Australian Bureau of Statistics

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AUSTRALIAN NATIONAL ACCOUNTS MULTIFACTOR PRODUCTIVITY, 1995-96

SUMMARY OF FINDINGS

NOTE: When analysing the productivity indexes (labour, capital or multifactor) presented in this publication, it is crucial to note that they are subject to the vagaries of the growth cycle[1] as well as the effects of any measurement error in either output or input. Differences in the amplitude and phase of the output and input cycles can result in productivity indexes deviating substantially from their long-term trend.

PRODUCTIVITY AND RELATED MEASURES, 1995-96

		Market sector		*Non-farm market sector*	
		Index (a)	*Percentage change 1994-95 to 1995-96*	*Index (a)*	*Percentage change 1994-95 to 1995-96*
A	Gross product	114.3	4.6	114.8	3.7
B	Hours worked	101.1	0.6	101.7	0.4
C	Capital stock	112.6	3.0	115.3	3.2
D	Total labour and capital input	105.1	1.4	106.0	1.3
	Labour productivity (A/B)	113.1	4.0	112.9	3.3
	Capital productivity (A/C)	101.5	1.5	99.6	0.5
	Capital-labour ratio (C/B)	111.4	2.4	113.4	2.8
	Multifactor productivity (A/D)	**108.8**	**3.1**	**108.3**	**2.4**

(a) 1989-90 = 100.0

Market sector

The index of *market sector multifactor productivity* (MFP) for 1995-96 increased by 3.1 per cent from the previous year, due to a 4.6 per cent increase in gross product against a smaller rise of 1.4 per cent in total labour and capital input. Hours worked increased by 0.6 per cent, the fourth consecutive annual increase since 1991-92. Capital stock recorded a growth rate of 3.0 per cent in 1995-96. The increase in capital stock was exceeded by a much stronger increase in gross product and resulted in capital productivity increasing by 1.5 per cent.

Labour productivity recorded a stronger growth of 4.0 per cent compared with 0.6 per cent in the previous year. The capital-labour ratio increased by 2.4 per cent in 1995-96, after falling for 3 consecutive years.

Non-farm market sector

The picture presented in the table above for the *non-farm market sector* is similar to that for the *market sector*, except gross product grew by a smaller amount. This is because gross product for the market sector was boosted by the good farm season in 1995-96. As the labour and capital inputs grew by about the same amount in the market and non-farm market sectors, the weaker growth in output of the non-farm market sector has led to lower growth in the non-farm market sector productivity statistics.

1 Growth-cycle values are derived as the percentage deviation of the original estimates from their long-term trend - see Appendix 1.

INQUIRIES

- for *further information about statistics in this publication and the availability of related unpublished statistics*, contact Leon Ting on Canberra (06) 252 6807 or any ABS State Office.
- for *information about other ABS statistics and services* please refer to the back page of this publication.

NOTES ON THE ESTIMATES

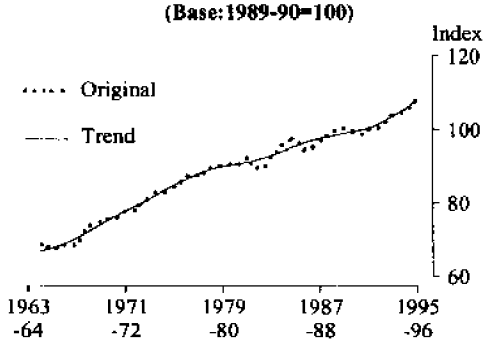
Latest growth cycle - market sector

A simple way to estimate the underlying trend of productivity measures is to compare the values of a productivity index spanning a growth cycle e.g. from the peak of one growth cycle to the peak of another. Such estimates rest on the assumption that both labour and capital inputs are being utilised to the same degree at each growth-cycle peak. Growth cycle peaks are identified by the size of the percentage deviation of the original MFP estimates from their long-term trend. (For details see Appendix I.) The following growth cycles have been identified:

- 1964-65 to 1968-69
- 1968-69 to 1973-74
- 1973-74 to 1981-82
- 1981-82 to 1984-85
- 1984-85 to 1988-89
- 1988-89 to 1995-96.

1994-95, previously identified as a provisional growth cycle peak, has been provisionally replaced, in this issue, by 1995-96. (See the last paragraph on this page). The analysis which follows is purely for the market sector.

MULTIFACTOR PRODUCTIVITY INDEXES ORIGINAL AND TREND MARKET SECTOR (Base:1989-90=100)



The average annual growth rate of MFP over the latest growth cycle (1988-89 to 1995-96) was 1.2 per cent. This was lower than the average annual growth rates over previous growth cycles except the one from 1984-85 to 1988-89 which grew at an average annual rate of 0.8 per cent.

- *Gross product* at average 1989-90 prices grew at an average annual rate of 2.4 per cent, higher than from 1973-74 to 1981-82 (2.1%) and from 1981-82 to 1984-85 (1.8%), but lower than from 1984-85 to 1988-89 (3.8%) and in the two growth cycles spanning the mid 1960s to early 1970s.

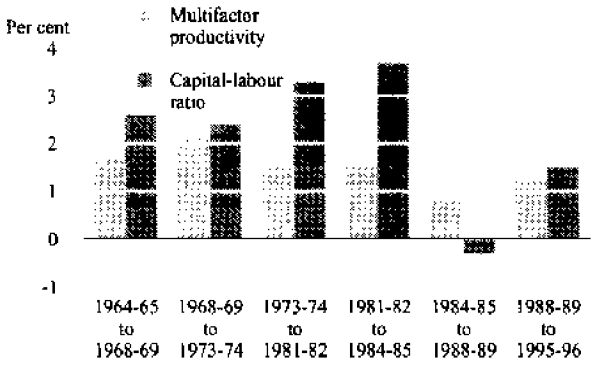
- *Hours worked* grew at an annual rate of 0.6 per cent in the latest growth cycle after a rapid annual growth of 3.1 per cent in the previous growth cycle. In the two growth cycles from the early 1970s through to the mid 1980s, there was a reversal of growth, with hours worked declining. (Increasing employment in the 1970s was being offset to a large extent by shorter working hours, greater part-time employment and longer annual leave.)

- *Capital stock* grew at an annual rate of 2.1 per cent in the latest identified growth cycle. This was lower than in the three growth cycles from the early 1970s to late 1980s, and was considerably lower than in the two cycles from the mid 1960s to early 1970s.

- Over the latest identified growth cycle, economic growth was achieved with either greater use of capital intensive techniques or better use of labour, reflected by faster growth in capital over hours worked with the *capital-labour ratio* increasing at an annual average rate of 1.5 per cent. The growth in the *capital-labour ratio* followed a decline in the previous growth cycle, but the rate of increase was considerably lower than in the four preceding growth cycles spanning the mid 1960s to mid 1980s, during which the average annual increase ranged between 2.4 and 3.7 per cent (refer to graph below).

- An associated outcome of capital stock growing faster than hours worked was that the average annual growth rate of capital productivity was lower (0.3%) than that of labour productivity (1.7%) over the latest growth cycle, with multifactor productivity growing at an average annual growth rate of 1.2 per cent. Compared with the previous growth cycle, 0.3 per cent was a lower growth rate for *capital productivity*, but 1.7 per cent was a higher growth rate for *labour productivity*.

MULTIFACTOR PRODUCTIVITY AND CAPITAL-LABOUR RATIO, AVERAGE ANNUAL GROWTH RATES OVER MFP GROWTH CYCLES, MARKET SECTOR

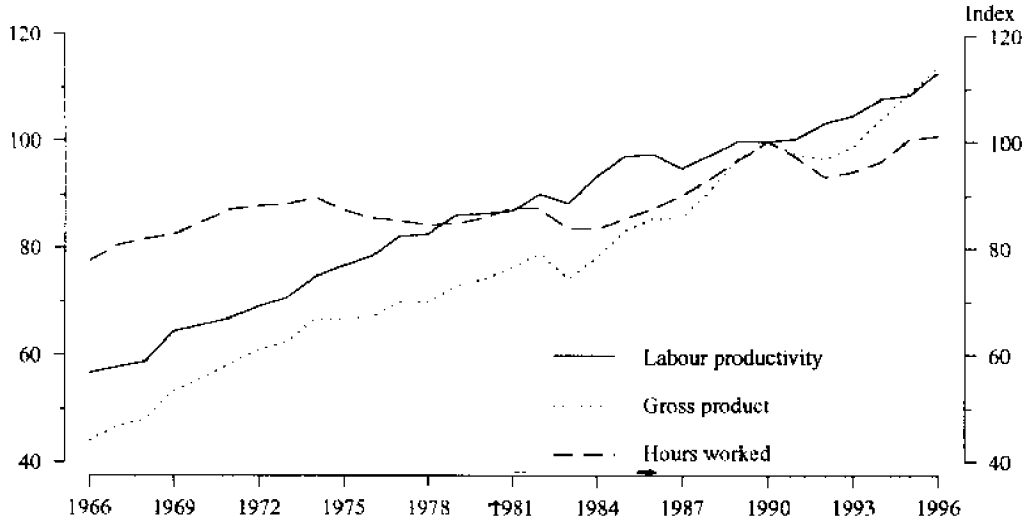


Revisions in this issue

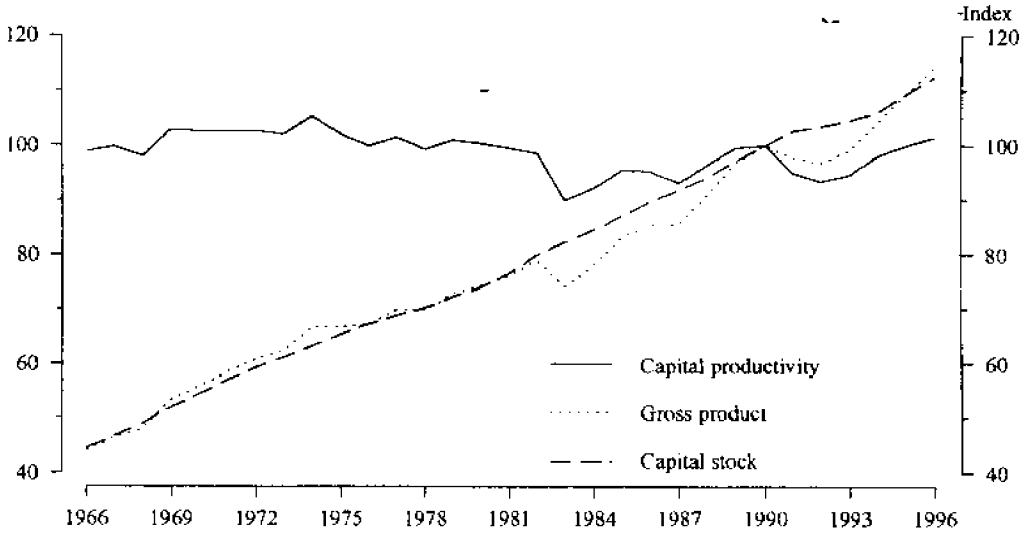
The availability of firmer data has led to some minor revisions and one big revision. The big revision is to the constant price estimates of gross product for 1994-95, which has arisen from the introduction of new benchmark data for manufacturing gross product. This has led to the latest growth cycle peak being provisionally revised from 1994-95 to 1995-96.

GROSS PRODUCT, INPUTS AND PRODUCTIVITY
MARKET SECTOR
(BASE YEAR:1989-90 = 100.0)

Graph 1 : Labour



Graph 2 : Capital



Graph 3 : Labour and capital

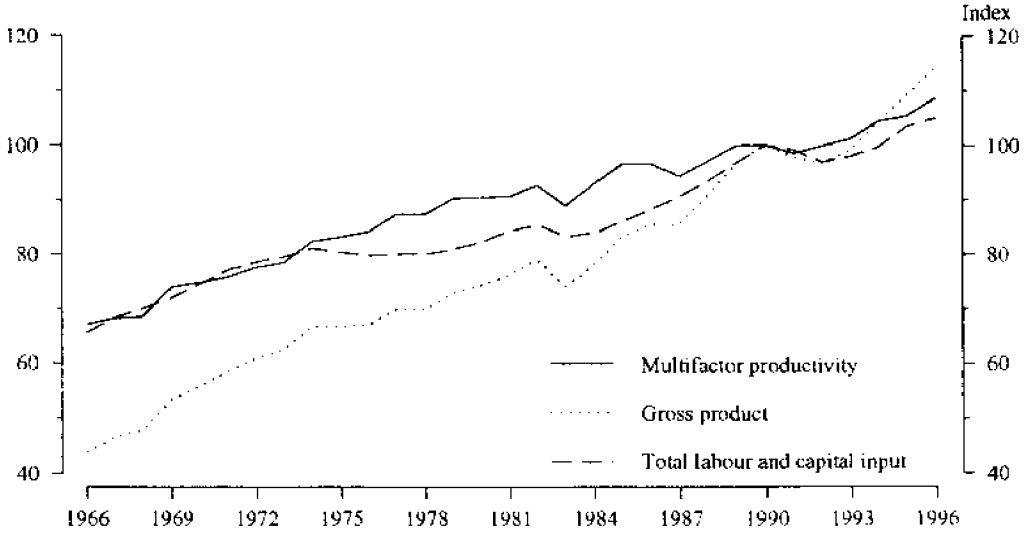


TABLE 1. PRODUCTIVITY AND RELATED MEASURES, 1964-65 TO 1995-96: MARKET SECTOR

	Productivity			*Output*	*Inputs*			
Period	*Labour(a)*	*Capital(b)*	*Multifactor(c)*	*Gross product*	*Hours worked*	*Capital stock*	*Total labour and capital*	*Capital -labour ratio*
				INDEX BASE YEAR: 1989-90 = 100.0				
1964-65	58.3	103.1	69.3	43.6	74.8	42.3	62.9	56.6
1965-66	56.8	98.9	67.1	44.0	77.5	44.5	65.6	57.4
1966-67	57.9	99.8	68.3	46.7	80.6	46.8	68.4	58.1
1967-68	58.8	98.0	68.5	48.0	81.7	49.0	70.1	60.0
1968-69	64.6	102.9	74.1	53.4	82.7	51.9	72.1	62.8
1969-70	65.7	102.6	74.9	55.8	84.9	54.4	74.5	64.1
1970-71	67.0	102.6	75.9	58.5	87.3	57.0	77.1	65.3
1971-72	69.2	102.7	77.6	61.0	88.1	59.4	78.6	67.4
1972-73	70.7	102.1	78.5	62.5	88.4	61.2	79.6	69.2
1973-74	74.6	105.4	82.4	66.8	89.5	63.4	81.1	70.8
1974-75	76.7	102.1	83.2	66.9	87.2	65.5	80.4	75.1
1975-76	78.5	99.9	84.2	67.2	85.6	67.3	79.8	78.6
1976-77	82.2	101.5	87.4	69.9	85.0	68.9	80.0	81.1
1977-78	82.7	99.3	87.3	69.8	84.4	70.3	80.0	83.3
1978-79	86.2	101.0	90.2	73.0	84.7	72.3	80.9	85.4
1979-80	86.6	100.4	90.4	74.3	85.8	74.0	82.2	86.2
1980-81	87.1	99.6	90.5	76.3	87.6	76.6	84.3	87.4
1981-82	90.3	98.6	92.6	79.0	87.5	80.1	85.3	91.5
1982-83	88.6	90.0	89.0	74.2	83.7	82.4	83.4	98.4
1983-84	93.5	92.3	93.1	78.2	83.6	84.7	84.0	101.3
1984-85	97.4	95.6	96.8	83.4	85.6	87.2	86.2	101.9
1985-86	97.7	95.3	96.8	85.6	87.6	89.8	88.4	102.5
1986-87	95.1	93.2	94.4	85.7	90.1	92.0	90.8	102.1
1987-88	97.6	96.5	97.2	91.0	93.2	94.3	93.6	101.2
1988-89	100.2	99.7	100.0	97.0	96.8	97.3	97.0	100.5
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	100.5	95.1	98.6	97.8	97.3	102.8	99.2	105.7
1991-92	103.6	93.5	99.9	96.9	93.5	103.6	97.0	110.8
1992-93	105.0	94.8	101.2	99.2	94.5	104.6	98.0	110.7
1993-94	108.2	98.2	104.5	104.3	96.4	106.2	99.8	110.2
1994-95	108.8	100.0	105.5	109.3	100.5	109.3	103.6	108.8
1995-96	113.1	101.5	108.8	114.3	101.1	112.6	105.1	111.4
				COMPOUND ANNUAL PERCENTAGE CHANGE				
				Between MFP growth-cycle peaks				
1964-65 to 1968-69	2.6	—	1.7	5.2	2.5	5.2	3.5	2.6
1968-69 to 1973-74	2.9	0.5	2.1	4.6	1.6	4.1	2.4	2.4
1973-74 to 1981-82	2.4	−0.8	1.5	2.1	−0.3	3.0	0.6	3.3
1981-82 to 1984-85	2.6	−1.0	1.5	1.8	−0.7	2.9	0.4	3.7
1984-85 to 1988-89	0.7	1.0	0.8	3.8	3.1	2.8	3.0	−0.3
1988-89 to 1995-96	1.7	0.3	1.2	2.4	0.6	2.1	1.2	1.5
1964-65 to 1995-96	2.2	−0.1	1.5	3.2	1.0	3.2	1.7	2.2

(a) Constant price gross product per hour worked. (b) Constant price gross product per unit of capital stock. (c) Constant price gross product per combined unit of labour and capital.

TABLE 2. PRODUCTIVITY AND RELATED MEASURES, 1964-65 TO 1995-96: NON-FARM MARKET SECTOR

	Productivity			*Output*	*Inputs*			
Period	*Labour(a)*	*Capital(b)*	*Multifactor(c)*	*Gross product*	*Hours worked*	*Capital stock*	*Total labour and capital*	*Capital -labour ratio*
				INDEX BASE YEAR: 1989-90 = 100.0				
1964-65	60.2	117.4	72.5	42.5	70.6	36.2	58.6	51.3
1965-66	59.0	112.2	70.6	43.3	73.4	38.6	61.3	52.6
1966-67	59.3	111.2	70.8	45.5	76.7	40.9	64.3	53.3
1967-68	61.4	110.1	72.2	47.8	77.8	43.4	66.2	55.8
1968-69	65.9	112.3	76.3	52.1	79.1	46.4	68.3	58.7
1969-70	67.6	112.0	77.6	55.2	81.6	49.3	71.1	60.4
1970-71	68.8	110.9	78.3	58.1	84.5	52.4	74.2	62.0
1971-72	70.7	109.4	79.4	60.3	85.3	55.1	75.9	64.6
1972-73	73.2	109.6	81.5	62.5	85.4	57.0	76.7	66.7
1973-74	76.3	112.5	84.7	66.8	87.5	59.4	78.9	67.9
1974-75	78.0	108.0	85.0	66.5	85.3	61.6	78.2	72.2
1975-76	79.7	104.7	85.8	66.4	83.3	63.4	77.4	76.1
1976-77	83.6	106.3	89.2	69.1	82.7	65.0	77.5	78.6
1977-78	83.9	103.9	89.0	69.3	82.6	66.7	77.9	80.8
1978-79	85.7	104.1	90.4	71.6	83.5	68.8	79.2	82.4
1979-80	87.5	104.7	91.9	73.7	84.2	70.4	80.2	83.6
1980-81	88.7	104.2	92.7	76.4	86.1	73.3	82.4	85.1
1981-82	91.1	101.7	93.8	78.6	86.3	77.3	83.8	89.6
1982-83	91.0	93.1	91.5	74.6	82.0	80.1	81.5	97.7
1983-84	94.1	93.3	93.9	77.1	81.9	82.6	82.1	100.9
1984-85	98.0	96.9	97.6	82.6	84.3	85.2	84.6	101.1
1985-86	99.0	96.5	98.2	85.1	86.0	88.2	86.7	102.6
1986-87	95.5	93.4	94.8	85.0	89.0	91.0	89.7	102.2
1987-88	98.4	97.1	98.0	90.9	92.4	93.6	92.8	101.3
1988-89	101.1	100.5	100.9	97.4	96.3	96.9	96.5	100.6
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	100.3	94.0	98.2	97.2	96.9	103.4	99.0	106.7
1991-92	103.4	92.2	99.6	96.6	93.4	104.8	97.0	112.2
1992-93	104.3	92.9	100.4	98.6	94.5	106.1	98.2	112.3
1993-94	107.6	96.1	103.7	103.9	96.6	108.1	100.2	111.9
1994-95	109.3	99.1	105.8	110.7	101.3	111.7	104.6	110.3
1995-96	112.9	99.6	108.3	114.8	101.7	115.3	106.0	113.4
				COMPOUND ANNUAL PERCENTAGE CHANGE				
				Between MFP growth-cycle peaks				
1964-65 to 1968-69	2.3	−1.1	1.3	5.2	2.9	6.4	3.9	3.4
1968-69 to 1973-74	3.0	−	2.1	5.1	2.0	5.1	2.9	3.0
1973-74 to 1981-82	2.2	−1.3	1.3	2.1	−0.2	3.3	0.8	3.5
1981-82 to 1984-85	2.5	−1.6	1.3	1.7	−0.8	3.3	0.3	4.1
1984-85 to 1988-89	0.8	0.9	0.8	4.2	3.4	3.3	3.3	−0.1
1988-89 to 1995-96	1.6	−0.1	1.0	2.4	0.8	2.5	1.4	1.7
1964-65 to 1995-96	2.0	−0.5	1.3	3.3	1.2	3.8	1.9	2.6

(a) Constant price gross product per hour worked. (b) Constant price gross product per unit of capital stock. (c) Constant price gross product per combined unit of labour and capital.

EXPLANATORY NOTES

Introduction

This publication provides estimates for 1995-96 of multifactor productivity (MFP) for Australia. Estimates of MFP were first released in 1989 by the Australian Bureau of Statistics (ABS) in an Information Paper entitled *Development of Multifactor Productivity Estimates for Australia, 1974-75 to 1987-88* (5229.0). Updated and extended estimates, covering the period 1964-65 to 1988-89, were released the following year in an Occasional Paper entitled *Estimates of Multifactor Productivity, Australia* (5233.0). Estimates have been published annually since 1991 when estimates in respect of 1989-90 were released.

2. The MFP estimates are an extension of the 'labour productivity' estimates (i.e. output per employed person and per hour worked) published in *Australian National Accounts: National Income, Expenditure and Product* - annual (5204.0) and quarterly (5206.0).

Multifactor productivity

3. The most obvious limitation of labour productivity measures is that they attribute to only one factor of production - labour - changes in efficiency attributable to factors other than labour. This limitation has given rise to many attempts to obtain a measure of growth in efficiency which takes account of (and nets out the contribution of) all other factor inputs. In practice, the residual (MFP) is largely a measure of the effect of improvements in the quality of those inputs and in how they are used. It includes technical progress, improvements in the work force, improvements in management practices, economies of scale, etc. MFP can also be affected in the short to medium term by other factors such as the weather and by variations in capacity utilisation associated with the business cycle.

4. MFP is measured as the ratio of an index of output to a combined index of two or more factor inputs. It is derived here using constant price (i.e. 'real') gross product as the measure of output, and labour and capital as the inputs. Labour is measured using hours worked, while capital is measured as the real capital stock of equipment, non-dwelling construction, inventories, livestock and agricultural land. Labour and capital are combined as the weighted geometric mean of their respective growth rates, to form a Tornqvist index of the inputs. The income shares of labour and capital are used for weights (see Appendix II). The following paragraphs briefly describe the data and methodology used to derive the estimates and touch on some of their major shortcomings. A more detailed description is set out in the occasional paper *Estimates of Multifactor Productivity, Australia* (5233.0).

Industry classification

5. The industry classification in this publication is the Australian and New Zealand Standard Industrial Classification (ANZSIC) (1292.0).

Measurement of output

6. ABS constant price estimates of gross product by industry are derived using three different methods: double deflation, the gross output method, and extrapolation using hours worked or deflated input cost data. The theoretically preferred method is double deflation. However, in practice, the method selected to derive constant price estimates for a particular industry depends on the data available in respect of that industry and an assessment of the relative merits of the different methodological options.

7. Double deflation involves subtracting constant price estimates of intermediate input from constant price estimates of gross output, and so is consistent with the definition of gross product at current prices. It is used to derive estimates for Agriculture, Mining and Gas. The gross output method is the method most commonly used by the ABS: it involves extrapolating base year gross product estimates by movements in constant price estimates of gross output, or an indicator of gross output. The third and least satisfactory method uses hours worked or deflated input cost data to extrapolate base year gross product. This method is used to derive constant price gross product estimates for Government administration and defence; Finance and insurance; Property and business services; Education; Health and community services; and part of Personal and other services.

8. The ABS considers that these six industry divisions where the third method is used should be excluded from multifactor productivity analysis at this stage, for the same reason that they are excluded from labour productivity analysis, i.e. the measures of real gross product for these industries either assume that there has been no change in labour productivity or do not measure it adequately. The ABS also considers that Ownership of dwellings should be excluded as there is no labour input measure available for this 'industry'.

9. Therefore, estimates of MFP have been produced only for the market sector (i.e. the economy net of these industries and the nominal industry - Ownership of dwellings) and the non-farm market sector (i.e. the economy net of these industries and Agriculture, forestry and fishing).

10. The gross output method assumes that constant price estimates of gross output and intermediate input have the same growth rate. It therefore takes no account of structural changes within an industry and changes in the efficiency with which intermediate inputs are used in the production process. Nevertheless, it is thought to produce estimates of adequate quality, particularly at the highly aggregated levels of the market and non-farm market sectors.

Measurement of capital input

11. In measuring the contribution of factors of production,

the flow of capital services is the desired capital 'measure'. In practice, this flow cannot be measured directly and a measure of productive capital stock is used instead. The rationale is that the flow of capital services provided by an asset is a function of its cost, the length of its life, the intensity of its use in the process of production and its susceptibility to technical obsolescence.

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

- Equipment;
- Non-dwelling construction;
- Real estate transfer expenses;
- Private non-farm stocks;
- Farm and public authority stocks;
- Rural land; and
- Livestock.

13. Capital stock estimates for equipment, non-dwelling construction and real estate transfer expenses[1] are published in *Australian National Accounts: Capital Stock, Australia* (5221.0) – issued annually. A full description of the methodology used to derive them is presented in *Estimates of Depreciation and Capital Stock, Australia* (Occasional Paper 1985/3) and is summarised in *Australian National Accounts: Concepts, Sources and Methods* (5216.0). Gross and net capital stock estimates are averaged to derive estimates of 'productive' capital stock. Estimates for the inventory items (expressed as increases from the previous period) are published in *Australian National Accounts: National Income, Expenditure and Product* - annually (5204.0) and quarterly (5206.0).

14. Estimates of the capital stock of rural land have been obtained from *Australian National Accounts: Balance Sheet, 30 June 1995* (5241.0). The capital stock of rural land has been assumed to be fixed in constant price terms, with no allowance made for changes in either its area or quality. The value at average 1989-90 prices is estimated to be approximately $64,500 million. Estimates of livestock have been derived specifically for the purpose of estimating MFP, by multiplying estimates of livestock numbers by average prices in 1989-90.

15. Capital stock is compiled in the form of a Tornqvist index (i.e. the weighted geometric mean of the component growth rates). Consistent with the concept of productive capital stock, the different asset types (as outlined above) have been weighted together according to the capital services they provide. Imputed rental prices are used as the capital service weights. Rental prices have been calculated using a simple formula that includes price change, depreciation and the internal rate of return (see Appendix III).

16. Of all the constituents of the MFP measures, capital input poses the most problems. In addition to the practical difficulties of accurately measuring productive capital stock, such as the lack of information about the mean asset lives, there are major basic problems. One of these is the assumption that the capital stock is homogeneous, which it clearly is not. Another is that the capital stock estimates embody, to some extent, the effects of technological change, and so the MFP estimates do not fully reflect the impact of technological change.

Measurement of labour input

17. The market sector hours worked index used for the MFP estimates appearing in this publication is derived by subtracting the 'non-market' sector hours worked from 'all industries' hours worked. The series are based on ABS monthly labour force estimates (*The Labour Force, Australia* - 6203.0), supplemented by estimates of hours worked for defence service personnel. Non-market sector hours worked estimates are derived by multiplying employment estimates for individual industries from labour force surveys by corresponding industry average hours worked estimates. All hours worked estimates include a calendar correction for the changing incidence of public holidays (such as Australia Day, and some State holidays) reflected in labour force survey estimates.

18. Non-farm market sector hours worked estimates are derived by subtracting hours worked estimates for the Agriculture, forestry and fishing industry (based on labour force survey data) from the market sector estimates. More comprehensive details about the latest methods of compilation of industry employment and hours worked estimates can be obtained by contacting the number on the front of the publication.

19. By using hours worked as the measure of labour input, changes in productivity arising from changes in the skill level of the labour force are reflected in the MFP estimates. To obtain a measure of MFP that excluded the effect of changing skill levels, it would be necessary to adjust hours worked for changes in the quality of the labour force.

Accuracy of the MFP estimates

20. It is evident from the foregoing that a good deal of caution needs to be exercised in interpreting the MFP estimates. In addition, two further points should be noted:

- MFP estimates are derived as a residual, and are therefore subject to any errors in the output and input measures. Furthermore, because the growth in MFP is comparatively low, such errors assume relatively greater importance with respect to MFP estimates.

1 Estimates of the capital stock of real estate transfer expenses (RETE) for the market sector have been derived by multiplying the capital stock of RETE for all sectors by the capital stock of non-dwelling construction in the market sector divided by the construction capital stock for all sectors. Estimates of the capital stock of RETE for the non-farm market sector have been derived in a similar way.

- MFP estimates are subject to the vagaries of the growth or business cycle (as capacity utilisation varies so does MFP growth).

21. Taking into account all of these factors, MFP estimates are probably most useful when computed as average growth rates between growth-cycle peaks. (The growth-cycle peaks identified in this publication were determined as peak deviations of the non-farm market sector MFP index from its long-term trend - see Appendix I.) In this way, most of the effects of variations in capacity utilisation and much of the random error are removed. However, average growth rates still reflect any systematic bias resulting from the methodology and data used.

Related ABS publications

22. In addition to those mentioned above, other ABS publications and occasional papers which may be of interest include:

Occasional Paper: Productivity, Prices, Profits and Pay, 1964-65 to 1989-90 - I. Castles (5239.0).

Quarterly Indexes of Industrial Production, Australia (8125.0) - issued quarterly

23. Current publications produced by the ABS are listed in the *Catalogue of Publications and Products, Australia* (1101.0). The ABS also issues, on Tuesdays and Fridays, a *Release Advice* (1105.0) which lists publications to be released in the next few days. The Catalogue and Release Advice are available from any ABS office.

Symbols and other usages

– nil or rounded to zero

W. McLennan
Australian Statistician

APPENDIX I

MARKET AND NON-FARM MARKET SECTOR GROWTH CYCLES

MFP growth-cycle estimates for the market and non-farm market sectors are computed as the percentage deviation of the MFP indexes from their long-term trend. The latter are derived by applying an 11-term Henderson moving average to the MFP indexes. For the first five observations and last five observations, modified versions of the 11-term Henderson average are applied.

MULTIFACTOR PRODUCTIVITY GROWTH CYCLE, 1964-65 TO 1995-96 (a)
(MFP index numbers have a base: 1989-90 = 100.0)

	Market sector			*Non-farm market sector*		
Period	*Multifactor productivity*	*Trend*	*Growth cycle*	*Multifactor productivity*	*Trend*	*Growth cycle*
1964-65	**69.3**	**66.9**	**2.4**	**72.5**	**70.2**	**2.3**
1965-66	67.1	67.8	−0.7	70.6	71.0	−0.4
1966-67	68.3	69.0	−0.7	70.8	72.1	−1.3
1967-68	68.5	70.5	−2.0	72.2	73.4	−1.2
1968-69	**74.1**	**72.3**	**1.8**	**76.3**	**75.0**	**1.3**
1969-70	74.9	74.3	0.6	77.6	76.8	0.8
1970-71	75.9	76.2	−0.3	78.3	78.6	−0.3
1971-72	77.6	77.8	−0.2	79.4	80.2	−0.8
1972-73	78.5	79.5	−1.0	81.5	81.8	−0.3
1973-74	**82.4**	**81.3**	**1.1**	**84.7**	**83.5**	**1.2**
1974-75	83.2	83.2	–	85.0	85.2	−0.2
1975-76	84.2	85.0	−0.8	85.8	86.8	−1.0
1976-77(b)	87.4	86.6	0.8	89.2	88.1	1.1
1977-78	87.3	88.2	−0.9	89.0	89.5	−0.5
1978-79	90.2	89.4	0.8	90.4	90.7	−0.3
1979-80	90.4	90.2	0.2	91.9	91.6	0.3
1980-81	90.5	90.6	−0.1	92.7	92.2	0.5
1981-82	**92.6**	**91.2**	**1.4**	**93.8**	**92.9**	**0.9**
1982-83	89.0	92.1	−3.1	91.5	93.7	−2.2
1983-84	93.1	93.3	−0.2	93.9	94.6	−0.7
1984-85	**96.8**	**94.5**	**2.3**	**97.6**	**95.6**	**2.0**
1985-86	96.8	95.7	1.1	98.2	96.7	1.5
1986-87	94.4	96.9	−2.5	94.8	97.7	−2.9
1987-88	97.2	97.7	−0.5	98.0	98.4	−0.4
1988-89	**100.0**	**98.3**	**1.7**	**100.9**	**98.8**	**2.1**
1989-90	100.0	99.0	1.0	100.0	99.1	0.9
1990-91	98.6	99.7	−1.1	98.2	99.5	−1.3
1991-92	99.9	100.5	−0.6	99.6	100.1	−0.5
1992-93	101.2	101.9	−0.7	100.4	101.4	−1.0
1993-94	104.5	103.8	0.7	103.7	103.3	0.4
1994-95	105.5	105.8	−0.3	105.8	105.5	0.3
1995-96(c)	**108.8**	**108.2**	**0.6**	**108.3**	**107.9**	**0.4**

(a) Peaks of the MFP growth cycle are shown in bold. (b) Despite the relatively high value of the non-farm market sector growth cycle in 1976-77, it has not been identified as a growth-cycle peak after having taken account of the general economic situation at that time, including the relatively depressed labour market. (c) A growth cycle peak has been identified provisionally as occuring in 1995-96 on the basis of the non-farm market sector growth cycle and after taking account of the relatively high level of capacity utilisation.

APPENDIX II
CAPITAL AND LABOUR INCOME SHARES

Total income = Corporate gross operating surplus + Proprietors' capital income + Wages, salaries and supplements + Proprietors' labour income

a) Capital's income share is given by:

$$S_k = \frac{\text{Corporate gross operating surplus + Proprietors' capital income}}{\text{Total income}}$$

b) Labour's income is given by:

$$S_l = \frac{\text{Wages, salaries and supplements + Proprietors' labour income}}{\text{Total income}}$$

Average shares are used in the translog index of MFP:

$$W_{kt} = 1/2\,(S_{kt} + S_{k(t-1)})$$
$$W_{lt} = 1/2\,(S_{lt} + S_{l(t-1)})$$

CAPITAL AND LABOUR AVERAGE SHARES (W_{kt} and W_{lt})

	Market sector		*Non-farm market sector*	
Period	*Capital*	*Labour*	*Capital*	*Labour*
1964-65	0.35	0.65	0.31	0.69
1965-66	0.34	0.66	0.30	0.70
1966-67	0.33	0.67	0.29	0.71
1967-68	0.33	0.67	0.30	0.70
1968-69	0.34	0.66	0.31	0.69
1969-70	0.35	0.65	0.31	0.69
1970-71	0.34	0.66	0.31	0.69
1971-72	0.32	0.68	0.29	0.71
1972-73	0.32	0.68	0.29	0.71
1973-74	0.30	0.70	0.28	0.72
1974-75	0.28	0.72	0.26	0.74
1975-76	0.27	0.73	0.25	0.75
1976-77	0.28	0.72	0.26	0.74
1977-78	0.28	0.72	0.26	0.74
1978-79	0.29	0.71	0.27	0.73
1979-80	0.31	0.69	0.28	0.72
1980-81	0.31	0.69	0.28	0.72
1981-82	0.30	0.70	0.28	0.72
1982-83	0.29	0.71	0.27	0.73
1983-84	0.31	0.69	0.29	0.71
1984-85	0.34	0.66	0.32	0.68
1985-86	0.35	0.65	0.33	0.67
1986-87	0.35	0.65	0.33	0.67
1987-88	0.36	0.64	0.33	0.67
1988-89	0.37	0.63	0.34	0.66
1989-90	0.37	0.63	0.34	0.66
1990-91	0.36	0.64	0.33	0.67
1991-92	0.36	0.64	0.33	0.67
1992-93	0.36	0.64	0.33	0.67
1993-94	0.37	0.63	0.33	0.67
1994-95	0.37	0.63	0.34	0.66
1995-96	0.37	0.63	0.34	0.66

APPENDIX III

AGGREGATION OF CAPITAL ASSETS

Rental prices (which are used to form weights to aggregate the capital stocks for each asset type) are derived using the formula :

$$p_{it} = f_{it} (r_t + d_{it}) - \Delta f_{it} \qquad (1)$$

where for each asset type, i, at time t,

p_{it} is the rental price

f_{it} is the price deflator for new capital goods

r_t is the nominal internal rate of return on capital

d_{it} is the average rate of economic depreciation

Δf_{it} is the revaluation of assets due to inflation in new goods prices

$$d_{it} = \frac{D_{it}}{N_{it}}$$

D_{it} is the total depreciation in the year (at constant prices)

N_{it} is the net capital stock (at constant prices).

Before the rental prices are calculated for each asset type, equation (1) is used to solve for an implicit rate of return, r_t, rather than using a market interest rate.

Computing the internal rate of return empirically is necessary because the rate of capital gain can be greater than the market interest rate plus depreciation. The rate of return (r_t) is solved for all asset types by assuming total capital income equals the rental price multiplied by the total real productive capital stock, K_t :

$$Y_t = p_t K_t$$

and substituting for the rental price in equation (1):

$$\frac{Y_t}{K_t} = f_t (r_t + d_t) - \Delta f_t$$

and so

$$r_t = \frac{Y_t}{K_t f_t} - d_t + \frac{\Delta f_t}{f_t}$$

The capital stocks of each asset type are then combined to form a Tornqvist index in which the rental prices are used to form weights, viz

$$\frac{K_t}{K_{t-1}} = \prod_i \left[\frac{K_{it}}{K_{i(t-1)}} \right]^{w_{it}}$$

where K_{it} is the real productive capital stock of each asset type, i, at time t, and

$$w_{it} = \frac{p_{it} K_{it}}{\sum_i p_{it} K_{it}}$$

For agricultural land, livestock and inventories, depreciation is assumed to be zero. The rental prices for agricultural land, livestock and farm stocks - calculated using equation (1) - turn out to be negative for many years. Such a situation makes little sense and these assets have been assigned a rental price of 4 per cent per annum.

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