AUSTRALIAN NATIONAL ACCOUNTS
MULTIFACTOR PRODUCTIVITY, 1992-93

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, 1992-93

		Market sector		Non-farm market sector	
		Index (a)	Percentage change 1991-92 to 1992-93	Index (a)	Percentage change 1991-92 to 1992-93
A	Gross product	100.2	2.9	99.8	2.8
B	Hours worked	94.6	1.1	94.7	1.4
C	Capital stock	105.2	1.1	106.5	1.3
D	Total labour and capital input	98.2	1.0	98.6	1.4
	Labour productivity (A/B)	105.9	1.7	105.4	1.3
	Capital productivity (A/C)	95.2	1.7	93.7	1.4
	Capital-labour ratio (C/B)	111.2	-	112.5	-
	Multifactor productivity (A/D)	**102.0**	**1.8**	**101.2**	**1.3**

(a) 1989-90 = 100.0

Market sector

The estimate of *market sector multifactor productivity* (MFP) for 1992-93 increased by 1.8 per cent from the previous year, caused by a 2.9 per cent increase in gross product against a smaller rise of 1.0 per cent in total labour and capital input. Hours worked increased by 1.1 per cent following a fall of 3.7 per cent in the previous year. Capital stock recorded a growth rate of 1.1 per cent in 1992-93 following a growth of 0.9 per cent the year before. The increase in capital stock set against the increase in gross product resulted in capital productivity increasing by 1.7 per cent.

Labour productivity rose by 1.7 per cent after a strong growth of 2.9 per cent in the previous year. The capital-labour ratio remained the same in 1992-93 as that in the previous year.

Non-farm market sector

Both hours worked and capital stock grew more strongly in the *non-farm market sector*, recording increases of 1.4 per cent and 1.3 per cent respectively. Growth in gross product was much the same, consequently all three measures of productivity were weaker when compared with the *market sector*.

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

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. Appendix I identifies the same MFP growth cycles as those in the previous issue as follows:

- 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.

The analysis which follows is purely for the market sector. However, the picture presented is not significantly different if it is based on the non-farm market sector.

**MULTIFACTOR PRODUCTIVITY INDEXES
ORIGINAL AND TREND
MARKET SECTOR
(Base: 1989-90 = 100.0)**
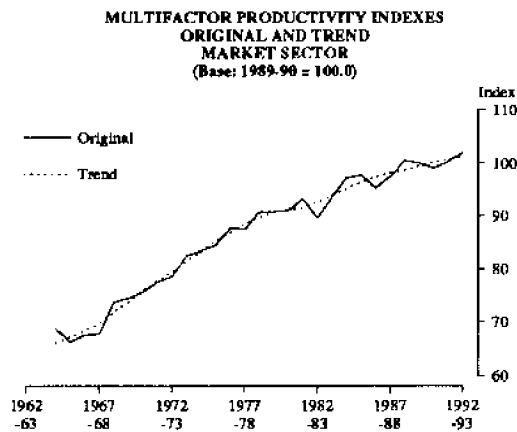
There have been revisions to all three productivity measures since the previous issue, but these have not altered the picture significantly from that previously presented. The most notable revisions are the stronger compound annual growth rates of all 3 measures between 1984-85 and 1988-89 compared with those previously presented over the same period. This is primarily due to the upward revision to estimates of growth in gross product.

The average annual growth rate of MFP over the latest growth cycle (1984-85 to 1988-89) is 0.8 per cent. This is much lower than the average annual growth rates over previous growth cycles, which vary between 1.4 and 2.3 per cent. The latest growth cycle differs in a number of other respects that have a bearing on the lower MFP growth rate.

- *Gross product* at average 1989-90 prices grew at an average annual rate of 3.7 per cent, substantially higher than from 1973-74 to 1981-82 (2.1%) and from 1981-82 to 1984-85 (1.8%), but lower than in the mid 1960s (5.2%) to early 1970s (4.6%).

- *Hours worked* grew at a rapid annual rate of 3.0 per cent in the latest growth cycle. This is much greater

than at any time from the beginning of the 1960s through to the mid 1980s, when there was practically no growth at all. (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 2.6 per cent in the latest growth cycle. This is very similar to that of the early 1970s to mid 1980s but considerably lower than in the mid 1960s (4.8%) to early 1970s (3.7%).

- Over the latest growth cycle, economic growth had been achieved with greater use of labour intensive techniques, reflected by faster growth in hours worked over capital stock and by the *capital-labour ratio* declining at an annual average rate of 0.4 per cent. The growth rate in the *capital-labour ratio* is much lower than in the previous four growth cycles (spanning the mid 1960s to mid 1980s) during which the average annual growth rate of the ratio ranged between 2.1 and 3.3 per cent (refer to graph below).

- An associated outcome of hours worked growing faster than capital stock is that the average annual growth rate of labour productivity is lower (0.7%) than that of capital productivity (1.1%), over the latest growth cycle, with multifactor productivity growing at an average annual growth rate of 0.8 per cent. Compared with the previous four growth cycles, 0.7 per cent is a low growth rate for *labour productivity*, but 1.1 per cent is the highest growth rate for *capital productivity*.

MULTIFACTOR PRODUCTIVITY AND CAPITAL-LABOUR RATIO, AVERAGE ANNUAL GROWTH RATES OVER MFP GROWTH CYCLES, MARKET SECTOR
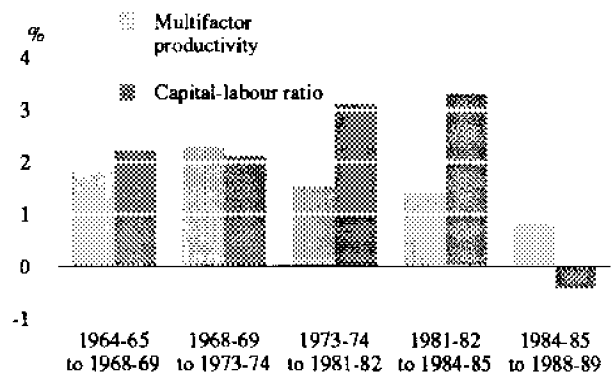
It appears that labour productivity grew more slowly over the latest growth cycle because, unlike the previous four growth cycles, there was not an increasing proportion of capital for labour to use. On the other hand, capital productivity grew more rapidly because better use was made of capital. The overall outcome was that MFP grew more slowly over the latest growth cycle, albeit in circumstances of relatively strong gross product growth and rapid labour growth.

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

Graph 1: Labour
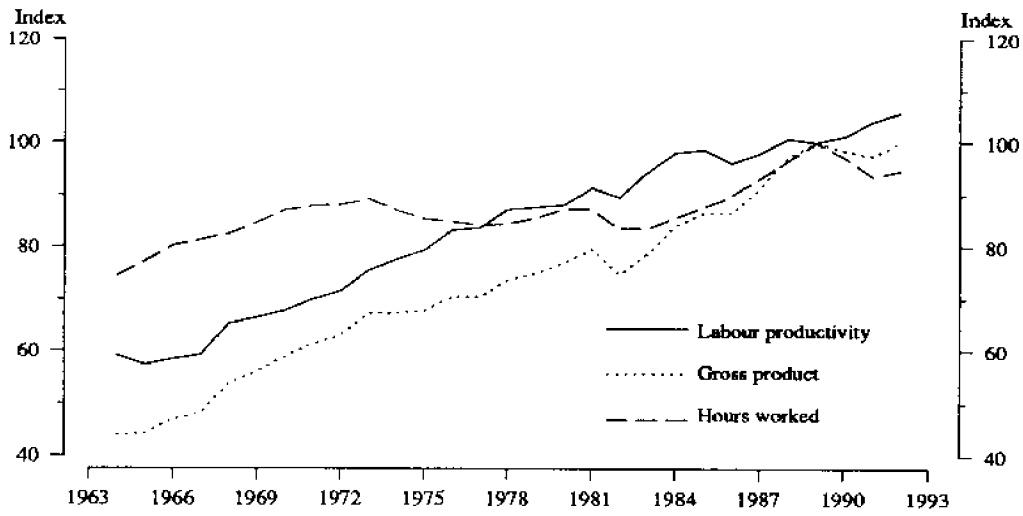
Graph 2: Capital
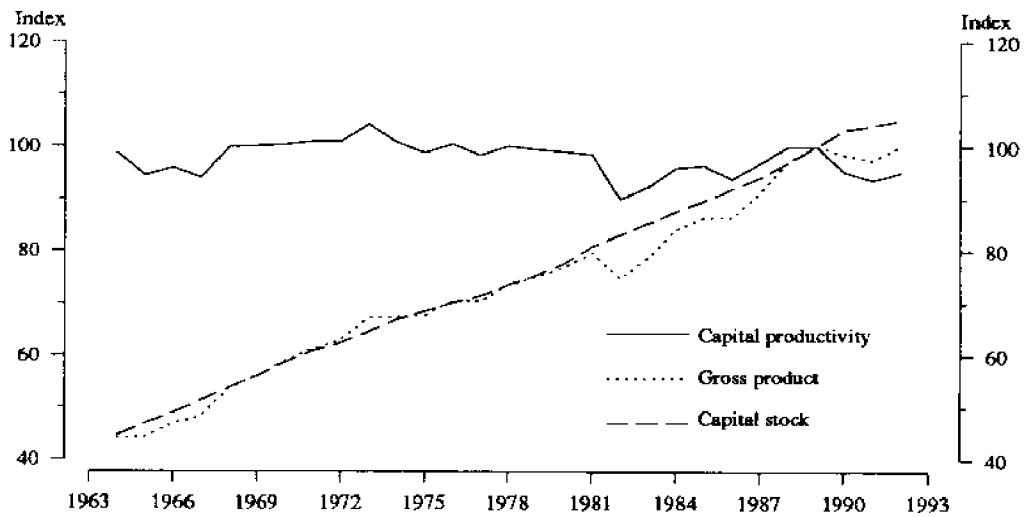
Graph 3: Labour and capital

TABLE 1. PRODUCTIVITY AND RELATED MEASURES, 1964-65 TO 1992-93: MARKET SECTOR

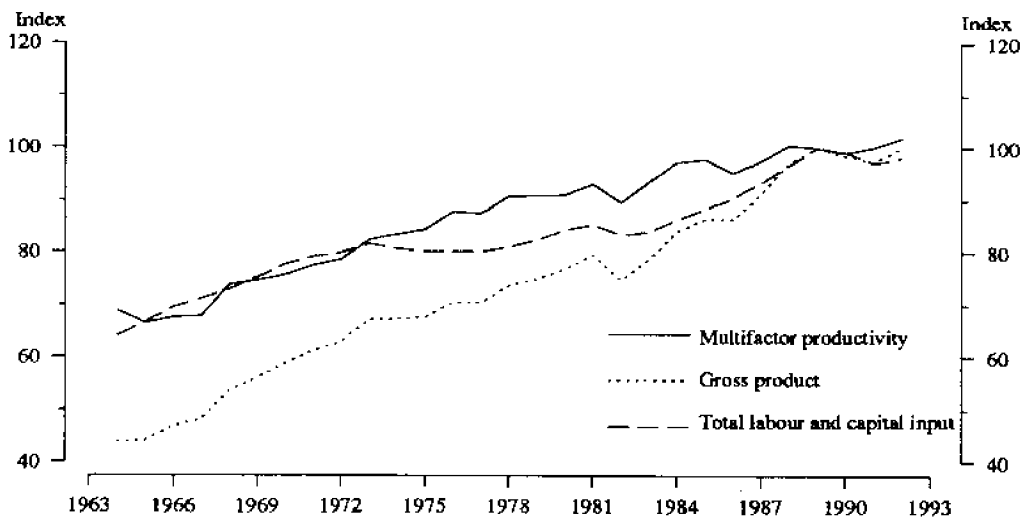| Period	Productivity			Output		Inputs		
	Labour(a)	Capital(b)	Multifactor(c)	Gross product	Hours worked	Capital stock	Total labour and capital	Capital -labour ratio
INDEX BASE YEAR: 1989-90 = 100.0								
1964-65	59.1	98.7	68.8	44.0	74.5	44.6	64.0	59.9
1965-66	57.4	94.5	66.4	44.3	77.2	46.9	66.7	60.8
1966-67	58.5	95.9	67.6	47.0	80.3	49.0	69.5	61.0
1967-68	59.3	94.0	67.8	48.3	81.4	51.4	71.2	63.1
1968-69	65.3	99.8	73.8	53.8	82.4	53.9	72.9	65.4
1969-70	66.4	100.0	74.6	56.2	84.6	56.2	75.3	66.4
1970-71	67.7	100.3	75.7	58.9	87.0	58.7	77.8	67.5
1971-72	69.9	100.8	77.5	61.4	87.8	60.9	79.2	69.4
1972-73	71.5	100.8	78.7	63.0	88.1	62.5	80.1	70.9
1973-74	75.4	104.2	82.5	67.3	89.2	64.6	81.6	72.4
1974-75	77.6	100.7	83.5	67.4	86.9	66.9	80.7	77.0
1975-76	79.4	98.8	84.4	67.7	85.3	68.5	80.2	80.3
1976-77	83.1	100.4	87.8	70.4	84.7	70.1	80.2	82.8
1977-78	83.6	98.3	87.5	70.3	84.1	71.5	80.3	85.0
1978-79	87.2	100.1	90.8	73.6	84.4	73.5	81.1	87.1
1979-80	87.6	99.5	90.9	74.9	85.5	75.3	82.4	88.1
1980-81	88.0	99.0	91.0	76.8	87.3	77.6	84.4	88.9
1981-82	91.3	98.5	93.2	79.6	87.2	80.8	85.4	92.7
1982-83	89.5	90.0	89.6	74.7	83.5	83.0	83.4	99.4
1983-84	94.3	92.3	93.6	78.7	83.5	85.3	84.1	102.2
1984-85	98.1	95.9	97.3	84.0	85.6	87.6	86.3	102.3
1985-86	98.7	96.4	97.9	86.5	87.6	89.7	88.4	102.4
1986-87	96.0	93.9	95.3	86.3	89.9	91.9	90.6	102.2
1987-88	98.0	96.9	97.6	91.2	93.1	94.1	93.4	101.1
1988-89	100.7	100.1	100.5	97.2	96.5	97.1	96.7	100.6
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	101.2	95.3	99.1	98.4	97.2	103.2	99.3	106.2
1991-92	104.1	93.6	100.2	97.4	93.6	104.1	97.2	111.2
1992-93	105.9	95.2	102.0	100.2	94.6	105.2	98.2	111.2

COMPOUND ANNUAL PERCENTAGE CHANGE

Period	Labour(a)	Capital(b)	Multifactor(c)	Gross product	Hours worked	Capital stock	Total labour and capital	Capital -labour ratio
Between MFP growth-cycle peaks								
1964-65 to 1968-69	2.5	0.3	1.8	5.2	2.6	4.8	3.3	2.2
1968-69 to 1973-74	2.9	0.9	2.3	4.6	1.6	3.7	2.3	2.1
1973-74 to 1981-82	2.4	−0.7	1.5	2.1	−0.3	2.8	0.6	3.1
1981-82 to 1984-85	2.4	−0.9	1.4	1.8	−0.6	2.7	0.4	3.3
1984-85 to 1988-89	0.7	1.1	0.8	3.7	3.0	2.6	2.9	−0.4
1964-65 to 1988-89	2.2	−	1.6	3.4	1.1	3.3	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 1992-93: NON-FARM MARKET SECTOR

| Period | Productivity | | | Output | | Inputs | | |
	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	60.9	118.9	73.9	42.8	70.3	36.0	57.9	51.2
1965-66	59.7	114.1	72.0	43.7	73.2	38.3	60.7	52.3
1966-67	60.1	112.8	72.1	45.9	76.4	40.7	63.7	53.3
1967-68	62.2	111.6	73.6	48.2	77.5	43.2	65.5	55.7
1968-69	66.7	114.3	77.b	52.6	78.9	46.0	67.6	58.3
1969-70	68.5	113.9	79.1	55.7	81.3	48.9	70.4	60.1
1970-71	69.6	112.7	79.7	58.6	84.2	52.0	73.5	61.8
1971-72	71.6	111.1	81.0	60.9	85.0	54.8	75.2	64.5
1972-73	74.0	111.3	82.9	63.0	85.1	56.6	76.0	66.5
1973-74	77.3	114.4	86.1	67.4	87.2	58.9	78.3	67.5
1974-75	78.8	109.1	86.2	67.0	85.0	61.4	77.7	72.2
1975-76	80.7	106.0	87.1	67.0	83.0	63.2	76.9	76.1
1976-77	84.6	107.4	90.5	69.7	82.4	64.9	77.0	78.8
1977-78	84.8	105.1	90.2	69.8	82.3	66.4	77.4	80.7
1978-79	86.8	105.4	91.7	72.2	83.2	68.5	78.7	82.3
1979-80	88.6	105.5	93.1	74.3	83.9	70.4	79.8	83.9
1980-81	89.9	105.5	94.0	77.1	85.8	73.1	82.0	85.2
1981-82	92.0	102.9	94.9	79.2	86.1	77.0	83.5	89.4
1982-83	91.9	94.2	92.6	75.3	81.9	79.9	81.3	97.6
1983-84	94.9	94.3	94.6	77.7	81.9	82.4	82.1	100.6
1984-85	98.7	98.0	98.5	83.3	84.4	85.0	84.6	100.7
1985-86	100.0	98.0	99.3	86.1	86.1	87.9	86.7	102.1
1986-87	96.5	94.6	95.9	85.7	88.8	90.6	89.4	102.0
1987-88	98.7	97.9	98.4	91.2	92.4	93.2	92.7	100.9
1988-89	101.9	101.0	101.6	97.6	95.8	96.6	96.1	100.8
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	101.0	94.3	98.7	97.8	96.8	103.7	99.1	107.1
1991-92	104.0	92.4	99.9	97.1	93.4	105.1	97.2	112.5
1992-93	105.4	93.7	101.2	99.8	94.7	106.5	98.6	112.5

COMPOUND ANNUAL PERCENTAGE CHANGE

Between MFP growth-cycle peaks								
1964-65 to 1968-69	2.3	—1.0	1.3	5.3	2.9	6.3	3.9	3.3
1968-69 to 1973-74	3.0	—	2.0	5.1	2.0	5.1	3.0	3.0
1973-74 to 1981-82	2.2	—1.3	1.2	2.0	—0.2	3.4	0.8	3.6
1981-82 to 1984-85	2.4	—1.6	1.2	1.7	—0.7	3.3	0.4	4.0
1984-85 to 1988-89	0.8	0.8	0.8	4.0	3.2	3.2	3.2	—
1964-65 to 1988-89	2.2	—0.7	1.3	3.5	1.3	4.2	2.1	2.9

(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 1992-93 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 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).

Measurement of output

5. 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.

6. 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 Public administration and defence; Finance, property and business services; and Community services.

7. The ABS considers that these three industry divisions 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'.

8. In order to provide measures of overall productivity change which are not influenced by the assumption of 'no labour productivity change' in these industries, the estimates of MFP have been produced 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, fishing and hunting).

9. 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

10. 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.

11. 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;
- Agricultural land; and
- Livestock.

12. 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).

13. Estimates of the capital stock of agricultural land and livestock have been derived specifically for the purpose of estimating MFP. The capital stock of agricultural land has been assumed to be fixed, with no allowance made for changes in either its area or quality. The value at average 1989-90 prices is estimated to be approximately $122,000 million. It would be desirable to include the capital stock of land used by industries other than agriculture, but no estimates are currently available.

14. 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).

Measurement of labour input
15. 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.

16. 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 New Years Day, Australia Day, Easter and some State holidays) reflected in labour force survey estimates.

17. Non-farm market sector hours worked estimates are derived by subtracting hours worked estimates for the Agriculture, forestry, fishing and hunting 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 will be set out in an addendum to *Australian National Accounts: Concepts, Sources and Methods* (5216.0) available by contacting the number on the front of the publication.

18. 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
19. 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:

(a)   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, they assume relatively greater importance with respect to MFP estimates.

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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.

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

20. 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
21. 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

22. 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 *Publications Advice* (1105.0) which lists publications to be released in the next few days. The Catalogue and Publications Advice are available from any ABS office.

Symbols and other usages
    –   nil or rounded to zero

I. CASTLES
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 multiplying 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 1992-93 (a)
(MFP index numbers have a base: 1989-90 = 100.0)

Period	Market sector			Non-farm market sector		
	Multifactor productivity	Trend	Growth cycle	Multifactor productivity	Trend	Growth cycle
1964-65	68.8	66.2	2.6	73.9	71.6	2.3
1965-66	66.4	67.2	-0.8	72.0	72.4	-0.4
1966-67	67.6	68.4	-0.8	72.1	73.4	-1.3
1967-68	67.8	69.9	-2.1	73.6	74.8	-1.2
1968-69	73.8	71.9	1.9	77.8	76.4	1.4
1969-70	74.6	73.9	0.7	79.1	78.3	0.8
1970-71	75.7	76.0	-0.3	79.7	80.1	-0.4
1971-72	77.5	77.8	-0.3	81.0	81.7	-0.7
1972-73	78.7	79.6	-0.9	82.9	83.2	-0.3
1973-74	82.5	81.4	1.1	86.1	84.9	1.2
1974-75	83.5	83.4	0.1	86.2	86.5	-0.3
1975-76	84.4	85.3	-0.9	87.1	88.0	-0.9
1976-77(b)	87.8	86.9	0.9	90.5	89.4	1.1
1977-78	87.5	88.6	-1.1	90.2	90.7	-0.5
1978-79	90.8	89.9	0.9	91.7	92.0	-0.3
1979-80	90.9	90.7	0.2	93.1	92.9	0.2
1980-81	91.0	91.2	-0.2	94.0	93.4	0.6
1981-82	93.2	91.7	1.5	94.9	94.0	0.9
1982-83	89.6	92.7	-3.1	92.6	94.8	-2.2
1983-84	93.6	93.9	-0.3	94.6	95.6	-1.0
1984-85	97.3	95.2	2.1	98.5	96.6	1.9
1985-86	97.9	96.5	1.4	99.3	97.6	1.7
1986-87	95.3	97.6	-2.3	95.9	98.5	-2.6
1987-88	97.6	98.3	-0.7	98.4	99.1	-0.7
1988-89	100.5	98.8	1.7	101.6	99.4	2.2
1989-90	100.0	99.5	0.5	100.0	99.7	0.3
1990-91	99.1	100.2	-1.1	98.7	100.0	-1.3
1991-92	100.2	100.8	-0.6	99.9	100.3	-0.4
1992-93	102.0	101.2	0.8	101.2	100.4	0.8

(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.

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})

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

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) :

$$\frac{Y_t}{K_t} = f_t(r_t + d_t) - \Delta f_t , \qquad \text{and so}$$

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

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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