The New Economy? A New Look at Australia's Productivity Performance

Staff
Research Paper

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Preface

This paper draws on a paper presented by the author at a seminar convened by the Australian Bureau of Statistics (ABS) on *Capital Stock and Multifactor Productivity* in Canberra on 6 May 1999.

It offers a new look at Australia's productivity performance in two senses. First, the ABS has upgraded its methodology for estimating productivity and has extended the time horizon of estimates by two years to 1997-98. The ABS estimates provide the foundation for this paper and enable an update of the earlier work of the Industry Commission on *Assessing Australia's Productivity Performance* (IC 1997). Second, a new methodology is developed in this paper to assess the implications of Australia's productivity performance for growth in output and living standards.

Other previous and continuing work on Australia's productivity performance includes the work of Paul Gretton and Bronwyn Fisher on *Productivity Growth and Australian Manufacturing Industry* (Gretton and Fisher 1997) and forthcoming papers by the Productivity Commission on *Microeconomic Reform and Australian Productivity: Exploring the Links* (PC 1999) and a staff research paper on *Productivity and the Structure of Employment* (Barnes et al 1999).

The current paper has benefited from unpublished data and comments provided by the ABS. Particular thanks are due to Peter Harper and Charles Aspden.

The assistance of colleagues in extracting and manipulating domestic data (Darrell Porter and Tracey Horsfall) and international data (Paul Roberts) is acknowledged. Tracey Horsfall and Maggie Eibisch assisted in the presentation of material for both this and the original seminar paper.

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Productivity Commission.

The new economy?

A new look at Australia's productivity performance

Key points

☐ Australia's productivity performance is now at an all-time high. Productivity growth is faster now than in the so-called 'Golden Age' of growth around the 1960s.

   ☐ ABS estimates show that multifactor productivity growth has accelerated to an average 2.4 per cent a year between 1993-94 and 1997-98, compared with a long-term average of 1.4 per cent a year.

   ☐ Growth in *trend* multifactor productivity has accelerated to 2.5 per cent a year over the two years to 1997-98.

   ☐ Strong productivity growth has been sustained well beyond the period that could be associated with recovery from the early 1990s recession.

☐ The productivity acceleration over recent years is due to very strong growth in output, even though input growth has also been strong.

   ☐ The acceleration has not come from a reduction in labour. In fact, the growth in hours worked over recent years is high by historical standards.

☐ There is evidence to support the notion of 'the new economy'. Qualitative assessments have emphasised greater flexibility and resilence in the Australian economy. The analysis presented in this paper shows the Australian economy to have taken a new growth path which has opened up possibilities for faster growth and more rapid improvements in living standards.

   ☐ Up until the 1990s, Australia showed a remarkably stable pattern of gradual growth in output (per hour worked) based on steady capital accumulation and steady but unspectacular growth in multifactor productivity.

   ☐ From the beginning of the 1990s, Australia has taken a different and faster growth path, based on stronger MFP growth.

   ☐ Output per hour worked is now 15 per cent higher than it would have been had Australia continued on the old growth path. Put another way, the growth that would have taken 13 years on the old path has been achieved in six years.

   ☐ These more rapid increases in output per hour worked also mean more rapid improvements in average incomes — a foundation for better living standards.

☐ Australia's growth experience in the 1990s is unique in the 33 years of evidence available. It is also rare, if not unique, among high-income countries in the 1990s. (Norway is one of two other possibilities examined in the paper.)

☐ An implication of the new growth path is that Australia can pursue growth in output and living standards without running up against savings and balance of payments constraints that would most likely frustrate the alternative path of relying on large increases in investment and capital accumulation.

☐ The ABS has introduced enhancements to its productivity estimation methods.

  ☐ The major changes are a switch from constant price to chain volume measures for output and capital; and a major overhaul of capital measurement methodology. The Finance and insurance industry is now included in the estimates.

  ☐ These changes have the effect of raising estimates of productivity growth slightly for the 1990s. More noticeable differences are reductions in productivity growth estimated for the 1960s and 1970s.

  ☐ The new estimates show a decline in capital productivity from the 1960s through to the mid-1980s. The decline reflects large increases in capital relative to labour. From the mid-1980s, however, combinations of slower growth in capital relative to labour, and stronger growth in multifactor productivity, worked to slow down and then reverse the decline in capital productivity.

1 Introduction

Australians have enjoyed relatively high living standards this century, built in large part on an abundance of natural resources. However, Australia's productivity growth — a major contributor to growth in living standards — has been low by international standards over the long term (IC 1997).

By the 1980s, pessimism about the outlook for Australian commodity exports, the emergence of strong competition in manufactures from Asia and concern about our slippage in the international league tables of per capita incomes focused the attention of policymakers on the need for policy reform.

It was realised that the Australian economy needed to show better productivity performance if Australians were to enjoy the ongoing improvements in living standards that they value.

Australian governments embarked on major policy reforms from the mid-1980s. Both macro and micro approaches were adopted. An emphasis on microeconomic reforms was designed in large part — but not exclusively — to improve Australia's productivity performance.

1.1 Talk of 'the new economy'

There is now a growing perception that the Australian economy is performing in a different way than it has in the past. A number of commentators have taken a lead from official statements.

In its recent *Semi-Annual Statement on Monetary Policy*, the Reserve Bank observed that the combination of strong growth and exceptionally low inflation observed over recent years is quite unlike the experience of the preceding 30 years. It went on to say, 'That such a performance has been maintained, almost two years after the Asian crisis first broke in Thailand, is indicative of the extent to which the Australian economy's underlying strength and resilience have been improved over time.' (RBA 1999, p. 1).

In the *Budget Papers,* the Commonwealth Treasury attributed the current combination of favourable economic indicators to a sound macroeconomic policy

framework, coupled with microeconomic reforms which have delivered higher productivity growth and a more responsive and flexible economy (Treasury 1999, p. 3-3). It also noted that the strong productivity performance in recent years has helped the economy to withstand the international downturn by supporting growth in real household incomes and profits and by contributing to low inflation (p. 3-20).

Thus both macro and micro policy influences appear to be behind the remarkable performance of the Australian economy. Reforms that have increased flexibility, resilience and productivity growth are seen as a central part of the story.

The policy focus on productivity has in turn focused attention on productivity estimates. The Australian Bureau of Statistics (ABS) plays a major role in generating output and input measures and producing official productivity indicators.

The ABS view on Australia's productivity performance has been in hiatus for a time while the Bureau undertook improvements in its estimation methodology. Previous ABS estimates, covering Australia's productivity performance up to 1995-96, showed signs of acceleration in Australia's productivity growth in the 1990s — but care in interpretation was necessary (IC 1997).

The ABS released new productivity estimates on 23 April 1999. They extend estimates of productivity performance up to 1997-98 and are based on the improved methodology.

The principal objective of this paper is to:

☐ interpret the latest estimates and, in particular, examine evidence that the economy is performing differently.

Other objectives are to:

☐ explore the differences between the new and old productivity estimates; and

☐ interpret the trends in capital productivity — an area of some difference between the old and new estimates.

2   Enhancements in the ABS productivity estimation methods

This chapter gives a brief overview of the changes the ABS has introduced to its productivity estimation methods. A full description of the changes is presented in a feature article in the National Accounts publication (ABS 5204.0: 1997-98).

2.1   Changes in estimation of MFP

The fundamentals of the ABS approach to estimating multifactor productivity (MFP) have not changed. The Bureau measures capital and labour inputs, combines them in a composite index, and calculates productivity as the ratio of output to composite inputs.

The ABS has, however, introduced some important refinements.

Chain-volume measures: The ABS now uses a chain-volume method of measuring the value of output and capital stocks over time, rather than (fixed-weight) constant-price estimates.

Industry coverage: The new estimates now include Finance and insurance. This brings the industry coverage more into line with practices adopted in many other countries.

MFP is calculated for the market sector only and excludes sectors in which outputs cannot be meaningfully measured (eg outputs in public administration are often measured in terms of expenditures). Based on 1997-98 data, the market sector now covers 61 per cent of GDP[1]. Finance and insurance adds 6.3 percentage points.

Capital input measurement: This is an area of significant change and is outlined separately.

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[1] Calculated at basic prices from ABS 5204.0.

Measurement of capital

Adjustments to the measurement of capital include, first, *changes to the asset boundary*:

☐ added
– defence assets that could be used for civilian purposes;
– livestock;
– intangibles (software, mineral exploration, certain artistic originals); and
– non-agricultural land;

☐ dropped
– ownership transfer costs.

A major change is the introduction of a much *more detailed tracking of assets*. Previously, only aggregate holdings of equipment at an industry sector level were used. Now the following asset types are separately tracked at the industry level:

☐ road vehicles;

☐ other transport equipment;

☐ industrial machinery and equipment;

☐ computers and computer peripherals;

☐ electronic and electrical machinery and communications equipment; and

☐ other plant and equipment.

The foundations for deriving a capital input measure from the capital stock estimates have been strengthened substantially. The approach adopted brings the capital measurement system into line with what is increasingly recognised internationally as 'best practice'.

The centrepiece of the changes is to introduce explicit relationships which account for the decline in efficiency of an asset which comes with age. *Age-efficiency profiles* for different types of asset determine the capital services that are produced from available capital stocks over time.

Capital services are the capital input measure used in the ABS productivity calculations. In the consistent framework used to measure stocks and flows, capital services is equal to depreciation plus the rate of return.

A further improvement in deriving the capital services measure is to include provision for the effects of *taxes and various allowances and subsidies* on returns to different asset types.

The detailed industry and asset estimates of capital stocks and services are aggregated to form a total capital stock and a capital input measure.

The ABS considers the use of age-efficiency profiles, the detailed 'bottom-up' construction of the capital input measure, and the use of chain-volume measurement to be major factors affecting the measurement of capital input.

2.2   Comparison of old and new estimates

There is insufficient information available to examine the difference that individual aspects of the enhancements have made to the measurement of capital and productivity. Differences in the measured outcomes provide the only available basis of comparison.

Figure 2.1 compares old and new estimates of capital inputs and capital productivity. It shows lower capital inputs in the new series, especially in the 1960s and 1970s. There are correspondingly higher levels of capital productivity.

Figure 2**.**1   **New and old ABS estimates of capital input and capital productivity[a]**
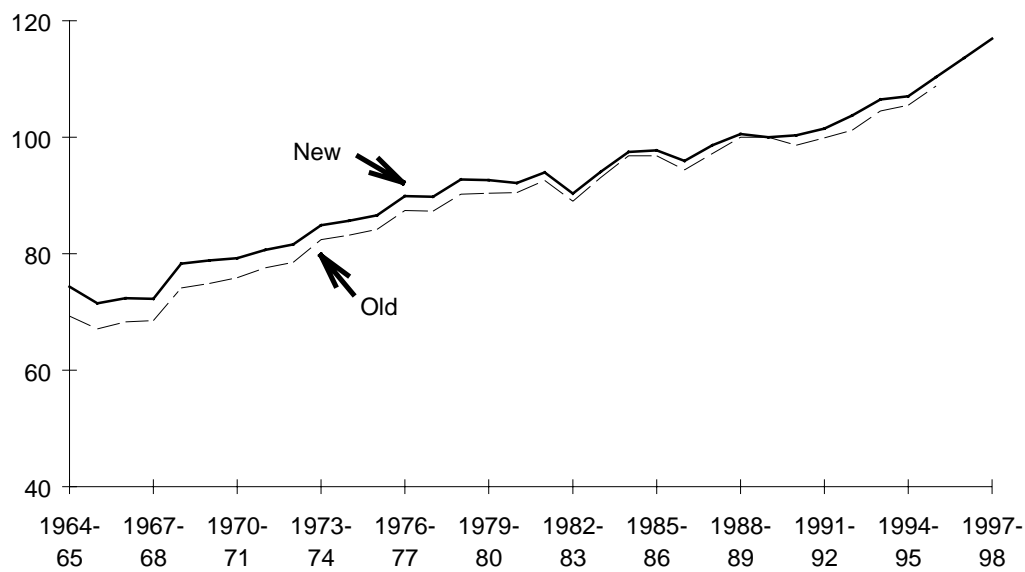
indexes, 1989-90=100
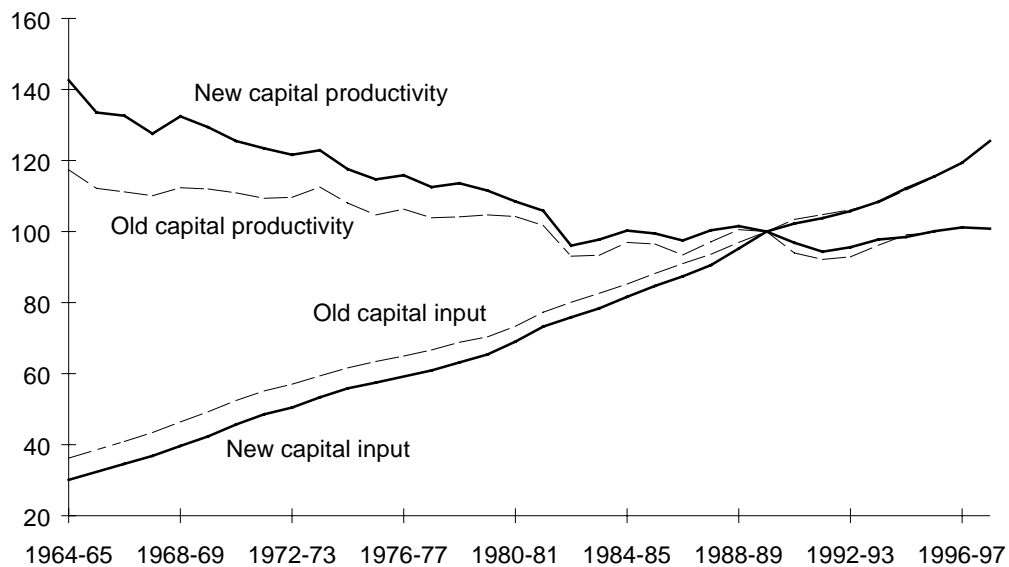
[a] The new series have been rebased to 1989-90 to assist comparison with the old series.

Data source: ABS 5234.0, 5204.0.

This effect is translated into the MFP estimates. (There is only minor variation in the output index due to the inclusion of Finance and insurance and the switch to chain-volume measurement). Figure 2.2 shows a higher level of MFP in the new series. The difference is more pronounced in the 1960s and 1970s, meaning a slower estimated rate of MFP growth over this earlier period in the new series. On the other hand, the higher levels in the 1990s imply a slightly higher rate of growth in the new series over recent times.

Figure 2.2   **Old and new ABS estimates of MFP**a
indexes, 1989-90=100

a The new series has been rebased to 1989-90 to assist comparison with the old series.
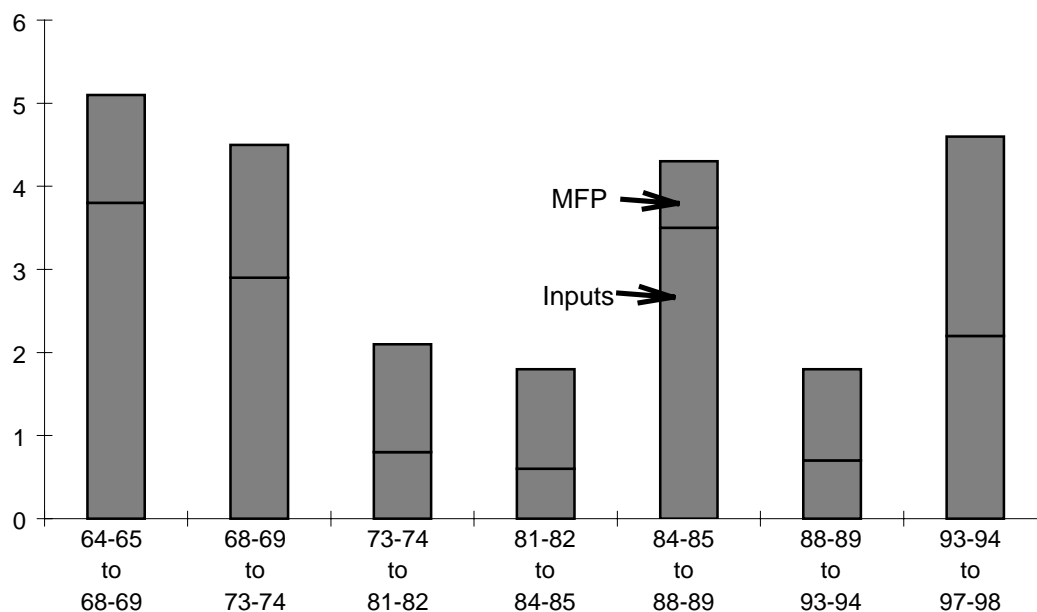
Data source: ABS 5234.0, 5204.0.

3   An assessment of productivity trends

The presentation of productivity results concentrates on the 1990s experience. The long-term picture is first sketched as background.

3.1   The major trends

Figure 3.1 shows the extent to which inputs and multifactor productivity (MFP) growth have contributed to output growth since the mid-1960s. The figure is based entirely on ABS estimates. The 33-year period is partitioned into productivity cycles which correspond to intervals between productivity peaks. Growth rates are calculated from productivity peak to productivity peak to avoid the spurious effects of business cycles.

Figure 3**.**1   **The importance of input growth and productivity growth to output growth has changed since the mid-1960s**

growth rates, % p.a.

Data source: ABS 5204.0.

The figure shows the relative decline in importance of inputs from the 1960s and 1970s, a period which still showed signs of the immigration and industrialisation

path to further development that Australia followed after the second World War. This decline in the relative importance of inputs fits with the broad pattern of development of countries as they mature (see box 4.2 in the next chapter). As a general rule, developed economies become less reliant on input growth and more reliant on productivity growth as a source of output growth.

The late 1980s stands out as an aberration, with strong input growth arising from strong expansion in labour (associated with a decline in real wages) and an expansion in capital (particularly in property). Productivity growth in that period was low.
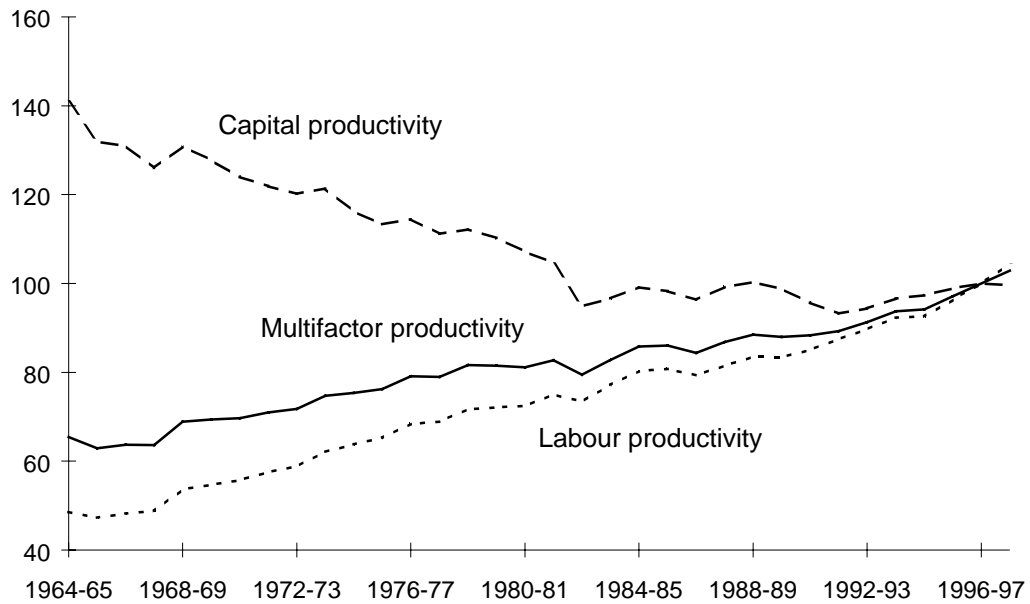
The latest productivity cycle, from 1993-94 to 1997-98, also stands out in showing strong growth in both inputs and productivity. Growth in inputs and productivity are not necessarily independent events, as improved productivity can create conditions favourable to additional investment and employment. The latest cycle is examined further below.

Figure 3.2 shows the year-to-year movements in the different productivity measures. A general upward trend in labour productivity and MFP is evident. Capital productivity, on the other hand, shows a secular decline until the 1980s. Capital productivity trends are interpreted in chapter 5.

MFP is the preferable indicator of overall production efficiency. Labour productivity and capital productivity are partial indicators and, as such, can be difficult to interpret from an efficiency point of view. For example, an increase in capital (per unit of labour) or a reduction in labour (to an extent that created production bottlenecks) would both produce an increase in labour productivity without indicating the effect on overall efficiency.

Figure 3.3 focuses on MFP growth and shows that there has been a substantial acceleration in productivity growth over the latest cycle — 1993-94 to 1997-98. Productivity growth in this latest cycle has been 2.4 per cent a year, whereas previous cycles have shown average growth in the range of 0.8 to 1.6 per cent a year. Annual average growth since 1964-65 has been 1.4 per cent.

Figure 3.2   **Labour productivity and MFP have trended upward, but capital productivity declined until the 1980s**

indexes, 1996-97=100

Data source: ABS 5204.0.

Figure 3.3   **MFP growth has accelerated to an all-time high in the latest productivity cycle**

% p.a.
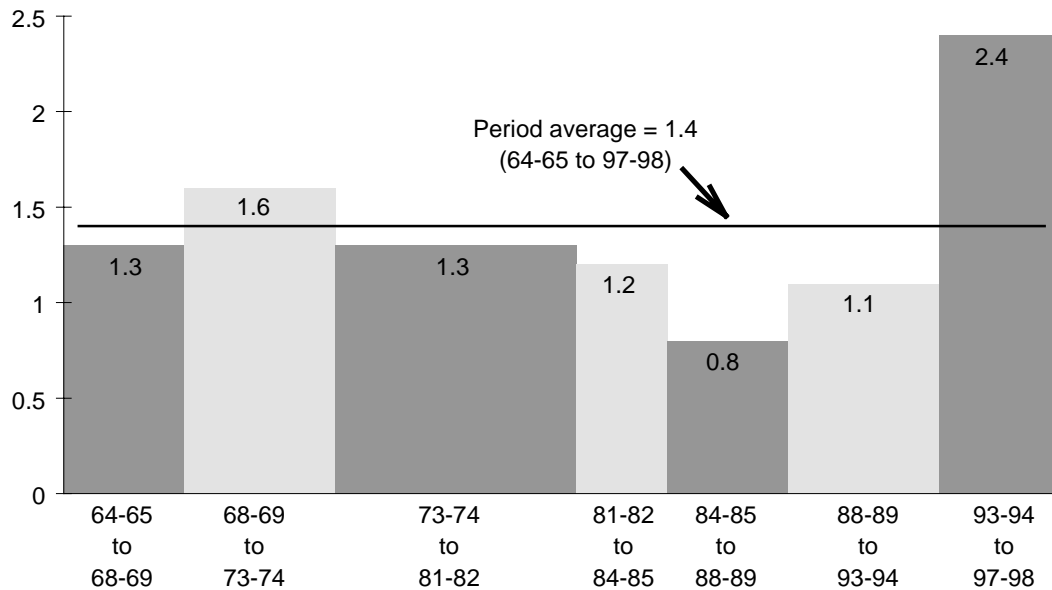
Data source: ABS 5204.0.

3.2 What underlies the recent trends?

Table 3.1 shows the following factors underlie the dramatic increase in productivity growth over the latest productivity cycle:

☐ There has (obviously) been stronger growth in output than inputs. But the growth in both output and inputs is strong by historical standards. Thus the surge in productivity growth is not coming from choking back on inputs.

☐ On the inputs side, there is strong growth in labour input by historical standards. And so the productivity improvement is not coming from less employment of labour.

☐ Capital growth is strong, but not quite up to the historical average, given the relatively large net investments in the 1960s and 1970s.

☐ Both capital and labour productivity have increased. The increase in capital productivity runs counter to the long term decline (chapter 5).

Table 3.1 **The recent acceleration in MFP growth is based on high output growth, even with high input growth**

growth rates, % p.a

	Recent cycle (93-94 to 97-98)	Long term (64-65 to 97-98)
Output	4.6	3.3
Inputs	2.2	1.9
Labour	1.4	1.0
Capital	3.8	4.4
Labour productivity	3.1	2.3
Capital productivity	0.8	-1.0
Capital-labour ratio	2.4	3.4

Data source: ABS 5204.0.

Effects of the cycle and recession

Drawing the boundaries between productivity cycles has some influence on the determination of trends. In the previous ABS estimates, productivity growth over the latest available peak-to-peak cycle (1988-89 to 1995-96) was measured at an average rate of 1.2 per cent a year. With a peak now identified in 1993-94, productivity growth over the latest cycle (1993-94 to 1997-98) is now measured at an average rate of 2.4 per cent a year. The comparison of old and new estimates in the previous chapter showed that year-to-year productivity growth is only slightly

higher over the 1990s (and has continued at a high rate for another two years) in the new estimates. Even allowing for this, the redrawing of the productivity cycle boundary has clearly had an influence.

The determination of productivity peaks, however, is not arbitrary. Peak points in the productivity cycle are determined by the ABS, using consistent application of a statistical technique. The ABS calculates a trend series (using a Henderson 11-period moving average) and productivity peaks are determined as years in which the gap between the actual and trend productivity series turns from increasing to decreasing.

The 1990s recession would also have affected productivity results. Productivity growth commonly rises rapidly coming out of a recession as capacity utilisation steps up from unusually low rates. It is quite possible that productivity growth in the early part of the latest cycle still reflects some effects of the recession. (There is a hint of this in one of the industry sectors examined below).

An examination of the ABS trend series is a way to get a picture of underlying productivity trends without the intrusion of the boundary issue from the peak-to-peak technique. It also reduces the influence of business cycles.

Figure 3.4   **The trend rate of productivity growth is now at an historical high**[a]

growth over previous year, %
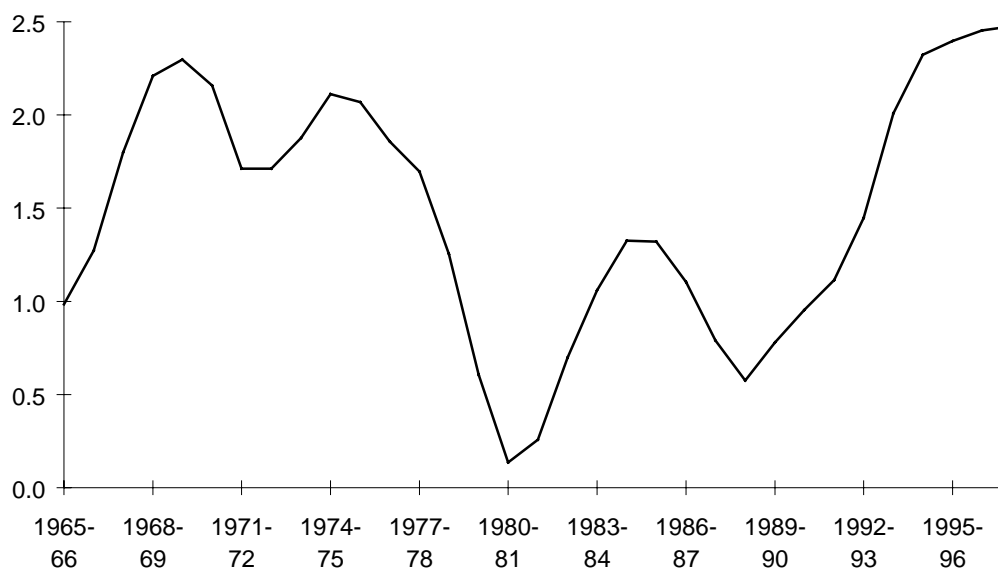
a Year-to-year growth in the ABS trend MFP series.

Data source: Unpublished ABS data

Figure 3.4 shows the year-to-year growth in the ABS trend MFP series. It reveals the underlying trend in productivity growth to have been at or above 2 per cent a year since 1993-94. The growth in trend productivity only broke through 2 per cent a year briefly back in the late 1960s and briefly again in the mid-1970s.

The use of the trend series reduces the influence of the recession. But, even so, it is worth noting that the highest growth in trend productivity has come outside of the period subject to influence from recovery from the recession. While there may be some question about recovery from recession still exerting some influence on the actual 1993-94 result, further influence beyond that time becomes increasingly unlikely. From 1995-96, trend productivity has been growing at the historically high rate of 2.5 per cent a year.

It is also very clear from figure 3.4 that trend productivity growth in the 1990s accelerated well beyond the recovery shown after the 1980s recession.

Sectoral origins

It is also of interest to look at the sectoral origins of the productivity acceleration. Labour productivity growth estimates have to be used, because the Bureau does not yet publish sectoral MFP estimates.

From an efficiency point of view, the use of labour productivity estimates does not provide the ideal guide to the sectoral origins of productivity growth. As stated before, changes in labour productivity can reflect relative expansion of capital or reduction of labour, without necessarily indicating whether (multifactor) efficiency has been improved.

Table 3.2 shows growth in industry labour productivity over the latest cycle (left-hand column). It reveals strong growth in labour productivity in Mining, Electricity gas and water, Communications and Finance and insurance.

Capital growth appears to be a major factor underlying labour productivity growth in Mining and Communications. Less labour appears to be a major factor only in Electricity, gas and water. (Figure 3.4)

Table 3.2 also shows the percentage industry contributions to labour productivity growth in the market sector (right-hand column). To calculate contributions, the productivity growth in each industry is multiplied by a production weight calculated for 1993-94. Contributions take account of the fact that some sectors matter more than others because of size. A large increase in productivity growth counts for less if it is in a small segment of the market sector and conversely.

Table 3.2   **Sectoral growth in labour productivity over the latest cycle**

	Growth rates	Contributions
	% p.a	%
Agriculture	-1.9	-3
Mining	7.6	15
Manufacturing	1.9	12
Electricity, gas & water	10.7	15
Construction	2.8	7
Wholesale trade	8.2	20
Retail trade	1.9	5
Accommodation, cafes and restaurants	-0.5	-1
Transport and storage	2.0	6
Communications	6.7	8
Finance & insurance	5.8	16
Cultural and recreation services	0.5	..

Data source: ABS 5204.0.

Figure 3.5   **Sectoral growth in output and inputs, 1993-94 to 1997-98**
          % p.a.
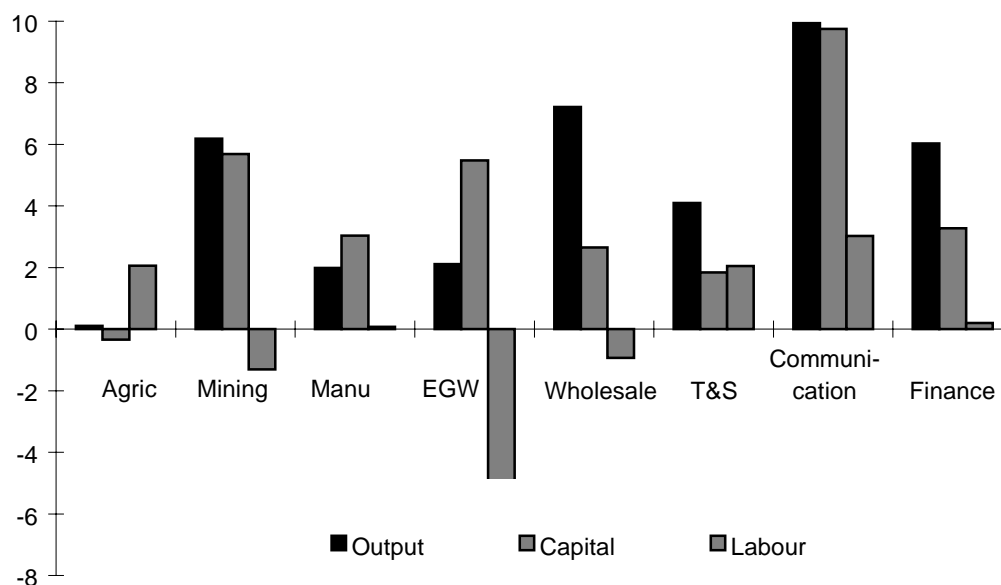
Data source: ABS 5204.0.

The contributions column raises the profile of manufacturing because of its large relative size. The other sectors mentioned earlier still feature strongly.

Some further examination of Wholesale trade shows it was knocked around by the early 1990s recession; and its strong growth in labour productivity is likely to reflect some delay in its recovery from that recession. Agriculture, which shows solid productivity growth over the long term (IC 1997), is subject to the vagaries of climate.

This picture of the sectoral origins can only be taken as broadly indicative. A clearer picture would require sectoral MFP estimates and a longer time series to examine and allow for the different cycles of different industries.

3.3   Some implications

The main difference between the new and old estimates is a reduction in productivity growth estimated for the 1960s and 1970s. Productivity growth still remains strong for this period, as a glance at the underlying trend series (figure 3.4) reveals. The period remains as something of a 'Golden Age', but not quite to the extent previously thought. This is perhaps more in line with the work of Angus Maddison and others, which has shown that there was a major period of 'catch-up' from the 1950s up until the mid-1970s in Europe associated with post-war reconstruction. Australia, however, in part because of its isolation, did not knock on the door of the 'Convergence Club'. (Maddison 1995,1997)

If the 1960s and 1970s were the 'Golden Age' of growth in output and productivity, it seems we might need to reach for an even more superlative term for the 1990s. The acceleration in productivity growth in the 1990s is outstripping any earlier results.

There would be a combination of factors underlying this acceleration. In the early part of the 1990s there is likely to be some effects from recovery from the recession. But underlying productivity growth has still accelerated outside of the recession-affected period. There is also likely to be some — and possibly a major — dividend from reform. And there may be other factors, particularly underlying technological advance, although too much should not be made of that, given that embodied technological change is captured in the input measure (chapter 5). There could be disembodied advances such as organisational and management improvements (which could be related in parts to reform and to advances in information technology).

As a dividend from reform, we could expect to see greater input growth (eg due to greater returns on investment), better allocation of resources (to more productive uses) and better technical efficiency in input use (eliminating inefficient processes and practices and spurring the search for even better ways of doing things).

It is not just wishful thinking to suggest that microeconomic reform may be playing a very important role. The Commission is undertaking research into the links between reform and productivity. A forthcoming study (PC 1999) adds to the weight of evidence that the economy is operating differently in an environment with much clearer allocation signals and much clearer incentives to raise productivity performance.

4   Evidence on the new economy and some implications

This chapter uses published ABS data and a new methodology to examine evidence of a shift in the way the Australian economy operates.

4.1   A break with the past

Economic growth is to be analysed in a way that warrants at least brief explanation. The essence of the technique is to examine the evolution of input-output relationships in an economy over time.

Paired observations of output per unit of labour and capital per unit of labour in each year are plotted on a chart. (Observations from the ABS data set, excluding the latest cycle, are plotted in figure 4.1).

Figure 4.1   Australia's growth path from 1964-65 to 1992-93
indexes, 1996-97=100
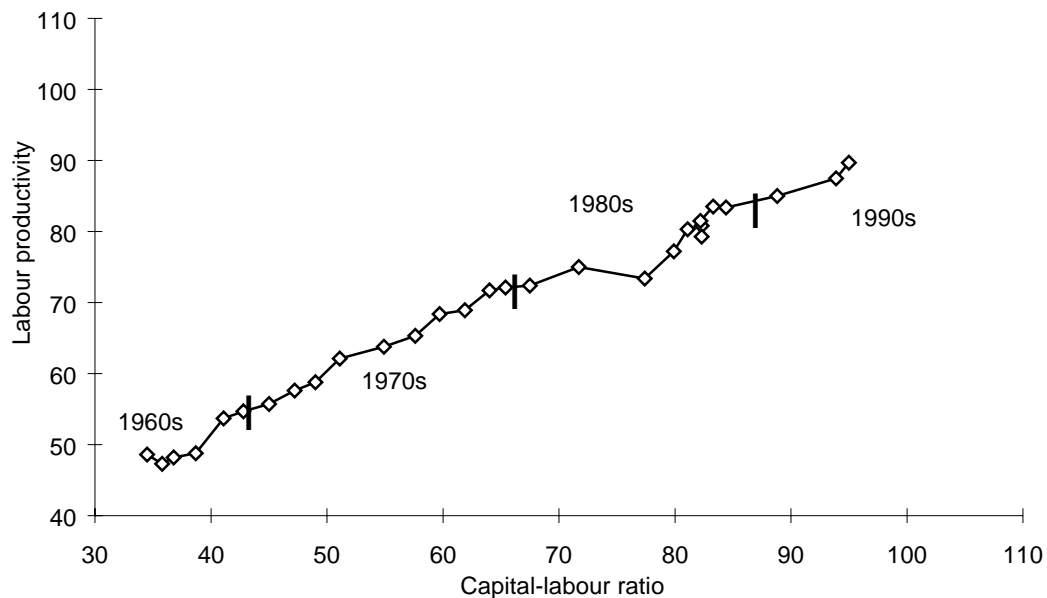
Data source: ABS 2504.0

These observations can be thought of as depicting points on an aggregate (per unit labour) production function. Shifts from one observation to another represent combinations of shifts *around* the aggregate production function (based on increases in the capital-labour ratio) and shifts *of* the production function (due to productivity improvement). The derivation in box 4.1 provides a formal demonstration.

Because the capital-labour ratio increases over time, the observations generally line up in chronological order from left to right. Joining the points in chronological order maps out what may be termed the 'growth path' of an economy's output per labour input — or labour productivity. It shows how an economy progresses from a lower level of labour productivity to a higher level. The Australian case, based on output per hour worked, is shown in figure 4.1.

Next it can be observed that growth in labour productivity is often used as a proxy indicator of growth in average living standards. With plausible assumptions, growth in labour productivity bears a reasonable approximation to growth in average income per head.[1]

Thus, the growth path can also be interpreted as a pathway to better living standards.

International comparisons are included in box 4.2 and appendix A to help interpretation of growth paths. Some countries, for example Japan, have pursued a growth trajectory based heavily on investment and capital accumulation. Hence its growth path appears relatively drawn out, reflecting large increases in the capital-labour ratio. Some countries have pursued trajectories based on productivity growth (for at least some periods). Their growth paths are steeper or have steep sections. Hong Kong is a prime example.

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[1] Since income and output are very closely related, growth in labour productivity will be a close approximation to growth in income per head if there have been no major shifts in the population/workforce dependency ratio, participation rates, or average hours worked.

| Box 4.1 | **The relationship between labour productivity, capital deepening and multifactor productivity** |

To assist the interpretation of the factors underlying the growth path analysis used in this chapter, take a simple Cobb-Douglas production function (with constant returns to scale). Actual observations on growth paths do not require or necessarily conform precisely to a particular specification of the production function. It just helps to use a specification which provides a simplified view of the relationships involved.

Output (Y) can be expressed as a function of labour (L), capital (K) and multifactor productivity (M):

$$Y = M.K^{\alpha}L^{1-\alpha}$$

$$^Y/_L = M.(^Y/_L)^{\alpha} \tag{4.1}$$

Taking differential logs:

$$y = \alpha.k + m \tag{4.2}$$

where

y = growth in labour productivity

k = growth in the capital-labour ratio

m = growth in multifactor productivity.

The parameter α is the marginal product of capital, which equals the capital share of total income if factors are paid their marginal products (normally assumed as a property of competitive markets).

Equations (4.1) and (4.2) show that labour productivity is a positive function of capital deepening and multifactor productivity, both in the levels and in terms of rates of growth.

Figure 4.2 shows a curve fitted from the Australian observations up until 1992-93, the year before the commencement of the latest productivity cycle.[2] The curve is one way of capturing the history of Australia's growth path and projecting beyond 1992-93, based on that history. The curve shows literally the average return Australia has derived in terms of additional output per hour worked from increases in capital per hour worked. On a broader interpretation, it shows how effective capital deepening has been in improving our living standards.

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[2] A non-linear function was used, reflecting the general decline in productivity growth from the 1960s and early 1970s through to the 1990s (chapter 3).

## Box 4.2   **Growth paths for different countries**

The different strategies used by countries to pursue development and better living standards are revealed in their growth paths.

The comparisons in this box are drawn from data contained in the Summers and Heston (1991) Penn World Tables (PWT). It needs to be noted that the quality of the data inputs is generally not up to the standard of the ABS data, upon which figure 4.2 is based. Labour input is measured in terms of number of employees (PWT) rather than hours of work (ABS). Capital is measured in terms of capital stock (PWT), rather than flow of capital services (ABS). The PWT data refer to the economy as a whole, whereas the ABS data are confined to the market sector. And data collection standards vary between countries.

The growth paths for each country are based on indexes set at 100 for 1985. Consequently, the comparisons give no indication of the vast differences in levels of labour productivity and capital-labour ratios that exist between countries at different stages of development. The same scales are used in all charts to facilitate comparisons between countries.
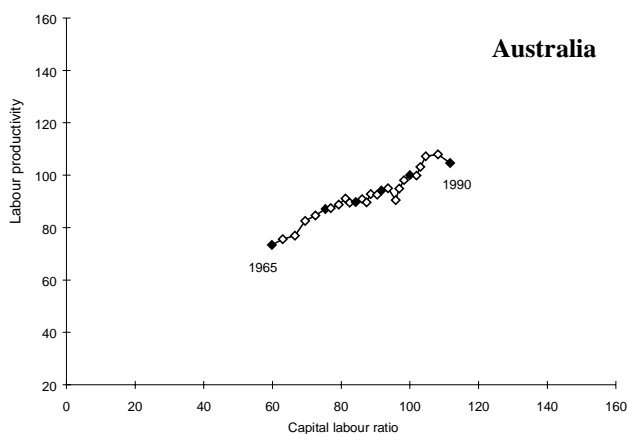
Australia

The Australian growth path is reproduced from the PWT for comparison.

United States
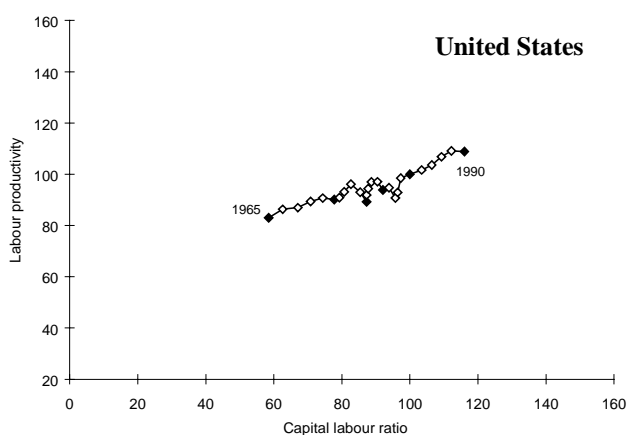
The US shows relatively slow productivity growth. This is to be expected of a country which has already, in general, reached the productivity 'frontier'.

Box 4.3 (continued)

A common view of development is that countries initially focus on investing in physical and human capital to develop their economic and social infrastructure. This, amongst other things, then provides a platform for rapid growth 'catch up' to more developed countries. Once developed, countries typically become more reliant on productivity growth than input accumulation to underpin further growth in output and living standards. Consequently, as a broad generalisation, one expects to see:

☐ high income countries with relatively flat growth paths confined to a relatively narrow span of capital-labour ratios;

☐ rising income countries with a broad span of capital-labour ratios (capital accumulation) and/or a steep gradient in their growth path reflecting 'catch up' productivity growth; and

☐ low income countries with little evidence of sustained increases in either capital accumulation or productivity growth.

Growth paths for a more diverse range of countries, which illustrate these patterns, are included in appendix A.
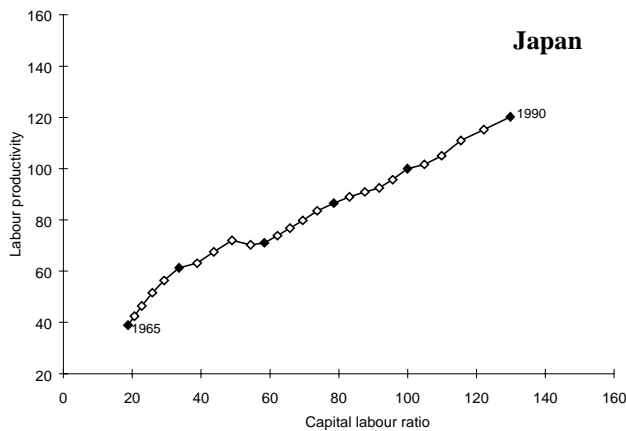
Japan shows growth based on productivity growth in the 1960s, combined with high investment from the 1970s. (See appendix A for a more up-to-date picture).
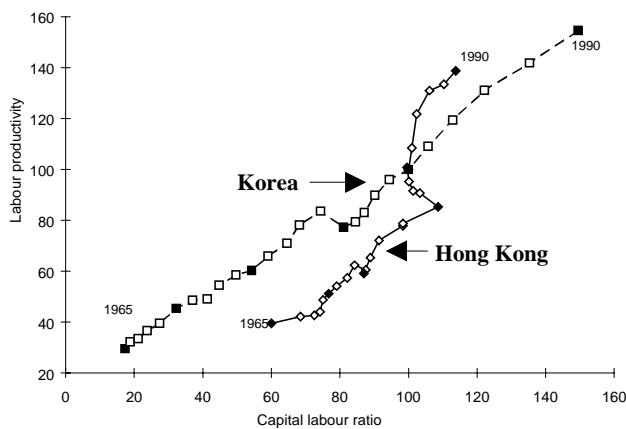
Korea and especially Hong Kong show periods of extensive growth based heavily on MFP growth.

Figure 4.2   **Australia takes a different growth path in the 1990s**[a]
                Indexes, 1996-97=100

a The fitted curve uses data for years up to 1992-93. The curve is of the form $(^Y/_L) = 40.66 \ln (^K/_L) -98.39$.

Data source: ABS 5204.0.

The observations describe a remarkably stable pattern ($R^2 = 0.99$ for the fitted curve). It suggests that any productivity growth up until the 1990s has served to keep the Australian economy on a steady growth path. The 1980s recession is the only period off the path up until the 1990s.

The observations for the latest productivity cycle (from 1993-94) are included in figure 4.2 as squares. They show the emergence of a very different growth path. Here, productivity growth is putting the economy on a new growth trajectory.

As a result of the new growth path:

☐ output per hour worked in the market sector was 15 per cent higher in 1997-98 than it would have been if the economy had stuck to the old historical growth path; and

☐ taking 1991-92 as a departure point, output per hour worked grew over the next six years to a level that would have taken over 13 years to achieve, had the economy remained on the old growth path.[3]

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[3] The estimate of 13 years is based on the assumption that the capital-labour ratio would increase at the historical average rate of 3.4 per cent a year on the old growth path.

Figure 4.2 also illustrates an important difference between the recessions of the 1980s and 1990s. In the 1980s recession, reduction in labour shifted the capital-labour ratio to the right, but output declined even more than labour, so the economy 'fell off' the underlying growth path. There was a subsequent recovery back onto the growth path. In the 1990s, the capital-labour ratio shifted to the right again, but production remained 'on track'. This would be due to increased MFP. A continuation of productivity growth thereafter also meant that the economy 'took off' on a different growth path coming out of the recession, rather than just recovered to the historical path.

Another possible explanation for why the economy remained on track in the 1990s recession is that cuts in labour could have been more severe in the 1990s recession than in the 1980s recession (which would have preserved the growth path output-labour relationship in the 1990s). However, the rightward shift in the capital-labour ratio appears no more severe in the 1990s recession than in the 1980s recession. The Reserve Bank has demonstrated that the reduction in employment was no more severe in the 1990s recession than in the 1980s recession, but that the recovery in employment from the 1990s recession was delayed (RBA 1998).

From visual inspection, it seems that the structural break had its origins around the same time as the recession of the early 1990s. Indeed, the fact that the economy remained on track during the recession suggests that productivity growth was higher from at least 1990-91.

There is nothing in the 33-year Australian history examined here of similar magnitude or direction. From a brief examination of other high-income countries' experience (albeit on poorer quality data) it also does not appear to have occurred elsewhere in the 1990s. Norway is the only other possibility among countries examined[4] (appendix A).

4.2 Some implications

The shift in Australia's growth path suggests Australia has opened up new frontiers of growth possibilities and more rapid payoffs in terms of contributions to average living standards. Provided nothing happens to undo the productivity gains that have been achieved, those contributions to improvements in living standards are locked in. Pursuing further opportunities for productivity growth will deliver opportunities for further relatively rapid improvements in living standards.

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[4] Ireland is another possible candidate, but 1990s data are not readily available for this country.

Figure 4.3   **Growth in labour productivity now comes with less capital deepening**[a]
% p.a.
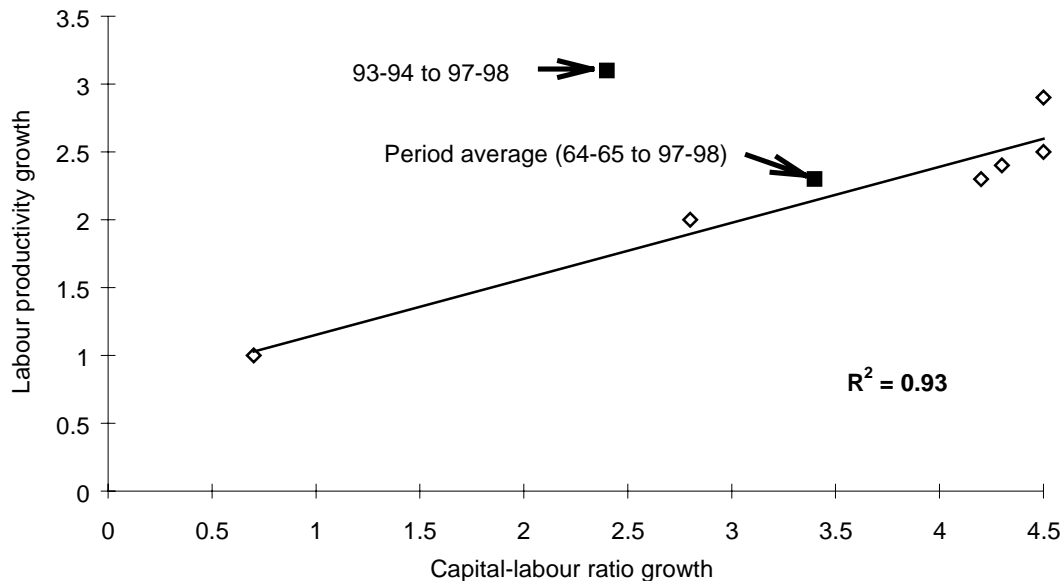
a The data for the regression are observations on the variables over productivity growth cycles identified by the ABS. The latest cycle and the period average are omitted from the regression. The fitted line takes the form y = 0.41k + 0.74.

Data source: ABS 5204.0.

Figure 4.3 provides further illustration of the living standards implications. It shows the same labour productivity and capital-labour ratio variables in terms of rates of growth.

A straight line is fitted from observations of the growth in labour productivity and capital deepening over each of the productivity cycles, excluding the most recent cycle. Again, there is a tight fit ($R^2 = 0.93$).

However, the observation for the latest cycle is on a different part of the chart, showing a much greater return now from capital deepening. It means Australians are getting a much greater return in terms of contributions to average living standards for a much lower ask in terms of capital deepening.

To put it another way, to get the equivalent growth in labour productivity and living standards on the basis of the historical fitted line, the capital-labour ratio would have to increase by 5.7 per cent a year instead of the 2.4 per cent a year shown in the latest cycle. Presumably, the scale of investment required to achieve an annual 5.7 per cent increase would be out of reach, given Australia's savings and balance of payments records.

Analysis of the effects on the distribution of income would also be needed to complete an assessment of the living standards effects. And it should also be remembered that growth in employment and reduction in unemployment are also paths to increased living standards.

5 Interpreting the trends in capital productivity

The ABS's new estimates of capital productivity show a more pronounced secular decline through to the 1980s recession, compared with the previous estimates (chapter 2). This has surprised some. For example, at the ABS seminar on *Capital Stock and Multifactor Productivity* in May 1999, some participants expected to see little long-term movement in Australia's capital productivity.

Economic theory leads us to look for two opposing forces that affect capital productivity:

☐ the law of diminishing returns; and

☐ technological change.

In neo-classical steady-state growth models, these forces are *assumed* to be exactly offsetting, implying a flat capital productivity profile over time. But, in practice, these steady state conditions may not apply.

Diminishing returns are likely to be a major influence underlying the ABS estimates. As observed several times in this paper, the capital-labour ratio has generally been increasing over time. This means that, on average, a unit of capital increasingly has less labour to work with. This would produce a decline in capital productivity over time.

This observation is the mirror image of the well-known fact that increases in the capital-labour ratio raise labour productivity. With capital deepening, each unit of labour has, on average, more capital to work with and so more output can be produced per unit of labour input. The opposite is true on the capital side.

So, if diminishing returns produce a decline in capital productivity, what about the offsetting effects of technological change?

Whilst the theory is based solely on there being technological change that has the offsetting effect, the practice is different. First, in practice, a major part of technological change is embodied in purchases of new plant and equipment. The ABS procedures, in allowing for quality improvements in price deflators, incorporate most of these embodied technological changes in the capital *input*

measure used in the productivity calculations. They are not part of the unexplained productivity residual.

Consequently, embodied technology does not have as dramatic or immediate offsetting effect on capital productivity. It can still have some effect through learning-by-doing efficiencies and so on — but it is unlikely to be sufficient to fully offset diminishing returns.

This leaves disembodied technological change as a potential offsetting factor. The second practical issue is that there may be other disembodied efficiency improvements, apart from those of 'technological' origins — eg better organisational, management and work practices, including reductions in any so-called X-inefficiencies. All these factors show up in the MFP component of the ABS calculations.

Thus, in practice, the capital productivity outcome will depend on the relative strength of the (negative) effects of growth in the capital-labour ratio and the (positive) effects of growth in MFP.

Box 5.1 shows a mathematical demonstration of this relationship. And the data in table 5.1 show a pattern consistent with it. Capital productivity declines with the big increases in capital deepening in the 1960s and 1970s and increases when MFP increases (all other things equal), especially in the 1990s.

Table 5.1   **Growth in capital productivity depends on growth in the capital-labour ratio and growth in MFP**

growth rates, % p.a.

	Capital productivity	Capital-labour ratio	Multifactor productivity
1964-65 to 1968-69	-1.9	4.5	1.3
1968-69 to 1973-74	-1.5	4.5	1.6
1973-74 to 1981-82	-1.8	4.3	1.3
1981-82 to 1984-85	-1.8	4.2	1.2
1984-85 to 1988-89	0.3	0.7	0.8
1988-89 to 1993-94	-0.8	2.8	1.1
1993-94 to 1997-98	0.8	2.4	2.4
1964-65 to 1997-98	-1.0	3.4	1.4

Source: ABS 5204.0.

Box 5.1　A decomposition of changes in capital productivity

This derivation provides a guide to the factors underlying capital productivity growth and decline.

Capital productivity — output (Y) divided by capital (K) — can be expressed as

$$Y/_K \quad = \quad Y/_L \cdot L/_K$$

where　　　　　　L　=　labour input.

Taking differential logs:

$$c \quad = \quad l - k$$

where　　　　　　c　=　growth in capital productivity

　　　　　　　　l　=　growth in labour productivity

　　　　　　　　k　=　growth in the capital-labour ratio.

Using equation (4.2) from box 4.1:

$$c \quad = \quad (\alpha - 1)\, k + m \qquad\qquad\qquad (5.1)$$

where　　　　　　m　=　growth in multifactor productivity.

Since α, the capital share in total income is less than unity, capital productivity declines with increases in k (capital deepening), but increases with increases in m (MFP).

The value of α varies over time. But if α is given a value of 0.3 as a rough guide, equation (5.1) and the information in table 5.1 can be used to approximate the growth in capital productivity, also given in table 5.1

The trends in capital productivity can therefore be explained in these terms:

☐ the decline in capital productivity up until the 1980s recession was due to the dominance of large increases in the capital-labour ratio;

☐ some arrest to that decline over the balance of the 1980s was due to recovery from the recession and a much smaller increase in the capital-labour ratio (0.7 per cent a year compared with the long-term average of 3.4 per cent a year) in the late 1980s; and

☐ the increase in capital productivity in the 1990s was due to the dominance of recovery from the recession and much stronger growth in MFP.

Underlying these broad outcomes, there could be several factors (apart from the size of labour input) that would show up in the capital productivity 'residual':

☐ greater workforce skill and flexibility over time would increase capital productivity;

☐ more stringent environmental requirements would reduce it;

☐ poor allocation of capital and inefficient use would reduce capital productivity; and

☐ compositional changes — both industry and asset type — could have either positive or negative effect.

Figure 5.1 shows that the industry composition of capital input has changed markedly over time. The influence of this and other dimensions of the capital story warrants further investigation.

Finally, it is worth noting that declining capital productivity is a feature of other countries' experience. Figure 5.2 shows capital productivity has declined in a number of countries since the 1970s.
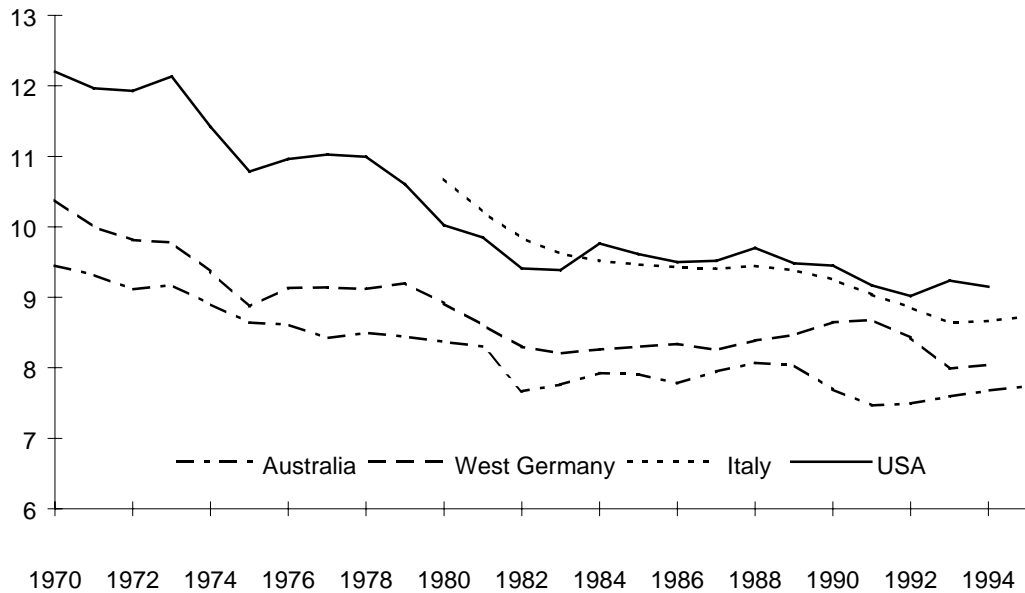
Figure 5.1   **The industry composition of capital input has changed since the 1960s[a]**

%
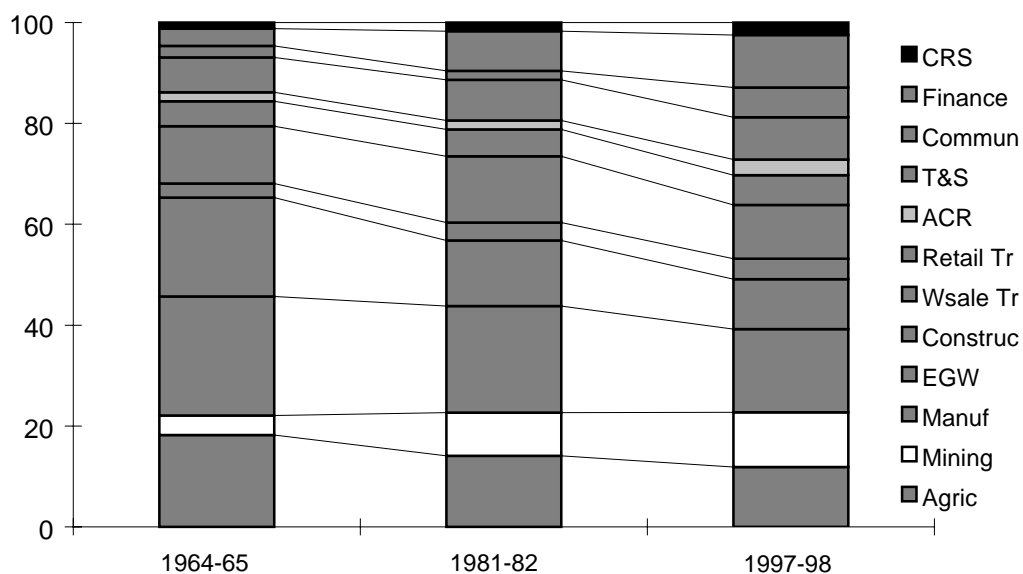
a Capital input is measured in terms of capital services.

Data source: Unpublished ABS data.

Figure 5.2   **Capital productivity has declined in a number of countries**[a]

a Capital input is measured in terms of consumption of fixed capital.
Data source: OECD (1997).

Whether the ABS has got the estimation of capital stock and input measures exactly right is yet to be fully determined. The Bureau has described the latest estimates as 'experimental' and has sought feedback before making any final adjustment. But there is nothing in the mere fact that the measures produce a decline in capital productivity over a period to suggest that they are wrong. Unless there is strong offsetting MFP growth, capital deepening will produce a decline in capital productivity. Moreover, the much stronger theoretical underpinnings and the much greater care and detail the ABS has taken in construction of the new estimates leads to confidence that they represent a considerable improvement on the earlier estimates.

A International comparisons of growth paths

Chapter 4 introduced the notion of growth paths and box 4.2 gave some international examples.

This appendix presents a range of further examples and a representation of some countries' growth paths based on other data sources. For most of the high-income countries, OECD sources are used because data are available into the 1990s. For the United States, Bureau of Labour Statistics data are used.

The examples are grouped under headings of high-income countries, rising-income countries and low-income countries. Expectations about the form of growth paths for these country groupings were outlined in box 4.2.

High-income countries

A general feature of the high-income countries is that their growth paths have flattened out in the 1990s. This is in stark contrast to the Australian experience. Norway also appears to have experienced rapid growth in the 1990s.
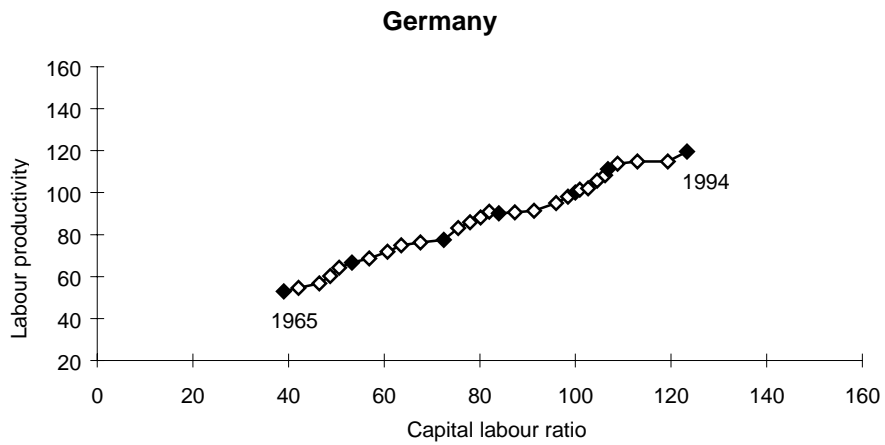
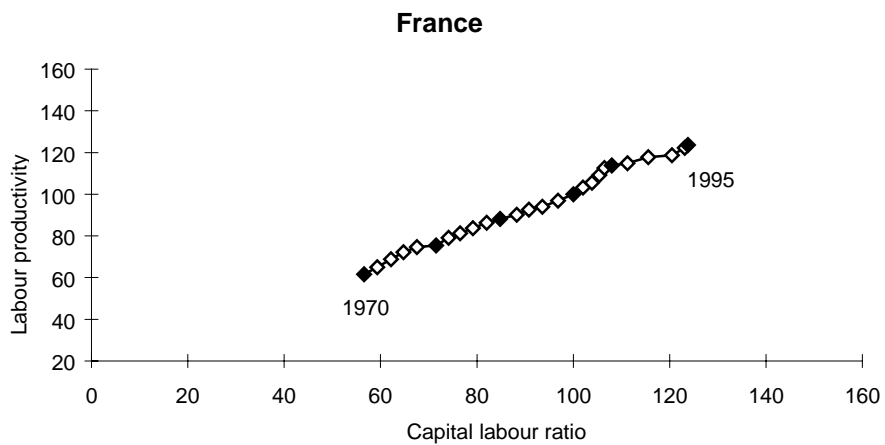**United States**

L = hours worked

K = capital services

Source: Bureau of Labour Statistics accessed at <http://www.bls.gov/news.release/prod3.t01.htm> on 19 May 1999. (Rebased 1985 =100)
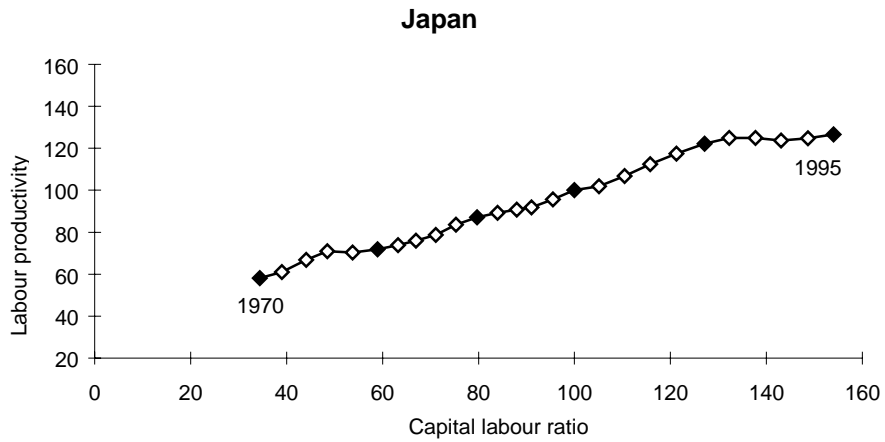
Japan

Labour productivity (y-axis): 20, 40, 60, 80, 100, 120, 140, 160
Capital labour ratio (x-axis): 0, 20, 40, 60, 80, 100, 120, 140, 160

1970

1995

L = no. of employees
K = gross capital stock
Source: OECD (1997). (Rebased 1985 =100)

Germany

Labour productivity (y-axis): 20, 40, 60, 80, 100, 120, 140, 160
Capital labour ratio (x-axis): 0, 20, 40, 60, 80, 100, 120, 140, 160

1965

1994

L = no. of employees
K = consumption of fixed capital
Source: OECD (1997). (Rebased 1985 =100)

France

Labour productivity (y-axis): 20, 40, 60, 80, 100, 120, 140, 160
Capital labour ratio (x-axis): 0, 20, 40, 60, 80, 100, 120, 140, 160

1970

1995

L = no. of employees
K = gross capital stock
Source: OECD (1997). (Rebased 1985 =100)
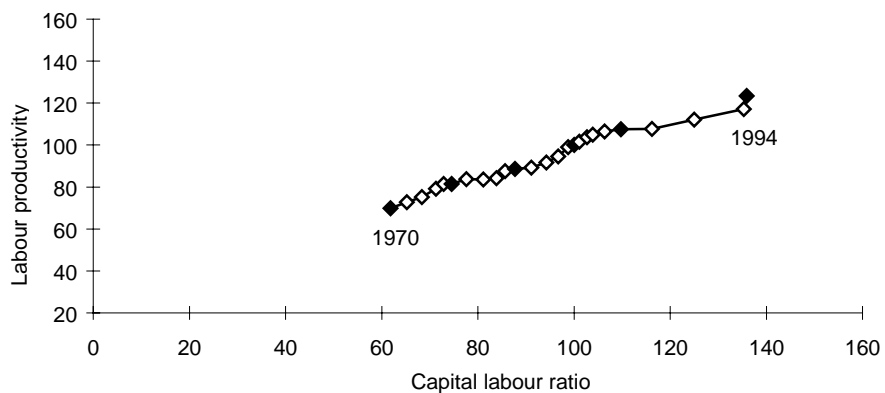
United Kingdom

L = no. of employees
K = gross capital stock
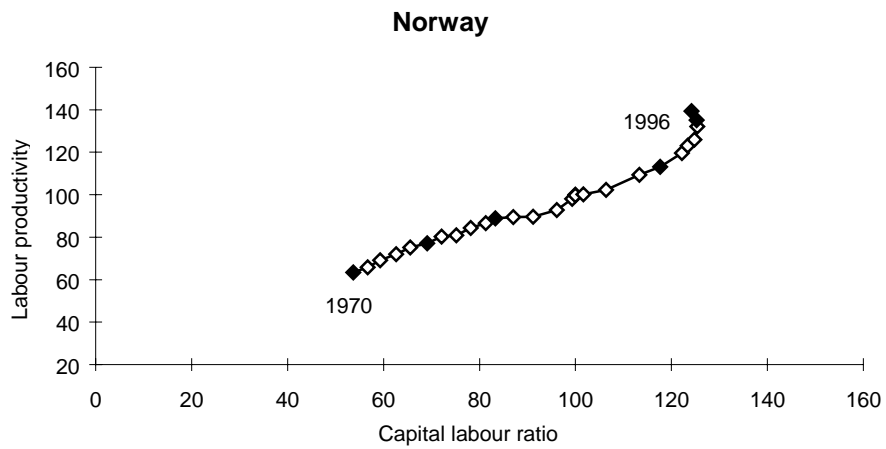*Source:* OECD (1997). (Rebased 1985 =100)

Canada
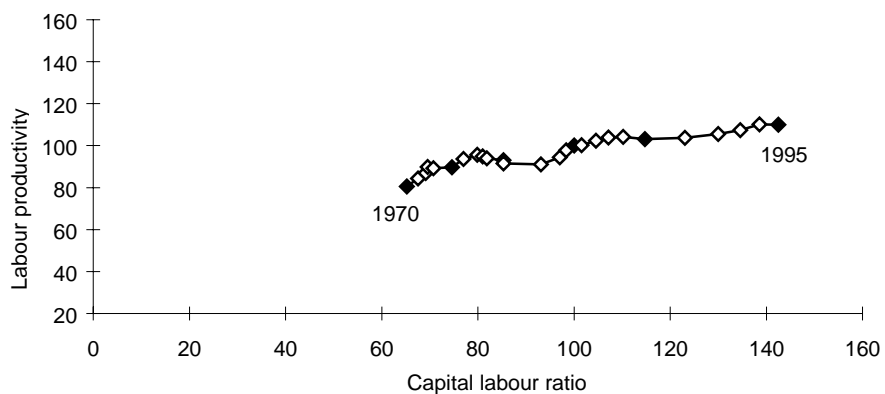
L = no. of employees
K = consumption of fixed capital
Source: OECD (1997). (Rebased 1985 =100)

Sweden

L = no. of employees
K = gross capital stock
Source: OECD (1997). (Rebased 1985 =100)

Norway

L=No. of employees
K=Gross capital stock
Source: OECD 1997. (Rebased 1985 =100)
Note: Employment numbers were extended from 1992 to 1996 using data from OECD Economic Outlook, No. 62, December 1997.
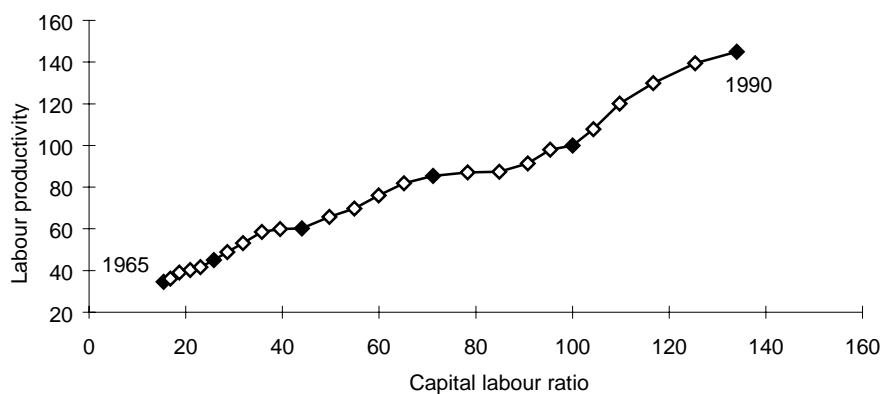
New Zealand

L = no. of employees
K = gross capital stock
Source: Summers and Heston (1991), PWT v.5.6.

Rising-income countries

All charts are sourced from data in the Penn World tables (Summers and Heston (1991), PWT v.5.6). For general description of that data, see box 4.2.
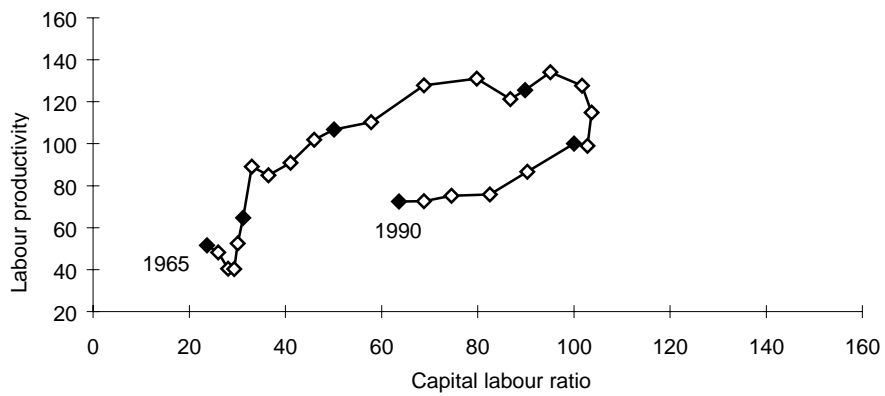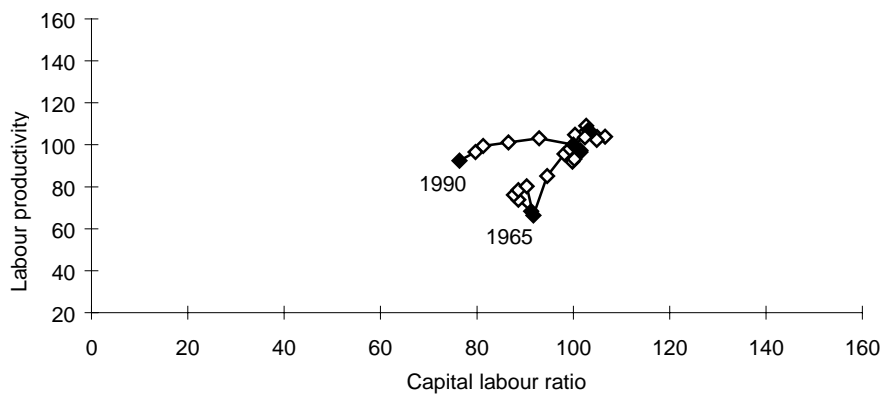
Taiwan

Thailand

India

Low-income countries

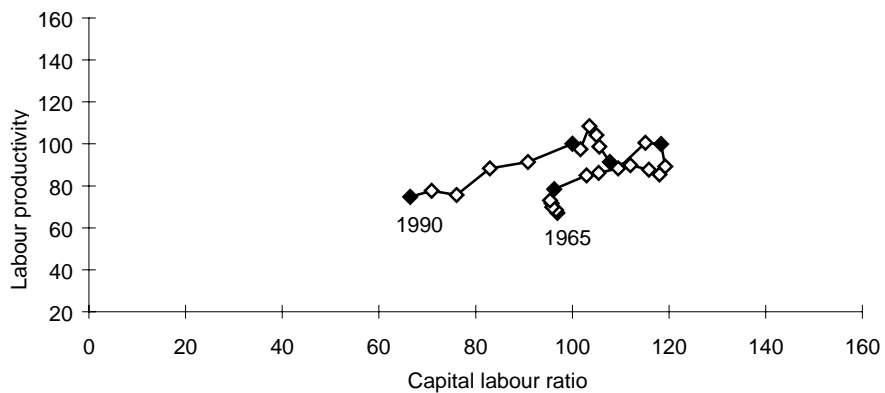Data for charts are sourced from Summers and Heston (1991), PWT v.5.6.

Nigeria

Kenya

Zimbabwe

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