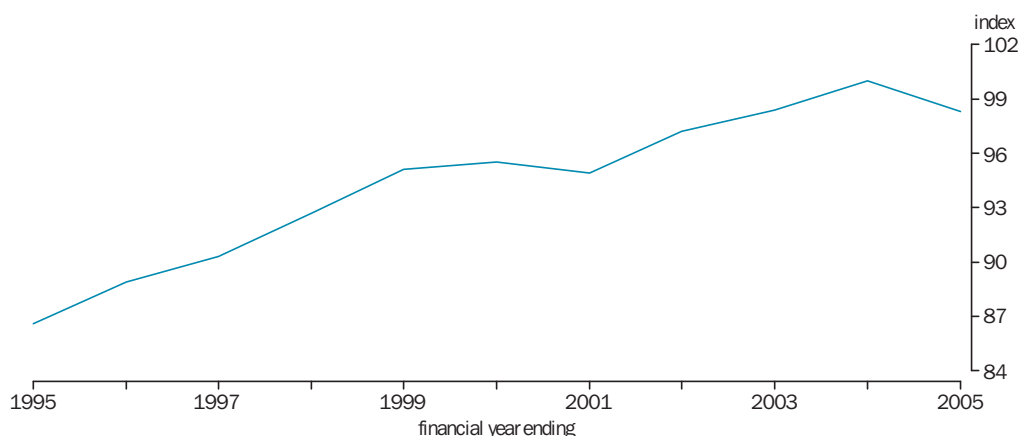


Productivity: key points

Multifactor productivity(a)



(a) Reference year for MFP indexes is 2003–04 = 100 .

Source: Australian System of National Accounts, cat. no. 5204.0.¹

In recent years Australia has generally experienced improved productivity growth. During the decade 1994–95 to 2004–05, Australia's multifactor productivity rose 1.3% per year on average.

The relationship of productivity to progress

Productivity growth is an important source of growth in goods and services. A nation that achieves productivity growth produces more goods and services from its labour, its capital and its land, energy and other resources, than it would in the absence of such growth. Productivity growth can generate higher incomes. Benefits might also accrue in the form of lower output prices.

About the headline indicator and its limitations: Multifactor productivity

A nation's productivity is the ratio of the volume of goods and services it produces (its output) to the volume of inputs (such as labour and capital) it uses in that production. Much – but not all – of Australia's output growth can be accounted for by increases in the inputs to production. The amount by which output growth exceeds input growth is the productivity improvement.

Productivity can be measured in a variety of ways. The most comprehensive Australian measure available at present is multifactor productivity for the market sector. Multifactor productivity represents that part of the growth in output that cannot be explained by growth in labour and capital inputs.

Productivity: Other indicators

Labour productivity; Research and development expenditure, proportion of GDP; Investment in software, proportion of GDP; Managers and professionals, proportion of total employment; Proportion of businesses with web site or homepage; Hours worked and quality adjusted hours worked.

Some differences within Australia

Rates of productivity improvement are not uniform across the whole economy; they can differ appreciably from industry to industry. Estimates of multifactor productivity dissected by industry are not yet available for Australia from the ABS (although the Productivity Commission has produced estimates). But it is possible to examine industry changes in labour productivity (the ratio of output to labour input). These figures must be read with some care, as part of the rise in labour productivity will be due to 'capital deepening' (an increase in the ratio of capital to labour) or to changes in intermediate inputs.

During the last decade, the most rapid increases in labour productivity were achieved by: Agriculture, forestry and fishing (6.2% per year on average), Communication services (4.4% per year on average), Wholesale trade (4.2% a year on average) and Manufacturing (3.0% per year on average).

Links to other dimensions

See also the commentaries *National income, Inflation, Competitiveness and openness, Education and training, The natural landscape, Health and Work*.

Productivity

Progress and the headline indicator

A nation's productivity is the ratio of the volume of goods and services it produces (its output) to the volume of inputs (such as labour and capital) it uses in that production. Much – but not all – of Australia's output growth can be accounted for by increases in the inputs to production. The amount by which output growth exceeds input growth is the productivity improvement.

Australia experienced substantial productivity improvement in the two most recent productivity growth cycles (1993–94 to 1998–99 and 1998–99 to 2003–04). In the 1993–94 to 1998–99 growth cycle, real output of the market sector grew by an average 4.6% per year. In contrast labour inputs grew at 1.3% and capital at 4.3%, and combined these inputs grew at a rate of 2.4% per year. The 2.2% difference between this growth in output and growth in inputs is the measure of the average annual productivity improvement that occurred during this period.

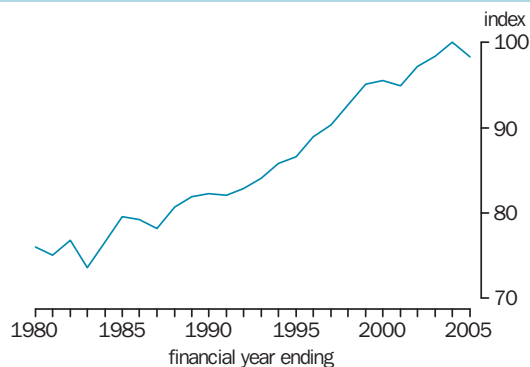
Similarly for the 1998–99 to 2003–04 growth cycle, output growth has averaged 3.1% per year. Input growth during this period was 0.9% for labour and 3.8% for capital giving a combined growth in inputs of 2.1%. The 1.0% difference is the measure of average annual productivity improvement during this latter period.

Productivity can be measured in a variety of ways. The most comprehensive Australian measure available at present is multifactor productivity for the market sector. Multifactor productivity represents that part of the growth in output that cannot be explained by growth in labour and capital inputs (see box).

A longer term view

Multifactor productivity estimates for Australia extend back to the mid-1960s. The improvement in multifactor productivity recorded during the decade 1994–95 to 2004–05 was 13.5%, averaging 1.3% per year. This was higher than the improvements recorded for the two earlier

Multifactor productivity: longer term view(a)



(a) Reference year for MFP indexes is 2003–04 = 100.
Source: Australian System of National Accounts.¹

Measuring Australia's productivity

Productivity measures are, in concept, ratios of the form:

$$\text{Productivity} = \text{Output volume} / \text{Input volume}$$

This ratio derives from the 'production function':

$$\text{Output} = \text{Productivity} * f(\text{Input})$$

which expresses the notion that growth in the volume of goods and services produced can result from growth in the volume of inputs used in the production process or growth in productivity or a combination of both.

There are many different measures of productivity; the main difference between them lies in which inputs are used in the denominator of the productivity ratio.

The most comprehensive measure of productivity is *gross output multifactor productivity*, which takes account of all inputs to production. Typically, the inputs are classified into capital (K), labour (L), energy (E), materials (M) and services (S) – and referred to as the KLEMS approach to productivity measurement. In principle, all the output and input measures are adjusted for quality change. But this approach demands a lot of data, and estimates of gross output multifactor productivity are available for industries in few countries.

More easily implemented are *value added multifactor productivity* (MFP) approaches which typically take account of just two inputs – capital and labour. MFP is the most comprehensive measure of productivity available for Australia at present. In principle, the labour input measure should be adjusted for improvements in the quality of labour ('human capital') so such improvements flow through to the MFP measure. Although the current official estimates are not 'quality-adjusted', the ABS has recently produced experimental measures of productivity that do allow for changes in the quality of labour. These are discussed in the *Some differences within Australia* section later on.

If only one input appears in the denominator, a single factor productivity measure is obtained. The most common such measures are *labour productivity* (the ratio of output to labour input) and *capital productivity* (the ratio of output to capital input). MFP is superior to such single-factor measures as an indicator of efficiency of resource use because the latter may also reflect substitutions between capital and labour inputs.

The MFP measure available for Australia at present relates to the market sector and does not take account of the efficiency with which inputs from other sectors (such as energy, subsoil assets, materials and services) are used in production.

decades. The improvement for the period 1984–85 to 1994–95 was 8.8%, averaging 0.8% per year and for 1974–75 to 1984–85, the improvement was 12.7%, averaging 1.2% per year. It should be noted, though, that the 10 year periods used for this analysis do not coincide with productivity growth cycles.

Some differences within Australia

Rates of productivity improvement are not uniform across the whole economy; they can differ appreciably from industry to industry. ABS estimates of multifactor productivity dissected by industry are not yet available (although the

Labour productivity(a), average annual growth rate – 1994–95 to 2004–2005

Industry(b)	%
Agriculture, forestry and fishing	6.2
Mining	0.9
Manufacturing	3.0
Electricity, gas and water supply	1.3
Construction	1.6
Wholesale trade	4.2
Retail trade	2.4
Accommodation, cafes and restaurants	1.6
Transport and storage	2.8
Communication services	4.4
Finance and insurance	2.4
Health and community services	1.1
Cultural and recreational services	1.6
All market sector industries	2.1

(a) Gross product per hour worked. (b) Estimates are not available for Property and business services, Government administration and defence, Education, and Personal and other services.

Source: Australian System of National Accounts.¹

Productivity Commission has produced estimates). But it is possible to examine industry changes in labour productivity (the ratio of output to labour input). These figures must be read with some care; part of the rise in labour productivity will be due to 'capital deepening' (an increase in the ratio of capital to labour).

During the decade 1994–95 to 2004–05, the most rapid increases in labour productivity were achieved by: Agriculture, forestry and fishing (6.2% per year on average), Communication services (4.4%), Wholesale trade (4.2%) and Manufacturing (3.0%). Some of these industries have experienced significant technological advance or industrial reorganisation. Productivity in the Agriculture industry can be significantly influenced by the weather.

Factors influencing change

A nation's productivity improvement is the outcome of a wide variety of interrelated influences. At the level of the individual firm or industry, key influences include technological advances and improvements to the quality of labour, or to management practices and work arrangements. National productivity levels may also improve with a shift of labour, capital and other inputs away from firms or industries that produce less output for a given level of input (i.e. are less productive) toward firms or industries that produce more (i.e. are more productive).

Such changes may in turn be prompted or assisted by changes in the overall economic environment, such as increased levels of domestic competition, reduced barriers to resource reallocation and greater openness to the international marketplace.

During the past few decades, successive Australian governments have enacted reforms that have sought to create an economic environment favourable to increased competition, better allocation of resources and more innovation. Key policy influences have included reduction of tariffs and other barriers to international trade, relaxation of barriers to international investment, changes to the structure and rates of taxation, domestic competition policy and reforms to financial, labour and other markets.

Economists continue to investigate the links each of these varied influences has on productivity growth, and many are not yet well understood. Some are discussed below in more detail.

Knowledge and innovation

Knowledge and innovation is one influence on productivity. For example, the development of new technologies and the application of these technologies (some of which may be developed in other countries) can improve Australia's productivity and raise national income. No single indicator encapsulates all aspects of knowledge and innovation. Therefore, several indicators, for which data are available, are provided: proportion of businesses which are innovating; some of Australia's investments in knowledge (namely expenditure on research and development and computer software); businesses' use of the Internet; and improvements in the quality of labour.

Worldwide during recent decades, new goods and services have emerged that account for rapidly growing shares of total expenditure. New production processes and new industries have emerged. Australia's capacity to take advantage of these changes depends on many factors, such as the existence of individuals, firms and institutions that can develop or apply new technologies,

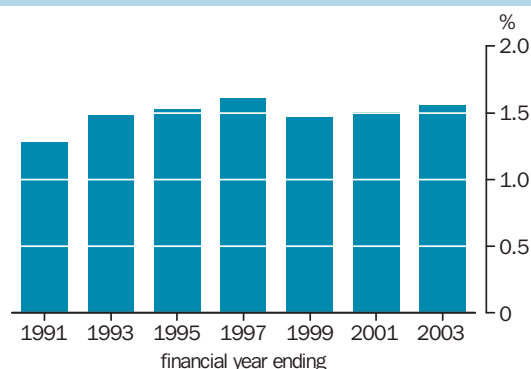
Measuring knowledge and innovation

There is no single measure that encapsulates all the elements of knowledge and innovation. An array of measures is needed. Aspects relevant to Australia's progress include the following.

- ◆ The proportion of businesses that are innovating.
- ◆ The economic resources and the number of people devoted to the creation and application of knowledge. Indicators include the proportion of businesses innovating and the proportion of GDP devoted to research and development.
- ◆ The skills and knowledge embodied in the labour force (discussed in the commentary *Education and training*).
- ◆ The rate at which current developments in information and knowledge are taken up. Among the most prominent of such developments in recent years are information technology and the Internet. Indicators include the ratio of investment in software to GDP and the proportion of businesses which have their own web site or home page.

Other aspects of knowledge and innovation have a bearing on productivity but are not measured here.

Research and development expenditure, proportion of GDP – selected years



Source: Research and Experimental Development, All Sector Summary.²

especially for the acquisition and sharing of information. There is evidence to suggest that the differences between countries' growth rates can be attributed in part to differences in their investments in information and communications technology and improvements in the quality of labour.²

During the three years to December 2003, innovation was undertaken by 34.8% of businesses employing more than 4 people, that is they developed new goods or services or significantly improved their operational or organisational processes. A higher proportion of these businesses implemented new or significantly improved operational processes (22.9%) than introduced new or significantly improved goods or services (16.6%). The level of innovation was highest for businesses with 100 or more employees (60.8%).

Research and development

Research and development (R&D) can be viewed in many ways. One international standard definition is:

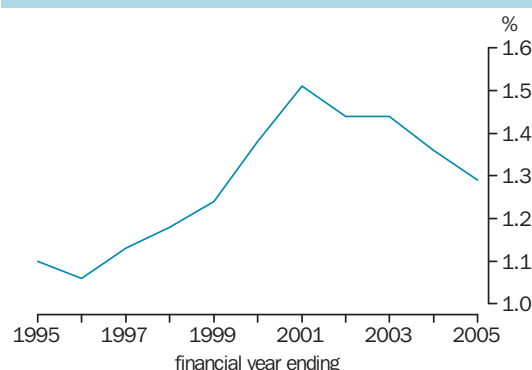
'systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge, with or without specific practical application, or new

Proportion of businesses(a) innovating, 2001–2003

Proportion of businesses which introduced or implemented:	%
Any new or significantly improved goods or services	16.6
Any new or significantly improved operational processes	22.9
Any new or significantly improved organisational/managerial processes	21.4
Any new goods, services or processes	34.8

(a) Proportions are of businesses with more than 4 people employed. Source: Innovation in Australian Business 2003, cat. no. 8158.0.³

Investment in software, proportion of GDP



Source: Australian System of National Accounts.¹

or improved products, processes, materials, devices or services'.²

R&D encompasses both basic research (undertaken primarily to acquire new knowledge without a specific or immediate application in view) and applied research. The proportion of Australia's GDP devoted to R&D expenditure rose during the early part of the 1990s, to a high in 1996–97 of 1.6% and has stayed at around that level since then.

The proportion of Australian GDP devoted to research and development is relatively low among OECD countries. In 2000–01 Australia ranked 13th among OECD countries for gross expenditure on R&D as a proportion of GDP; for example, the corresponding proportion for Japan was 3.0%, for the USA 2.7%, for Germany 2.5% and for Canada 1.9%. Its position remained roughly the same in 2002–03. But Australia also imports technology and processes embodying R&D from elsewhere.²

The major sources of funds for R&D expenditure in Australia in 2002–03 were business 46.4% (\$5,688m), and Commonwealth government 37.7% (\$4,612m), similar proportions to 2000–01.

Investment in computer software

In recent years, information technology has become progressively more important to the Australian economy, as it has elsewhere. In this field, innovations are embodied in both hardware and software. Australian investment expenditure on software is one indicator of the rate at which the new technology is being taken up. Over the last decade Australian investment on software as a proportion of GDP rose from 1.1% in 1994–95 to a peak of 1.5% in 2000–01 but has since fallen to 1.3% in 2004–05. Software prices fell steadily in this period.

Business take-up of the Internet

One of the most recent waves of innovation in Australia and other countries is use of the Internet by businesses. More and more firms are using the Internet for business transactions (say, for receiving customer orders). In some industries (such as news and entertainment), services can be delivered to customers through the Internet. Other

Proportion of businesses with web site or home page(a)

No. of employees	1998	2000	2001	2002	2003	2004
	%	%	%	%	%	%
1-4	4	9	14	15	15	16
5-19	8	24	32	34	33	38
20-99	21	46	56	55	51	58
100 or more	58	68	81	81	80	83
All businesses	6	16	22	24	23	25

(a)2003 and 2004 estimates are post introduction of the new tax system and may not be comparable with previous estimates.

Source: *Business Use of Information Technology, various issues, cat. no. 8129.0.*⁴

businesses use the Internet to provide customers with information about the goods and services available.

In June 1998, 6% of businesses had a web presence (either on their own web site or another entity's web site). By June 2001, this proportion had risen to 22% but the take up rate has since slowed, with 25% of businesses having a web presence in 2004.⁴ Larger businesses continue to be more likely to have a web presence. In 2004, 83%, of businesses employing 100 or more people had a website or homepage compared with 16% of businesses with 1 to 4 employees.

Quality adjusted labour inputs

Multifactor productivity represents that part of the growth in output that cannot be explained by growth in labour and capital inputs. There are, however, several ways to measure labour inputs. One might look simply at the *number of people employed*, but such a measure takes no account of changes in the mix of full-time and part-time employees, or, say, changes in overtime. A better measure is the *number of hours worked*: this is the labour input measure that underlies the estimates of labour and multifactor productivity used in this commentary. But one shortcoming of this measure is that it takes no account of changes in the aggregate quality of labour due to, say, an increase in the prevalence of highly qualified people in the work force.

Changes in the quality of labour are currently ascribed to changes in productivity, but there is an argument that they should be viewed instead as changes in inputs (similar to changes in the mix of different capital services). And so a better measure would be the *number of hours worked, adjusted for changes in the quality or composition of labour*. Such a series provides some information about the contribution that increased knowledge (characterised by qualifications and (potential) experience) has played in improving the quality of Australia's workforce and, hence, to economic growth. The ABS has recently produced such a series, although it is still regarded as experimental.

Because the quality of labour has tended to increase in recent times, the effect of adjusting for

Hours worked and quality adjusted hours worked



Source: *Australian System of National Accounts.*¹

changes in the quality of labour input has been to increase the contribution of labour inputs to growth and so decrease labour and multifactor productivity estimates. Over the past 20 years, unadjusted hours worked increased on average by 1.3% a year, whereas quality-adjusted labour inputs increased by 1.6% a year. The changes to labour composition, mean that growth in multifactor productivity calculated using the quality-adjusted labour input series is slightly lower than growth in unadjusted multifactor productivity: 0.8% a year compared to 1.1% over the period 1984-85 to 2004-05.

Links to other dimensions of progress

Productivity is an important source of output growth; it contributes to growth in national income. During a period of productivity growth, it is possible to raise real wages and other incomes without increasing inflationary pressures. Also, industries that experience higher rates of productivity growth than others can enhance their international competitiveness.

Education is important too as it both disseminates existing knowledge among the Australian population and enhances the probability that Australians will generate or adopt new technologies and other innovations.

Knowledge and innovation can contribute to Australia's productivity growth (and hence to improvements in national income and competitiveness) because they enhance the prospects of technological advances and of improvements to management and work practices and other aspects of economic production.

Knowledge and innovation can also result in improved approaches to satisfying the needs of Australians (say, through better health services) and to protecting Australia's environmental resources.

Natural assets (such as soil, minerals, water and timber) are used in production. If Australian industry can use such assets more efficiently, economic growth will, for a given volume of

output, require less draw-down of these resources and so have a smaller impact on the environment.

See also the commentaries *National income*, *Inflation*, *Competitiveness and openness*, *Education and training*, *The natural landscape*, *Health and Work*.

Endnotes

- 1 Australian Bureau of Statistics 2005, *Australian System of National Accounts 2004–05*, cat. no. 5204.0, ABS, Canberra.
- 2 Australian Bureau of Statistics various issues, *Research and Experimental Development, All Sector Summary*, cat. no. 8112.0, ABS, Canberra.
- 3 Australian Bureau of Statistics 2003, *Innovation in Australian Business*, cat. no. 8158.0, ABS, Canberra.
- 4 Australian Bureau of Statistics 1999 and 2005, *Business Use of Information Technology*, cat. no. 8129.0, ABS, Canberra.