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Editor's Note

Welcome to the eighteenth issue of *Economic Issues*, a series published by the South Australian Centre for Economic Studies as part of its Corporate Membership Program. The scope of *Economic Issues* is intended to be broad, limited only to topical, applied economic issues of relevance to South Australia and Australia. Within this scope, the intention is to focus on key economic issues ─ public policy issues, economic trends, economic events ─ and present an authoritative, expert analysis which contributes to both public understanding and public debate. Papers will be published on a continuing basis, as topics present themselves and as resources allow.

The authors of this paper are Jim Hancock, Deputy Director, SA Centre for Economic Studies and Wing Hsieh, Research Assistant, SA Centre for Economic Studies.

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Michael O'Neil
Director
SA Centre for Economic Studies
April 2006

Author's Note

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South Australia's Recent Productivity Performance

Overview

It is well known that the South Australian economy has grown significantly more slowly than the Australian economy over the last decade. It is also known that the differential cannot be much explained by differences in labour productivity trends. This study investigates the contribution to output growth from changes in labour quality, the capital intensity of the economy, and multifactor productivity.

Estimates of the average quality of labour were made by developing indexes which take into account the qualifications and experience mix of the employed workforce. There was only a very small increase in the average quality of South Australia's labour between 1994-95 and 2003-04; it was equivalent to about a 1 per cent increase in labour supply. Australia had a significantly greater improvement in average labour quality, equivalent to about a 4 per cent increase in labour supply. The difference reflects slower growth in the proportion of degree-qualified workers in South Australia. It also reflects slower growth in the proportion of the workforce who are in age groups where experience is most valued (and stronger growth in the proportions of very inexperienced and end-of-career workers whose experience is valued less in the market).

Estimates of capital services consumed in the production process suggest that the capital-labour ratio rose by about 26 per cent in South Australia over the decade to 2004-05. Nationally there was an increase of similar magnitude. These estimates are affected by assumptions about depreciation and the composition of the capital stock, and under plausible alternative assumptions a different picture emerges of these relative trends. However, under any plausible set of assumptions there was a significant increase in the capital intensity of the South Australian economy over the decade.

Multifactor productivity estimates, which were derived as a residual, indicate that South Australia's multifactor productivity rose by 14 per cent between 1994-95 and 2003-04. This is an appreciably faster rise than the 9 per cent recorded nationally, although the difference is sensitive to underlying assumptions.

This analysis strongly reinforces the argument that differences between South Australian and national output growth over the last decade lie entirely in a more rapid expansion of the scale of the national economy. Productivity growth appears to have been moderately stronger in South Australia than it was nationally.

For governments seeking to raise living standards, productivity is worthy of closer attention than the scale of the economy. Productivity has a more direct connection with per capita living standards than do gross aggregates such as gross product and employment which can be influenced by both changes in productivity and scale.

1. Introduction

This paper investigates South Australian labour productivity trends over recent years.

Labour productivity is fundamentally a statistical construct – it is the ratio of a measure of output to labour inputs. This ratio is affected by a variety of factors, which in this paper are grouped into 3 types:

- human capital deepening;
- physical capital deepening; and
- increases in multifactor productivity.

Thus we model labour productivity change as:

Labour productivity change	=	Labour quality change	+	Contribution from capital deepening	+	Change in multifactor productivity

A detailed derivation and specification of this relation is contained in Appendix A.

Such a breakdown is useful because it allows us to separate the various economic factors that influence statistical measures of labour productivity. In particular, it lets us identify whether changes in labour productivity occur because we are using more, or better resources, or because production processes have become more efficient. A similar breakdown is employed by the Australian Bureau of Statistics (ABS) in its recent analytical work on Australian productivity trends (ABS 2005a).

In this study we regard multifactor productivity as a close analogue to total productivity, with the distinction being that the measures herein omit some factors of production such as the depletion of natural resources. There is some confusion in the economics profession about what is meant by changes in multifactor productivity. Lipsey and Carlaw (2000) list nine examples of explanations of total factor productivity offered by reputable researchers in the productivity field, each differing in some material aspect. They argue, and we concur, that there is no necessary connection between technological change and multifactor productivity growth. It is conceptually quite possible in the model above that technological change would show up as capital deepening. For instance, in a production process that combined labour with a single capital input in the form of a personal computer, replacing that personal computer with a machine of double the capacity would imply a doubling of the capital inputs. The impacts on measured total factor productivity would depend on the output effects, and indeed it is conceivable that total factor productivity could fall in the face of a commercially valid decision to replace the computer. Lipsey and Carlaw argue that the key source of changes in total factor productivity are the gains in output that producers get from changing the ways in which they combine inputs. This is the most appropriate interpretation of the multifactor productivity measures herein (subject to the caveat that the measures here are not as comprehensive as a true total factor productivity measure).

When we focus on labour productivity measures alone, they will potentially be strongly influenced by technological change via its impact on capital deepening. Some of the confusion in the literature arises because the term "productivity" is applied to the results of both labour productivity and multifactor productivity analyses.

In practice, data constraints make it difficult to apply the breakdown comprehensively to any of the Australian States. An experimental index of labour quality for South Australia over the period 1994-95 to 2003-04 is developed and used to identify the contribution of labour quality changes to labour productivity growth. Further, an experimental index of capital services for South Australia is also developed and used to identify the contribution of capital deepening to labour productivity growth.

Using these two experimental series it is then possible to derive estimates of multifactor productivity growth in South Australia as a residual.

In the main, this paper is concerned with an analysis of South Australia's economic performance over the last decade. Section 2 in this paper reviews trends in labour productivity. Section 3 presents an index of labour quality and discusses the drivers of changes in labour quality. This index is then used to make quality-adjusted labour productivity estimates. Section 4 presents an index of capital services and uses it to make estimates of capital deepening and multifactor productivity growth.

Section 5 presents some conclusions. It also highlights the distinction between policies to boost usage of labour and capital inputs and policies that boost multifactor productivity, and it attempts to draw out the implications for economic development policy. This breakdown has policy relevance because when we use more, or better resources, they typically have an opportunity cost. In contrast, the introduction of more efficient production processes means that more is produced with any given set of inputs. Productivity gains are much more likely to lead to gains in living standards than growing the scale of the economy.[1]

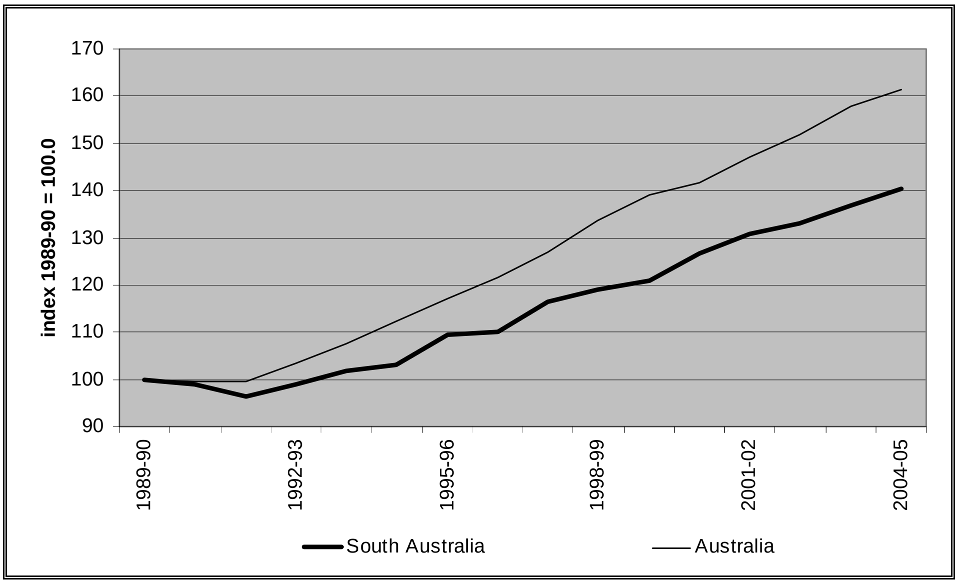
Appendices present supplementary information relating to the technical details of the analysis.

2. Labour productivity

The standard macroeconomic measure of production is gross product (gross state product – GSP – in the case of a State and gross domestic product – GDP – in the case of Australia as a whole), which includes the dwelling stock as a producing sector of the economy. Our emphasis in this paper is on a more literal definition of producers, encompassing entities that make decisions about how to combine labour, land, capital and other resources to produce outputs. Accordingly, the analysis herein focuses on gross product net of imputed dwelling rents, which for brevity is referred to herein as "gross product".

Since the late 1960s the South Australian economy has grown more slowly than the Australian economy as a whole. ABS gross product data in Figure 1 illustrates that this is so over the period 1989-90 to 2004-05 (see also Table 1). Over this period Australia's real gross domestic product (GDP) has increased by 3.2 per cent per annum, whilst South Australia's real gross state product (GSP) has increased by 2.3 per cent per annum.

Figure 1
Real gross product net of dwelling rents – indexes



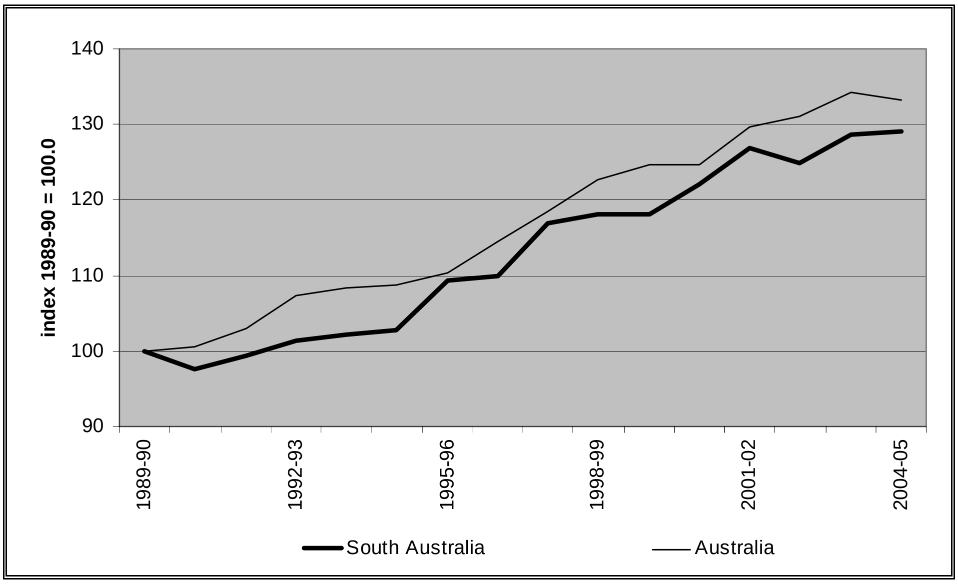
Source: ABS (2005b), ABS (2006) and SACES calculations.

It can be seen that there has been a prolonged expansion both for Australia and South Australia. Gross product has been rising since 1991-92 and, taking into account continuing growth in 2005-06 (not included in Figure 1), this means that South Australia and Australia have had 14 consecutive years of growth.

Figure 2 shows labour productivity indexes for South Australia and Australia and Figure 3 shows annual percentage increases.

Labour productivity in South Australia rose by 1.7 per cent per annum between 1989-90 and 2004-05, whereas Australia's labour productivity rose by 1.9 per cent per annum. But the apparent difference between South Australian and Australian productivity growth over the period should not have much weight attached to it. The small difference that exists is attributable to an arbitrary choice of start and end points for the analysis.[2] For instance, if the calculation is made over the period 1994-95 to 2004-05 it shows South Australian labour productivity rising by 2.3 per cent per annum, outpacing Australia's 2.1 per cent per annum. In addition, statistical tests indicate that there is no significant difference between the average annual productivity growth rates for South Australia and Australia over this period.

Figure 2
Labour productivity: real gross product per hour worked



Note: The indexes are valid for comparisons of movements over time. However, they do not support direct comparisons of productivity levels – e.g. the fact that South Australia and Australia had index values of 100.0 in 1989-90 does not mean that their productivity levels were the same.

Source: ABS (2005b), ABS (2006) and SACES calculations.

Productivity growth rates are quite variable from year to year (Figure 3). They are affected by short term influences such as farm conditions and also are potentially prone to measurement error (Appendix B addresses the influence of the farm sector). These short term variations are not reflective of underlying structural trends and therefore it is advisable not to attribute too much weight to short period variations in productivity growth rates. Productivity growth rates may also be subject to cyclical influences and it is desirable to control for these in any assessment of long-term trends.[3]

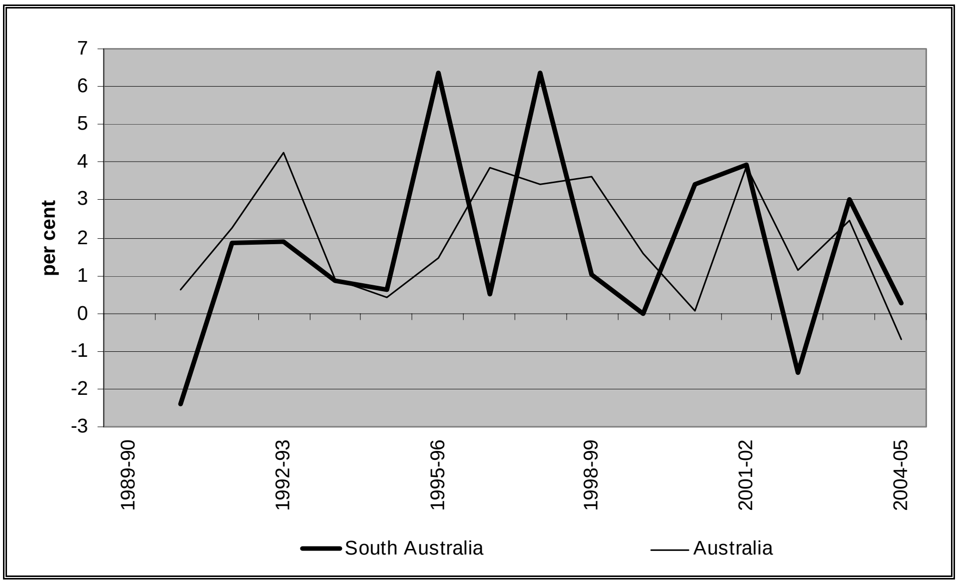
Visual inspection suggests that there are some differences in the timing of productivity changes, with Australian productivity rising faster than South Australia's in the first half of the 1990s, and South Australia then outpacing Australia through the middle of the 1990s. South Australia was hard hit by the recession of the early 1990s and the duration of that recession was probably extended by the emergence of very large losses at the State Bank of South Australia. It is significant that most of the ground lost during this period was, seemingly, regained later.

Table 1
Input, Output and Productivity Indexes

	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
Inputs											
Capital											
SA	100.0	102.8	105.5	109.7	114.4	117.0	119.9	123.4	128.2	135.6	143.0
Aus	100.0	104.5	109.4	114.9	120.7	126.5	131.1	135.6	141.4	149.4	157.5
Labour - Raw											
SA	100.0	100.3	100.0	100.1	101.1	102.7	104.2	103.8	107.1	106.9	109.3
Aus	100.0	102.7	103.0	104.2	105.9	108.5	110.4	110.3	112.6	114.3	117.5
Average Labour Quality											
SA	100.0	98.8	99.0	99.0	100.3	101.6	99.6	99.5	99.5	100.8	#N/A
Aus	100.0	100.3	100.9	101.5	101.6	101.8	102.4	102.7	102.9	103.8	#N/A
Labour - Quality Adjusted											
SA	100.0	99.1	99.1	99.1	101.3	104.3	103.7	103.3	106.6	107.7	#N/A
Aus	100.0	103.0	103.9	105.7	107.7	110.5	113.0	113.3	115.9	118.6	#N/A
Capital											
SA	100.0	102.8	105.5	109.7	114.4	117.0	119.9	123.4	128.2	135.6	143.0
Aus	100.0	104.5	109.4	114.9	120.7	126.5	131.1	135.6	141.4	149.4	157.5
Capital-labour ratio											
SA	100.0	103.8	106.5	110.7	112.9	112.2	115.6	119.5	120.3	125.9	#N/A
Aus	100.0	101.4	105.3	108.7	112.1	114.5	116.0	119.7	122.0	125.9	#N/A
Total inputs											
SA	100.0	100.2	100.9	102.1	105.1	108.0	108.4	109.2	112.9	116.0	#N/A
Aus	100.0	103.5	105.7	108.7	111.8	115.6	118.7	120.3	123.9	128.3	#N/A
Output											
Real GSP (excluding imputed dwelling rent)											
SA	100.0	106.2	106.6	113.0	115.3	117.3	122.7	126.9	129.1	132.7	136.1
Aus	100.0	104.1	108.2	113.1	118.9	123.6	126.0	130.8	135.0	140.4	143.7
Productivity											
Labour productivity - raw											
SA	100.0	105.9	106.6	112.9	114.1	114.2	117.8	122.3	120.5	124.2	124.6
Aus	100.0	101.4	105.1	108.5	112.2	113.9	114.2	118.5	120.0	122.9	122.3
Labour productivity - quality adjusted											
SA	100.0	107.2	107.6	114.1	113.8	112.4	118.3	122.9	121.1	123.2	#N/A
Aus	100.0	101.1	104.2	106.9	110.4	111.9	111.5	115.5	116.5	118.4	#N/A
Capital deepening											
SA	100.0	101.1	101.9	103.1	103.7	103.5	104.5	105.7	106.0	107.7	#N/A
Aus	100.0	100.5	101.7	102.8	103.9	104.6	105.1	106.2	107.0	108.2	#N/A
Multifactor productivity											
SA	100.0	106.0	105.7	110.7	109.7	108.6	113.2	116.2	114.3	114.4	#N/A
Aus	100.0	100.6	102.4	104.1	106.3	107.0	106.2	108.7	109.0	109.4	#N/A

Source: ABS (2005b), ABS (2006) and SACES calculations.

Figure 3
Annual changes in labour productivity



Source: ABS (2005b), ABS (2006) and SACES calculations.

3. Labour quality

One factor that will affect labour productivity, measured on a simple hours-worked basis, is changes in the skill mix of the labour force. It will generally be the case, for instance, that a skilled tradesperson working for an hour is more productive than an apprentice working for an hour. If the proportion of skilled tradespersons in the labour force changes over time, then production per hour worked will rise. It is useful to separate these labour quality factors from other influences on labour productivity such as technological change and capital deepening.

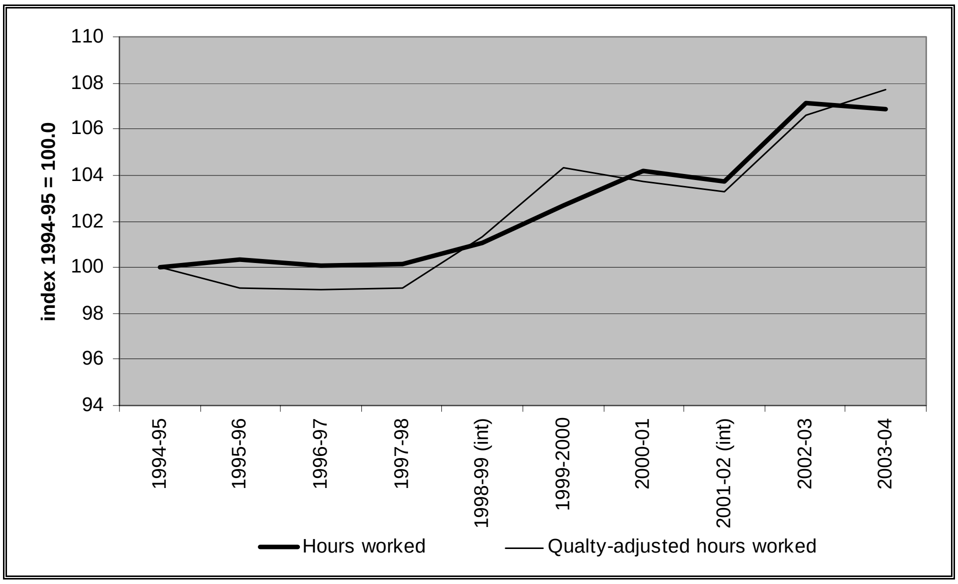
To make allowance for this influence, estimates were made of quality-adjusted hours worked. These estimates allow for changes in the qualification and experience levels of the labour force. They also include gender effects, which may correlate with other factors that affect productivity.

This is not an exhaustive list of the factors which affect labour quality – ideally one would also include factors like literacy, numeracy and language fluency and possibly also variables relating to health and attitude (such as motivation). However, the exercise is constrained by the data sets that are available for such an analysis.

The derivation of quality-adjusted hours worked estimates is described in detail in Appendix C. Estimates were based on data from the ABS Survey of Income and Housing Costs. Basically the estimation process uses observed hourly wage rates for different types of workers as proxies for labour quality. Hours of work are then weighted by those quality proxies and an index of quality-adjusted hours worked is compiled. This approach has recently been introduced by the ABS in its productivity analyses for Australia – see Reilly, Milne and Zhao (2005) and ABS (2005a, c) – and has also been used overseas. There are some differences between the approach used by the ABS and the approach adopted here, and these are discussed in Appendix C.

Figure 4 compares the indexes of *hours worked* and *quality-adjusted hours worked* for South Australia for the period 1994-95 to 2003-04. It can be seen that there is very little difference in the cumulative growth of the indexes over the full 9 year period. Hours worked in South Australia rose by 6.9 per cent while quality-adjusted hours worked rose by 7.7 per cent. The small differential – 0.8 per cent – can be interpreted as the contribution from changes in average labour quality.

Figure 4
Hours worked and quality adjusted hours worked in South Australia

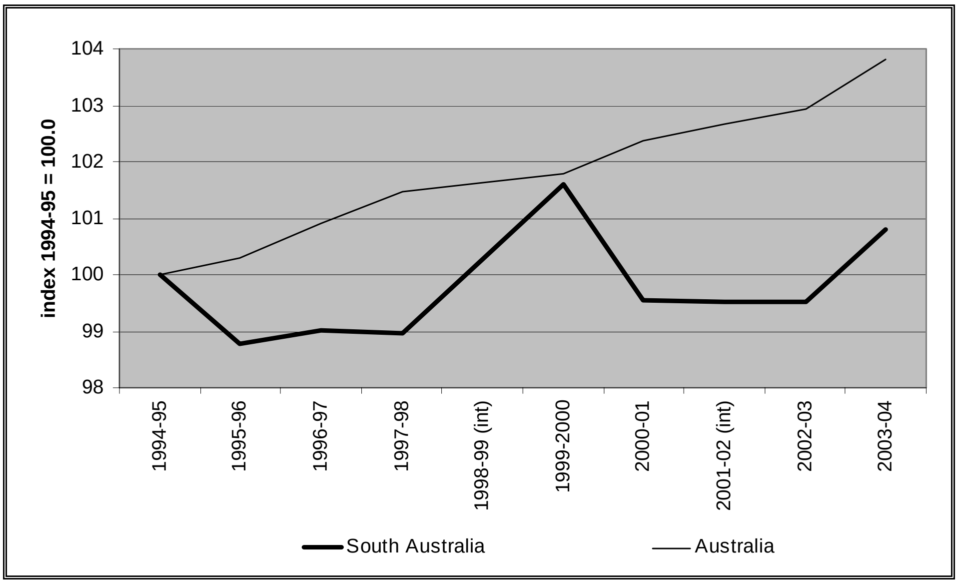


Note: (int) = interpolated.
Source: ABS (2006). SACES estimates.

The 0.8 per cent increase in average labour quality in South Australia was much smaller than occurred nationally, as can be seen in Figure 5. Average labour quality for Australia increased by 3.8 per cent. Even if one makes allowance for the “noisy” character of the South Australian data by discounting the fall in the first year, the overall conclusion of slower labour quality growth still stands. Australia’s average labour quality has risen about 3 per cent more than South Australia’s over the last decade.

The quality adjusted hours worked indexes simultaneously take into account changes in the experience, qualifications and gender profile of the workforce. Figure 6 shows partial indexes that illustrate the influence of these factors on labour quality one by one. Table 2 shows the influence on labour quality between 1994-95 and 2003-04 for South Australia and Australia.

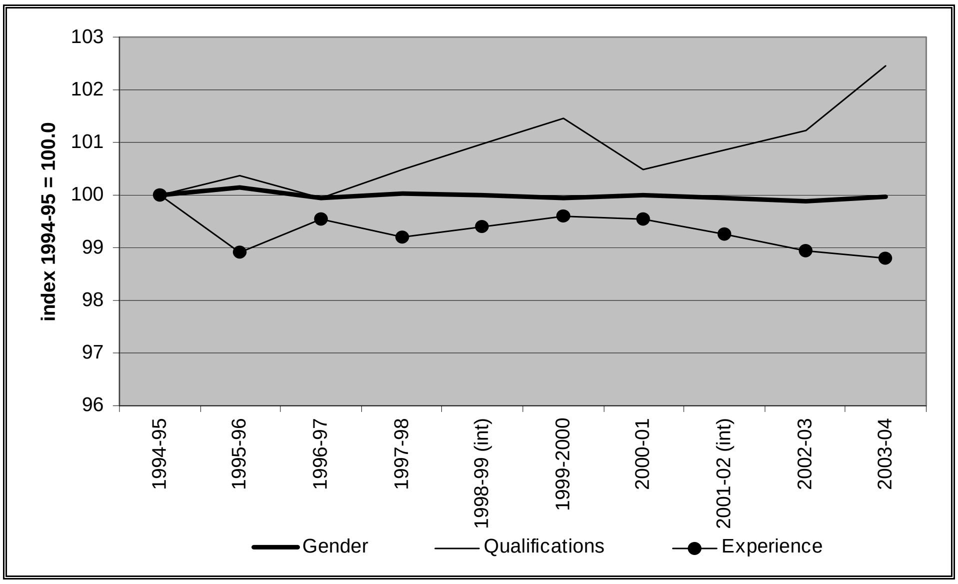
Figure 5
Labour quality indexes for South Australia and Australia



Note: (int) = interpolated.
Source: SACES estimates.

It can be seen in Figure 6 that the major upward influence on average labour quality in South Australia has been an increase in the average qualification level. Changes in the qualifications mix boosted the labour quality index by 2.4 per cent over the 9 years to 2003-04. This effect was offset by a negative influence from the experience profile, which was associated with a 1.2 per cent fall in average labour quality. Changes in the gender mix had no impact.

Figure 6
Quality impacts of changing gender, qualifications and experience profiles in South Australia



Source: SACES estimates.

Table 2 shows that the national change in labour quality differs from South Australia's mainly for two reasons. Firstly, changes in the experience profile made a positive contribution nationally (0.5 per cent), in contrast to the negative contribution seen in South Australia (minus 1.2 per cent). Secondly, the contribution from improvements in the qualifications profile was larger for Australia – it had a 3.7 percentage point contribution to the quality index.

Table 2
Quality impact of changing gender, qualifications and experience profiles per cent change in average labour quality

	South Australia	Australia
Gender	0.0	-0.3
Qualifications	+2.4	+3.7
Experience	-1.2	+0.5
Combined effect*	+0.8	+3.8

Note: * The individual effects do not sum to the total and in the case of south Australia the differences exceed what can be explained by rounding errors. The explanation for this lies in the fact that there are correlations between some factors and therefore a degree of duplication in a straight summation of the partial effects. The combined effect calculation avoids this duplication.
Source: SACES estimates.

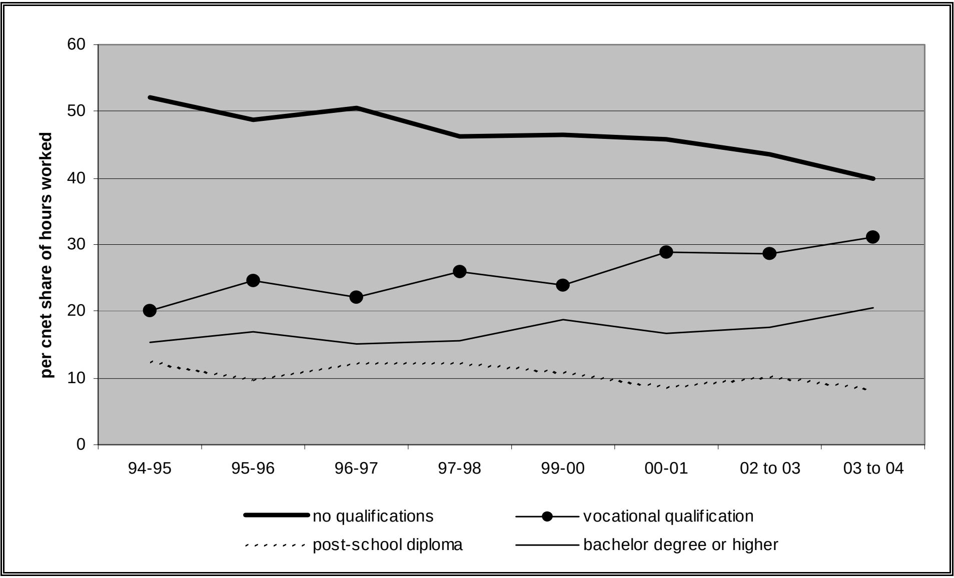
The negative impact of changes in the South Australian experience profile reflects strong growth in both workers with relatively low experience and older workers with much experience, and a reduced proportion of workers at middle stages of their careers. The share of hours worked by people with less than 10 years experience rose by 3.4 percentage points and the share accounted for by people with 25 or more years experience rose by 9.0 per cent, while the share worked by people with 10 to 24 years of experience fell by 12.4 per cent.

It is an unresolved question how much these patterns are simply a reflection of South Australia's historical birth rates and how much they are a reflection of the documented phenomenon of outward migration of young people, especially women and those with high skills and incomes, and inward migration of older and less well-off people (see South Australia 2004a).

The positive impact of changes in qualifications in South Australia is attributable mainly to a substantial reduction in the proportion of hours worked by people with no qualifications and rises in hours worked by people with vocational qualifications and degrees. The quality differentials applying to the different labour types, averaged over the period, were: no qualifications – 12 per cent below average; vocational training – 4 per cent below average; diploma – 11 per cent above average; and degree – 33 per cent above average.

It is also an unresolved question whether the differences between skill development in South Australia and in Australia reflect differences in education and training effort or reflect interstate and overseas migration patterns.

Figure 7
Share of hours worked by qualification type, South Australia



Source: Unpublished ABS data from *Survey of Income and Housing Costs* and SACES calculations.

Although there have been improvements in the qualifications dimension of South Australia's labour profile, they have not been as pronounced as those seen nationally. In fact there have been roughly comparable declines in the proportion of hours worked by people with no qualifications in South Australia and nationally. But growth in the proportion of hours worked by people with degrees and diplomas has been stronger nationally, whereas South Australia has had stronger increases in the proportion of hours worked by people with vocational qualifications. The reasons for this are not entirely clear, but the interstate migration of degree-qualified South Australians may have played a part.

4. Capital deepening and multifactor productivity

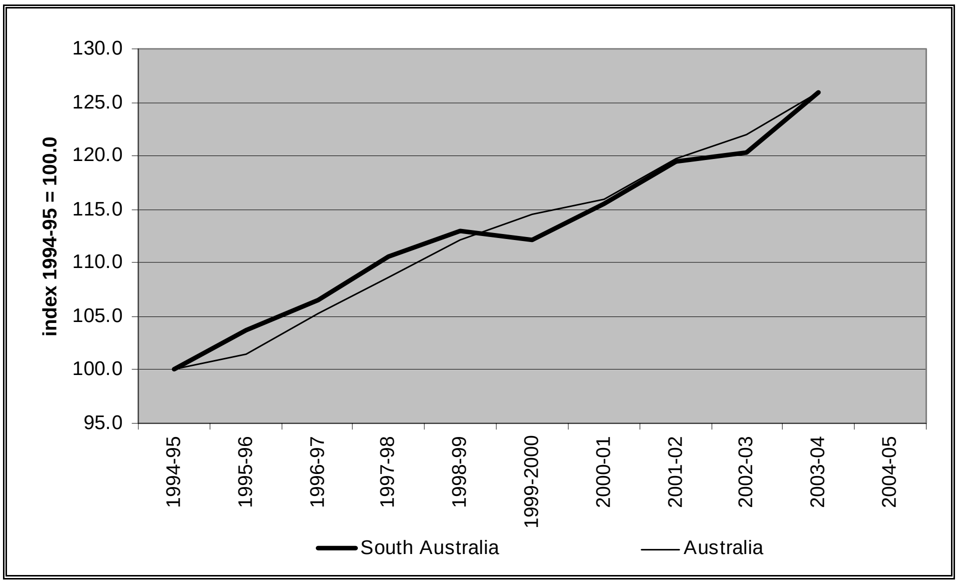
Once one allows for the impact of human capital deepening, the two remaining causes of productivity growth are physical capital deepening and increases in total factor productivity.

In recent years the ABS has done a substantial amount of work to improve its estimates of capital services in Australia. With these improved capital services estimates, trends in labour productivity can be broken down into the effects of capital deepening and multifactor productivity growth.

Unfortunately the ABS has not yet produced indexes of capital services for South Australia. Therefore, so as to enable further analysis of South Australian productivity trends, experimental estimates of capital services have been made (see Appendix D for a discussion of the methodology). However, the information used to construct these experimental estimates is quite limited. For this reason scenarios are presented in Appendix D to illustrate the sensitivity of results to underlying assumptions.

Figure 8 shows estimated capital-labour ratios in South Australia and Australia for all sectors excluding dwellings. The capital-labour ratio is defined as the quantum of capital services employed per unit of labour services (measured on a quality-adjusted basis). The estimates indicate that both South Australia and Australia had significant increases in capital intensity between 1994-95 and 2003-04 – "capital deepening" – and this finding is quite robust to changes in the key assumptions underlying the South Australian estimates (see Appendix D).[4] The estimates also suggest that the capital-labour ratio has grown by about the same amount in South Australia as it has nationally – it rose by 26 per cent in both cases. However, this result is quite sensitive to assumptions in the estimation methodology.

Figure 8
Capital-labour ratios

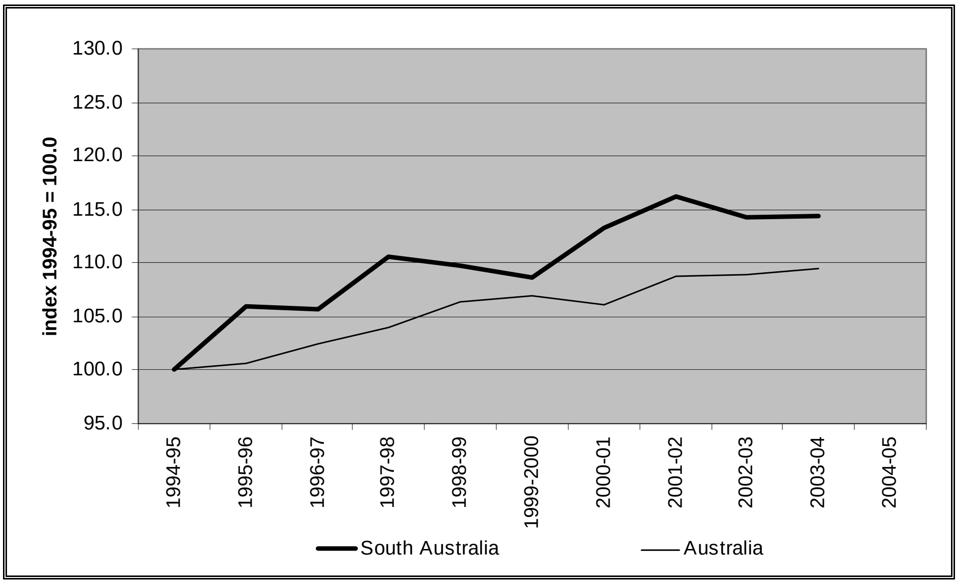


Source: SACES estimates.

Figure 9 shows indexes of multifactor productivity. These indexes are derived as a residual, after allowing for labour quality changes and capital deepening. Because they are a residual they will reflect any errors in the estimation of other components. Bearing in mind the "experimental" character of the capital estimates, they should be regarded as indicative, not conclusive.

The multifactor productivity estimates indicate that South Australia's multifactor productivity rose by 14 per cent between 1994-95 and 2003-04 whereas Australia's rose by just 9 per cent. It is my no means certain that this result is robust, but taking it at face value, one possible explanation is that South Australia experienced quite extensive restructuring of its economic base during the 1990s, and this could be expected to have led to increases in productivity.

Figure 9
Multifactor productivity



Source: SACES estimates.

Table 3 shows a statistical reconciliation between the growth of raw labour productivity and multifactor productivity over the period 1994-95 to 2003-04 (derived from data in Table 1). This reconciliation indicates that stronger multifactor productivity growth in South Australia is reflective mainly of slower growth in average labour quality. There is only a small difference in capital deepening. Although South Australia's labour productivity rise is similar to Australia's, productivity growth has played a relatively greater role than was the case nationally.

Table 3
Reconciliation of labour productivity and multifactor productivity changes 1994-95 to 2003-04

	South Australia	Australia
Labour productivity	24.2	22.9
Labour quality adjustment	-0.8	-3.7
Quality adjusted labour productivity	23.2	18.4
Capital deepening	7.7	8.2
Multifactor productivity	14.4	9.4

Source: SACES estimates.

5. Conclusions

Multifactor productivity trends and economic gains

Our statistical analysis decomposes output growth into productivity and scale effects. Earlier studies, such as O'Neil, Neal and Nguyen (2004) have noted that differences between South Australian and Australian output growth rates cannot to any substantial extent be explained by differing labour productivity trends. This study reinforces that point and also concludes that different rates of capital deepening are unable to explain the difference. When one compares growth rates over the last decade, it is clear that the main point of difference between South Australia and Australia is scale. Australia has increased its output by much more than South Australia, but this has been achieved by consuming more labour and capital inputs. In contrast, South Australia's multifactor productivity performance is quite similar to and indeed arguably surpassed Australia's.

The productivity data indicate that South Australia's multifactor productivity growth exceeded Australia's by about 5 percentage points over the nine year period 1994-95 to 2003-04. Such an outcome can arise either because South Australian producers did better in terms of reorganising production processes to produce particular goods more efficiently, or because they were oriented more towards the production of goods and services where productivity increased more quickly, or both. The 5 percentage point differential in multifactor productivity growth rates can be given some context by noting that South Australia's GSP per hour worked in, for instance, 2003-04, was about 7 per cent lower than Australia's. Thus the difference in multifactor productivity growth is quite major if one is interested in South Australia's relative economic performance. While there must be some doubt as to whether South Australia really did outperform Australia by as much as the data suggest, there are strong grounds to believe that South Australia did at least as well as Australia.

Productivity growth is not the full story of producers' performance. It is also advantageous to producers to be in sectors where price trends are favourable. Indeed, if a producer is in a sector where productivity is growing strongly but prices are falling sharply, it is possible that all of the productivity gains are effectively passed on to consumers. An obvious example of this is an industry like semiconductor manufacture: processor capacity doubles about every 18 months ("Moore's Law") without any commensurate increase in input requirements, which means that productivity is rising very rapidly. However, the semiconductor market is competitive and price reductions largely offset the productivity gains, so profit trends have been nowhere near as strong as productivity trends.

A basic measure of the favourability of pricing trends for a regional economy can be had by constructing an index of the purchasing power of gross product. This can be done by computing the ratio of prices received for production (both the locally consumed and exported portions) and the prices paid out on expenditures (both on locally produced and imported goods and services). Such a measure indicates that South Australia has had moderate growth in the purchasing power of its gross product over the last decade: it rose by about 4 per cent between 1994-95 and 2003-04, which was very similar to the national growth rate.[5] Thus it appears that South Australia's good productivity performance is coupled with reasonably favourable price trends. Overall, the picture is that South Australia's producers have increased their productivity, and have done so in sectors where they have been able to capture favourable price trends.

This overview of the totality of productivity and pricing trends brings an important point to the fore. It can never be sensible to adopt as a goal, to the exclusion of all else, the maximisation of productivity growth. The source of productivity gains is important. Those productivity gains that occur because producers find less costly ways to produce a particular product can be regarded as "constructive" gains in the sense that they increase the size of the economic cake. On the other hand where productivity gains can be realised from shifting resources to the production of different products with faster productivity growth, the matter of whether or not such changes can be considered as "constructive" must also take into account relative trends in the input and output prices of these alternative production choices. When analysts interpret productivity indices there is often an unstated assumption that productivity changes derive from cost saving rather than compositional change.

Human capital trends

While South Australian producers did shift to a more skilled labour input mix, the shift was less pronounced than was seen nationally. The explanation for this lies both in the qualifications and experience dimensions of the skill mix. The uptake of degree-qualified people in the South Australian employment mix has been growing more slowly than for the rest of Australia. Furthermore, there has been a relatively weak trend in the proportion of people of prime working age in the employment mix.

Trends in the skills mix may to some extent be reflective of trends in the South Australian industry mix, although the validity of this has not been explored here. But it would seem difficult for industry mix to explain the observed pattern that people leaving South Australia are relatively young and people moving to South Australia are relatively old. The more likely explanation lies in economic opportunity: young people leave because there are better job opportunities interstate. It is important to recognise that this dynamic is probably productivity-enhancing. Those who leave South Australia will tend to be those who feel that their skills are underutilised, and also under-rewarded in South Australia. Retaining people in jobs where their skills are underutilised will tend to depress average productivity levels. Interstate migration, on the other hand, diminishes the extent of this and will tend to boost average productivity levels.

Productivity and scale

Productivity analysis allows us to decompose output trends in ways that help us to understand trends in living standards. A very simplified stylised presentation of that decomposition is

Output growth	=	Growth in consumption of inputs ("scale effect")	+	MFP growth ("productivity effect")

Although the dichotomy is not absolute, increases in productivity will generally flow to increases in living standards whereas increases in the consumption of inputs generally will not. It follows that a government interested in raising living standards would do best to devote its efforts to productivity rather than the scale of the economy. This then raises the question as to what the circumstances are which could justify government interventions in the consumption of inputs.

The first ground for intervention is the case where the benefits of input consumption exceed their costs. A classic example of this would be measures to assist the provision of infrastructure where the benefits of provision exceed the costs of provision, but for some reason the market is unable to provide the infrastructure. In these cases "spillovers" can be said to arise from the infrastructure. But spillovers could also arise from other inputs, such as skilled labour, and so on.[6]

A second ground for intervention is that governments may seek to promote the formation of inputs where the benefits exceed the costs, particularly where the inputs are long-lived and deliver benefits over may years. For instance, there is evidence that investments in education at early ages yield substantial returns in future earnings and social and economic participation (Heckman 2000). Therefore it will generally be in the interests of resident children to be assisted with human capital formation. This is true if they remain residents within the economy (in which they become more valuable, and therefore better paid, providers of inputs in the future). But it will also be true if they move to different economies. To the extent that governments represent the interests of residents, they will have an interest in ensuring that appropriate levels of human capital formation occur, even if those residents may not use the human capital locally.

The distinction between human capital consumption and formation also helps to clarify views about programs such as skilled worker subsidy programs. These programs seek to assist business consumers of human capital inputs by subsidising the importation of human capital at times when there are labour shortages and wages for skilled labour are therefore high. Yet rising wages in response to labour scarcity is not of itself evidence of a market failure.

Thirdly, there is plausible evidence that average productivity levels are not entirely independent of scale, which gives rise to the "increasing returns to scale" literature in economics. Increasing scale appears to boost productivity levels, perhaps because the deeper and more diverse range of labour and related inputs that accompany scale allow a better exploitation of complementarities in production processes and stronger competitive incentives to improve processes. For instance, a firm that wanted to employ a software engineer might expect to choose from a more diverse field in Sydney than in Adelaide and thus get a better "match" between its job and its employee. But while a case can be made for the existence of scale effects, they may not be very large, especially when considered in net terms to include diseconomies such as congestion costs.

The distinction between scale and productivity allows some insight into the connection between various macroeconomic objectives adopted by the State Government and living standards. The State Strategic Plan (South Australia 2004b) includes in its targets:

- To better the Australian average employment growth rate within 10 years (Target 1.1);
- To exceed the national economic growth rate within 10 years (Target 1.5); and
- To exceed Australia's average productivity growth within 10 years (Target 1.10); and
- To equal or better the Australian average unemployment rate within 5 years (Target 1.2).

The "productivity growth" and "unemployment rate" targets have a quite strong connection with productivity and thus may be seen as harmonising closely with the promotion of higher living standards. This is obviously so with the productivity target. But it also applies to the unemployment target because unemployed labour can be regarded as a wasted resource. Although unemployment is not included in standard productivity measures, there is a case for its inclusion when one wishes to consider the functioning of an economy in its entirety, as unemployment is a form of resource wastage. In contrast, the employment growth and economic growth targets might be achieved simply by scale expansions with ambiguous effects on living standards. Certainly the productivity and unemployment targets have a stronger connection to living standards for the broad community and therefore a more convincing rationale.

Policies to foster productivity growth

This then leads to the question of exactly what policy framework is conducive to productivity growth.

Parham (1999, 2004), Dowrick (2001) and Banks (2002) argue that there was a surge in productivity growth during the mid to late 1990s and associate it with (in varying degrees) microeconomic reform and the emergence of new information and communication technologies (ICTs). Quiggin (2001) argues that "microeconomic reform" encompasses a wide range of policy changes which have had very mixed contributions to growth. Furthermore, he argues, microeconomic reform has been in progress since at least the early 1980s, and that therefore it is difficult to justify the use of just the period from the mid to late 1990s as a litmus test of its effectiveness. Hancock (2005) says that no statistically significant change in productivity growth can be identified from the data and argues that the existence of a productivity surge has never even been established – an argument that is rejected by Parham (2005). Of course this debate is specific to the history and the particular package of reforms adopted.

Dawkins and Rogers (1998) identify a range of factors affecting productivity levels. They make a distinction between factors which affect the "level" and factors which affect "long run growth". "Level" factors offer only a once-off gain – e.g. moving from a sub-optimal firm size to an optimal firm size. They can be realised only once, and therefore are not available year after year. "Long run growth" factors actually lead to permanently stronger growth – e.g. a greater arrival rate for new technologies would boost the potential for gains year after year.

Table 4
Determinants of Productivity

Factors affecting level	Factors affecting both level and growth	Factors affecting long-run growth
• Scale of firm • Scope of firm • Cyclical factors • Work practices • Capital intensity	• Industrial relations • International openness • Competition • Training • Infrastructure	• R&D and innovation • Growth of factor prices • Capital Investment • Human capital investment

Source: Dawkins and Rogers (1998).

One important issue that arises in the Dawkins and Rogers framework is the role of innovation. It is important to consider the relative importance of producing innovations and adopting innovations. The weight of evidence is that it is far more important to productivity growth to be an "adopter" of innovations than to be a "producer" of innovations.

Blandy, O'Malley and Walsh (2003) identify the fostering of a "pioneering" attitude as the critical element to unleash a process of dynamic productivity growth. This requires that all South Australians increase the extent to which they are willing to change their ways of work, adopt relevant skills, adopt new technologies, and so on, rather than simply continuing with their established practices. They advocate innovation and entrepreneurialism at the individual level as a key ingredient:

> "mass participation in the process of productivity advance is essential if a major shift in South Australia's growth rate is to occur. Advance in a few sectors of elite technology will scarcely alter *today's* rate of growth of Gross State Product … Hence, the sorts of strategies that will work in the short term (as well as in the long term) are those designed to have widespread impact".

Blandy, O'Malley and Walsh also identify the importance of acceptable outcomes for quality of life aspects that are not captured in standard productivity measures. There are important factors with a bearing on living standards that are not included in the gross product indexes that are used in productivity calculations. The omissions mainly relate to non-marketed factors which affect quality of life, such as environmental standards, health, security, etc. Inclusion of these non-market factors can have a significant impact on analyses of trends in living standards. For instance, Clarke and Lawn (2005) estimated a "Genuine Progress Indicator" for Victoria which they compared with a gross product based measure. They conclude that in per capita terms the genuine progress indicator rose by 22 per cent over the period 1986 to 2003, which was only half as much as the 45 per cent increase in per capita gross product that was recorded over the same period.

There is also the role of State Government as a producer to consider. State and local governments in South Australia account for around 15 per cent of final demand. The effectiveness of these expenditures, for instance in health, education and infrastructure provision, has a significant impact on the productivity of the economy. Indeed, these may be the areas in which State Government has most influence on productivity.

One of the challenges presented by productivity-enhancing reforms is that they have a potential to create winners and losers. Productivity reforms that create only winners are of course the easy ones to progress and, by virtue of that fact, it is hard to find many of them at any point in time – they will already have been done. On the other hand, if one drew up a list of uncompleted reforms which have been argued (whether rightly or wrongly) to be productivity-enhancing it could include, for example: deregulation of employment arrangements; removal of cross subsidies for public services in rural areas; introduction of user charges to finance infrastructure provision; removal of cross subsidies from large to small businesses via differentiated payroll taxes; removal of regulatory barriers to entry in activities such as pharmacy, specialist medical services, taxi services and some hospitality activities; reforming the tax system to stop non-employees shielding income from taxation; and introducing cost-reflective pricing of natural resources consumption and environmental damage by industry. All of these possible reforms have been suggested at one time or another, whether rightly or wrongly, to be conducive to productivity maximisation.

Although economists can sometimes make useful predictions about the distributive implications of reform, their professional training does not of itself allow them to strike an expert trade-off between, on the one hand, community wide-productivity gains and, on the other hand, the losses experienced by particular segments of the community. Those are ultimately political decisions which depend at least in part on judgments about individual rights. But policy designers will make it easier for governments to introduce productivity reform if they can design reform packages which follow the principle that those who benefit from reform should also be the ones who pay for it. Where this is not possible, productivity reforms will remain contentious.

There are several questions that arise from this paper yet remain unanswered. Firstly, our understanding of South Australia's changing skills mix, and the respective roles of education institutions and migration trends, is incomplete. Secondly, the paper's focus has been mainly historical, and as such it has not addressed in detail the availability of measures to boost the State's productivity performance, for instance the role of spillovers, scale and regulatory reform. Thirdly, gross product is imperfect as an indicator of living standards because it omits important dimensions of quality of life, and it would be interesting to know how a more comprehensive measure might affect the analysis. Fourthly, while the paper documents macroeconomic indicators of productivity, it does not present detailed analysis of the processes whereby productivity is increased.[7]

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Appendix A
Index framework

The index framework employed here is similar to that used in ABS (2005b). The foundations of that framework are explained in detail in ABS (2000) and in Reilly, Milne and Zhao (2005). In this analytical framework it is assumed that the production process can be represented by a production function. A very general form is:

$$Q = A\,f(L_1, L_2, ..., L_m, K_1, K_2, ..., K_n) \tag{A.1}$$

This function specifies that output, Q, depends on a multifactor productivity factor A, the amount of labour, of m different types $L_1, L_2, ..., L_m$, and the amount of capital of n different types $K_1, K_2, ..., K_n$.

A key point about the productivity factor A is that it does not include any of the inputs L or K, but instead is reflective of the nature of production processes. For example, consider a restaurant which has among its "inputs" three staff members and which has as its "output" meals served to customers. Assume that the production of a meal can be broken into three stages, which are seating the customer, taking their order and cooking the food. One way to arrange the production process is to have each staff member carry out all three stages. An alternative is to have each staff member focus on only one stage of production rather than three. It seems likely that there will be a difference in the number of customers which can be served under these two arrangements (*a priori* we would expect the second arrangement to be more productive, although ultimately this is an empirical question to be resolved by the entrepreneur running the restaurant). If the restaurant introduced a more productive division of labour then productivity would increase and this would be captured by an increase in the productivity factor A. To take the example further, suppose the restaurant prepares a scallop dish. One of the workers opens the scallops with a knife and trims them from the shell prior to cooking. This is a time consuming process and the worker can prepare only a few scallop dishes per hour. Then the restaurant learns that by heating the raw scallops over a moderate flame in a heavy pan the scallops will open of their own volition, at which point they can be trimmed from the shell, making it much quicker for the worker to prepare the scallop dish. In this case there is a "technological change" in the production process. This too shows up as an increase in the factor A.

An important facet of A.1 is that it allows us to decompose changes in output into changes in input usage and changes in productivity. By taking logarithms and differentiating with respect to time we get:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + S_{L_1}\frac{\dot{L}_1}{L_1} + S_{L_2}\frac{\dot{L}_2}{L_2} + ... + S_{L_m}\frac{\dot{L}_m}{L_m} + S_{K_1}\frac{\dot{K}_1}{K_1} + S_{K_2}\frac{\dot{K}_2}{K_2} + ... + S_{K_n}\frac{\dot{K}_n}{K_n} \tag{A.2}$$

where

$$S_{L_1} = \frac{\partial Q}{\partial L_1}\frac{L_1}{Q} \tag{A.3}$$

and likewise for the various other terms in L and K.

The various S coefficients are output elasticities for their associated input factors. These elasticities cannot be observed directly. However, if it is assumed that the production function exhibits constant returns to scale, that producers are cost minimisers, and that factor input markets are in competitive equilibrium, then it can be shown that each factor's output elasticity is equal to its share of total costs. These shares can be observed and they have a sum of 1.

Labour productivity is defined as

$$P = \frac{Q}{L} \tag{A.4}$$

and thus the change in labour productivity is given by

$$\frac{\dot{P}}{P} = \frac{\dot{Q}}{Q} - \frac{\dot{L}}{L} \tag{A.5}$$

Noting that the labour and capital income shares sum to 1 we can use (A.2) to construct the following labour productivity equation.

$$\begin{aligned}\frac{\dot{Q}}{Q} - \frac{\dot{L}}{L} &= \frac{\dot{A}}{A} + \sum_m S_m \frac{\dot{L}_m}{L_m} + \sum_n S_n \frac{\dot{K}_n}{K_n} - \frac{\dot{L}}{L} \\ &= \underbrace{\frac{\dot{A}}{A}}_{A} + \underbrace{\sum_m S_m \left(\frac{\dot{L}_m}{L_m} - \frac{\dot{L}}{L}\right)}_{B} + \underbrace{\sum_n S_n \left(\frac{\dot{K}_n}{K_n} - \frac{\dot{L}}{L}\right)}_{C}\end{aligned} \tag{A.6}$$

Equation (A.6) says that labour productivity growth is equal to (A) total factor productivity growth plus (B) growth in labour quality weighted by labour's income share plus (C) growth in the capital-labour ratio ("capital deepening") weighted by its income share.

There is a choice as to how to specify L: it could be specified in terms of raw labour inputs or quality-adjusted labour inputs. If it is specified in terms of quality-adjusted labour inputs, then the labour quality change term (B) in (A.6) reduces to zero and the capital deepening term measures capital inputs against quality adjusted labour inputs. This approach has been employed in this paper. Thus we explain trends in raw labour productivity in terms of:

- a labour quality factor;
- capital intensity, relative to quality-adjusted labour; and
- multifactor productivity.

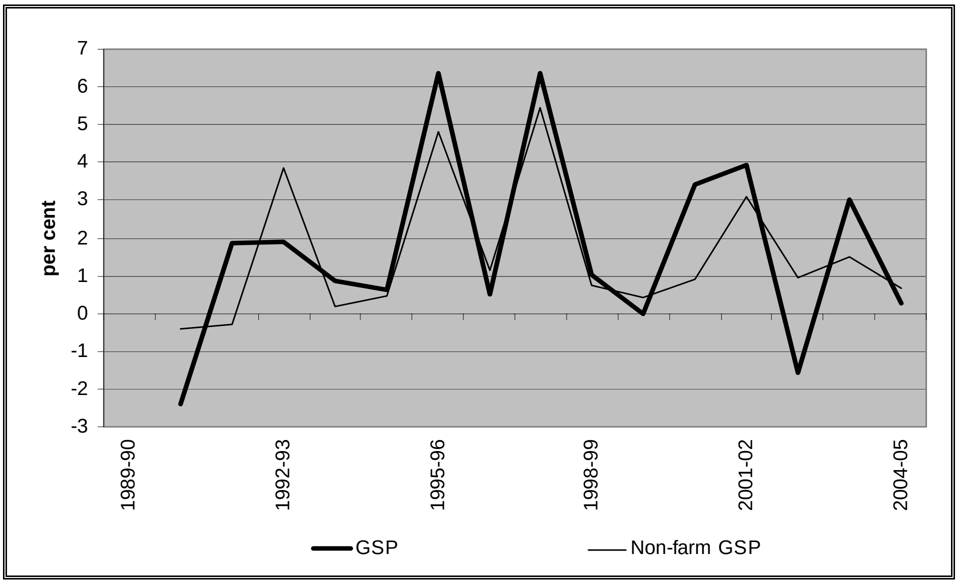
Appendix B
Influence of the farm sector on South Australian labour productivity estimates

When labour productivity measures are based on gross state product, there is a degree of volatility arising from seasonal influences on farm output. This short-term volatility can make it more difficult to discern underlying productivity trends and for this reason the ABS publishes productivity measures for Australia which are exclusive of the farm sector.

Unfortunately the published ABS data do not allow the construction of an identical series for South Australia. However, by making a rough estimate of non-farm GSP for South Australia it is possible to get a rough estimate of non-farm labour productivity in South Australia. Real non-farm GSP was approximated by deflating farm factor income by the national implicit price deflator for farm GDP and then deducting it from real GSP. Productivity was then calculated using non-farm hours worked. The resultant index is presented in Figure B.1 along with the index for the whole economy.

It can be seen in Figure B.1 that South Australia's non-farm labour productivity is less volatile than whole-economy labour productivity.

Figure B.1
South Australian labour productivity – whole economy and non-farm sector – annual change (per cent)



Source: ABS (2005c), ABS (2006) and SACES calculations.

Appendix C
A quality-adjusted hours worked index

C.1 Objective

The goal is to establish a quality-adjusted hours worked index. At present the ABS collects and publishes hours worked data for South Australia in the Labour Force Survey. However, these data do not show any changes in the quality mix of hours worked. The introduction of an index that can allow for quality changes will allow a more detailed description of the causes of productivity trends including identifying more clearly the part of productivity trends that must be attributed to changing efficiency of resource usage and changes in capital intensity.

ABS has published quality-adjusted productivity data in its most recent annual National Accounts publication (ABS 2005a) and the underlying methodology is described in detail in a recent ABS working paper (Reilly, Milne and Zhao 2005). The analysis here draws on that work although there are some points of difference.

C.2 Intuition of a labour quality index

A fundamental premise for a quality-adjusted labour index is that labour productivity is not homogeneous across workers. This fact gives a purpose for the index: the quality-adjusted labour index is intended to provide a more comprehensive measure of labour inputs by combining quality changes with raw quantities.

For example, compare two IT support workers, one with two years experience and one with four years experience. Other things equal, we would expect the support worker with more experience to more quickly and more effectively resolve problems in the system she manages than her colleague – i.e. to be more productive. Taking another example, if we had two IT workers with equal experience but one with relevant formal training and one without, then we would expect the worker with formal training to be more productive than his colleague. More generally, if we consider IT units employing IT workers, then other things equal we would expect a unit with a more experienced staff mix or a more qualified staff mix to be more productive.

The logic is not confined to a point in time. If an IT unit changed its staff mix over time to have a more experienced and more qualified profile we would expect its productivity to rise.

A quality-adjusted labour index needs weights to combine the different types of labour inputs. These weights need to be chosen to reflect the productivity specific to the different types of labour – for instance, if IT workers with a diploma are known to be 50 per cent more productive than IT workers without diplomas, then the weight given to a worker with a diploma will be 50 per cent greater than the weight given to a worker without a diploma. In fact the most common approach is to use wages as a measure of productivity. This approach rests on the assumption that wages are productivity reflective, and although there are models of wage setting processes which allow for deviations from that assumption, neither they nor the underlying premise are tested rigorously here (see Reilly, Milne and Zhao (2005) for further discussion of the possible qualifications to, and theoretical requirements necessary for, such an assumption).

In order to convey the intuition, a simple numerical example of a quality-adjusted hours worked index is presented in Table C.1. In Year 1 workers without diplomas work 200 hours and workers with diplomas also work 200 hours. In Year 2 workers without a diploma work 100 hours and workers with diplomas work 300 hours. Thus there is no change in the number of hours worked between years 1 and 2 – there are 400 hours worked in each. These numbers can be expressed as an index with a base value of 100.0 in Year 1, in which case the index also has a value of 100.0 in Year 2.

Now introduce productivity weights, with a weight of 1.5 for hours worked by workers with diplomas. In this case there is a productivity-weighted total of 500 hours of work in Year 1 and 550 hours of work in Year 2. Adopting an index value of 100.0 in Year 1, the index value in Year 2 is then 110.0.

Table C.1
A simple quality adjusted labour productivity index

	Year 1	Year 2	Productivity weight	Year 1	Year 2
Workers without diplomas	200	100	1	200	100
Workers with diplomas	200	300	1.5	300	450
Total	400	400		500	550
Weighted index	100.0	100.0		100.0	110.0

C.3 Data sources

A quality adjusted labour index for South Australia was constructed from the Survey of Income and Housing Costs (SIHC) which was run by the ABS for the years of 1994-95, 1995-96, 1996-97, 1997-98, 1999-2000, 2000-01, 2002-03 and 2003-04.

For each employee aged 15 or over in the sample the SIHC collects data on, *inter alia*:

- gender;
- qualifications;
- age;
- total current weekly employee income from wages and salary from main and second jobs; and
- number of hours usually worked per week in main and second jobs.

These data were used to produce population estimates of total income and total hours for each of 56 different labour types in each year. A third variable, average hourly income was then derived from this.

The 56 labour types reflect the following classification:

- gender – 2 types;
- qualifications – 4 types;
- potential experience – 7 types

There are two reasons for this classification. Firstly, given that the quality index in this analysis will be average hourly wages, it is important to decompose aggregate hours worked in those dimensions where there are marked variations in average wages. A vast body of work establishes that wages vary markedly across qualifications, experience and gender. Secondly, we are confined to variables for which we can establish a complete and consistent time series for the analysis period.

Qualifications

There were nine qualification categories in the SIHC but following the reasoning and methodology of Reilly, Milne and Zhao (2005) they were aggregated to four categories, with respondents allocated according to their highest post-school qualification:

- Still at school/no qualification
- Basic or skilled vocational qualification (including qualifications inadequately described)
- Associate or undergraduate diploma
- Bachelor degree, postgraduate diploma or higher degree

“Qualifications inadequately described” was combined with “vocational” on advice from the ABS. It is believed that this group comprises mostly people with training of a vocational nature that does not fit the strict “basic/skilled vocational” definition. Average hourly pay rates are similar across the two, which supports the assumption.

Potential experience

It is widely observed that wages increase with age. The classic rationalisation for this in human capital theory is that human capital is accumulated on the job, either via on-the-job training or learning by doing. A worker’s on-the-job training and accumulated learning will generally be greater the greater is his experience in a job. And experience is generally greater the older the worker is. Because there are considerable differences in average wages at different levels of experience, it is desirable to allow for experience.

However, as is usually the case, true measures of experience were not available in the data so a proxy, "potential years of experience", was calculated using a formula similar to that used by Reilly, Milne and Zhao (2005):

Potential experience = Age – 5 – Education years

Potential experience is the likely number of years a worker has been in the workforce. It is based on the necessarily simplistic premise that until the age of 5, and then for the duration of formal education, a person is not in the labour force, and that upon the completion of formal education employment is commenced immediately.

An estimate of the number of years of education was used, as actual data were not in the data set. The estimate was derived from qualification data, again using the assumptions of Reilly, Milne and Zhao (2005). People who are still at school or have no qualification are assumed to have 10 years of education. Those who have vocational qualifications are assumed to have completed year 10 then spent further two years studying, making a total of 12 years. People with diploma qualifications are assumed to have completed high school and then spent another two years studying for their diploma, therefore a total of 14 years of education. Holders of bachelor or higher degrees are assumed to have spent four years studying at university after Year 12, forming 16 years of education in total.

There are defects with the potential experience measure which may be significant at a practical level. They are discussed in Box C.1. But in spite of these flaws this rough measure should still pick up some of the productivity variations that would be revealed by a more accurate measure.

The total income and total hours data for each labour type were used to calculate estimates of average hourly wages for each labour type. Some summary results are presented in Table C.2. It shows the average hourly wage for South Australia for broad labour types as a proportion of the average for all employees. It can be seen that there is significant variation in average hourly wages across each of the controls. For instance, females on average earn 5.3 per cent less than average and males 3.4 per cent more. Workers with less than 5 years experience earn nearly 30 per cent less than average.

Box C.1
Limitations of the "potential experience" variable

First, the education classifications used have combined qualifications which probably entail different years of education. In allocating one unique number of years of education to all qualifications in a classification, deviations from actual years of schooling are bound to arise. To give an example that Reilly, Milne and Zhao (2005) raised, a doctoral degree will generally take 17 years of education consisting of 12 years of high school, 3 years for a bachelor degree and then a further two years of postgraduate study. However, holders of doctorates are attributed only 16 years of education under our assumptions. The method underestimates the actual years of education for holders of doctorates.

Second, there are variations from person to person in the number of years taken to complete particular qualifications, and this is not recognised in the potential experience estimates.

Third, in using highest educational qualification data to estimate years of education, there is a tendency to underestimate the actual number of years of schooling. This is because it ignores time that may be spent on lower qualifications. So for example if a person obtained a vocational qualification before she obtained a bachelor degree, only the bachelor degree will be accounted for.

Fourth, child rearing may also affect the years of experience due to time taken out of the workforce. This will be an issue mainly for females but will be true for some males. Reilly, Milne and Zhao (2005) made a child rearing adjustment to the estimates of females' experience, using the number of children as a proxy. However, the adjustment is quite complex to implement and still prone to error. Therefore it has not been implemented here.

Fifth, people may have other spells without employment – e.g., unemployment. Where this is so, potential experience will tend to overstate actual experience.

Sixth, the measures here ignore any part-time work experience gained by students while they are in full-time education. Yet such experience can be valuable, for instance in teaching general skills such as dealing with supervisors and customers.

Table C.2
Average hourly wages – sub-groups as a proportion of all employees, South Australia (per cent)

Gender:	
Male	103.4
Female	94.7
Qualifications:	
No post-school	86.9
Vocational	96.8
Diploma	109.5
Degree	134.6
Potential experience:	
< 5	70.6
5 - 9	87.9
10 - 14	99.0
15 - 19	103.6
20 - 24	105.5
25 - 29	111.4
30+	106.5

Source: Unpublished ABS data from *Survey of Income and Housing Costs,* and SACES calculations.

The SIHC includes income from wages and salary only, and excludes other forms of remuneration. As such it would certainly tend to underestimate absolute levels of labour income. However, in the current context it is income relativities across different labour types that are important, not absolute levels, so excluded income is important only in so much as it changes the relativities. It is probably the case that people on higher wages and salaries have proportionally more non-salary benefits, which would mean that the measures used here somewhat compress the relativities. However, there is no immediate solution to this and it is simply accepted as a limitation in the analysis.

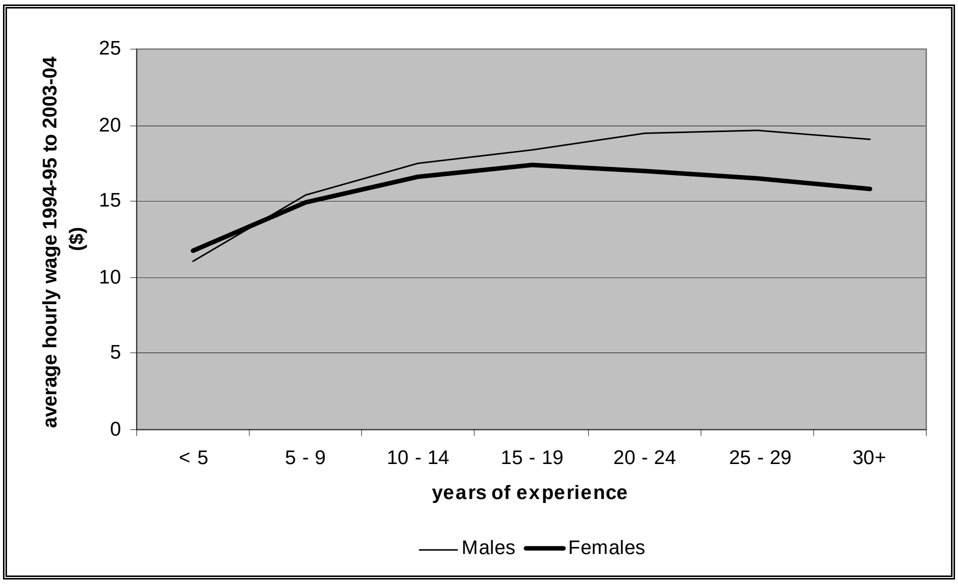
A further limitation in the analysis is the use of employee data instead of employed persons data to calculate the quality weights. Hours worked by employees form approximately 80 per cent of total hours worked. In the past twenty years, there has been an increasing trend in hours worked by employees. Where there are systematic differences in labour quality across different types of employed persons ideally this should be allowed for. However, as published data does not actually tell whether such differences exist, no such allowance has been made.

C.4 Labour quality factors in this analysis

The connection between qualifications and experience, on the one hand, and productivity, on the other, is intuitively apparent. However, the connection between gender and productivity is less apparent. One might adduce gender pay differentials as evidence of discrimination rather than productivity differences, in which case the efficacy of hourly pay as a productivity index would be undermined. It is an assumption of the analysis herein that the productivity explanation holds. Ultimately the assumption is one of convenience and it is accepted that, to the extent that it is invalid, the results herein are less valid.

However, it is noted that lower wages of females, or at least part of them, are not without possible explanations in terms of productivity-related factors. Figure C.1 shows the relationship between average hourly wages and potential experience for males and females in Australia. It is notable that the average hourly wages of females with less than 5 years of experience are about the same as males'. Males and females enter their working lives with about the same human capital on average. What is then required is an explanation for why females get much smaller growth in wages with experience. A possible explanation, discussed recently by Erosa, Fuster and Restuccia (2005) in their recent study of US wage outcomes, is that females accumulate less human capital because their careers are more likely to be interrupted, particularly by child raising. One aspect of this is that their years of actual experience are likely to fall short of years of potential experience by more than males'. A second aspect is that, by virtue of the greater likelihood of future interruptions to work, females have less incentive to accumulate human capital when they are on the job. In the data set that they analyse they conclude that fertility factors and associated human capital effects go a long way to explaining females' flatter earnings-experience profile.

Figure C.1
Potential experience-earnings profiles for males and females in Australia



Source: Unpublished ABS data from *Survey of Income and Housing Costs*, and SACES calculations.

This discussion of gender-related productivity differences brings to the fore an important point of interpretation. Any of the variables that are used as controls will tend to pick up not just their own influence on productivity but also the influence of correlated factors. Qualifications, experience and gender are just three of many factors that might bear a correlation with productivity. Other important factors include innate ability and motivation – which are extremely hard to measure. Moreover, the three variables included here may to some extent be surrogates for other productivity-affecting factors. One example is the correlation between gender and human capital accumulated on the job, as discussed above. Another is that qualifications may correlate with innate ability – for instance, those with high ability may be more likely to take education further. There may also be correlations with measurement errors in other included variables – e.g. the gender dimension being affected by the failings of the potential experience variable. These factors limit the validity of generalisations about the significance of gender, qualifications and experience in their own right as determinants of earnings. But they do not undermine their validity for the purpose of constructing quality indexes – to the extent that they are surrogates for systematic variations in other productivity influences, they are welcome in the productivity indexes.

C.5 Index construction

The data were used to construct a chain-weighted index of hours worked. The ABS uses Tornqvist indexes in National Accounts productivity estimates and consequently this approach has been adopted here.

With this approach the quality-adjusted labour index 1nL_t is given by

$$\ln L_t = \sum_j \frac{1}{2}(s_{j,t-1} + s_{j,t}) \ln \frac{h_{j,t}}{h_{j,t-1}} \ln L_{t-1} \; if \; t\rangle 1 \qquad \text{(C.1)}$$

where $1nL_0 = 0$, $h_{j,t}$ is the total hours worked by labour type j in period t and $s_{j,t}$ is the share of labour type j in total labour income in period t. $s_{j,t}$ is calculated as

$$s_{j,t} = \frac{w_{j,t} h_{j,t}}{\sum_i w_{i,t} h_{i,t}} \qquad \text{(C.2)}$$

where $w_{j,t}$ is the average hourly wage of labour type j in period t.[8]

Since $w_{j,t}$ has been derived from averaging the wage of labour type j in period t, $s_{j,t}$ is the actual income share.

Appendix D
Derivation of capital services estimates

The ABS publishes estimates of "capital services" used by the Australian market sector.

However, the analysis herein uses a broader concept than the "market sector" and in fact includes all industries that contribute to GSP, except for ownership of dwellings. This means that it is necessary:

- to construct a capital services index for Australia for all sectors excluding dwellings; and
- to develop a parallel series for South Australia.

The existing market sector capital services index is based on an inventory of "productive capital". The ABS calculates notional "rental payments" for the items in this inventory. An index of "capital services" is then produced by holding the rental payments fixed and measuring changes in the quantum of assets employed.

The rental payments are estimated across a broad range of assets, differentiated by asset type and age. Assets include both land and man-made assets. In recent years there has been relatively strong growth in the stock of "machinery and equipment" used and very strong growth in "computer software". This means that new ICT technologies tend to be recorded as increases in "capital services".

Because we do not have access to the detailed data lying behind ABS capital stock estimates, it is not possible for us to construct a capital services index for the non-market sector in the same detail. Instead, capital services estimates for the non-market sector were constructed by disaggregating the market sector estimates into land, capital stock and capital services per unit of capital stock components. Land and capital stock estimates for the non-market sector were then incorporated to produce a non-market sector estimate and an all sectors (excluding dwellings) estimate.

Estimates for South Australia were prepared by combining estimates of South Australian land and capital stock for all sectors excluding dwellings with national estimates of changes in capital services per unit of capital stock. Capital stock estimates were made with a perpetual inventory model incorporating gross fixed capital expenditure estimates for the period 1985-86 to 2004-05, depreciation rate assumptions for this period, and an assumed initial capital stock for the beginning of 1985-86. The capital stock estimation methodology is similar to that put forward by Louca (2003) but there are some differences in the assumptions made.

It is estimated that capital services in South Australia rose by 43 per cent over the period 1994-95 to 2004-05.

Our estimate of capital services for Australia, inclusive of all sectors except dwellings, shows an increase of 57 per cent. Of course a substantial difference is to be expected, as we know that the scale of the Australian economy has been increasing more rapidly than South Australia.

It is possible to abstract from these scale effects by considering instead measures of capital intensity. Indexes of capital intensity show how the capital-labour ratio changes over time within an economy, and they are presented for South Australia and Australia in Figure 8. The indexes say that both South Australia and Australia had significant increases in capital intensity over the period 1994-95 to 2003-04 – a phenomenon known as "capital deepening". Both the South Australian and Australian economies have become more capital-intensive over time. The capital-labour ratio in South Australia increased by about 26 per cent over that 9 year period, as it did nationally.

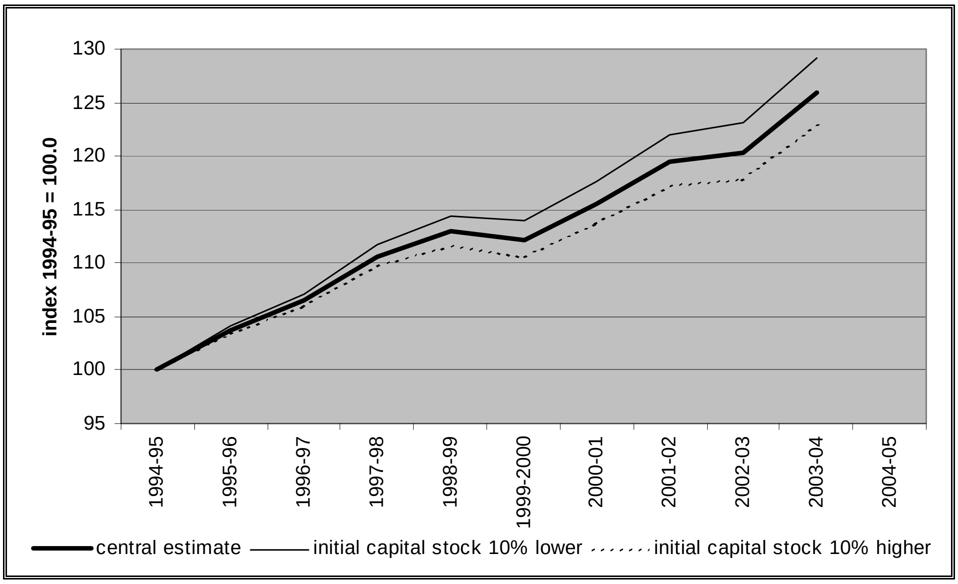
These indexes depend on assumptions about capital stocks, depreciation rates and rates of return. The calculations for South Australia draw on estimates for Australia, but make allowance for potential differences in growth of the capital stock. The South Australian calculations also rest on the assumption that South Australia's mix of manmade assets lags the Australian mix, an assumption which is intended to capture the fact that slower growth in the size of the South Australian economy and its capital stock implies an "older" capital stock.

One factor that affects the capital stock estimates is the assumption used to initialise the perpetual inventory model. Initialisation is required for June 1985. Capital stock figures are available for Australia in June 1985 and therefore an assumption was made about South Australia's share of that national capital stock. The assumption was that South Australia's 1985 share matched its share of Australia's gross fixed capital formation over the period 1981-82 to 1984-85 (which was 8.0 per cent).

Sensitivity tests were carried out to explore the impact of this initialisation assumption. Estimates of capital services were made with 10 per cent lower and 10 per cent higher initial capital stock. If the initial capital stock were in fact 10 per cent lower, the implication would be that the measure of capital services which was actually used had underestimated growth by 4.0 percentage points over the period 1994-95 to 2003-04. If the initial capital stock were in fact 10 per cent higher, the implication would be that the measure of capital services which was actually used had overestimated growth by 3.6 percentage points over the period 1994-95 to 2003-04.

Figure D.1 presents the results of the sensitivity tests in terms of capital-labour indexes. In the case where the June 1985 capital stock is in fact 10 per cent less than used in the central estimates, the capital-labour ratio is 3.2 per cent higher.

Figure D.1
Sensitivity test: Impact of assumptions regarding initial capital stock on capital-labour ratio in South Australia



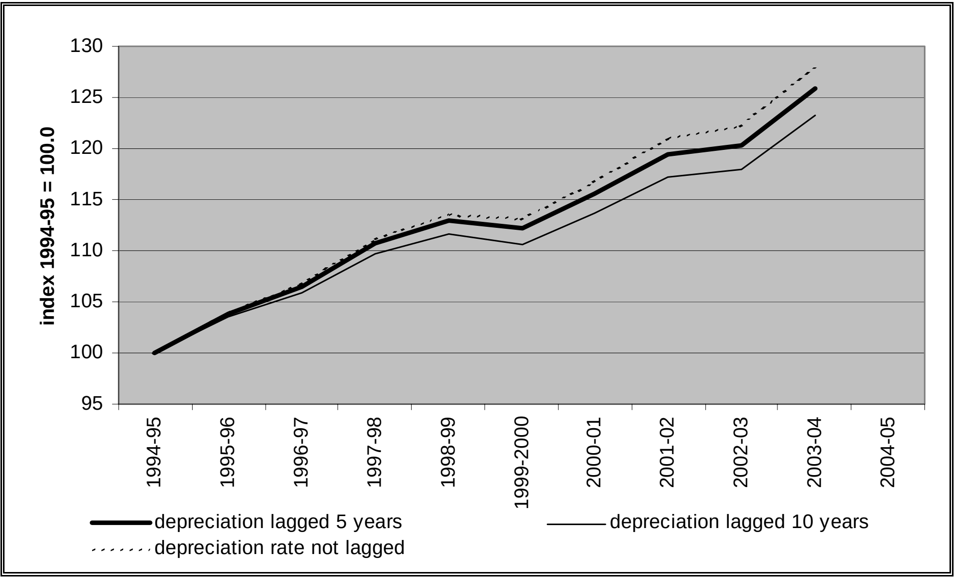
Source: SACES estimates.

Faster growth nationally means that the national asset stock will generally be newer than South Australia's, and this may influence its composition. There have been increases in national depreciation rates over the last two decades, which is strongly suggestive that investments today are increasingly in shorter-lived assets. As new investments will be less prevalent in the South Australian asset mix, it may also be the case that depreciation rates were lower, in which case capital stocks would have been growing faster than is assumed because there is less depreciation of them. For this reason, the central assumption was that South Australia's depreciation rate matched the 5-year lagged national depreciation rate. Such a difference could also affect changes in capital services per unit of capital, further confounding the analysis.

The impact of depreciation assumptions on capital services via faster capital stock growth was tested. One scenario was prepared in which South Australia's depreciation rate has no lag from the national depreciation rate and another with a 10 year lag. The results, in terms of capital intensity, are shown in Figure D.2. With no lag, capital intensity rises by 23 per cent (cf. 26 per cent on the base case) which is less than the 26 per cent national increase. With the 10 year lag it rises by 28 per cent.

These sensitivity tests indicate that under any scenario there has been a significant increase in capital intensity in South Australia. They also indicate that this increase is similar to what has been seen nationally, although under plausible alternative assumptions some modest differences are implied.

Figure D.2
Sensitivity test: Impact of assumptions regarding depreciation rates in South Australia



Source: SACES estimates.

End Notes

1 Understanding the distribution of gains in living standards requires a model of income distribution, which is beyond the scope of this paper.

2 The analysis window used here is determined by, and uses, the full period for which data are available.

3 Labour productivity has been observed to show countercyclical patterns. A possible rationale is as follows. During a recession employers retrench some workers to cut costs. But because workers are costly to recruit and train they also retain some workers in anticipation of a return to stronger trading conditions in the future and accept a degree of underutilisation of those workers. As the economy comes out of a recession, productivity grows strongly as utilisation rates are increased for those underutilised workers. Once they are fully utilised, employers begin rehiring and because this leads to increases in measured labour input, productivity growth falls back to something around the underlying structural rate of growth (which is associated with factors such as new technology). Later in the cycle, as labour shortage begin to emerge, employers who want to hire workers are forced to hire new workers who are on average less productive, and productivity growth rates can then actually fall below the underlying rate of growth.

4 The capital estimates for South Australia were boosted by the Olympic Dam expansion in the late 1990s and then grew more slowly when the completion of that expansion fed into lower levels of business investment.

5 There were in fact some pronounced differences from State to State: Queensland, for instance, had no growth in its purchasing power.

6 The presence of spillovers from infrastructure provision creates a case for government intervention, but direct provision is not the only possible form of intervention. An alternative is to reinforce the capacity of commercial providers to recoup costs from the beneficiaries of infrastructure. It is arguable that Australia has over the past couple of decades seen a significant rebalancing of its governmental interventions away from direct provision towards stronger commercial incentives to provide justifiable infrastructure. This change in policy approach reflects a view, right or wrong, that government decisions about infrastructure provision have been sufficiently imperfect that a better outcome could be had by pushing more of these decisions into the commercial sector with appropriate modifications to incentives. As Pritchett (1996) notes, there is no necessary reason that government spending on infrastructure creates assets of corresponding or greater value. In the developing world, he argued, it is typical for public investments to create 50 cents worth of asset stock for each $1 spent. Empirical analyses that fail to account for this are at risk of concluding that public infrastructure makes little contribution to productivity, when in fact the problem is that the resources devoted to public production were used ineffectively.

7 Bland and Will (2001) analysed the way in which productivity growth occurs in the firm structure. In their data set entry and exit of firms plays a relatively small role. They find that “the movement of resources into firms with above-average labour productivity and out of firms with below-average productivity was associated with a positive contribution to average labour productivity change”, but the relationship between productivity levels and resource movements was not very strong.

8 As an alternative to the averaged wage method, Reilly, Milne and Zhao (2005) also used an econometric wage equation method to derive an hourly wage estimate.