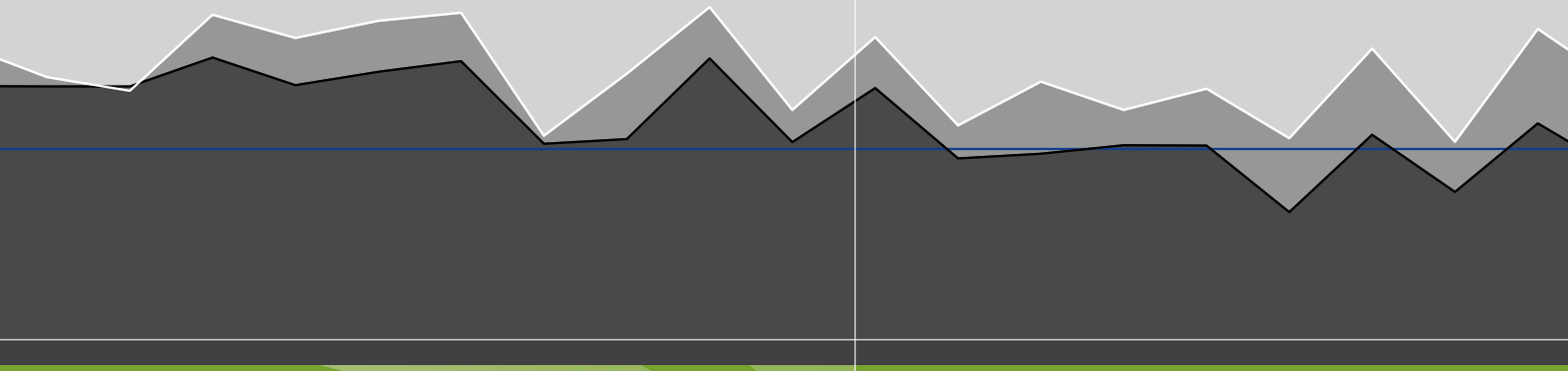
Australian Government
Productivity Commission

PC Productivity Update

July 2015



Features

- 2014 Australian productivity
- Contributions to output and growth
- Improving the efficiency of capital investment in public infrastructure
- Insights from recent productivity research

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Australian Government
Productivity Commission

The Productivity Commission is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed most simply, is to help governments make better policies, in the long term interest of the Australian community.

The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

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Foreword

Welcome to the **PC Productivity Update 2015**.

Following the practice of previous publications in this series, we provide an analysis of Australia's productivity performance in 2013-14 using the latest ABS statistics.

One of the Commission's roles is to promote public understanding of productivity issues, as well as contribute to public debate and encourage policy discussions. In this edition of the **Update**, our feature issue is capital investment in public infrastructure. Smart investment decisions and productive use of these assets will make a big difference in future economic growth. More can be done to improve decision making in the provision and use of public infrastructure.

In 2013-14, measured productivity presented some positive news: labour productivity for the whole economy increased by 1.4 per cent and, in the market sector, by 2.5 per cent; multifactor productivity has increased, albeit moderately, for the third consecutive year (0.4 per cent). Our detailed analysis suggests that Mining may have come out of the 'investment phase' and started acceleration of production – an early sign of productivity growth.

However, productivity growth is uneven among industries and some were negative in 2013-14. Furthermore, the productivity growth witnessed in 2013-14 remained well below what is required to maintain our historical growth in living standards and we have additional challenges to confront in Australia's ageing population, resource depletion, as well the changes in the structure of Australian industry, the terms of trade and other external events beyond our control.

We welcome your feedback on this edition of the **Update**.

Peter Harris
Chairman

Productivity at a glance

Australia's labour productivity growth for the total economy

Annual change, 2012-13 to 2013-14, GDP per hour worked

Labour productivity	**+1.4%**

Australia's productivity growth for the Market sector (12 industries)

Annual change, 2012-13 to 2013-14

Multifactor productivity	**+0.4%**
Labour productivity	+2.5%
Output	+2.5%
Labour input	0.0%
Capital input	+4.4%

Long-term, average annual growth rate, 1973-74 to 2013-14

Multifactor productivity	**+0.8%**
Labour productivity	+2.3%
Output	+3.0%
Labour input	+0.7%
Capital input	+4.4%

Data sources: ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0, November 2014); ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

For more detailed productivity statistics and commentary see Chapter 1.

Preamble

This edition of the **PC Productivity Update** begins by providing a snapshot of key nation-wide and industry-specific trends from the most recent release of the ABS productivity statistics. In 2013-14, labour productivity growth in both the Australian economy and the 12-industry market sector (which accounts for 65 per cent of the economy) was close to the trend of the last two and half decades. But growth of multifactor productivity remains below the longer-term average. This snapshot is followed by a closer look at recent changes in measured productivity for four industries — Agriculture, forestry and fishing; Mining; Electricity, gas, water and waste services; and Information, media and telecommunications — to highlight some of the main contemporary factors influencing those changes.

Chapter 2 reports on per capita national income growth in Australia and the contribution of productivity growth to that income growth. It highlights that as the terms of trade effects associated with the mining boom taper off, it will be crucial to achieve higher productivity in order to maintain and increase per capita incomes.

Investment in new capital has consistently played a key role in lifting Australia's labour productivity and supporting the introduction of new technologies and ways of working. Chapter 3 outlines recent work by the Commission aimed at improving the efficiency of public infrastructure investment through more transparent and rigorous project selection processes.

Finally, chapter 4 outlines recent work undertaken by the Commission to unpack the specific productivity performance within both the Mining and Financial and insurance services industries. The Mining report traces the transition of Mining industries through the investment phase of the mining boom to the production phase and towards positive MFP growth. The Financial and insurance services report indicates that it is productivity growth in the Insurance, Superannuation and Auxiliary services industry that has driven recent changes in the multifactor productivity for the Financial and insurance services industry as a whole.

1 2014 Australian productivity

1.1 Introduction

Analysis of Australia's productivity performance in 2013-14 is based on the latest Australian Bureau of Statistics (ABS) annual estimates of multifactor productivity (MFP) and labour productivity (LP) growth for both the 12 industry market sector as a whole, and for each of its 12 individual industries.

Productivity performance has been the main source of Australia's long-term economic growth, business competitiveness and real per capita income growth. It is an important determinant of a country's living standards and wellbeing. (Productivity is defined in box 1.1.)

Section 1.2 contains an update of 2013-14 productivity growth and the proximate causes (relative changes in output, labour and capital) in the (12 industry) market sector. Additional insights are provided in section 1.3 on the influences of productivity in four industries — Agriculture, forestry and fishing; Mining; Electricity, gas, water and waste services; and Information, media and telecommunications.

Box 1.1
What is productivity?

Productivity (the ratio of output produced to inputs used) measures how efficiently inputs, such as capital and labour, are used to produce outputs in the economy. It is sometimes referred to as productive efficiency. Productivity increases if output grows faster than inputs (or shrinks more slowly). Conventionally, growth of productivity is measured as the growth of output over and above the growth of inputs.

The ABS aggregate multifactor productivity (value adding output produced per unit of combined inputs of labour and capital) is the measure that comes closest to the underlying concept of productivity — efficiency of producers in producing output using both labour and capital. Growth of multifactor productivity is the growth of output over and above the growth of labour and capital inputs.

Labour productivity measures output produced per unit of labour input. Growth of labour productivity is the growth of output over and above the growth of labour input — it captures the value added from growth in capital (including more advanced technologies intrinsic in the new investment) that supports increased output without the increased use of labour (referred to as capital deepening) and multifactor productivity.

PC Productivity Update 2013 (PC 2013a) provides a more detailed discussion of the measurement issues associated with multifactor productivity and labour productivity.

1.2 2013-14 market sector update

In 2013-14, the 12 industry market sector represented 65 per cent of total industry gross value added. The non-market sector, including Health care and social assistance (7.5 per cent), Public administration and safety (6.2 per cent), and Education and training (5.5 per cent), totalled 19 per cent in 2013-14. The remaining four industries[1] accounted for 16 per cent of gross value added.

In terms of output, the four largest market sector industries in 2013-14 were Financial and insurance services, Mining, Construction, and Manufacturing, which collectively represented about 36 per cent of total industry value added and more than half that of the market sector (box 1.2).

Box 1.2
Shares of GDP of the 12 industries in the market sector, 2013-14

- Financial and insurance services (9.9 per cent)
- Mining (9.8 per cent)
- Construction (9.3 per cent)
- Manufacturing (7.5 per cent)
- Transport, postal and warehousing (5.6 per cent)
- Retail trade (5.2 per cent)
- Wholesale trade (4.6 per cent)
- Information, media and telecommunications (3.3 per cent)
- Electricity, gas, water and waste services (3.2 per cent)
- Agriculture, forestry and fishing (2.8 per cent)
- Accommodation and food services (2.7 per cent)
- Arts and recreation services (0.9 per cent)

Source: ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0, November 2014).

1 These industries are Rental, hiring and real estate services, Professional scientific and technical services, Administrative support services and Other services. They are included in what is known as the 16 industry market sector but are not covered in this analysis.

Market sector MFP recorded positive growth in 2013-14

Australia's market sector MFP is estimated to have grown by 0.4 per cent in 2013-14,[2] achieving the same level of growth as in the previous year (table 1.1).[3] This was a result of higher growth in output (2.5 per cent) than growth in total value adding inputs (2.1 per cent). As labour input remained unchanged, capital input (increasing by 4.4 per cent) was the source of growth of value adding inputs.

In the current (incomplete) productivity cycle from 2007-08 to 2013-14, annual MFP growth in the market sector remains negative (at -0.1 per cent). This contrasts with positive growth of long-term productivity performance from 1973-74 (table 1.1). In the latest period, the negative MFP growth was the result of:

- relatively low output growth (2.4 per cent per year), compared with the longer-term average of 3.0 per cent per year
- slightly higher growth in total inputs (2.5 per cent), compared with the longer-term average of 2.3 per cent per year.

Growth of labour productivity (LP) results from a growth in MFP and the contribution of capital. The latter, captured by the measure of 'capital-deepening', is typically positive and larger than MFP (box 1.3). In 2013-14, LP growth was 2.5 per cent. This was close to its longer-term average between 1973-74 and 2013-14 (2.3 per cent), though down from 3.7 per cent in the previous year. The reduced rate of LP growth in the latest year was due to a significant decrease in the measured contribution of capital — capital deepening declined to 2.1 per cent in 2013-14, down from 3.3 per cent in the previous year. But the contribution of capital deepening was still well above the longer-term average of 1.6 per cent per year.

2 The growth rates used in the latest ABS publication of productivity estimates (ABS, *Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002) are expressed as natural logarithms multiplied by 100. For consistency, this paper has also applied this method to productivity data sourced from this ABS publication.

3 Annual rates of MFP and LP growth are affected by the utilisation rate of inputs (notably capital) as well as other factors. Hence some of this annual change can be due to the effect of the business cycle. For this reason the ABS reports estimates over the productivity cycle which matches peaks in the business cycle. This concept was explained in the *PC Productivity Update 2013* (PC 2013a, p. 13).

Table 1.1
Summary productivity statistics, market sector (12)[a]

Per cent

	Long term growth rate	Last complete cycle	Period since the last cycle	Latest years[c]		
	1973-74 to 2013-14	2003-04 to 2007-08	2007-08 to 2013-14	2011-12	2012-13	2013-14
Output (GVA)	3.0	4.0	2.4	4.5	2.6	2.5
Total inputs	2.3	4.0	2.5	3.4	2.2	2.1
Labour input	0.7	2.4	0.0	0.2	-1.1	0.0
Capital input	4.4	5.9	5.3	6.8	5.9	4.4
MFP	**0.8**	**0.0**	**-0.1**	**1.1**	**0.4**	**0.4**
Capital deepening[b]	1.6	1.6	2.5	3.1	3.3	2.1
Labour productivity	**2.3**	**1.6**	**2.4**	**4.2**	**3.7**	**2.5**
Capital labour ratio	3.7	3.5	5.2	6.6	7.0	4.4

[a] Annual growth rates or average annual growth rates in designated periods. [b] Capital deepening is the change in the ratio of capital to labour, weighted by the capital share of market sector income. Labour productivity growth equals the sum of the growths of MFP and capital deepening. [c] Productivity statistics for years prior to 2013-14, in particular year 2012-13, differ from the estimates released by the ABS in previous years, as a result of revisions by the ABS to historical hours worked series, as outlined by the ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.055.002, December 2014). This flowed through to measured labour productivity and multifactor productivity estimates. Readers are encouraged to exercise caution in comparing historical statistics between data released at different points in time.

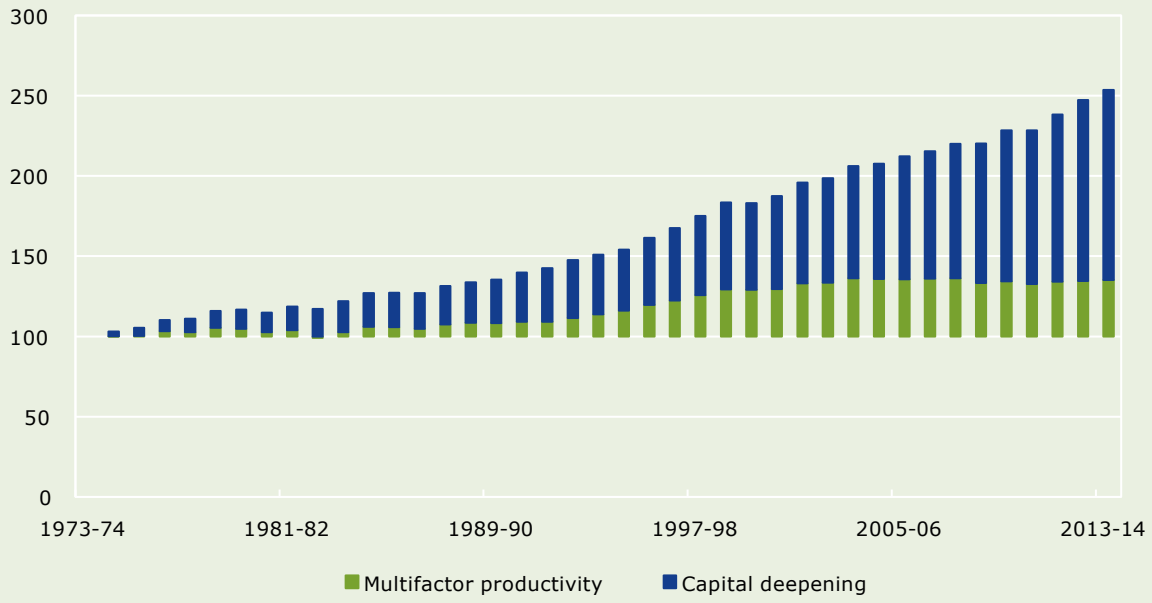
Source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity*, *2013-14*, Cat. no. 5260.0.55.002, December 2014).

Box 1.3
Importance of capital to the growth of labour productivity

Between 1973-74 and 2013-14, LP increased by 2.3 per cent per year, of which about two thirds (1.6 per cent) was attributable to 'capital deepening' (KD) with the remainder to MFP growth. The contribution of capital varied across sub-periods (figure below) and, in all sub-periods before 1993-94 and after 1998-99, it was consistently above 50 per cent (table below). In fact, since 2003-04, MFP growth has been on average zero or negative and LP growth has been reliant on the contribution of capital.

Market sector (12) contribution of MFP and capital to the growth of labour productivity, 1973-74 to 2013-14[a]

Index 1973-74 = 100



Average annual growth rates, per cent

	1973-74 to 1981-82	1981-82 to 1984-85	1984-85 to 1988-89	1988-89 to 1993-94	1993-94 to 1998-99	1998-99 to 2003-04	2003-04 to 2007-08	2007-08 to 2013-14
LP	2.1	2.3	1.3	2.4	3.9	2.3	1.6	2.4
KD	1.6	1.6	0.7	1.5	1.3	1.3	1.6	2.5
MFP	0.5	0.7	0.6	0.9	2.6	1.0	0.0	-0.1

[a] In addition to economies of scale and capacity utilisation (PC 2013a, p. 5), these measures of MFP and capital deepening may also be affected by changes in the human capital embedded in the labour force (or human capital deepening) and changes in the relative sizes of the 12 industries in the market sector.

Sources: Commission estimates based on the data from ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014) and Barnes (2011).

(continued next page)

Box 1.3 (continued)

Importance of capital to the growth of labour productivity

While investment in capital is expected to benefit future productivity (and income) growth, it comes at a cost to the economy — consumers have to sacrifice current consumption in return for higher income in the future. The returns however are not guaranteed and will depend on how successful investment decisions are and how efficiently capital is used in production. Any waste will detract from future productivity (and income) growth.

The contribution of capital to LP growth has been substantial. This means that, along with the growth of MFP, an improvement in the efficient use of investment resources will have a significant impact on the future growth of output and average income in the Australian economy.

Mixed results for industry MFP growth in 2013-14

In 2013-14, MFP growth and the underlying proximate causes differ between the 12 industries in the market sector (table 1.2).[4] However, broadly speaking, they can be classified into three groups.

The first group consists of six service industries, each of which recorded positive MFP growth in 2013-14:

- Wholesale trade (3.1 per cent)
- Retail trade (1.5 per cent)
- Accommodation and food services (1.1 per cent)
- Information, media and telecommunications (3.1 per cent)
- Financial and insurance services (3.3 per cent)
- Arts and recreation services (5.4 per cent).

The source of productivity growth in four of the six service industries was tied to higher output — they produced more output using fewer or proportionally less inputs. The exceptions were Wholesale trade and Accommodation and food services which produced less output (by -2.2 and -0.2 per cent respectively) with even less inputs (by -5.4 and -1.3 per cent).

All the six industries also recorded a positive growth in LP as a result of solid MFP growth and capital growth. LP growth was particularly high in three industries — Information, media and telecommunications (by 13.9 per cent), Arts and recreation services (8.2 per cent), and Wholesale trade (6.0 per cent). In these industries, LP growth was associated with significant declines in the use of labour.

The second group consists of three industries. Among the six industries that recorded negative MFP growth in 2013-14, positive output growth was recorded in Mining (9.1 per cent), Construction (3.8 per cent), and Agriculture, forestry and fishing (2.1 per cent). In these industries, MFP declined but only marginally, as input growth only slightly exceeded output growth. In fact, Mining recorded its highest LP growth (8.1 per cent) since 2000-01 due to the contribution of capital input (up 11.8 per cent).

The statistics indicate that the three remaining industries were lagging others in 2013-14. Output growth dropped by 2.1 per cent in Electricity, gas, water and waste services, 1.8 per cent in Manufacturing, and 0.6 per cent in Transport, postal and warehousing. MFP growth in these industries was negative because total input use did not decline by the same proportion. In Electricity, gas, water and waste services, labour and capital inputs actually increased by 6.5 per cent and 1.6 per cent respectively, which resulted in significant declines in both MFP (-5.4 per cent) and LP (-8.6 per cent). For the same reason, Transport, postal and warehousing also posted negative MFP (-3.1 per cent) and LP (-1.9 per cent) growth.

4 Historical statistics for the 12 industries prior to 2013-14 may differ from the ABS data released in previous years. The discrepancy was caused by the statistical revisions done by the ABS in December 2014 (see footnote C in table 1.1).

Table 1.2
Industry productivity growth 2013-14

Per cent

	Output (GVA)	Total inputs	Labour input	Capital input	Labour productivity	MFP
Agriculture, forestry and fishing	2.1	2.2	4.9	1.1	-2.8	-0.1
Mining	9.1	9.2	1.0	11.8	8.1	-0.1
Manufacturing	-1.8	-1.5	-1.8	-1.1	0.0	-0.3
Electricity, gas, water and waste services	-2.1	3.3	6.5	1.6	-8.6	-5.4
Construction	3.8	4.6	4.8	4.0	-1.0	-0.7
Wholesale trade	-2.2	-5.4	-8.3	1.1	6.0	3.1
Retail trade	2.3	0.7	0.0	2.8	2.3	1.5
Accommodation and food services	-0.2	-1.3	-2.0	1.0	1.7	1.1
Transport, postal and warehousing	-0.6	2.5	1.3	4.4	-1.9	-3.1
Information, media and telecommunications	2.4	-0.8	-11.5	6.0	13.9	3.1
Financial and insurance services	5.2	1.9	2.3	1.6	2.9	3.3
Arts and recreation services	2.6	-2.8	-5.6	2.7	8.2	5.4
Market sector (12)	**2.5**	**2.1**	**0.0**	**4.4**	**2.5**	**0.4**

Source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

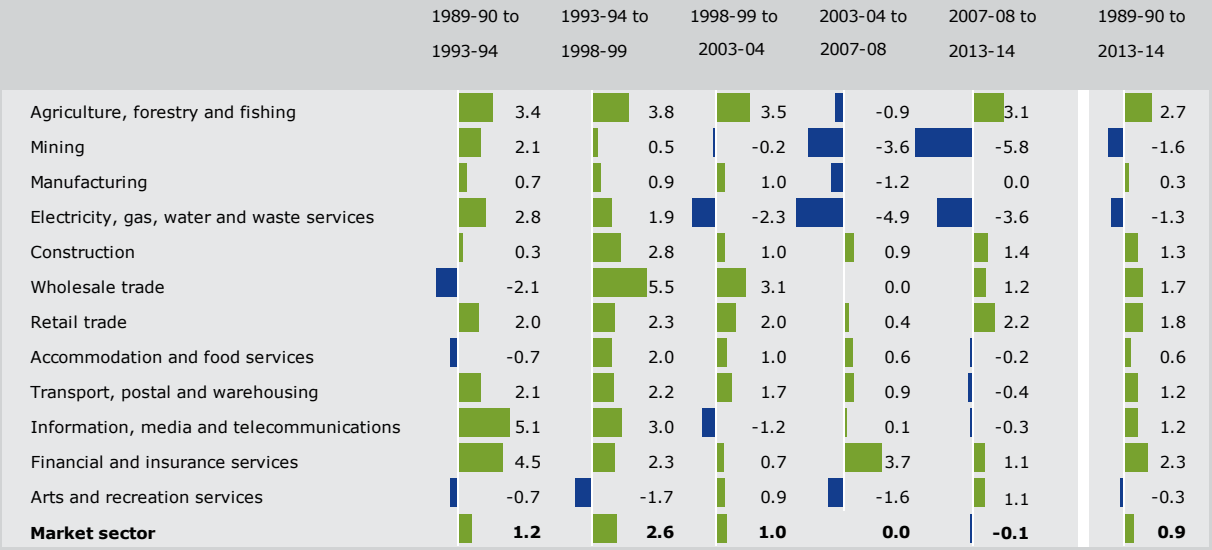
Taking a longer-term perspective (figure 1.1), eight of the twelve industries recorded positive MFP growth in nearly all sub-periods between 1989-90 and 2013-14. The average annual MFP growth was highest in Agriculture, forestry and fishing (2.7 per cent) and Financial and insurance services (2.3 per cent). They were followed by Retail trade (1.8 per cent) and Wholesale trade (1.7 per cent).

MFP growth lagged behind in four industries. In particular, negative MFP growth in Mining and Electricity, gas, water and waste services in the last decade has suppressed the average between 1989-90 and 2013-14. Arts and recreation services has turned around negative MFP growth in the latest sub-period (from 2007-08 to 2013-14) but still recorded an average annual negative growth (-0.3 per cent per year) in the period from 1989-90. Historically, MFP growth was relatively lower in Manufacturing and it has remained flat since 2007-08.

As observed in previous years, specific factors were behind the variability in MFP growth among the 12 industries. The following section provides a closer examination of the proximate causes of productivity growth for Agriculture, forestry and fishing, Mining, Electricity, gas, water and waste services, and Information, media and telecommunications. Chapter four presents a more detailed analysis of the productivity in Mining and Financial and insurance services.

Figure 1.1
Industry MFP, 1989-90 to 2013-14, by ABS productivity cycle[a]

Per cent per year



	1989-90 to 1993-94	1993-94 to 1998-99	1998-99 to 2003-04	2003-04 to 2007-08	2007-08 to 2013-14	1989-90 to 2013-14
Agriculture, forestry and fishing	3.4	3.8	3.5	-0.9	3.1	2.7
Mining	2.1	0.5	-0.2	-3.6	-5.8	-1.6
Manufacturing	0.7	0.9	1.0	-1.2	0.0	0.3
Electricity, gas, water and waste services	2.8	1.9	-2.3	-4.9	-3.6	-1.3
Construction	0.3	2.8	1.0	0.9	1.4	1.3
Wholesale trade	-2.1	5.5	3.1	0.0	1.2	1.7
Retail trade	2.0	2.3	2.0	0.4	2.2	1.8
Accommodation and food services	-0.7	2.0	1.0	0.6	-0.2	0.6
Transport, postal and warehousing	2.1	2.2	1.7	0.9	-0.4	1.2
Information, media and telecommunications	5.1	3.0	-1.2	0.1	-0.3	1.2
Financial and insurance services	4.5	2.3	0.7	3.7	1.1	2.3
Arts and recreation services	-0.7	-1.7	0.9	-1.6	1.1	-0.3
Market sector	**1.2**	**2.6**	**1.0**	**0.0**	**-0.1**	**0.9**

[a] Figures in this table are average annual growth rates in each designated productivity cycle.

Sources: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

1.3 Industry developments

Agriculture, forestry and fishing

MFP growth was slightly negative in 2013-14

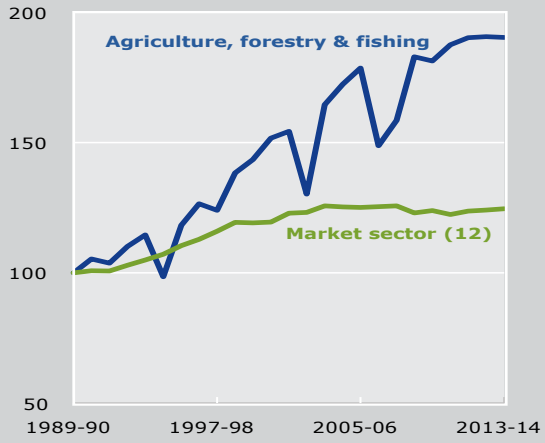
Historically, the trend of MFP growth in Agriculture, forestry and fishing has been considerably higher than the market sector average but year-to-year movements have been volatile (figure 1.2). The volatility in agricultural productivity has been more influenced by the changes in output than changes in inputs. The year-to-year changes in output have arisen, in large part, from variations in weather and market conditions.

In 2013-14, the output of Agriculture, forestry and fishing increased by 2.1 per cent (against a long-term average of 2.5 per cent per year between 1989-90 to 2013-14), while capital input increased by 1.1 per cent (compared to a long-term trend of 0.6 per cent per year) and labour input increased by 4.9 per cent.[5]

With the substantial increase in labour inputs, which was unusual in the context of negative growth of -1.5 per cent per year on average in the past two and half decades, total value adding input growth was slightly higher than output at 2.2 per cent. Consequently, MFP was estimated to have declined by 0.1 per cent (figure 1.3[6]).

Figure 1.2
MFP in Agriculture, forestry and fishing, 1989-90 to 2013-14

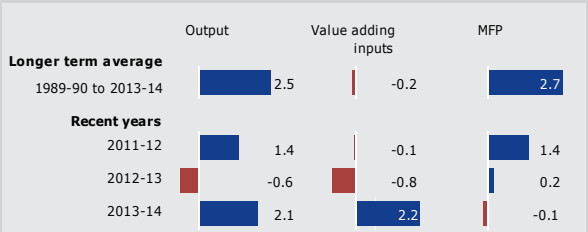
Index 1989-90 = 100



Data source: ABS *(Estimates of Industry Multifactor Productivity, 2013-14,* Cat. no. 5260.0.55.002, December 2014).

Figure 1.3
MFP growth in Agriculture, forestry and fishing[a]

Per cent



[a] Average annual growth rates and annual growth rates in designated periods.

Data source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2012-13*, Cat. no. 5260.0.55.002, December 2013).

5 The magnitude of this growth in labour input was very rare for Agriculture, forestry and fishing. Although the exact reason for the change is unclear, it may be attributable, in part, to the recent statistical revision as explained in the footnote C of Table 1.1.

6 The estimates of productivity for Agriculture, forestry and fishing differ significantly from those reported in the *PC Productivity Update* (2014). The differences was a result of the statistical revision that the ABS undertook in 2014 (See footnote C of table 1.1). The revision also affected the ABS productivity statistics presented in the rest of Section 1.3.

Weather conditions varied across States and the Northern Territory

Weather conditions are a powerful determinant of agricultural productivity and rainfall, in particular, is highly influential in the short term. But the actual impact on productivity growth varies in magnitude (figure 1.4). In 2013-14, rainfall remained low — with below average rainfall recorded in the Murray-Darling Basin — but its influence on the growth of agricultural productivity was less pronounced.

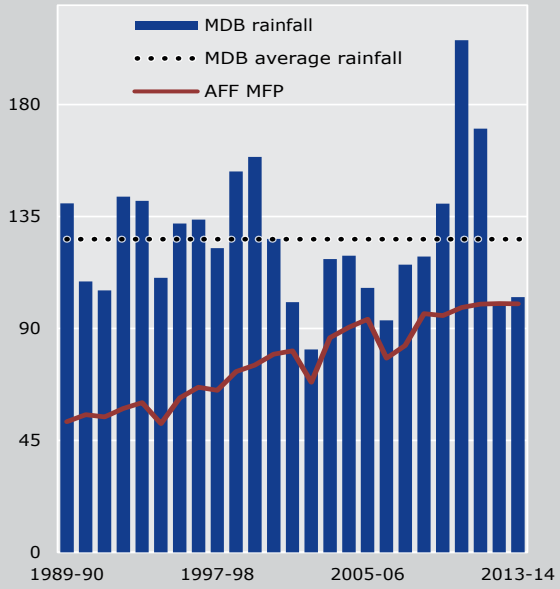
In this year, weather conditions were unfavourable particularly in Queensland and northern New South Wales (ABARES 2014a). By the end of January 2014, around two-thirds of Queensland had been drought declared by the Queensland Government — 23 shires were fully declared and another four shires partially declared. According to ABARES (2014b), in 2013-14, winter crop production in Queensland was expected to decline by 31.1 per cent from the previous year and by 17.4 per cent in New South Wales.

However, 2013-14 presented relatively favourable weather conditions in other states and the Northern Territory. As a result, the winter crop was expected to increase by 2.9 per cent in Victoria, 24.9 per cent in South Australia and 34.8 per cent in Western Australia (ABARES 2014b).

The net result of these different weather conditions was an increase in output in 2013-14. The flat MFP growth was associated with a substantial increase in measured labour inputs.

Figure 1.4
Rainfall in the Murray-Darling Basin (MDB)[a] and MFP in Agriculture, forestry and fishing, 1989-90 to 2013-14[b]

Index 2012-13 = 100



[a] Rainfall in MDB is a crude indicator of seasonal conditions that affect agriculture and it has various limitations. For example, it is a measure for only part of the country; total rainfall does not account for factors such as the timing of rainfall; nor does it reflect extreme events such as heatwaves and frosts which significantly affect agricultural production. [b] The MFP index is measured on a fiscal year basis (1 July to 30 June), while the rainfall index is measured on a calendar year basis.

Data sources: Commission estimates based on ABS (Estimates of Industry Multifactor Productivity, 2013-14, Cat. no. 5260.0.55.002, December 2014); Bureau of Meteorology (2014).

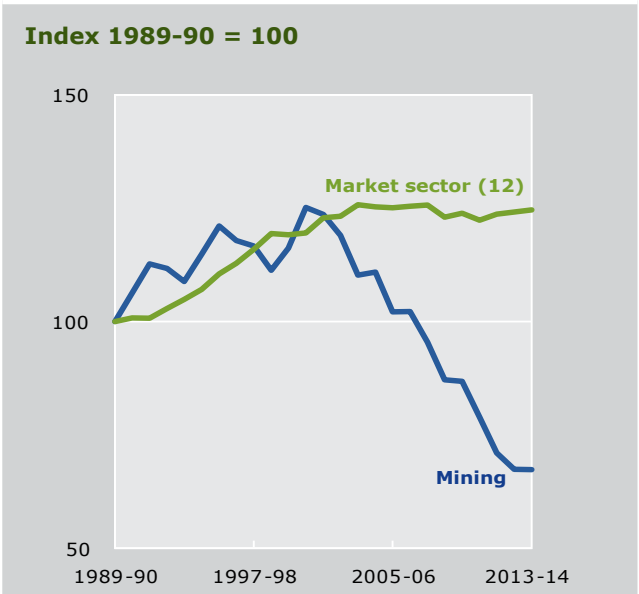
Opportunities for MFP growth in Agriculture, forestry and fishing

According to a report released by ABARES (Sheng et al. 2013), despite strong growth (1.6 per cent per year) in total factor productivity (TFP)[7] over four and half decades since 1961, the level of TFP in Australian broadacre agriculture was 30 per cent lower than in the United States and 5 per cent lower than in Canada. While the differences reflect dithering growing conditions, including variability in weather in Australia relative to the economies compared, an issue is whether, given these differences, there is scope to narrow the productivity gap.

Future growth in Australian agriculture is likely to depend on the more productive use of land, water and other natural endowments through the application of the most up-to-date equipment and technologies against the background of changing productive potential. The growth in Australia's population, which is expected to reach around 38 million by 2060 (PC 2013b), and a rapidly expanding middle class population in neighbouring Asian economies will provide increasing demand for agricultural produce (ABARES 2013; Hamshere et al. 2014).

7 TFP and MFP are similar in concept but differ in measurement. In the measure of TFP, intermediate input is included in both output and input but it is excluded from both in the measure of MFP.

Figure 1.5
MFP in Mining, 1989-90 to 2013-14



Data source: ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

Mining

MFP growth remained marginally negative in 2013-14

MFP growth in Mining remained negative in 2013-14 but its improvement (to -0.1 per cent) contrasts sharply with the downward movement of MFP by nearly 46 per cent between 2000-01 and 2012-13 (figure 1.5).

In 2013-14, negative MFP growth (figure 1.6) in Mining was caused by:

- output growth of 9.1 per cent
- slightly higher growth of total inputs (9.2 per cent), of which,
  - capital input increased by 11.8 per cent, and
  - hours worked increased 1.0 per cent.

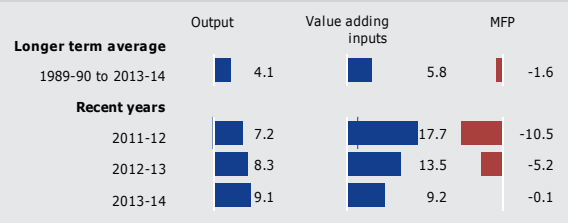
Previous PC analysis (Topp et al. 2008) reported that the decline in measured MFP for Mining was, in part, due to a lag effect — where the surge of large capital investment in the industry did not coincide with a rise in production.[8] This was likely to be a temporary phenomenon observed in the 'investment phase' of the mining boom. Once this investment is used in production, productivity is expected to increase because, with the new productive capacity coming on stream, output growth is likely to outpace the increase in inputs required during the 'production phase'.

It was indicated in the last issue of the PC Productivity Update (PC 2014) that it would not take long before the expanding mining activities moves into the production phase. The departure from strong negative MFP growth observed in 2013-14 is likely to be a sign of the beginning of this transition.

8 The other important cause of the negative growth of the measured MFP for Mining was a general decline in the quality of mineral and energy deposits being extracted.

Figure 1.6
MFP growth in Mining[a]

Per cent



[a] Average annual growth rates and annual growth rates in designated periods.

Data source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

This transition into the production phase is also evident from statistics on Australia's terms of trade and capital investment in the industry (figure 1.7). The fundamental driver of the investment boom in mining was the surge in commodity prices on the international market, particularly a rise in the prices of iron ore and other minerals that Australia exports. This rise in commodity prices was reflected in the substantial increase of the terms of trade (figure 1.7, left hand panel) — a measure of Australia's export prices relative to import prices. In the decade between 2000-01 and 2010-11, Australia's terms of trade index almost doubled (from 58.4 to 110.6).

The terms of trade index reached a peak in 2010-11. The pattern of capital investment in Mining followed a broadly similar pattern — after the recent peak in 2012-13, the growth in Mining capital investment declined in 2013-14 (figure 1.7, right hand panel).

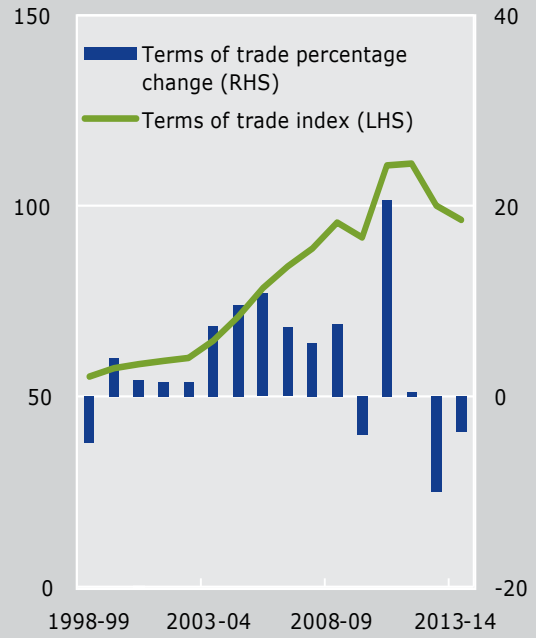
These trends are consistent with the slowing of negative growth in Mining MFP as observed in 2013-14. If mining has transitioned into the production phase, it is likely to show positive MFP growth in the years to come.

A more detailed analysis of recent Mining productivity by sub-industry is provided in Chapter 4.

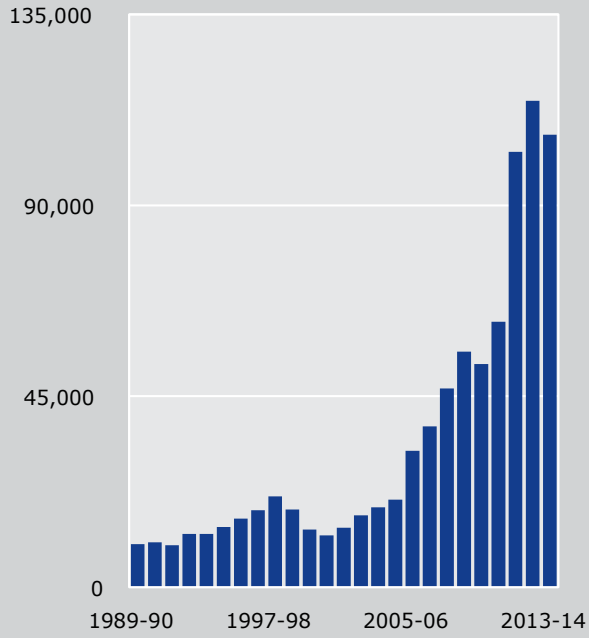
Figure 1.7
Terms of trade (LHS) and Real capital expenditure in Mining (RHS)[a]

1998-99 to 2013-14

Index 2012-13 = 100 (LHS) and annual growth rates, per cent (RHS)



$ million, 2012-13 constant prices



[a] Gross fixed capital formation from both public and private sources.

Data source: ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0, November 2014).

Electricity, gas, water and waste services (Utilities)

MFP growth in Utilities continues to decline

A slight improvement in Utilities MFP growth in 2012-13 gave way to a further decline in productivity in 2013-14, continuing a trend towards negative MFP growth for the industry (figures 1.8 and 1.9).

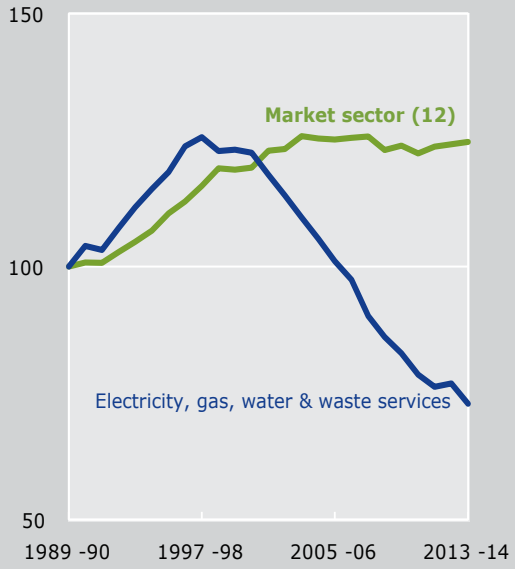
For 2013-14, the turnaround to negative MFP growth (from 0.9 per cent in the previous year to -5.4 per cent in 2013-14) was driven by:

- negative output growth (-2.1 per cent compared with 0.7 per cent growth in the previous year)
- a significant increase in input growth (3.3 per cent from -0.2 per cent in the previous year).

In 2013-14, a key factor for the significant drop in the MFP of Utilities (-5.4 per cent) and LP growth (-8.6 per cent) was a surge of labour input (6.5 per cent). According to ABS (2014b) employment statistics, this reflected a decline in the Electricity industry (down 10 per cent) but increased employment in the Gas supply (up 77.2 per cent) and Waste collection, treatment and disposal services (up 40.6 per cent) industries. The growth in the Gas supply industry was likely associated with the considerable activity and expected demand from LNG projects around Australia (Department of Industry and BREE, 2014) and, once they start producing output, measured productivity is likely to increase. Therefore, the negative impact of the LNG projects on measured MFP is unlikely to continue into the longer term.

Figure 1.8
MFP in Utilities, 1989-90 to 2013-14

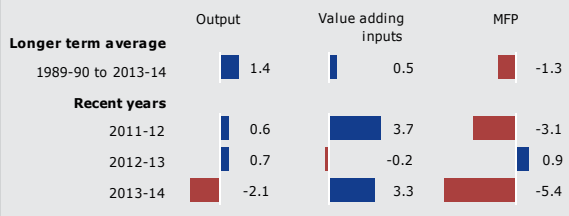
Index 1989-90 = 100



Data source: ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

Figure 1.9
MFP growth in Utilities[a]

Per cent



[a] Average annual growth rates and annual growth rates in designated periods.

Data source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

Recent productivity drivers

Previous editions of the PC Productivity Update (PC 2013a, 2014) highlighted three non permanent influences that contributed to negative MFP growth in Utilities since 1997-98:

- a surge in investment in large scale and often one-off infrastructure projects
- rising peak relative to average demand for electricity, lowering the average utilisation rate of transmission capacity
- the effect of drought on the output of the water supply sector.

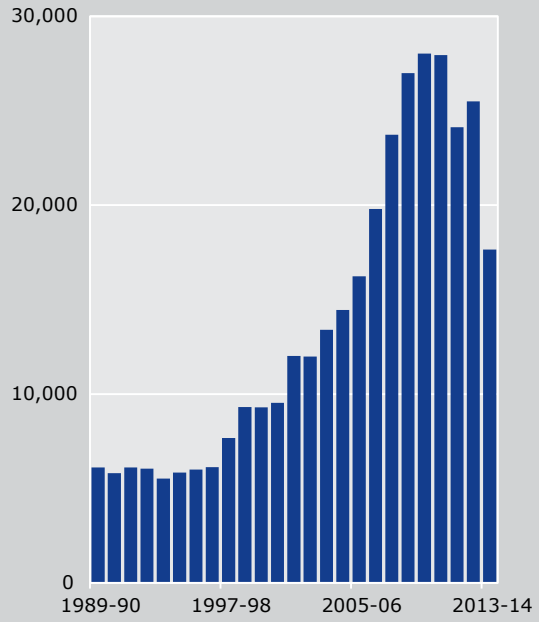
There are signs that negative productivity effects of these influences are starting to diminish.

Capital investment

Capital investment in Utilities declined by around 37 per cent in 2013-14 compared to the previous year (figure 1.10). The significant surge in capital investment that has added to installed capital capacity over recent years appears to continue to exert a downward influence on MFP growth. This is likely to dissipate if increases in capital through new investment were to stabilise over time and as the utilisation of installed capacity were to increase.

Figure 1.10
Real capital expenditure in Utilities,[a] 1989-90 to 2013-14

$million, 2012-13 constant prices



[a] Gross fixed capital formation including both public and private investments.

Data source: ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0, November 2014).

Electricity demand

The demand on the electricity network is expected to increase slightly before 2016-17 due to the growth in large industrial consumption, primarily driven by Queensland's LNG projects coming online from 2014-15 (AEMO 2014). This growth is likely to be moderated by the closure of other energy intensive sites, including the Bulwer Island refinery in Queensland, Point Henry aluminium smelter in Victoria, and others, such as car manufacturing plants in 2017.

In 2014-15, electricity demand is forecast to fall by 3.1 per cent before increasing in the short and medium-terms. AEMO (2014) forecasts average annual growth in electricity demand to be 0.2 per cent per year in the decade to 2012-24.[9] This rate of growth contrast with AEMO forecasts of 1.5 and 2.9 per cent per year growth in population and GDP respectively during this period.

Another historical driver of growth in energy investment has been the steady rise in peak relative to average demand for electricity, resulting in lower utilisation of the electricity network (PC 2013a). The rising peak demand was a consequence of more intensive use of air conditioning during a succession of hot summers in Australia up to 2008-09 (AER 2014). Since then, the impact of peak demand has tapered off. Despite further average trend summer temperatures, peak demand plateaued in 2013-14 when peak summer demand was around 6.2 per cent below 2008-09 levels.

The AER (2014) suggests that the underlying causes for this fall are similar to those that have reduced average electricity demand (i.e. slowing economic growth and reduced industrial loads; increased use of rooftop solar and adoption of energy efficiency measures; and changes in consumer behaviour in response to higher electricity costs). AEMO (2014) forecasts are based on the assumption that peak demand will remain below 2008-09 levels in most regions for at least the next 20 years.

Assuming declining demand and subdued growth in peak demand, AEMO (2014) has projected that national electricity market would require no additional capacity to maintain adequate supply for the next 10 years. To the extent that continued output growth in the industry is achieved without significant further capital investment, measured MFP growth should become positive in the electricity sector.

9 This forecast is based on the expected growth in the take-up of rooftop solar (13.6 per cent per year) and energy efficiency of 36 per cent per year (from a low base), and zero growth in residential and commercial electricity demand over this period.

Drought

The third influence on productivity in Utilities has been the major drought of the 2000s. This saw a dramatic reduction in water availability and the introduction of water consumption restrictions, resulting in reduced output in the water sector. However, according to the latest ABS figures, household water consumption levels were the highest in 2012-13 (1851 GL) since 2008-09 (when the ABS started the Water Account Australia series). This was 7.9 per cent higher than the previous year (1715 GL) but only 1.8 per cent higher than in 2008-09 (1818 GL).

Given the water supply industry relies on a relatively fixed capital cost structure (including a number of recently installed, but underutilised, desalination plants), productivity of this industry will largely be determined by output growth for some time to come. But, in the short to medium term, output of this industry will be influenced by two factors — the availability of water and changes in the demand by households and businesses in Australia's major cities and towns[10]. The evolution of these two factors are likely to shape productivity growth of the water supply industry in the foreseeable future.

As the factors underlying the productivity of Utilities are complex, short-term MFP growth in this industry will be uncertain. Over time, and with efficient investment in utility service infrastructure, increasing levels of demand by households and industry may see a reversal of the persistent decline in measured MFP growth.

Information, media and telecommunications

Information, media and telecommunications reversed MFP declines

Information, media and telecommunications recorded significant MFP growth in 2013-14, a considerable improvement on two previous years of negative MFP growth (figures 1.11 and 1.12). The result in 2013-14 was more than double its average MFP growth between 1989-90 and 2013-14.

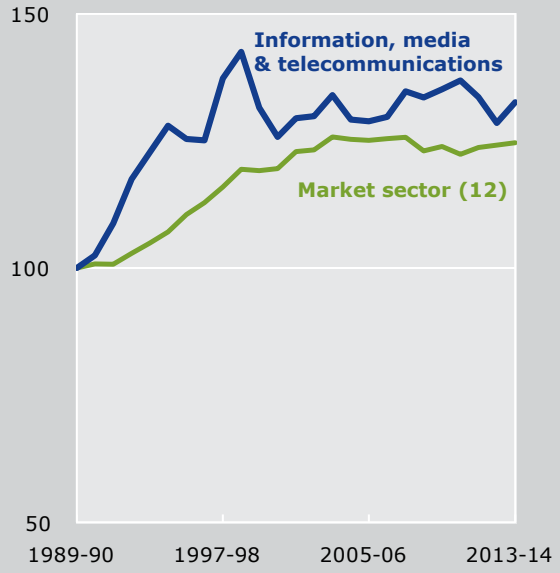
The reversal to positive MFP growth for the Information, media and telecommunications industry (3.1 per cent in 2013-14 from -3.9 per cent in the previous year) reflected:

- a moderate positive growth in output (2.4 per cent)
- a decline in total inputs (-0.8 per cent), of which
  - labour input dropped by 11.5 per cent, but
  - capital input increased by 6.0 per cent.

10 According to Topp and Kulys (2012), supplying irrigation water for agriculture is also a business of this industry but it is very small — typically accounting for only about 4 per cent of the Water supply, sewage and drainage subdivision.

Figure 1.11
MFP in Information, media and telecommunications, 1989-90 to 2013-14

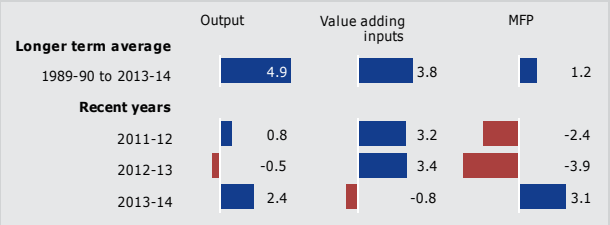
Index 1989-90 = 100



Data source: ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

Figure 1.12
MFP growth in Information, media and telecommunications[a]

Per cent



[a] Average annual growth rates and annual growth rates in designated periods.

Source: Commission estimates based on ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014).

Recent productivity drivers

According to the ABS (2014b) employment statistics, Publishing (except Internet & Music Publishing) and Telecommunications services — the two largest employing industries in Information, media and telecommunications — are likely to have been the main sources of the fall in hours worked in the whole industry.

More broadly, it is recognised that digital technology is having considerable impact on employment in Publishing. For example, IBISWorld (2014) found that newspaper publishing in Australia had 23 472 employees in 2010-11 and predicted that number would fall to 18 871 in 2013-14. This reduction accounts for almost a third of the employment decline estimated by the ABS during this period (ABS 2014b). With the influence of digital technology, newspapers around the world are changing their business models in order to reverse the decline in advertising revenue. In 2013 and 2014, paywalls were erected to the online content of Australia's major daily newspapers and other major organisational restructuring was announced. For example, in 2013-14, Fairfax Media continued to implement its *Fairfax of the Future* program announced in 2012, which aims to achieve annualised cost savings of around $311 million by 2015 (Fairfax Media 2014). Cost saving initiatives under the program were originally estimated to result in a reduction of 1 900 staff (Fairfax Media 2012).

It is also recognised that in telecommunications services many of the biggest telecommunication service providers have reported moves to either cut or outsource jobs in 2013-14 in anticipation of a post-NBN environment. That is, once the NBN is fully operational, these providers will be competing to add value and on-sell a wholesale product supplied by NBN. For example, in 2013-14, Telstra Group reported around 2 500 fewer jobs than the previous year (Telstra Corporation 2013, 2014).[11] Moreover, it was reported that Singtel-Optus shed around 1 700 jobs in the period between January 2012 and April 2014 (Ramli 2014).

It should be noted that, historically, employment in the Publishing and Telecommunication industries has been subject to substantial year-to-year variation, which have flowed through to affect year-to-year changes in productivity. The influence of recent reported changes in labour inputs on future productivity levels and growth are therefore uncertain.

11 This is a PC estimate based on Telstra Corporation Annual reports 2014 and 2013. It includes full time, part time and casual staff in controlled entities within the Telstra Group but excludes contractors and agency staff.

References

ABS (Australian Bureau of Statistics) 2014a, *Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260,0,55,002, December 2014.

ABS (Australian Bureau of Statistics) 2014b, *Labour Force, Australia*, Detailed, Quarterly, November 2014, Cat. no. 6291.0.55.003.

ABARES (Australian Agricultural and Resource Economics and Sciences) 2013, *What Asia wants: long-term food consumption trend in Asia*, Research report 13.12, ABARES, Canberra.

ABARES (Australian Agricultural and Resource Economics and Sciences) 2014a, *Agricultural Commodities: March Quarter*, Volume 4 No. 1, ABARES, Canberra.

ABARES (Australian Agricultural and Resource Economics and Sciences) 2014b, *Australian crop report: June 2014: No. 170*, ABARES, Canberra.

AER 2014, *State of the energy market 2014*, AER, Melbourne.

AEMO (Australian Energy Market Operator) 2014, *National electricity forecasting report*, June.

Barnes, P. 2011, *Multifactor Productivity Growth Cycles at the Industry Level*, Productivity Commission Staff Working Paper, Canberra.

Bureau of Meteorology 2014, '*Annual Rainfall - Murray Darling Basin (1990-1914)', Australian climate variability & change - Time series graphs*, Canberra, http://www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi?graph=rain&area=mdb&season=0112&ave_yr=0 (accessed 30 June 2015).

Department of Industry and BREE 2014, *Eastern Australian Domestic Gas Market Study*, Canberra, January.

Fairfax Media Limited 2012, *Fairfax of the future*, Media Release, Fairfax Media Limited, Sydney, 18 June.

Fairfax Media Limited 2014, *Annual Report 2014*, Fairfax Media Limited, Sydney.

Hamshere, P. Y. Sheng, B. Moir, F Syed and C. Gunning-Trant 2014, *What China wants: analysis of China's food demand to 2050*, paper presented at the 44th ABARES Outlook conference 4-5 March 2014, Canberra.

IBISWorld 2014, 'Newspaper publishing in Australia', *IBISWorld Market Research Report*, IBISWorld, Melbourne.

PC (Productivity Commission) 2013a, *PC productivity update*, May.

PC (Productivity Commission) 2013b, *An Ageing Australia: Preparing for the Future*, Commission Research Paper Overview, Canberra.

PC (Productivity Commission) 2014, *PC productivity update*, April.

Ramli, D. 2014, 'Optus set to slash 200 jobs', Sydney Morning Herald, April 29, Sydney.

Sheng, Y, K. Nossal and E. Ball 2013, *Comparing agricultural total factor productivity between Australia*, *Canada and the United States*, Paper presented at the 57th AARES Annual Conference, Sydney.

Telstra Corporation Limited 2013, *Annual Report 2013*, Telstra Corporation Limited, Melbourne.

Telstra Corporation Limited 2014, *Annual Report 2014*, Telstra Corporation Limited, Melbourne.

Topp, V., Soames, L., Parham, D. and Bloch, H. 2008, *Productivity in the Mining Industry: Measurement and Interpretation*, Productivity Commission Staff Working Paper, Canberra.

Topp, V. and Kulys, T. 2012, *Productivity in Electricity, Gas and Water: Measurement and Interpretation*, Productivity Commission Staff Working Paper, Canberra.

2 Contributions to output and income growth

Productivity is a measure of efficiency in production. Changes in productivity follow from the myriad of development and operating decisions of businesses, changes in public investment decisions and policy, as well as changes in the global and domestic economic environment. The outcome of all these changes determines how productivity evolves over time and its contribution to improved wellbeing in the longer run through the growth of real output and income.

Economic growth, as measured by GDP, is jointly determined by the three Ps — changes in **population**, its rate of **participation** of the working aged in economic activities (also referred to as 'labour utilisation'), and labour **productivity**.

Since the 1980s both population growth and labour productivity have been the main, but varying, contributors to real GDP growth which has averaged around 3.1 per cent per year. Population growth outweighed labour productivity growth in the 1980s while in the 1990s, labour productivity contributed almost two thirds to growth. In the more recent periods — the 2000s and the latest period from 2010 to 2014 — both factors have contributed in similar proportions to growth (figure 2.1).

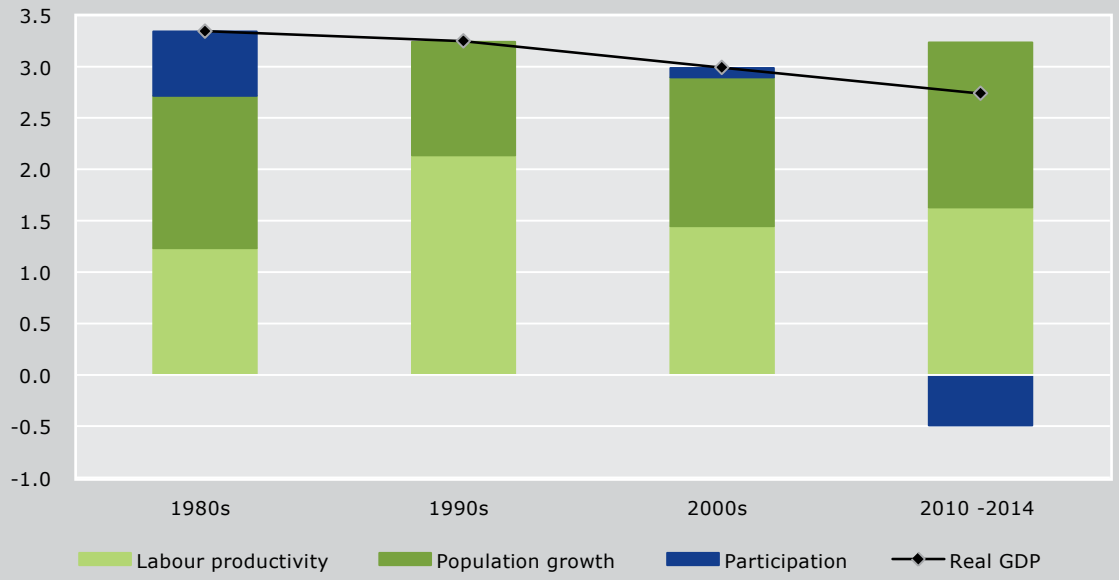
The contribution of participation[1] to economic growth declined from the 1980s and became negative in the latest (2010-14) period. From a peak in 2012, the share of the population of working age (15 to 64) is set to decline and it is likely that workforce participation will continue to decline for some years to have a negative longer-term impact on real output and per capita income.

Moreover, the ongoing shift in the structure of the Australian population towards older ages could well offset any efforts of increasing workforce engagement through, for example, lifting the levels of educational attainment, greater attachment of women to the labour force, and a deferral of retirement (PC 2013).

1 Participation is measured in terms of hours worked per working age person.

Figure 2.1
Contributions to the growth in aggregate real GDP[a]

Per cent



[a] Decades/periods are based on years ending in June. For example the 1980s refers to the 1979-80 to 1989-90 period, … , the 2000s refers to 1999-00 to 2009-10.

Sources: Estimates based on ABS (*Labour Force, Australia*, Cat no. 6202.0; *Population by Age and Sex, Australian States and Territories*, Cat. no. 3201.0; *Australian National Accounts: National Income, Expenditure and Product*, Cat. no. 5206.0; and *Labour Force Historical Time series, Australia, 1966 to 1984*, Cat. no. 6204.0.55.001).

Per capita income growth

While real GDP growth depends on growth in population, participation and labour productivity, real income growth also depends on the terms of trade and net foreign income (the earnings from Australian capital invested abroad less the earnings on foreign capital invested in Australia). While growth in population has had an important role in increasing the absolute size of the Australian economy, population growth by itself cannot increase per capita real output or income. Indeed, all else equal, population growth without an increase in the working age population will lower per capita income. Growth of per capita income will be jointly determined by the changes in the rate of participation, labour productivity which influence the growth in real GDP, the terms of trade and net foreign income.

In the last five decades, per capita national income growth has averaged around 2.1 per cent per year (figure 2.2). Its growth had been increasing since the 1970s to reach 2.3 per cent per year in the 2000s, but it has retracted in the latest 2010-14 period to 1.7 per cent per year.

Along with being an important contributor to output, labour productivity has also been the primary driver of per capita national income growth throughout the period since the 1960s, contributing on average 1.8 percentage points (or 85.4 per cent of the total) to average per capita income growth.

That contribution was lowest in the 2000s period, accounting for 62 per cent of the total change in per capita national income as improvements in the terms of trade made substantial positive contributions to income growth — adding 0.9 percentage points (or around 38 per cent of the total). However, reflecting the falling prices for Australia's key commodity exports (such as iron ore and coal prices), this contribution fell considerably in the latest period (2010-14) and is expected to fall further.

The contribution of net foreign income has been most significant between 2010 and 2014, adding around 0.4 percentage points (21 per cent of the total) to the per capita income growth. Overall, the contribution of net foreign income flows has been modest and variable since the 1960s. Net foreign income receipts have only been positive in the 1990s and in the four years since 2010.

Without a serious effort to resume and sustain productivity growth in Australia, the trend decline in the terms of trade from current high levels, and falling participation rates, indicate that Australia's national income growth per person will be subdued and improvements in living standards could be eroded (Harris 2013).

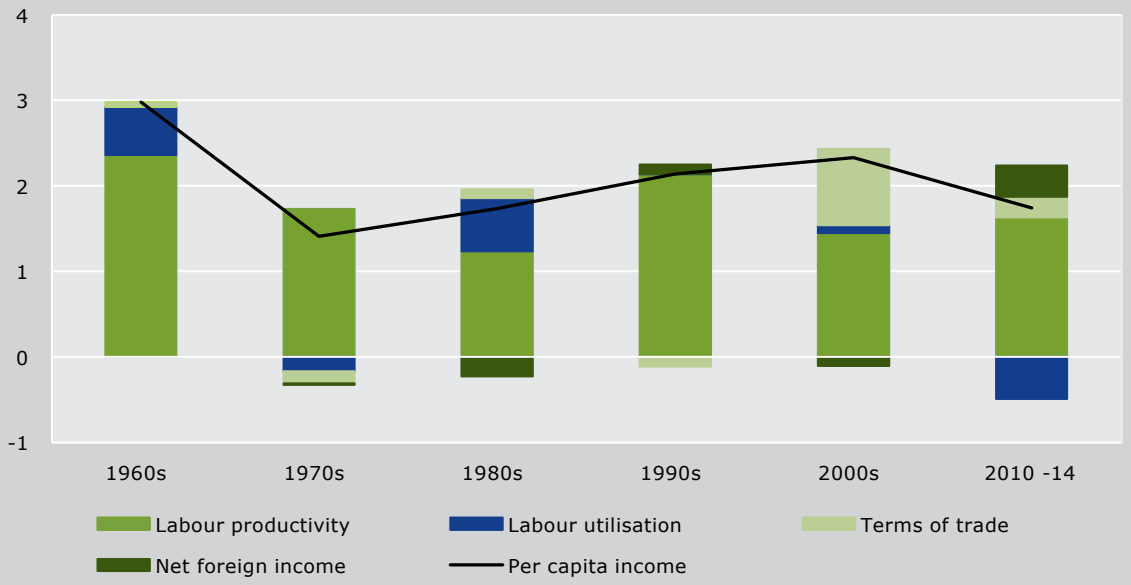
References

Productivity Commission 2013, *An Ageing Australia: Preparing for the Future*, Commission Research Paper, Canberra.

Harris, P. (Productivity Commission Chairman) 2013, *Observations on Productivity, National Income and the Demographic Outlook*, Australian Institute of Company Directors, breakfast address, Perth, 19 November 2013.

Figure 2.2
Contributions to average annual per capita income growth[a]

Percentage points contribution, annual average



[a] Post 1970s, periods are based on years ending in June. For example the 1980s refers to the 1979-80 to 1989-90 period. The 2000s refers to 1999-00 to 2009-10.

Source: Commission estimates based on ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0).

3 Improving the efficiency of capital investment in public infrastructure

Investment in infrastructure and other capital assets supports growth in the national economy. As the previous discussion shows (see box 1.3 for instance), capital deepening makes a critical contribution to growth in productivity and living standards. The quality of this capital investment is instrumental in achieving this contribution. Public infrastructure includes capital assets that play a unique role because, unlike other types of capital, it provides services to the community in general. Yet, the efficiency of public infrastructure investment is often under question. Recently, the Commission completed an inquiry on the provision of public infrastructure and found that, among many other things, that the delivery of public infrastructure projects could be improved by the application of more rigorous and transparent cost-benefit analysis (PC 2014). The analysis in this chapter is based on the findings from this inquiry.

3.1 The importance of capital in the Australian economy

As reported in chapter 1, the growth in real capital in the Australian economy has outpaced the growth in labour inputs resulting in more intensive use of capital (known as 'capital deepening'). Capital deepening contributed almost 60 per cent of the growth in national labour productivity with multifactor productivity (MFP) growth contributing the remaining 40 per cent. In 2013-14, there was an estimated $5.1 trillion or more of installed capital that was available for use in the Australian economy — over three times the value of production in that year (figure 3.1, top panel). Over the next 50 year period, the Commission has estimated that new capital investment will be more than five times the cumulative investment made over the last half century to around $38 trillion in today's prices (PC 2013).

The largest component of today's installed capital is in the form of non-dwelling constructions — which consists of non-residential buildings (i.e. buildings other than dwellings, including fixtures, facilities and equipment integral to the structure) and other structures (including streets, sewers, railways and runways) — which amount to over $2 trillion (or 43 per cent of the total). The next single most important component relates to dwellings, amounting to around 35 per cent of the total installed capital (figure 3.1, bottom panel).

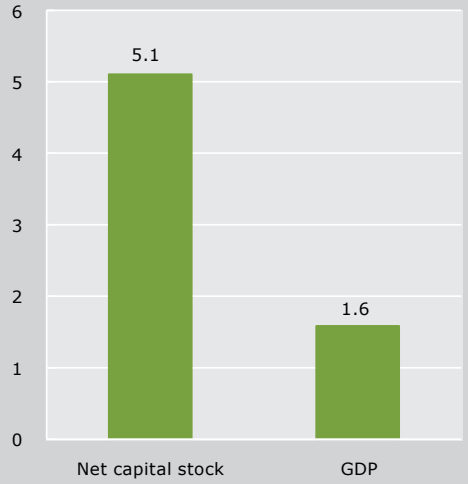
Additions to the stock of capital will usually increase output and add to labour productivity. However, for productivity to improve, the growth in output must exceed the growth in inputs. Poorly selected projects can detract from productivity as the resources they use would have delivered a higher output elsewhere in the economy.

Growth in the stock of capital is also important as a source of capital embodied technical change. Over time, technological change embodied in newer units improves the *quality* of the capital installed and, with it, improvements in the productivity of that capital. The introduction of new generations of capital equipment and general purpose technologies (such as ICTs) may also enable firms to undertake broader *technological and organisational change* that would enable the more productive utilisation of *all* factors of production adding to MFP growth.[1]

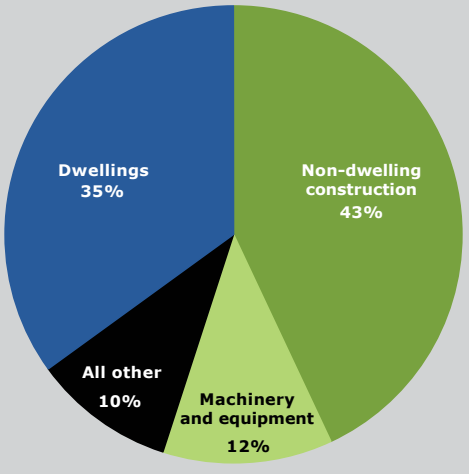
1 As MFP growth is measured as a residual, it may also include the effects of other factors such as changes in capital utilisation and measurement issues.

Figure 3.1
Net capital stock[a], as at 30 June 2014

Aggregate value ($ trillion)



By type of asset[a]



[a] Net capital stock is the stock of produced assets including machinery and equipment, non-dwelling construction, dwellings and other forms of produced capital including ownership transfer costs; weapons systems; cultivated biological resources; research and development; mineral and petroleum exploration; computer software; and artistic originals. The capital stock is 'net' of accumulated depreciation on installed capital.

Source: ABS (*Australian System of National Accounts, 2013-14*, Cat. no. 5204.0, October 2014).

3.2 The role of public infrastructure

Public infrastructure is an important part of Australia's total capital stock with available estimates suggesting that it amounts to nearly one fifth of the national stock of capital. According to the Commission's study into *Public infrastructure* (PC 2014), in 2011-12, Australian governments owned 'infrastructure and other (non-building) construction' assets valued at $614 billion, which comprised economic infrastructure, such as road, rail, energy and water assets. Governments owned a further $263 billion worth of buildings, much of which is social infrastructure, including schools and hospitals.

Efficient provision of public economic infrastructure (such as road, rail, energy and water assets) provides services that support production and consumption activities across the domestic economy and international trade. These services can also generate indirect or flow-on benefits such as through communications network infrastructure that increase the opportunity and capacity for business to collaborate and innovate, leading to technological and organisational change, and ultimately improved productivity.

Efficient provision of public social infrastructure (such as schools and hospitals) provides services that benefit individuals, but can also have broader economic implications. To the extent that public social infrastructure leads to the maintenance and improvement of education and health outcomes, such investment supports workforce participation and productivity, drives economic growth as well as promotes broader community wellbeing.

However, not all public infrastructure supports productivity and generates economic growth and wellbeing. Poorly selected public infrastructure investment can impede the efficient provision of public infrastructure services, crowd out private investment and reduce productivity, economic growth and wellbeing.

3.3 Governments play an important role

Whilst governments are often major providers of infrastructure, even where they do not have a funding and finance role, their general powers in relation to land use mean they are usually involved in long-term planning which gives them a role in project selection. This is particularly the case in areas of economic infrastructure, such as transport (such as road, railways and airports and bridges), utilities (such as electricity network, dams and waterways), and telecommunications. Governments are also often involved in the economic, environmental and safety regulation of economic infrastructure. In many areas of investment in social infrastructure (such as public schools and hospitals), governments are likely to be the dominant funders (box 3.1).

The increasing trend towards private involvement in the delivery of public infrastructure has changed the balance between government as the primary provider and government as a regulator of infrastructure services. Where the private sector is involved, governments may choose to shape provision directly by setting and enforcing construction and service delivery standards, imposing planning and zoning restrictions, or imposing other conditions and, in some cases, regulating prices. Alternatively, government may influence private investment indirectly through financial incentives such as tax arrangements and capital market interventions. Governments can also seek to purchase particular outcomes from the private providers, which can form part of a public private partnership arrangement, or be transacted under a purchase of service contract.

Box 3.1
Reasons for government involvement in the provision of public infrastructure

The basic reason for government involvement in the provision of public infrastructure is to address market failures that may lead to the under provision of infrastructure services if left entirely to the private sector. There are three main forms of market failure.

- **Natural monopolies** exist where it is more efficient for one business to supply the entire economy or a segment of the market under prevailing technologies than it would be for two or more businesses. Conditions of natural monopoly create the potential for a firm to exercise its market power by setting prices higher and the level of output lower, than would occur in a competitive market. This leads to a loss in benefit to the community.
- **Externalities** exist when the action of an individual or firm creates a benefit or a cost for others who are not a party to the transaction, and these benefits or costs are not fully reflected in market prices. Firms tend to underproduce goods with positive externalities (such as education) and overproduce goods associated with negative externalities (such as pollution).
- **Public goods** exist where consumption by one person of a particular product does not diminish consumption by others and it is hard to exclude others from materially benefitting from the consumption of the product. As a result, firms are likely to underprovide the supply of this type of product. Public goods are a special case of externalities.

Community service obligations (CSOs) are imposed by governments on infrastructure service providers to meet a social or other needs that the government views to be important. CSOs can be imposed through regulation, purchased by governments, or make up part of a package of commitments required by government before they authorise the investment. Without such intervention, markets may not provide access to basic levels or quality of service to groups that are less able to pay for such services or which are more costly to supply to. Supply of water, sewerage, roads, rail and telecommunications to certain rural communities are good examples.

3.4 Improving the assessment and selection of public infrastructure investment

In its recent report on *Public infrastructure*, the Commission assessed that there is considerable scope to improve the quality and efficiency of government investment in public infrastructure investment in Australia. In its report, the Commission presented a wide range of issues and made recommendations to improve the processes for selecting projects, financing initial capital commitments, and funding ongoing operations. Also included were recommendations to overhaul institutional governance to inject greater rigour into project evaluation and decision making, including more transparent and accountable processes and a more efficient regulatory environment (figure 3.2).

Most relevant to enhancing the efficiency of the provision of public infrastructure is improving project selection processes. Australia's cities and towns generally function adequately and assets undergo usual maintenance, although problems have emerged in some major cities. Nevertheless, the Commission found numerous examples of poor value for money arising from inadequate project selection and prioritisation. In particular, there was a bias toward large investments despite the returns to public investment often being higher for smaller, more incremental investments. In part, this was because the private sector is more interested in financing large investments (due to the costs involved), and governments have increasingly seen public private partnerships (PPPs) as a way of harnessing not just finance, but expertise in project delivery and operation.

Private investors need a return on their investment and, in a fully private venture, will carefully assess the cost-benefit ratio of projects under consideration. While they should apply the same discipline in PPPs, the involvement of government and the complex relationship between the initial financiers of a project and the long term investors can make this assessment difficult. As a result, it behoves government to ensure that the project, and the revenue streams it will generate either directly in user fees, and/or through government purchasing arrangements, will provide a return that is competitive for the investor's dollar. Where the government is the sole investor, they should be accountable to the taxpayer for ensuring value for money.

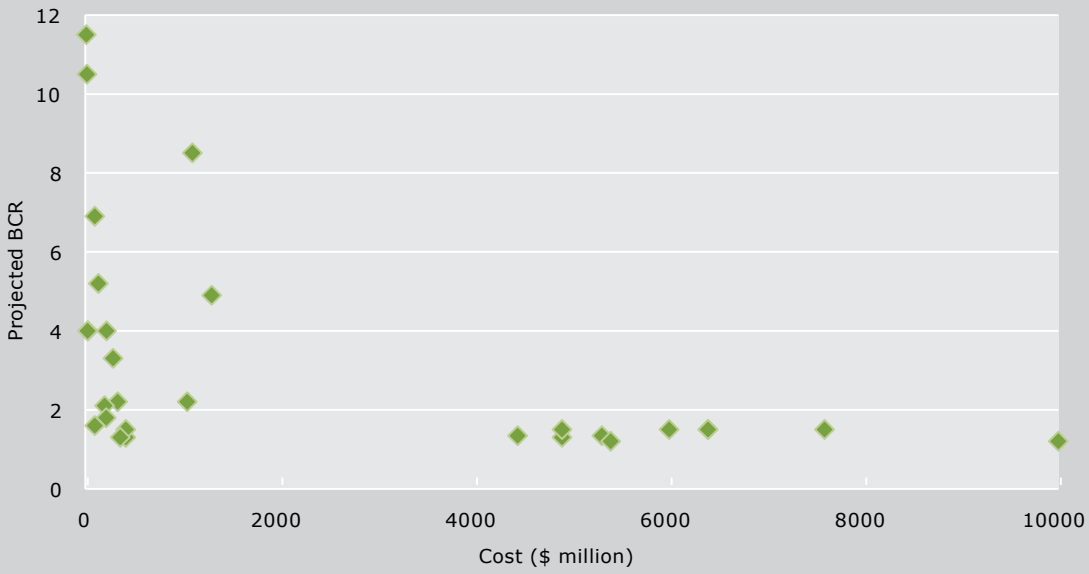
A key recommendation of the report was that governments should undertake a comprehensive and rigorous social cost–benefit analysis to all public infrastructure investment projects above $50 million. Such analyses should be publicly released during the commitment phase and be made available for due diligence. In general, cost-benefit analyses should be done prior to any in-principle commitment to a project or as soon as practicable thereafter.

Figure 3.2
Key components to improving the efficiency of public infrastructure investment and service provision

Governance arrangements	**Appropriate governance arrangements to provide an efficient regulatory environment, evaluation and decision making capabilities, and transparent and accountability processes**		
Key components	**Project selection**	**Development and financing of a project**	**Funding ongoing operations**
Recommended approach	Undertake rigorous cost benefit analysis that enables sound project selection of the option(s) that maximise(s) public benefit and economic efficiency	Provide enhanced opportunities for private sector involvement to: • access wider range of funding sources • increase project cost discipline • better manage project risks	Use, wherever possible, efficient pricing mechanisms based on direct user charges

Figure 3.3
Benefit–cost ratios versus cost

Projects submitted to Infrastructure Australia[a]



[a] Incudes project proposals that are submitted by State Governments for inclusion on Infrastructure Australia's priority list that are 'ready to proceed' (those with strong strategic and economic merit that have met all of Infrastructure Australia's criteria) or 'threshold' projects (those that are well developed and present a detailed preferred option). Other projects that are early stage or approved by State Governments are not included.

Source: Infrastructure Australia (2011, 2012a, 2013a).

Why a cost-benefit analysis is important

Although under-provision of infrastructure can have negative effects on the community, so too can over-provision with infrastructure that is too large, poorly matched to the needs of the community, or unnecessary. Proceeding with major infrastructure projects entails large resource costs that are only worth incurring if they are outweighed by the benefits of the services that they provide.

The economic efficiency of proposed public infrastructure projects can be assessed by conducting thorough and transparent social cost-benefit analysis. This analysis can examine if a project has a positive net benefit to the community, and whether proceeding with it will improve economic efficiency. A comprehensive analysis would consider feasible alternative projects to inform decision makers of the option with the greatest net benefits. This might be to address a particular problem, such as security of an urban water supply in the face of falling dam levels, or as part of prioritising enhancements, such as addressing the congestion points or 'black spots' in an urban transport network.

The value of retaining the flexibility to defer, modify or cancel projects can also be assessed through this process. Governments should select projects that have the highest return to the community as a whole. Social cost-benefit takes into account benefits other than the revenue stream that the project generates to include any positive or negative effects on economic activity, social activities, and the environment.

In Australia, rigorous analysis focusing on the community-wide costs and benefits is particularly important for large infrastructure projects. This is because, the benefit-cost ratio (BCR) is generally lower for large projects due to their large construction costs and rising utilisation rates over time, and many are typically only marginally above the acceptable threshold of 1 (figure 3.3). Rigorous analysis of large projects is also important as there is likely to be a large number of small unfunded projects with high benefit to cost ratios that could be completed instead.

How does cost-benefit analysis help selecting public infrastructure projects?

Community-wide (social) cost-benefit analysis involves aggregating the impacts on all members of the community and appropriately taking account of risks. It allows information to be analysed in a logical and consistent way and encourages decision makers to take into consideration all costs and benefits of a project, rather than making decisions based on selected impacts only. It should consider all, although may only be able to quantify some, economic, social and environmental outcomes to provide a reliable guide to what is in the overall interest of the community.

For example, benefits from a new toll road might include the value of travel-time savings on both the toll road and the wider transport network, reductions in accidents, and effects on pollution. Benefits that take the form of productivity improvements (such as reduced travel time for transporting goods) would be assessed alongside other types of benefits (such as reduced travel time for commuting or recreational trips).

The standard decision rule is that projects with positive net social benefits should be accepted for further assessment and compared with other project proposals. However, at any time, there is always a budget constraint and always an opportunity cost — so transparent ranking of options based on economic, social and environmental impacts is essential. Where there are mutually exclusive projects and a binding budget constraint, the project with the highest net benefits should normally be preferred.

As infrastructure investment usually involves a significant amount of money, it is important that the options considered include deferring the investment. Delaying an investment has a considerable saving. Just in time investment raises productivity as the average utilisation rates are higher. Similarly, options for repair and enhancement should be considered if they can delay a major investment. In these cases an options approach to the cost-benefit analysis would allow different packages of investment that deliver slightly different service flows, but at different costs, to be compared. For example, demand management for urban water could delay a major investment in a new dam for a lower net cost and

little reduction in benefits if the population is happier with restrictions than with higher water prices. Moreover, comprehensive analysis would consider the ongoing maintenance and operating costs of an infrastructure project along with construction costs to identify the most cost-effective design in the longer term.

Cost-benefit analysis that distinguishes between the impacts of a project on particular groups, such as regional communities and low-income households allows decision makers to form judgements about whether distributional or equity issues should be addressed. Ideally, such issues would be addressed through a transparent public process.

Governments may sometimes have legitimate reasons to make project selection decisions that run contrary to the rankings suggested by a cost-benefit analysis. For example, some aspects of a project that are not quantifiable in monetary terms may be considered important. There also may be a network effect that is hard to quantify. The reasons for such decisions should be clearly explained and scrutinized.

What may impede the effectiveness of a cost-benefit analysis?

For cost-benefit analysis to play a useful role in guiding project selection, it needs to be rigorous and consistently applied. In its inquiry, the Commission outlined three key factors that have the potential to reduce the effectiveness of cost-benefit analysis.

- **Optimism bias.** There is a systematic tendency for project appraisers conducting cost-benefit analysis to be overly optimistic — the bias is toward overstating benefits, and understating timings and costs, both with respect to initial capital commitment and operation costs. Over estimates of traffic forecasts on toll roads and tunnels are a particular problem. Optimism bias can be countered by rigorous analysis of plausible outcomes for the project and by using reference class forecasting. The latter does not attempt to forecast the specific uncertain events that may affect a particular project, but instead predicts outcomes based on those actually achieved for a set of similar past projects.

- **Treatment of risk and uncertainty.** Costs and benefits are expected values based on the probability of different outcomes. Cost-benefit ratios may be sensitive to certain assumptions which have to be made without sufficient evidential support. For example, inappropriate assumptions about allowance for project risk in the discount rate (that is, the risk premium) may alter the ranking of projects and lead to suboptimal project selection. More commonly, the interaction between the different parameters used to estimate the costs and benefits is ignored despite the potential for these relationships to have compounding impacts.

- **Treatment of 'wider economic benefits'.** Infrastructure projects create direct benefits for users of the resulting service provided by public infrastructure. Where cost-benefit analysis is done, such benefits are routinely estimated and included. However, projects can also create wider economic benefits and costs. For example, investment in transportation infrastructure brings consumers closer to more businesses, potentially facilitating greater competition and leading to a more innovative and a dynamic economy. However, such wider economic benefits are hard to quantify and their inclusion in a cost-benefit analysis has the potential to show one project to be superior to another purely because of differences in the way such benefits are defined and estimated. Cautious and consistent treatment across options of wider economic benefits is warranted.

There is also the possibility of **double counting** of benefits. For example, new transport infrastructure may reduce commuting times, and also increase the value of housing close to the infrastructure. However, if the latter has arisen because of reduced commuting times, then it is double counting to include both as separate benefits.

Any cost-benefit analysis should be conducted by independent analysts and be subject to public scrutiny.

Transparency in the process of cost-benefit analysis

A transparent cost-benefit analysis can play a critical role in project selection, particularly where all the benefits and costs are not internal to the investor, that is, the decisions rest with government. Making cost-benefit analyses public for both projects that have been selected, and those that have not been selected can improve the transparency of decision making. Such transparency strengthens the incentives for decision makers to focus on the overall net benefits of projects from a community wide perspective. It also allows particular estimates, such as construction costs or patronage, to be scrutinized and testing to be done on how the use of different estimates would affect a project's net benefits. Transparency can help to improve the quality of analysis because proponents and practitioners know that any flaws are likely to be exposed.

References

Infrastructure Australia 2011, *Communicating the Imperative for Action: June 2011 Report to COAG*, Canberra.

Infrastructure Australia 2012, *Australian Infrastructure – Progress and Action: June 2012 Report to COAG*, Canberra.

Infrastructure Australia 2013, *National Infrastructure Plan: June 2013 Report to COAG*, Canberra.

PC (Productivity Commission) 2013, *An Ageing Australia: Preparing for the Future*, Commission Research Paper Overview, Canberra.

PC (Productivity Commission) 2014, *Public Infrastructure*, Inquiry Report No. 71, Canberra.

4 Insights from recent productivity research

4.1 Productivity growth within Mining

Aggregate data indicate that Mining is transforming from a substantial investment phase to a predominantly production phase. To shed more light on the transition in Mining, the Commission has updated the productivity estimates for the four major industries in Mining:

- Coal mining
- Oil and gas extraction
- Iron ore mining
- Other metal ore mining.

Collectively, these four industries accounted for over 90 per cent of total Mining output in 2013-14 based on industry value added shares.

The multifactor productivity (MFP) estimates of these industries have been derived using ABS data and follow a similar methodology to that used by the ABS to derive MFP estimates for Mining as a whole. They are, nevertheless, Commission estimates not ABS estimates.

The updated estimates indicate that different industries within Mining are at different stages in their investment/production phases or cycles, and hence exhibit different MFP growth rates, particularly in the post 2011-12 period.

In two industries — Coal mining and Other metal ore mining — MFP growth was estimated to have been positive in 2012-13, even though there was no MFP growth in Mining as a whole (figure 4.1). These two industries appear to be further along the post-investment or 'production phase' of the commodity price boom, with input growth now slowing or decreasing and output growth stable or, in the case of Coal mining, increasing more rapidly in 2012-13.

In contrast, total input growth in both Oil and gas extraction and Iron ore mining continued at high rates in 2012-13, so that MFP growth continued to be negative. In fact, aggregate capital investment in Oil and gas was at record levels in 2012-13, and was close to record levels in Iron ore mining in that year (figure 4.1). Both industries also recorded comparatively high rates of growth in labour inputs. These results suggest that both groups were still largely in an investment phase during 2012-13.

Due to data limitations, it has not been possible to produce subdivision MFP estimates for 2013-14.[1] However, based on broad information and data that is available from the ABS, it is likely that MFP in Coal mining continued to increase in 2013-14, given that output growth appears to have been comparatively strong (6.5 per cent), while capital investment was receding compared with the previous year (down 33.1 per cent) (figure 4.1). Output in Other ore mining declined slightly in 2013-14 (-0.7 per cent) and therefore MFP growth could be positive only if capital investment and labour input in this industry declined even further.

1 Further extension of annual MFP estimates requires more detailed data on capital investment for 2013-14. Aggregate investment data is available for the industries of Coal mining and Oil and gas but only available for Other metal ore mining and Iron ore mining as a whole. Further, investment data for 2013-14 is not available by asset types. For these reasons, in figures 4.1, MFP for all the industries and investment for Coal mining and Oil and gas do not go beyond 2012-13.

Based on ABS National Accounts data, Iron ore mining recorded historically high output growth in 2013-14 (22 per cent), suggesting that many of the major new projects that have been developed over the last five to ten years moved further to the production phase. This trend suggests that MFP growth in this subdivision in 2013-14 was likely to be higher than in the previous year (but possibly still slightly negative), although this will not be confirmed until additional data on inputs and output are available. Over the next few years, iron ore production is forecast to grow significantly (BREE 2014). With investment now slowing,[2] continued output growth is likely to underpin further increases in MFP growth in this subdivision over the next few years.

In contrast, MFP growth in the Oil and gas subdivision is likely to have been firmly negative in 2013-14, as output growth was comparatively low (1.4 per cent) while labour use was up substantially (27 per cent) and capital investment continued at record levels (up 16 per cent) (figure 4.1). Very large investments in LNG capacity in 2013-14 underpinned high input growth, although based on forecasts of LNG production by the Bureau of Resource and Energy Economics (BREE 2014), production from these investments is not expected to contribute to output growth in this subdivision before 2015-16. In essence, the Oil and gas subdivision was still in an investment phase in 2013-14, and measured productivity is likely to remain subdued for a number of years to come.

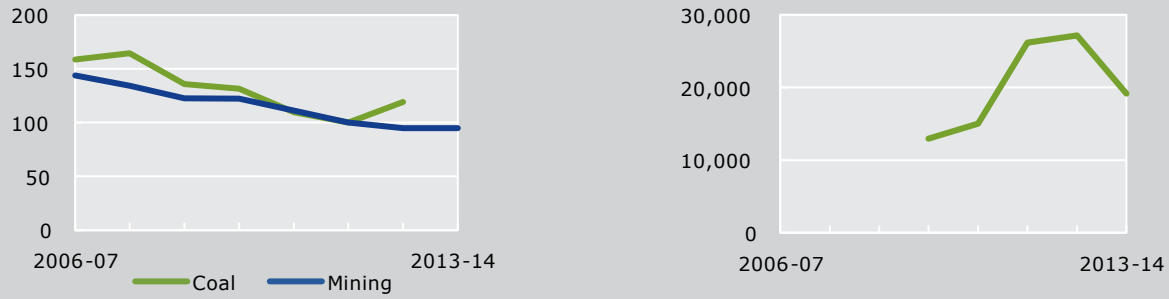
In summary, if forecasts are achieved — particularly for Coal and Iron ore — Mining MFP growth should be positive over the next few years and contrast with a decline during the investment phase of the mining boom. More broadly — and given the increase in the relative size of the industry as a result of the commodity price boom — achieving positive MFP growth in Mining would flow through to raise productivity growth in the market sector in aggregate.

2 According to ABS data, capital investment in 'total ore mining', which includes the industries of Iron ore mining and Other metal ore mining, declined by 29.5 per cent in 2013-14.

Figure 4.1
MFP and Investment

MFP index 2011-12 = 100 (LHS); Investment, $ millions (RHS)[a]

Coal mining



Other metal ore mining

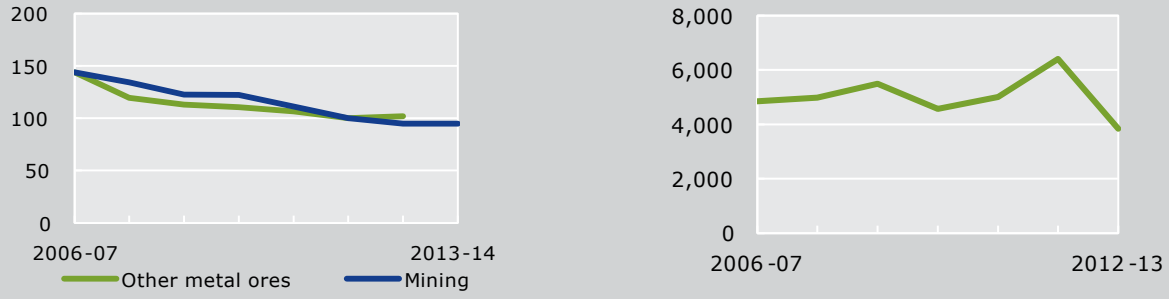


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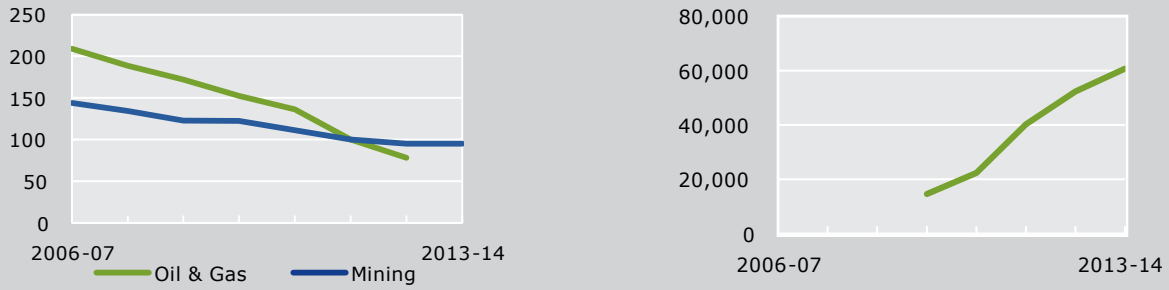
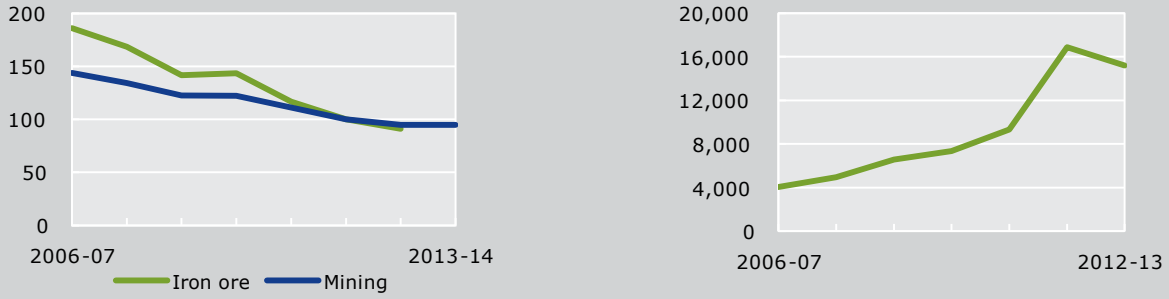
Figure 4.1 (continued)
MFP and Investment

MFP index 2011-12 = 100 (LHS); Investment, $ millions (RHS)[a]

Oil and gas



Iron ore mining



[a] Coal mining and Oil and gas investment data is private new capital formation available to 2013-14 (at current prices, September 2014), Other metal ore and iron ore mining investment data is gross fixed capital formation only available to 2012-13 (at current prices, 2012-13).

Source: Commission estimates; ABS (*Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December 2014); ABS (*Private New Capital Expenditure and Expected Expenditure, Australia*, Cat. no. 5625.0, September 2014).

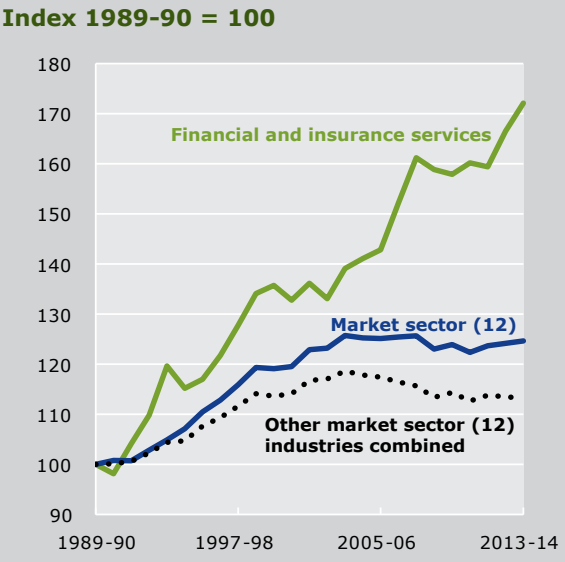
4.2 Productivity in Financial and insurance services

MFP growth consistently above market sector average

For more than two decades, multifactor productivity (MFP) in Financial and insurance services has increased ahead of average MFP growth in the market sector of the Australian economy — 2.3 per cent per year compared with 0.9 per cent per year over the 24-year period to 2013-14. Productivity growth for other market sector industries (combined) averaged 0.5 per cent per year and, while increasing to 2003-04, it has been on the decline since then (figure 4.2). This has offset the increase in Financial and insurance services, leading productivity in the market sector as a whole to decline over the 2003-04 to 2013-14 period.

MFP growth for Financial and insurance services, however, was interrupted in 2000-01 following the economic slowdown and again in 2007-08 following the global financial crisis.

Figure 4.2
MFP in Financial and insurance services and the market sector



Data source: ABS (*Experimental Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002).

MFP growth differs across parts of Financial and insurance services

Recent Commission research (forthcoming) has been undertaken to provide a more disaggregated picture of aggregate productivity estimates for Financial and insurance services published by the ABS, by estimating MFP for Finance separately from Insurance, superannuation and auxiliary services (combined).[3] The disaggregated data indicate that estimates for Financial and insurance services as a whole conceals considerable variation in estimated MFP across the industries in the sector (figure 4.3).[4] In particular, these disaggregated estimates show that the bulk of Financial and insurance services' MFP slowdown, from the high growth rates up to 2007-08, was attributable to Insurance, superannuation and auxiliary services (combined) (figure 4.3). It also suggests that MFP in the Finance industry declined over the first half of the decade before increasing.

While there has been some year-to-year variations in labour and capital inputs around trend values, overall, it was variations in value added between years that have been the main drivers of changes in MFP over the period.

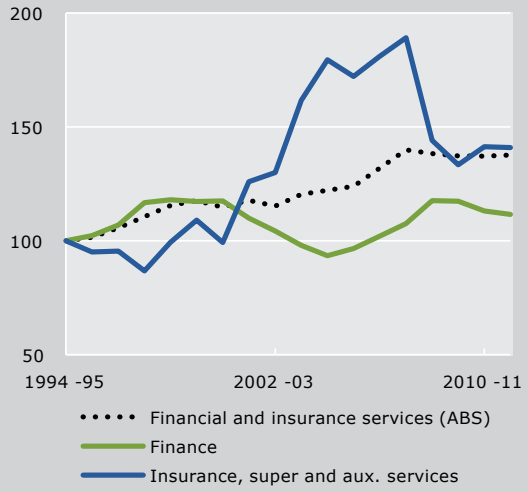
In particular, the large increase in MFP in the Insurance, superannuation and auxiliary services industry (combined), over the period 2000-01 to 2007-08, reflects the expansion in output of auxiliary services and the (imputed) insurance services charge. The subsequent decline in estimated MFP reflected a contraction in all services income (with the exception of rental income). Similarly, the above trend growth in MFP in the Finance industry in the years 2005-06 to 2008-09 reflected the above trend growth in the (imputed) output of the Finance industry. On the other hand, capital deepening in the Finance industry ahead of relatively flat output growth over the period 2000-01 to 2004-05 was the main proximate cause of the MFP decline for the industry over the period (figure 4.4).

3 Data availability limits further disaggregation. This research only covers the period until 2012-13.

4 While estimates for the division as a whole are available from 1989-90 to 2013-14, insufficient data were available to estimate productivity at the subdivision level for the period 1989-90 to 1993-94 and for years after 2012-13.

Figure 4.3
MFP for the Financial and insurance services and for its industries[a]

Index 1994-95 = 100



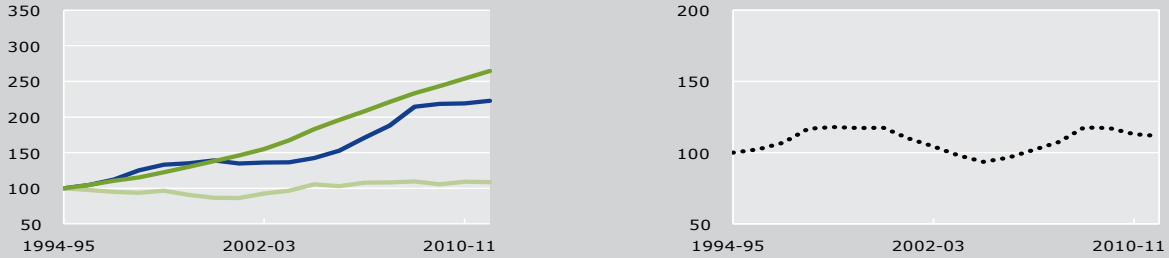
[a] Financial and insurance services (ABS) differs from the aggregate of the subdivision estimates due to limitations on available data and associated differences in estimation methodology.

Source: Commission estimates.

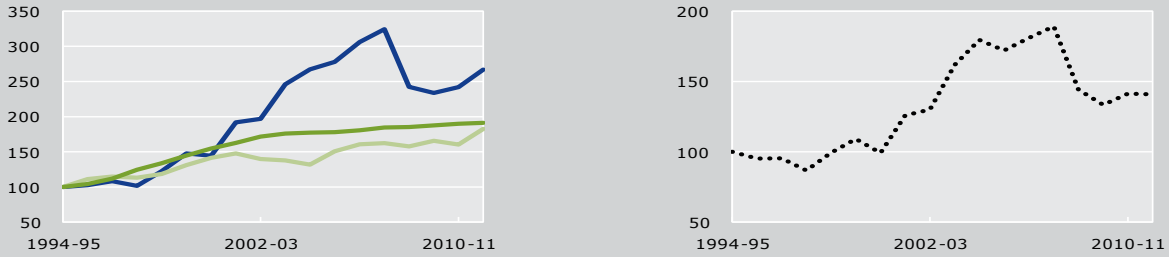
Figure 4.4
MFP and its proximate causes for Finance, and Insurance, superannuation and auxiliary services[a]

Index 1994-95 = 100

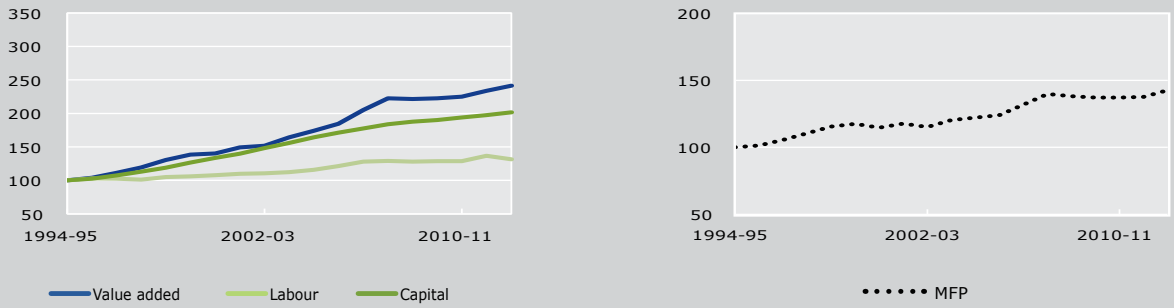
Finance



Insurance, superannuation and auxiliary services



Financial and insurance services in total



[a] Value added and capital are chain volume measures. Labour is hours worked.

Source: ABS (*Experimental Estimates of Industry Multifactor Productivity, 2012-13*, Cat. no. 5260.0.55.002); and Commission estimates.

Measurement of output affects the interpretation of productivity estimates

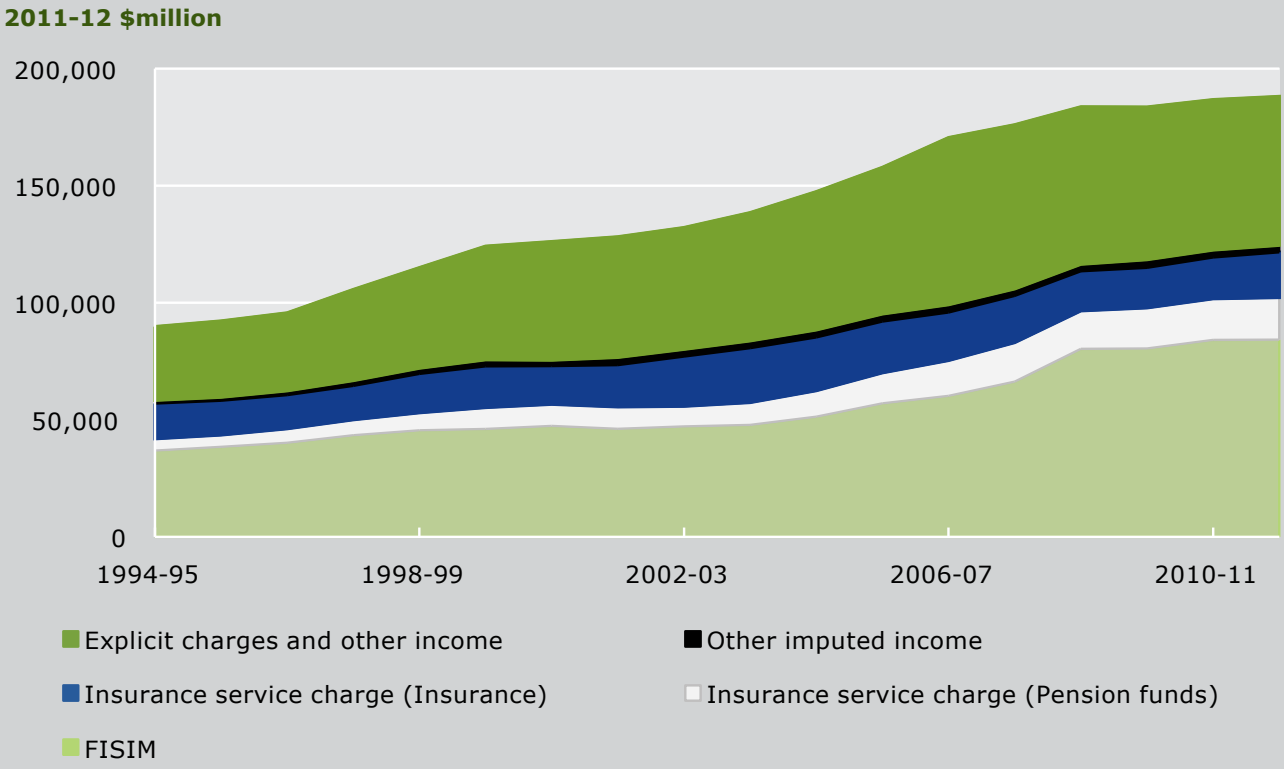
The output concept used to estimate MFP is real value added — measured as the difference between the real value of services produced and the intermediate inputs used in the process of producing these services. For most market sector industries, the value of production can be directly measured. But, for much of Financial and insurance services, it is not possible to directly measure output so that the value of services produced must be imputed.

The implicit fees for intermediation services provided by the industry are often embedded in margins of financial transactions. For banks and financial companies it is the margin between the interest paid on borrowing and interest received on loans. The imputed output measured for these services is referred to as 'Financial intermediation services indirectly measured' (FISIM). For most types of insurance, the margin is the difference between premiums and claims plus net income earned on reserves. For superannuation service providers, output is measured as administrative costs incurred. Only for Auxiliary services is the output directly measured from service revenue.

As a proportion of the value of Financial and insurance services production, the value of FISIM has increased over time (figure 4.5). In the period between 1994-95 and 2011-12, in real, inflation adjusted terms, the value of FISIM increased as a share of industry gross output from 41 to 45 per cent. Estimation of FISIM involves a wide range of conceptual and technical issues, including the effect of changes in market risk and the extent to which risk premia should be included in the output measure.

Imputed insurance service charges represented 20 per cent of gross output in 2011-12. Estimation of imputed insurance charges is also sensitive to trends in underlying premia and claims as well as the level of net income from reserves. While both FISIM and insurance service charges are based on the margin in intermediation services, the imputed service charge relating to superannuation is based on a business activity measure. Superannuation services account for 10 per cent of Financial and insurance services output in 2011-12, up from 6 per cent in 1994-95.

Figure 4.5
Components of real production of Financial and insurance services[a,b]



[a] Other imputed income includes imputed output of financial intermediaries nec, and of the RBA; and imputed income for insurance and superannuation. 'Explicit charges and other income' includes fees, rental income, income from trading securities, sales of goods and services for Auxiliary services, and own account software and R&D. [b] Deflated by CPI (All groups).

Source: Commission estimates based on unpublished ABS data.

Measuring of inputs is also important

In productivity analysis, labour inputs are measured in terms of hours worked. While this concept is relatively straightforward, the estimates are influenced by assumptions about days worked during each year after account is taken of public holidays, the average hours worked during each year, as well as data sampling and industry classifications conventions applied by the ABS. In particular, the industry estimates are reliant on the accurate recognition of the industry in which each sampled worker is engaged and population-based workforce benchmarks.

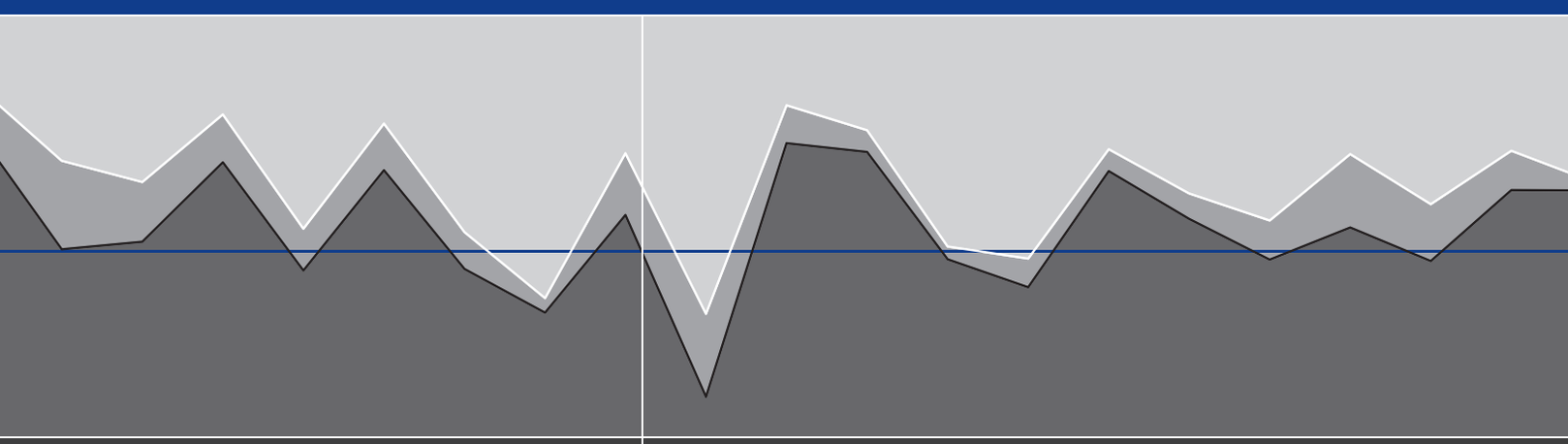
Estimates of capital inputs are dependent on the accuracy of the translation of investment data into a measure of net capital stock of an industry and associated productive capital inputs, using a statistical construct termed the 'perpetual inventory system.' Estimates of capital inputs and changes over time are sensitive to modelling assumptions. Of particular importance in the context of the Financial and insurance services industries is the take up of ICT technologies and the restructuring of business operations around the new technologies.

References

ABS (Australian Bureau of Statistics) 2014, *Estimates of Industry Multifactor Productivity, 2013-14*, Cat. no. 5260.0.55.002, December, ABS, Canberra.

BREE (Bureau of Resources and Energy Economics) 2014, *Resources and Energy Quarterly*, March Quarter 2014, BREE, Canberra, March.

Topp, V., Soames, L., Parham, D. and Bloch, H. 2008, *Productivity in the Mining Industry: Measurement and Interpretation*, Productivity Commission Staff Working Paper, Canberra.



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