for aggregated classes of assets. Even if detailed GFCF were available, additional modelling would be required for each asset, such as retirement distributions, mean asset lives and efficiency profiles. By using asset classes the modelling process is representative of an average asset. However, this raises a number of issues because the asset class is not as homogenous as it is assumed. Hulten (1999) gives the example of different working lives for the many types of machine tools, some with short working lives and some with long working lives. As Hulten (1999) points out, by placing these heterogeneous assets into a single, broad class, the model effectively treats the different assets as though they were one. Changes in the mix of assets contained within the aggregate can affect the quality of the modelled results.

For the purpose of productivity analysis it is important to recognise that the capacity of an asset to deliver services (its efficiency) will generally decline over time. In order to account for declining efficiency the model applies assumptions regarding the age-efficiency profile for each asset. This means that an older asset will make less of a contribution to the capital stock than a newer asset of the same type. The estimate of capital stock derived in this way is known as the productive capital stock and is derived for each asset class. A flow measure of capital services is estimated for an industry that reflects the different mix of assets used, and is based on the productive capacity of capital.

Capital services for an individual industry are created by aggregating different vintages of the same type of asset, and then aggregating different assets using rental prices as weights to form an aggregate index. The capital services produced by an asset over its life are not usually observed, however, they may be approximated by assuming that capital services are directly proportional to the productive capital value of the asset. This relationship is fixed over the asset's life, but does vary between asset types and even between different vintages of the same asset, since it depends on the expected life of the asset and the rate of decline in the asset's efficiency, which may change over time.

SENSITIVITY ANALYSIS OF CAPITAL INPUTS *continued*

Capital services (inputs) are assumed to change at the same rate as the movement in the volume of this productive capital stock. It is implicitly assumed that there is a constant utilisation of this stock, that is, no adjustment is made to the movements to account for any real world change in capacity utilisation of these assets due either to the business cycle or technological change.

Currently the ABS produces industry capital services indexes and these are used as the capital input for industry and market sector MFP estimates. The following section describes the way in which capital services indexes are compiled and the implications for industry MFP estimates.

AGGREGATE CAPITAL SERVICES INDEXES

In order to combine the individual indexes of capital services for each asset type into a single index for the industry or market sector it is necessary to aggregate the elemental indexes. This is achieved by weighting them together via the use of their respective price weights. As the prices of capital services are not normally observable on the market it is necessary to derive them using economic theory. These price weights are also known as the user cost of capital or rental prices. A key focus of the remainder of this appendix is on the user cost of capital equation and the sensitivity of the aggregate capital services indexes to changes in the rate of return component of the equation. The ABS currently uses a combination of endogenous and exogenous rates of return in the user cost of capital equation. The sensitivity of capital services indexes to changes in mean asset lives is also investigated.

The user cost of capital equation in its most basic form is comprised of three components: depreciation of the asset, a rate of return reflecting financing costs, and a capital gain/loss component. In practice the equation also includes a corporate income tax component, tax depreciation allowances, investment credits and indirect taxes. The user cost equation[6] used by the ABS is as follows:

$$UC_{ijt} = T_{ijt}(r_{it}.p_{ijt} + d_{ijt}.p_{ijt} - p_{ijt} + p_{ij(t-1)}) + p_{ijt}.x_{it}$$

Where:

- i = industry
- j = asset type
- t = discrete time period
- T = income tax parameter
- r = rate of return
- p = price for new capital goods
- d = depreciation rate
- x = effective average non-income tax rate on production.

RATES OF RETURN

Rates of return may be calculated in one of two ways. First, by using an endogenous rate of return which is represented by the internal rate of return for the industry. Using an endogenous rate of return to calculate user costs of capital imposes some implicit assumptions, namely that the underlying production function exhibits constant returns to scale, that markets are competitive, and that the expected return is the same as the realised return (OECD 2001b). Also, using an endogenous rate of return imposes the same rate of return for all asset types within an industry. This is done by equating non-labour income to capital rent, where capital rent is defined as the sum across all assets of their rental price multiplied by the real productive capital stock. The rate of return is then estimated by equating this to the non-labour income (BLS 1983, Hall and Jorgenson 1967).

6 For a complete derivation of this equation see Hall and Jorgenson (1967).

RATES OF RETURN *continued*

There are a few issues surrounding the calculation of endogenous rates of return. The first issue is whether the user cost should be in real or nominal terms. OECD (2001b) indicates that the user cost should be in nominal terms, as the user cost of capital is analogous to compensation of employees. The second issue is whether non-labour income should be on a gross or net basis. The third issue is whether the productive capital stock or the net capital stock should be used to estimate the endogenous rate of return. Currently real productive capital stock is used in deriving ABS MFP estimates, rather than a nominal productive or net capital stock, and this is why the rates of return presented in tables A2.1 and A2.2 are relatively high. The ABS will consider changing its approach at a suitable time in the future.

The second approach to calculating rates of return is to use an exogenous rate of return such as the interest rate on government bonds. Using an exogenous rate may lead to a difference between the calculated capital rent and capital income. Capital income differs from capital rent as capital income is defined as the sum of gross operating surplus (GOS) and the proportion of gross mixed income that would represent a return on the owner's capital.

The endogenous approach is an ex post approach to calculating the rate of return as it calculates the rate of return after the results of the investment decision are known. A practical issue involved in using an endogenous rate of return is that when capital income is small, the associated internal rate of return will be small. The second approach or the exogenous approach could be considered an ex ante approach to calculating the rate of return because it is the expected return on an investment decision.

The rental price equation employed here can give rise to negative rental prices when there are large changes in capital gains and losses. This is a problem for estimating capital services indexes because rental prices are used to form weights, and a negative weight causes problems in forming an aggregate index. Currently the ABS uses a combination of endogenous and exogenous rates of return when estimating capital services estimates to overcome the problem of negative rental prices in some industries in some years. When rates of return are low the ABS applies a floor to the rate of return equal to 4 per cent plus the consumer price index (CPI), which could be considered an exogenous rate. If the endogenous rate is greater than or equal to this floor then the endogenous rate is used in the user cost equation. If the derived endogenous rate is less than the set exogenous rate of 4 per cent plus the CPI, then the exogenous rate is used. However, applying this floor does not prevent negative user costs in all cases.

Tables A2.1 and A2.2 show the average rates of return for the entire period by industry calculated using the exogenous approach, the endogenous approach and the rates of return actually used to produce the estimates in this paper (referred to as 'current' in the tables). The deviations from the average exogenous rate of return are also shown. The tables are split into two periods covering roughly the last 40 years, where table A2.1 is from 1964–65 to 1984–85 and table A2.2 is from 1984–85 to 2005–06.

The tables show that the average exogenous and endogenous rate of return can differ substantially for each industry. For the majority of industries the average endogenous rate of return is less than the average exogenous rate of return. By definition, the current approach used by the ABS produces average rates of return that are higher than the exogenous rate of return, however, for the majority of industries, the deviations from the exogenous rate of return are not significant.

There are some industries, such as Electricity, gas & water that on a year to year basis have an endogenous rate of return that is consistently below the minimum exogenous rate of return. In contrast, there are other industries, such as Agriculture, where there are some years that the endogenous rate of return is significantly higher than the exogenous rate of return.

RATES OF RETURN *continued*

A2.1 AVERAGE RATES OF RETURN AND DERIVATIONS FROM THE EXOGENOUS RATE OF RETURN, Market sector industries—1964–65 to 1984–85

	AVERAGE RATES OF RETURN			DEVIATIONS FROM EXOGENOUS RATE OF RETURN	
	Exogenous	*Endogenous*	*Current*	*Endogenous*	*Current*
	(1)	(2)	(3)	(4)	(5)
Agriculture, forestry & fishing	11.8	7.2	13.3	–4.6	1.5
Mining	11.8	15.3	15.5	3.5	3.7
Manufacturing	11.8	14.4	15.4	2.6	3.6
Electricity, gas & water	11.8	7.2	11.8	–4.6	—
Construction	11.8	14.9	15.2	3.1	3.4
Wholesale trade	11.8	10.9	12.4	–0.8	0.6
Retail trade	11.8	9.7	11.9	–2.1	0.2
Accommodation, cafes & restaurants	11.8	9.3	11.8	–2.5	—
Transport & storage	11.8	5.9	11.8	–5.9	—
Communication services	11.8	10.6	12.4	–1.1	0.6
Finance & insurance	11.8	14.2	15.9	2.4	4.1
Cultural & recreational services	11.8	7.6	11.8	–4.2	—

— nil or rounded to zero (including null cells)

A2.2 AVERAGE RATES OF RETURN AND DERIVATIONS FROM THE EXOGENOUS RATE OF RETURN, Market sector industries—1984–85 to 2005–06

	AVERAGE RATES OF RETURN			DEVIATIONS FROM EXOGENOUS RATE OF RETURN	
	Exogenous	*Endogenous*	*Current*	*Endogenous*	*Current*
	(1)	(2)	(3)	(4)	(5)
Agriculture, forestry & fishing	8.0	1.6	8.3	–6.3	0.4
Mining	8.0	7.1	8.9	–0.8	0.9
Manufacturing	8.0	7.6	8.8	–0.7	0.8
Electricity, gas & water	8.0	3.6	8.0	–4.3	—
Construction	8.0	13.6	14.3	5.6	6.3
Wholesale trade	8.0	6.1	8.2	–1.9	0.3
Retail trade	8.0	6.3	8.2	–1.6	0.2
Accommodation, cafes & restaurants	8.0	4.4	8.0	–3.6	0.1
Transport & storage	8.0	1.1	8.0	–6.8	—
Communication services	8.0	7.8	8.7	–0.2	0.8
Finance & insurance	8.0	8.0	10.5	—	2.5
Cultural & recreational services	8.0	1.6	8.0	–6.4	—

— nil or rounded to zero (including null cells)

ASSET PRICE DEFLATOR

Another key component of the user cost equation is the choice of price deflator. Currently, the ABS uses ex post asset specific price changes in estimating holding gains, but in some cases this has led to negative rental prices for particular assets, due large changes in the asset price. To avoid this issue the current practice is to set any negative rental price to a very small positive number (0.001). By adjusting the negative rental prices in this way the capital stock weights for that asset return to positive values and the weights of the remaining assets are also adjusted. As a consequence, the corresponding

ASSET PRICE DEFLATOR
continued

capital services index also returns to a 'reasonable' level. Further research will attempt to identify improved methods of dealing with negative rental prices.

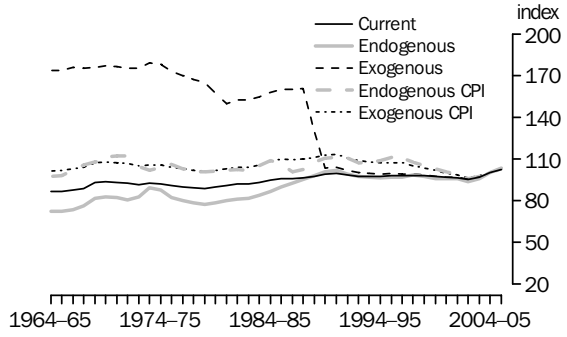
One approach that might overcome the negative rental prices is to consider that the user cost equation is an expectations model. The ABS's current approach to user costs is that the variables are measured ex post rather than ex ante. By shifting to an ex ante approach and assuming that businesses generally base their expectations of holding gains on movements in the CPI, the CPI would then replace the price deflator (p_{ijt}) in the user cost of capital equation above. However, there would be some assets, such as computers, where expectations of price change would likely be different to the general level of inflation, and different price deflators may be required. This is an area for further investigation.

Given the possible combinations of rates of return and price deflators the following combinations were tested – the results of which are shown in figures A2.3 to A2.14:

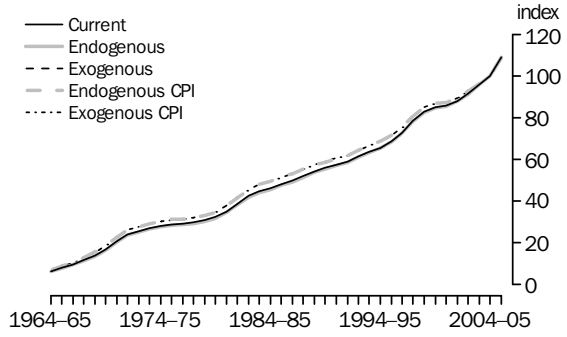
- Current ABS approach (as described above)
- Exogenous rate of return with separate asset price deflators
- Exogenous rate of return with the CPI as the price deflator
- Endogenous rate of return with separate asset price deflators
- Endogenous rate of return with the CPI as the price deflator.

Capital services for the market sector industries, using different rates of return (2004–05 = 100)

A2.3 AGRICULTURE, FORESTRY & FISHING

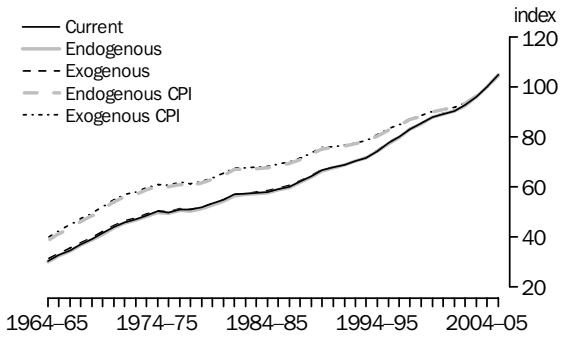


A2.4 MINING

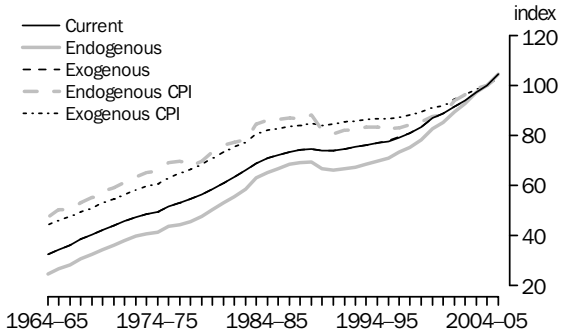


Capital services for the market sector industries, using different rates of return (2004–05 = 100) continued

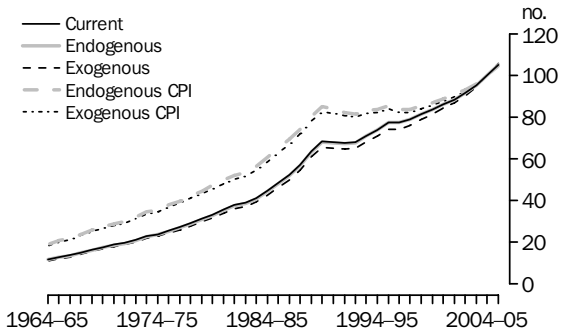
A2.5 MANUFACTURING



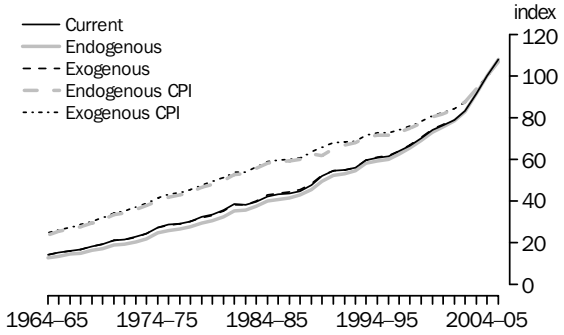
A2.6 ELECTRICITY, GAS & WATER



A2.7 CONSTRUCTION

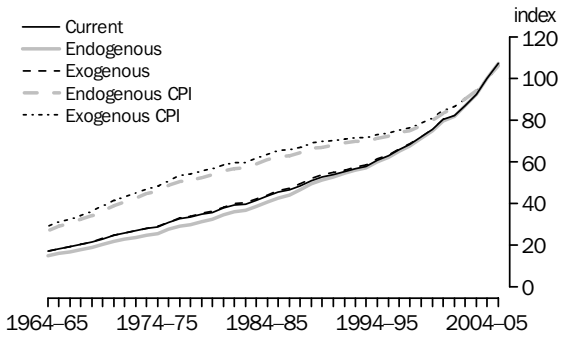


A2.8 WHOLESALE TRADE

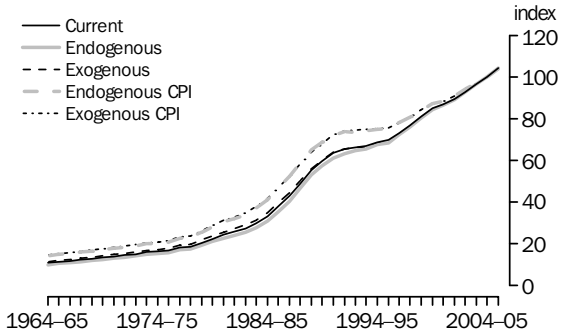


Capital services for the market sector industries, using different rates of return (2004–05 = 100) continued

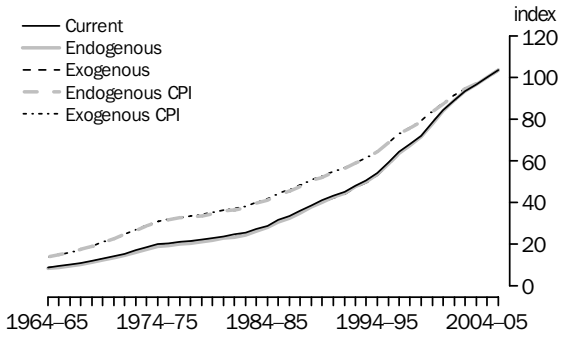
A2.9 RETAIL TRADE



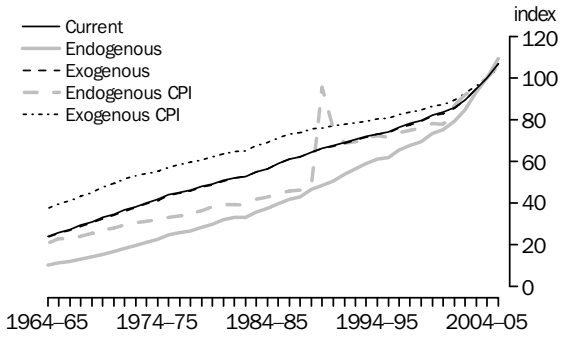
A2.10 ACCOMMODATION, CAFES & RESTAURANTS



A2.11 COMMUNICATIONS SERVICES

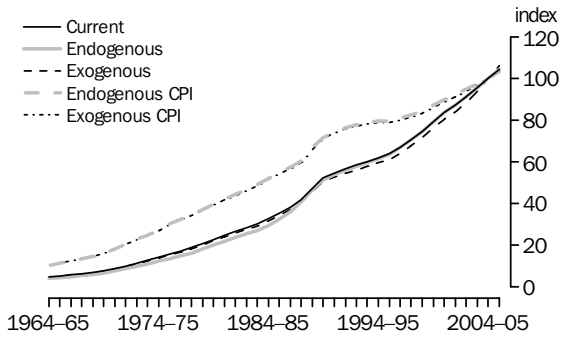


A2.12 TRANSPORT & STORAGE

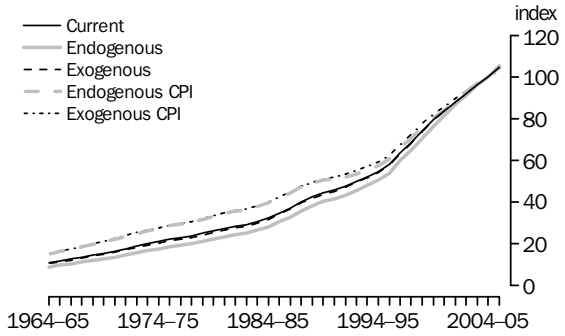


Capital services for the market sector industries, using different rates of return (2004–05 = 100) continued

A2.13 FINANCE & INSURANCE



A2.14 CULTURAL & RECREATIONAL SERVICES



The data show that for Mining and to a lesser degree Manufacturing, the approach used has little effect on the capital services index. With the exception of Agriculture, forestry & fishing and Transport & storage, the rest of the industries also show minimal differences in the choice between an exogenous and endogenous rate of return, but there is more notable impact when the CPI price deflator is used. For Agriculture, forestry & fishing and Transport & storage the graphs highlight problems with negative rental prices.

Figure A2.3 shows that for the Agriculture, forestry & fishing industry the exogenous capital services curve does not exhibit the same pattern as the other series. The reason behind this is the volatility in land prices earlier in the series. This leads to a negative rental price for land when an exogenous rate of return equal to 4 per cent plus the CPI is used. In this instance the negative rental price was not set to 0.001. For the Agriculture, forestry & fishing industry, land contributes significantly to the overall capital stock and has fallen in price over the period. Consequently, the aggregation to total capital rent (rental price multiplied by productive capital stock) gives a negative value for land and for total assets. This means that the asset weights for all assets other than land become negative. The rental price weight is positive for land because its negative capital rent is divided by a negative capital rent for the industry. While the other asset's rental price weights are negative because their positive capital rent is divided by the negative total.

However, land does not contribute directly to the capital services index as the productive capital stock of land does not change over time. Therefore, it is not the large weights for land themselves that lead to the wayward capital services index such as the one shown in figure A2.3 but their distorting effect on the weights for other assets. While this effect is shown occurring for exogenous rates it also occurs for endogenous rates but a further adjustment has been made to the rental price in this case, that is setting the negative rental price to 0.001.

Capital services for the market sector industries, using different rates of return (2004–05 = 100) continued

For the Transport & storage industry negative rental prices occur using an endogenous rate of return when the asset price deflator is the CPI. The negative rental price occurs across a number of assets over various years, with the most common being land and non-dwelling construction.

Tables A2.15 and A2.16 show the growth rates of capital services indexes for selected time periods based on exogenous, endogenous and current rates of return. For the majority of time periods and industries, the growth rates do not differ substantially with the choice of rate of return.

A2.15 ANNUAL AVERAGE GROWTH IN CAPITAL SERVICES INDEX, Market sector industries

	1985–86 TO 1995–96		1995–96 TO 2005–06		1985–86 TO 2005–06	
	Exogenous	*Endogenous*	*Exogenous*	*Endogenous*	*Exogenous*	*Endogenous*
Agriculture, forestry & fishing	–4.6	0.3	0.3	0.4	–2.2	0.3
Mining	3.6	3.7	4.8	4.7	4.2	4.2
Manufacturing	2.7	2.8	3.0	3.1	2.9	2.9
Electricity, gas & water	0.8	0.6	3.0	4.0	1.9	2.3
Construction	4.9	4.9	3.6	3.1	4.2	4.0
Wholesale trade	3.5	3.9	5.8	6.0	4.6	5.0
Retail trade	3.2	3.8	5.4	5.6	4.3	4.7
Accommodation, cafes & restaurants	5.6	6.6	4.3	4.3	4.9	5.4
Transport & storage	2.3	3.9	3.8	5.7	3.0	4.8
Communication services	6.5	6.6	5.9	5.8	6.2	6.2
Finance & insurance	5.9	6.8	5.7	5.1	5.8	5.9
Cultural & recreational services	5.3	5.8	6.1	6.9	5.7	6.4

With the exception of Agriculture, forestry & fishing, and Transport & storage, the growth rates of the capital services indexes do not differ substantially with the choice of rate of return or the asset price deflator. The subsequent impact on growth rates of MFP estimates will also be relatively small, assuming every thing else remains constant.

A2.16 ANNUAL AVERAGE GROWTH IN CURRENT CAPITAL SERVICES MEASURES, Market sector industries

	1985–86 to 1995–96	*1995–96 to 2005–06*	*1985–86 to 2005–06*
	%	%	%
Agriculture, forestry & fishing	0.2	0.5	0.3
Mining	3.6	4.7	4.2
Manufacturing	2.8	3.1	2.9
Electricity, gas & water	0.8	3.0	1.9
Construction	4.8	3.1	3.9
Wholesale trade	3.6	5.8	4.7
Retail trade	3.3	5.5	4.4
Accommodation, cafes & restaurants	6.3	4.1	5.2
Transport & storage	2.3	3.7	3.0
Communication services	6.4	5.7	6.1
Finance & insurance	6.1	5.0	5.5
Cultural & recreational services	5.3	6.1	5.7

As figures A2.3 to A2.14 show, the use of the CPI shows that for the majority of industries, growth in the capital services index was slower, which would lead to faster growth in MFP as opposed to using the existing asset price deflators. The reason for this slower growth is that assets with falling price deflators, e.g. software and computers,

Capital services for the market sector industries, using different rates of return (2004–05 = 100) continued

have a smaller rental price weight using the CPI. Since these two assets generally had the fastest growth in productive capital stock, the smaller weight means a flatter capital services index as the other slower growing assets receive a greater weight when using the CPI. As mentioned earlier, at least for these assets which show persistent price falls, the use of the CPI may not be appropriate.

MEAN ASSET LIVES

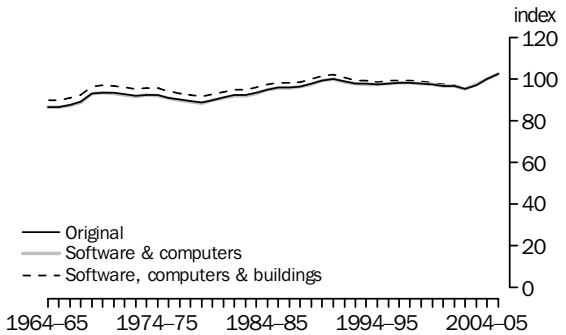
Mean asset lives are an important component in the measurement of capital stock. Asset lives are influenced by a number of variables including changes in technology, quality, and the rate of use. The choice of mean asset lives impacts on capital stock estimates through the Perpetual Inventory Method (PIM), and has flow through effects to capital services estimates and ultimately, MFP estimates.

The ABS has updated mean asset lives for some assets as more information has become available, although the most recent review was conducted in 1996–97. To test the sensitivity of any potential changes to the mean asset lives on capital services estimates and subsequent MFP estimates, changes were made to the mean asset lives for computers, computer software and non-dwelling construction[7]. For computer hardware and software, recent tax lives, sourced from the *Australian Master Tax Guide, 2006* (CCH 2006), were used.

In 1996–97, the mean asset life for computers, in-house software, and purchased software were 4.9 years, 6 years and 4 years, respectively. Figures A2.17 to A2.28 compare the currently published capital services estimates to a capital service estimate using an updated mean asset life of 4 years for computers, and a mean asset life of 4 years for all software. Another capital service index is also shown in the figures using the updated computer and software lives and updated mean asset lives for non-dwelling construction, where the mean asset lives have been decreased by 20 years, from on average 50 years to 30 years. The adjusted asset lives for computers and software have been applied from 1990 to 2006 to allow a long enough time series to capture any potential change in capital services, and the adjusted mean asset lives for non-dwelling construction have been applied for the whole time series.

Capital services for the market sector industries, using different mean asset lives (2004–05 = 100)

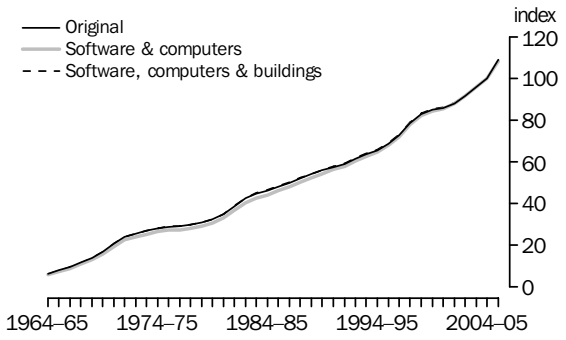
A2.17 AGRICULTURE, FORESTRY & FISHING



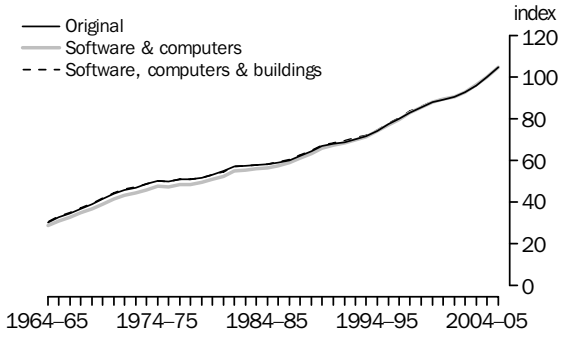
7 Retirement distributions are the extent to which assets are retired before, on, or after the mean asset lives and the current approach used by the ABS assumes a Winfrey S3 probability distribution for most asset types. The choice of mean asset lives used in this sensitivity analysis is restricted to a set of mean asset lives for which a Winfrey S3 probability function has already been derived.

Capital services for the market sector industries, using different mean asset lives (2004–05 = 100) continued

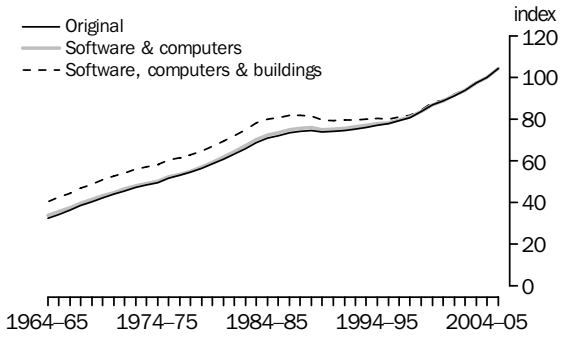
A2.18 MINING



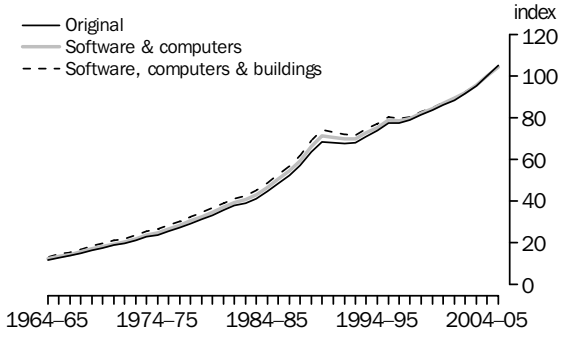
A2.19 MANUFACTURING



A2.20 ELECTRICITY, GAS & WATER

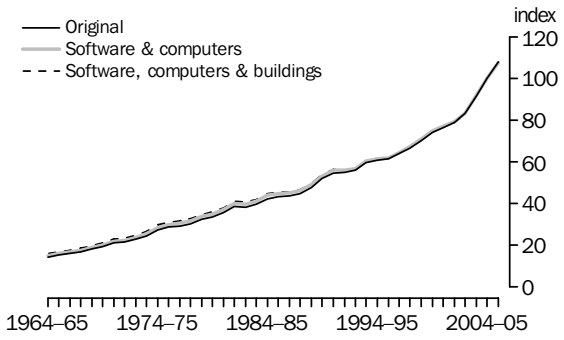


A2.21 CONSTRUCTION

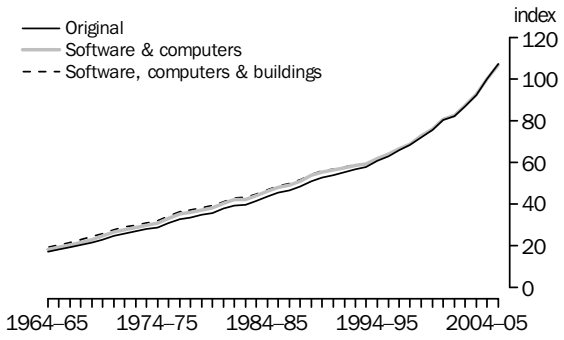


Capital services for the market sector industries, using different mean asset lives (2004–05 = 100) continued

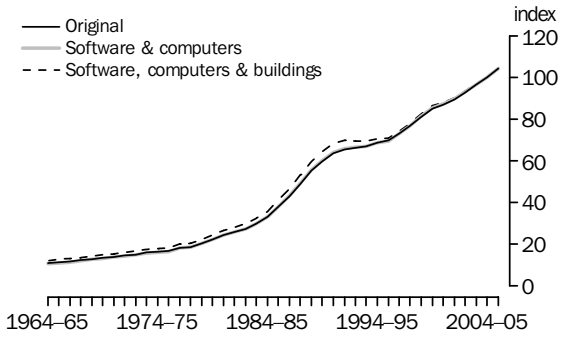
A2.22 WHOLESALE TRADE



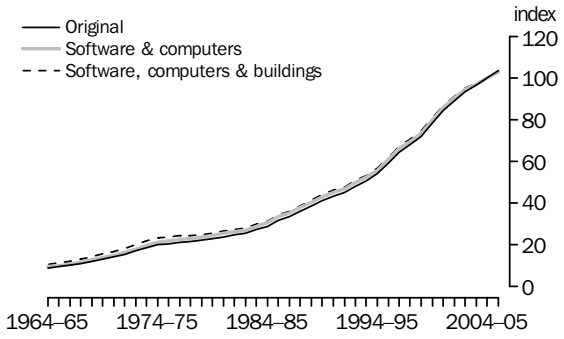
A2.23 RETAIL TRADE



A2.24 ACCOMMODATION, CAFES & RESTAURANTS

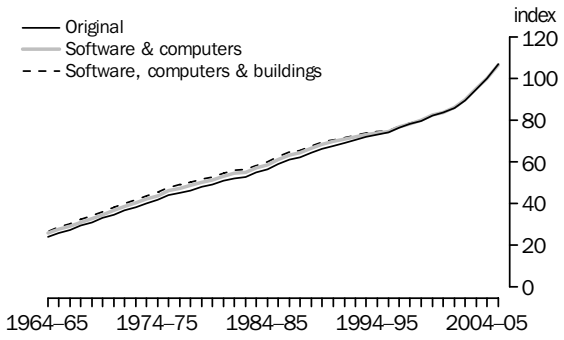


A2.25 COMMUNICATIONS

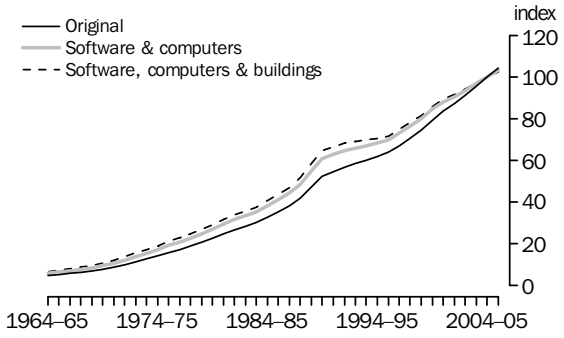


Capital services for the market sector industries, using different mean asset lives (2004–05 = 100) continued

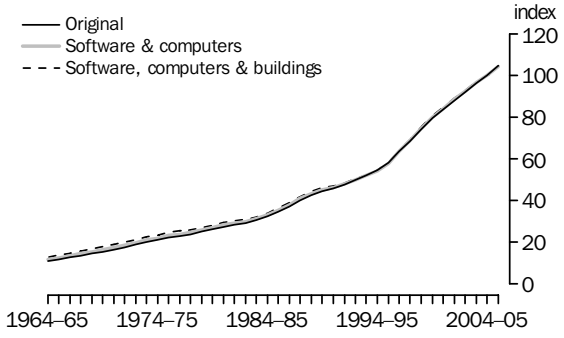
A2.26 TRANSPORT & STORAGE



A2.27 FINANCE & INSURANCE



A2.28 CULTURAL & RECREATIONAL SERVICES



The results in figures A2.17 to A2.28 show that changing the mean asset lives for computers and software has very little impact on capital services estimates in any industry in the market sector. Even the more sizeable changes to the mean asset lives of non-dwelling construction had little effect on capital service estimates at the industry level for most industries, indicating that capital services, and hence MFP estimates, are not particularly sensitive to changes in mean asset lives.

CONCLUSIONS

Several aspects of the capital services model were tested for sensitivity of the assumptions. The results show that there were only minimal differences to growth in capital services in respect of the choice of rate of return. The other aspect of the rental price equation that was considered was the choice of price deflator used to estimate capital gains. The choice between an asset price deflator and the CPI showed some differences in growth rates for capital services, but did not change the underlying growth patterns. However, this did not completely resolve the issue of negative rental prices as

CONCLUSIONS *continued*

they also occurred in the Transport & Storage industry when the CPI was used as the asset price deflator.

The other aspect that was sensitivity tested was mean asset lives. The results were that the capital services index is not particularly sensitive to the choice of mean asset lives.

GLOSSARY

Assets Entities functioning as stores of value and over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived by their owners by holding them, or using them, over a period of time (the economic benefits consist of primary incomes derived from the use of the asset and the value, including possible holding gains/losses, that could be realised by disposing of the asset or terminating it).

Basic price The amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus any tax payable plus any subsidy receivable, on that unit as a consequence of its production or sale; it excludes any transport charges invoiced separately by the producer.

Capital income Capital income is the sum of gross operating surplus and the proportion of gross mixed income that would represent a return on the owner's capital.

Capital productivity Capital productivity estimates are indexes of real GDP per unit of capital services used in production. The have been derived by dividing the index of the chain volume measure of GDP by an index of capital services. The capital productivity indexes reflect not only the contribution of capital to changes in production, but also the contribution by labour and other factors affecting production.

Capital rent Capital rent is the rental price multiplied by the productive capital stock.

Capital services Capital services reflect the amount of 'service' each asset provides during a period. For each asset, the services provided in a period are directly proportional to the asset's productive capital value in the period. As an asset ages and its efficiency declines so does the productive capital value and the services the asset provides.

Chain price indexes Annually-reweighted chain Laspeyres price indexes referenced to the same year as the chain volume measures. They can be thought of as a series of indexes measuring price change from a base year to quarters in the following year using current price values in the base year as weights, linked together to form a continuous time series. In other words, chain price indexes are constructed in a similar fashion to the chain volume indexes.

Chain volume measures Annually-reweighted chain Laspeyres volume indexes referenced to the current price values in a chosen reference year (i.e. the year when the quarterly chain volume measures sum to the current price annual values). Chain Laspeyres volume measures are compiled by linking together (compounding) movements in volumes, calculated using the average prices of the previous financial year, and applying the compounded movements to the current price estimates of the reference year.

Compensation of employees The total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the employee during the accounting period. It is further classified into two sub-components: wages and salaries; and employers' social contributions. Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including the work done by members of a household within an unincorporated enterprise owned by the same household. Compensation of employees excludes any taxes payable by the employer on the wage and salary bill (e.g. payroll tax, fringe benefits tax).

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

Consumption of fixed capital Consumption of fixed capital is the value, at current prices, of the reproducible fixed assets used up during a period of account as a result of normal wear and tear, foreseen obsolescence and the normal rate of accidental damage. Unforeseen obsolescence, major catastrophes and the depletion of natural resources are not taken into account.

Current prices Estimates are valued at the prices of the period to which the observation relates. For example, estimates for 2002–03 are valued using 2002–03 prices. This contrasts to chain volume measures where the prices used in valuation refer to the prices of the previous year.

Cultivated assets Cultivated assets include livestock raised for breeding, dairy, wool, etc.and vineyards, orchards and other plantations of trees yielding repeat products that are under the direct control, responsibility and management of institutional units. Immature cultivated assets are excluded unless produced for own use.

Entertainment, literary or artistic originals Entertainment, literary or artistic originals are original 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. Included are works produced on own-account. In some cases there may be multiple originals (e.g. films). See also *Intangible fixed assets*.

Fixed assets Fixed assets are produced assets that are used repeatedly or continuously in production processes for more than one year. Fixed assets consist of tangible and intangible fixed assets. See also *Intangible fixed assets*; *Produced assets*; and *Tangible fixed assets*.

Gross domestic product (GDP) Is the total market value of goods and services produced in Australia within a given period after deducting the cost of goods and services used up in the process of production but before deducting allowances for the consumption of fixed capital. Thus gross domestic product, as here defined, is 'at market prices'. It is equivalent to gross national expenditure plus exports of goods and services less imports of goods and services.

GDP per capita The ratio of the chain volume estimate of GDP to an estimate of the resident Australian population. Population estimates use data published in the quarterly publication *Australian Demographic Statistics* (cat. no. 3101.0) and ABS projections.

Gross domestic product per hour worked The ratio of the chain volume estimate of GDP to an estimate of hours worked. Hours worked estimates are derived as the product of employment and average hours worked. Movements in chain volume estimates of GDP per hour worked are commonly interpreted as changes in labour productivity. However, it should be noted that these measures reflect not only the contribution of labour to changes in production per hour worked, but also the contribution of capital and other factors (such as managerial efficiency, economies of scale, etc.).

Gross fixed capital formation - general government Expenditure on new fixed assets plus net expenditure on second-hand fixed assets whether for additions or replacements (other than weapons of destruction and weapon delivery systems). Expenditure on new roadworks (or upgrading existing roads) is included but expenditure on road repair and maintenance is classified as government final consumption expenditure.

Gross fixed capital formation - private Expenditure on fixed assets broken down into dwellings, non-dwelling construction, machinery and equipment, livestock, intangible fixed assets and ownership transfer costs. The machinery and equipment category includes plant, machinery, equipment, vehicles, etc. Expenditure on repair and maintenance of fixed assets is excluded, being chargeable to the production account. Additions to fixed assets are regarded as capital

Gross fixed capital formation - private *continued*	formation. Also included is compensation of employees and other costs paid by private enterprise in connection with own-account capital formation. Expenditure on dwellings, non-dwelling construction, and machinery and equipment is measured as expenditure on new and second-hand assets, less sales of existing assets. Ownership transfer costs comprise of stamp duty, real estate agents' fees and sales commissions, conveyancing fees and miscellaneous government charges.
Gross fixed capital formation - public corporations	Expenditure on new fixed assets plus net expenditure on second-hand fixed assets and including both additions and replacements. Also included is compensation of employees and other costs paid by public corporations in connection with capital works undertaken on own account.
Gross mixed income of unincorporated enterprises	The surplus or deficit accruing from production by unincorporated enterprises. It includes elements of both compensation of employees (returns on labour inputs) and operating surplus (returns on capital inputs).
Gross operating surplus	The operating surplus accruing to all enterprises, except unincorporated enterprises, from their operations in Australia. It is the excess of gross output over the sum of intermediate consumption, compensation of employees, and taxes less subsidies on production and imports. It is calculated before deduction of consumption of fixed capital, dividends, interest, royalties and land rent, and direct taxes payable, but after deducting the inventory valuation adjustment. Gross operating surplus is also calculated for general government and it equals general government's consumption of fixed capital.
Gross output	The total value of all output measured at basic prices. Basic prices valuation of output removes the distortion caused by variations in the incidence of commodity taxes and subsidies across the output of individual industries.
Gross value added	The value of output at basic prices minus the value of intermediate consumption at purchasers' prices. The term is used to describe gross product by industry and by sector.
Hours worked	The hours worked by all labour engaged in the production of goods and services, including hours worked by civilian wage and salary earners, employers, self-employed persons, persons working one hour or more without pay in a family business or on a farm, and members of the Australian defence forces. It is the product of average hours worked and total employment.
Input-output table	An input-output table is a means of presenting a detailed analysis of the process of production and the use of goods and services (products) and the income generated in the production process; they can be either in the form of (a) supply and use tables or (b) symmetric input-output tables.
Intangible fixed assets	Includes such assets as computer software, entertainment, literary or artistic originals, and mineral exploration intended to be used for more than a year.
Intangible non-produced assets	Includes such assets as purchased goodwill, 3G spectrum licences, patented entities and leases on land and subsoil assets. Estimation of these assets is in its infancy. Currently only the value of 3G spectrum licences is included in the national and sector balance sheets.
Intermediate inputs	Consists of the value of the goods and services consumed as inputs by a process of production, excluding the consumption of fixed capital. It is also known as intermediate consumption.
Inventories	Consist of stocks of outputs that are held at the end of a period by the units that produced them prior to their being further processed, sold, delivered to other units or used in other ways and stocks of products acquired from other units that are intended to be used for intermediate consumption or for resale without further processing.
Labour income	Labour income measure combines compensation of employees and the proportion of gross mixed income that would represent a return on the owner's labour.

Labour productivity estimates Labour productivity estimates are indexes of real GDP per person employed or per hour worked. They have been derived by dividing the chain volume measure of GDP by employment (or hours worked). Estimates are also made using labour inputs adjusted for the quality and composition of labour input. Labour productivity indexes reflect not only the contribution of labour to changes in product per labour unit, but are also influenced by the contribution of capital and other factors affecting production.

Laspeyres volume index Laspeyres volume index is a weighted arithmetic average of quantity relatives using the values of the earlier period as weights.

Livestock Livestock assets are classified as either fixed assets or inventories. Those livestock which are used in production of other products (e.g. breeding stock, animals for entertainment, sheep for wool and dairy cattle) are fixed assets. Inventories cover all other livestock types and includes those animals raised for meat or other one-off products (e.g. leather).

Machinery and equipment Consists of transport equipment, computing equipment and other machinery and equipment other than that acquired by households for final consumption. Tools that are relatively inexpensive and purchased at a relatively steady rate, such as hand tools, are excluded. Also excluded are machinery and equipment integral to buildings such as lifts, these being included in dwellings and non-residential buildings. Machinery and equipment acquired by households for final consumption (e.g. motor vehicles) are not treated as fixed assets. However, they are included in the memorandum item 'consumer durables' in the balance sheet for households. Houseboats, barges, mobile homes and caravans used by households as principal residences are included in dwellings.

Market output Output that is sold at prices that are economically significant or otherwise disposed of on the market, or intended for sale or disposal on the market.

Market sector Five industries are excluded from the market sector: Property and business services; Government administration and defence; Education; Health and community services; and Personal and other services. These are excluded because their outputs are not marketed and/or because their outputs are derived either wholly or primarily by using either deflated input cost data or hours worked as indicators of output. The chain volume measure of the production of a group of industries referred to as the market sector is defined to be the chain volume estimate of industry gross value added of all industries less the above five industries, less Ownership of dwellings (for which an index of capital services is used as the indicator of output), plus taxes less subsidies on products attributable to the market sector industries.

Mineral exploration Mineral exploration is the value of expenditures on exploration for petroleum and natural gas and for non-petroleum mineral deposits. These expenditures include pre-licence costs, licence and acquisition costs, appraisal costs and the costs of actual test drilling and boring, as well as the costs of aerial and other surveys, transportation costs etc., incurred to make it possible to carry out the tests.

Multifactor productivity Multifactor productivity estimates are indexes of real GDP per combined unit of labour and capital. They have been derived by dividing chain volume estimates of market sector GDP by a combined measure of hours worked and capital services.

Non-market output Goods and services produced by non-profit institutions that are supplied free, or at prices that are not economically significant, to other institutional units or the community as a whole.

Non-produced assets Non-produced assets are non-financial assets that come into existence other than through processes of production. Non-produced assets consist of tangible assets and intangible assets.

Other subsidies on production Consist of all subsidies, except subsidies on products, which resident enterprises may receive as a consequence of engaging in production. Other subsidies on production include: subsidies related to the payroll or workforce numbers, including subsidies payable on the total wage or salary bill, on numbers employed, or on the employment of particular types of persons, e.g. persons with disabilities or persons who have been unemployed for a long period. The subsidies may also be intended to cover some or all of the costs of training schemes organised or financed by enterprises. Subsidies aimed at reducing pollution are also included. See also *Subsidies on products*.

Other taxes on production Consist of all taxes that enterprises incur as a result of engaging in production, except taxes on products. Other taxes on production include: taxes related to the payroll or workforce numbers excluding compulsory social security contributions paid by employers and any taxes paid by the employees themselves out of their wages or salaries; recurrent taxes on land, buildings or other structures; some business and professional licences where no service is provided by the Government in return; taxes on the use of fixed assets or other activities; stamp duties; taxes on pollution; and taxes on international transactions. See also *Taxes on production and imports* and *Taxes on products*.

Output This consists of those goods and services that are produced within an establishment that become available for use outside that establishment, plus any goods and services produced for own final use.

Perpetual inventory method (PIM) The PIM is a method of constructing estimates of capital stock and consumption of fixed capital from time series of gross fixed capital formation. It allows an estimate to be made of the stock of fixed assets in existence and in the hands of producers which is generally based on estimating how many of the fixed assets, installed as a result of gross fixed capital formation undertaken in previous years, have survived to the current period.

Primary incomes Consist of incomes that accrue to institutional units as a consequence of their involvement in processes of production or their ownership of assets that may be needed for the purposes of production.

Produced assets Produced assets are non-financial assets that have come into existence as outputs from production processes. Produced assets consist of fixed assets and inventories. See also *Fixed assets*; *Inventories*.

Productive capital stock This is a measure of productive capacity and forms the basis for the measure of capital services. Productive capital stock estimates are derived as the written down value of each asset in accordance with its decline in efficiency due to age.

Producer's prices The producer's price is the amount receivable by the producer from the purchaser for a unit of a good or service.

Purchaser's prices The amount paid by the purchaser, excluding any deductible tax, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchaser's price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place.

Quality adjusted hours worked This measure of labour input takes account of changes in the aggregate quality of labour due to changes in educational attainment and the length of experience in the workforce. Labour productivity and multifactor productivity estimates based on quality adjusted hours worked are also calculated. For a description of this work see the feature article, 'Further developments in the analysis of productivity growth in Australia' in the September quarter 2001 issue of *Australian National Accounts: National Income, Expenditure and Product* (cat. no. 5206.0).

Rental prices This is also referred to as the user cost of capital. The rental price is the unit cost for the use of an asset for one period. That is, the price for employing or obtaining one unit of capital services.

Subsidies on products Subsidies payable per unit of a good or service. The subsidy may be a specific amount of money per unit of quantity of a good or service, or it may be calculated ad valorem as a specified percentage of the price per unit. A subsidy may also be calculated as the difference between a specified target price and the market price actually paid by a purchaser. A subsidy on a product usually becomes payable when the product is produced, sold or imported, but it may also become payable in other circumstances, such as when a product is exported, leased, transferred, delivered or used for own consumption or own capital formation.

Supply and use tables Supply and use tables are in the form of matrices that record how supplies of different kinds of goods and services originate from domestic industries and imports and how those supplies are allocated between various intermediate or final uses, including exports.

Tangible fixed assets Tangible fixed assets consist of dwellings; other buildings and structures; machinery and equipment; and cultivated assets. See also *Dwellings*; *Other buildings and structures*; *Machinery and equipment*; and *Cultivated assets*.

Tangible non-produced assets Tangible non-produced assets are non-produced assets that occur in nature and over which ownership may be enforced and transferred. Environmental assets over which ownership rights have not, or cannot, be enforced, such as international waters or air space, are excluded. Tangible non-produced assets consist of land, subsoil assets, non-cultivated biological resources and water resources. See also *Non-produced assets*.

Taxes less subsidies on production and imports Defined as 'taxes on products' plus 'other taxes on production' less 'subsidies on products' less 'other subsidies on production'.

Taxes on production and imports Consist of 'taxes on products' and 'other taxes on production'. These taxes do not include any taxes on the profits or other income received by an enterprise. They are payable irrespective of the profitability of the production process. They may be payable on the land, fixed assets or labour employed in the production process, or on certain activities or transactions.

Taxes on products Taxes payable per unit of some good or service. The tax may be a specific amount of money per unit of quantity of a good or service (quantity being measured either in terms of discrete units or continuous physical variables such as volume, weight, strength, distance, time, etc.), or it may be calculated ad valorem as a specified percentage of the price per unit or value of the goods or services transacted. A tax on a product usually becomes payable when the product is produced, sold or imported, but it may also become payable in other circumstances, such as when a good is exported, leased, transferred, delivered, or used for own consumption or own capital formation.

Tornqvist volume index Tornqvist volume index is a weighted geometric average of the quantity relatives using arithmetic averages of the value shares in the two periods as weights.

Total factor income That part of the cost of producing the gross domestic product which consists of gross payments to factors of production (labour and capital). It represents the value added by these factors in the process of production and is equivalent to gross domestic product less taxes plus subsidies on production and imports.

Wages and salaries Consist of amounts payable in cash including the value of any social contributions, income taxes, fringe benefits tax, etc., payable by the employee even if they are actually withheld by the employer for administrative convenience or other reasons and paid directly to social insurance schemes, tax authorities, etc., on behalf of the employee. Wages and salaries may be paid as remuneration in kind instead of, or in addition to, remuneration in cash. Separation, termination and redundancy payments are also included in wages and salaries. Wages and salaries are also measured as far as possible on an accrual rather than a strict cash basis.

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EU KLEMS Project

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Bureau of Labour Statistics

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Statistics New Zealand

http://www.stats.govt.nz/datasets/economic-indicators/productivity-statistics.htm

Statistics Canada

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