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South Australia's Recent Productivity Performance

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Editor'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

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

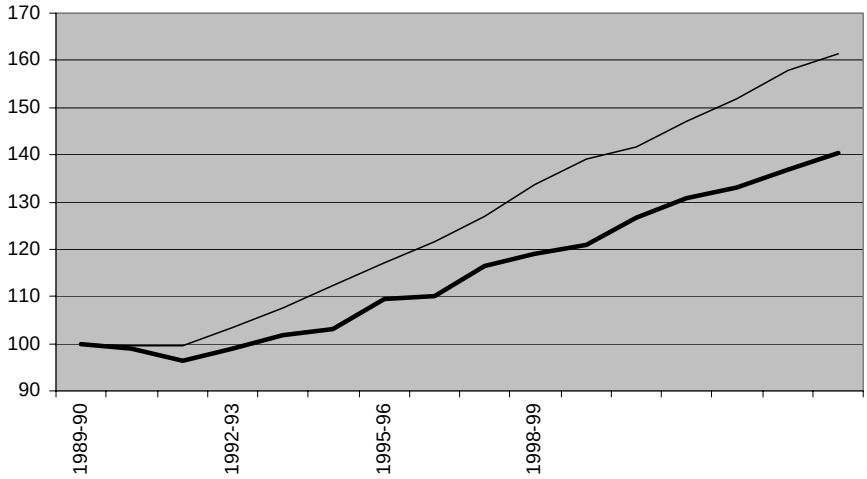
herein (subject to the caveat that the measures here are not as comprehensive as a true total factor productivity measure).

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

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".

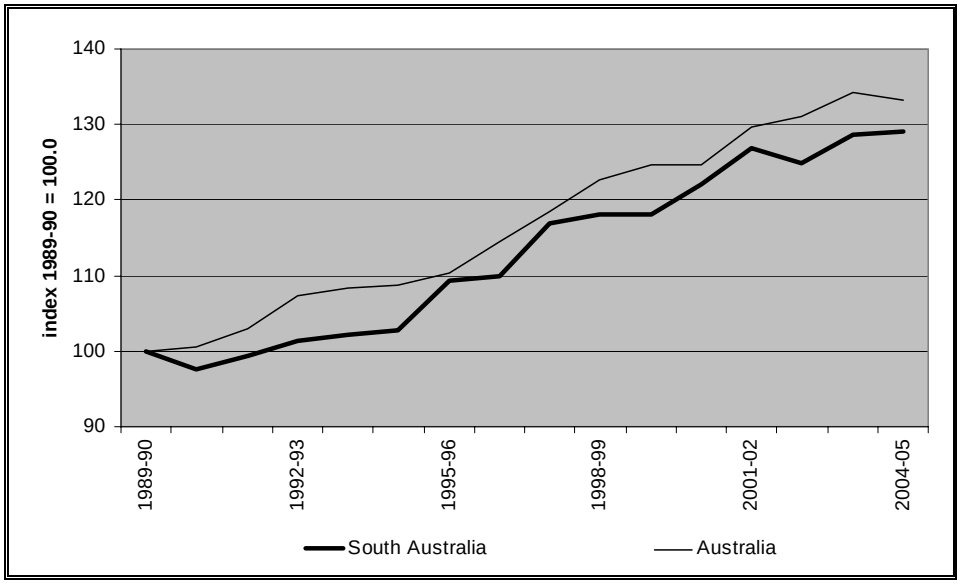
Since the late 1960s the South Australian economy has grown more slowly than the Australian economy as a whole. ABS gross product data in Figure 1 illustrates that this is so over the period 1989-90 to 2004-05 (see also Table 1). Over this period Australia's real gross domestic product (GDP) has increased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



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]

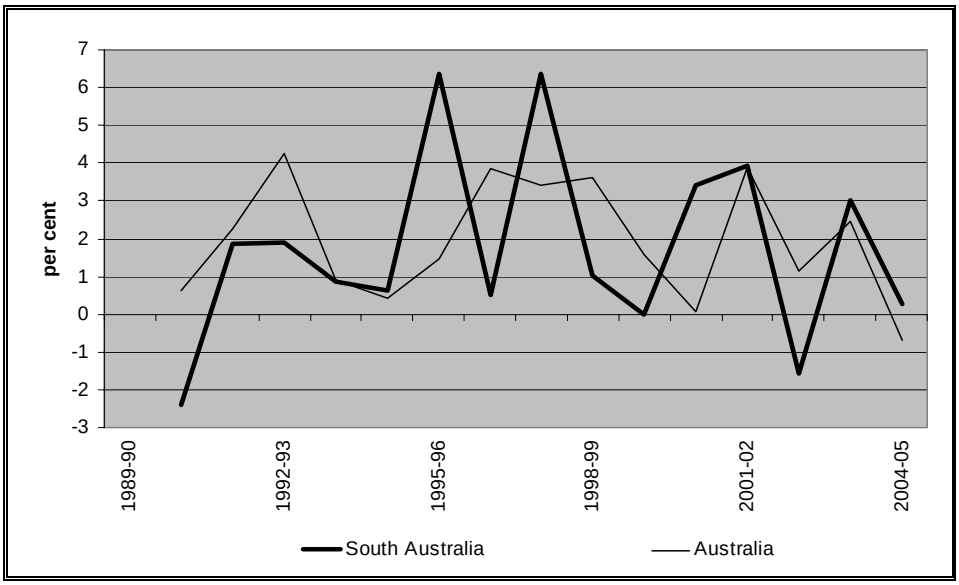
Visual inspection suggests that there are some differences in the timing of productivity changes, with Australian productivity rising faster than South Australia's in the first half of the 1990s, and South Australia then outpacing Australia through the middle of the 1990s. South Australia was hard hit 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

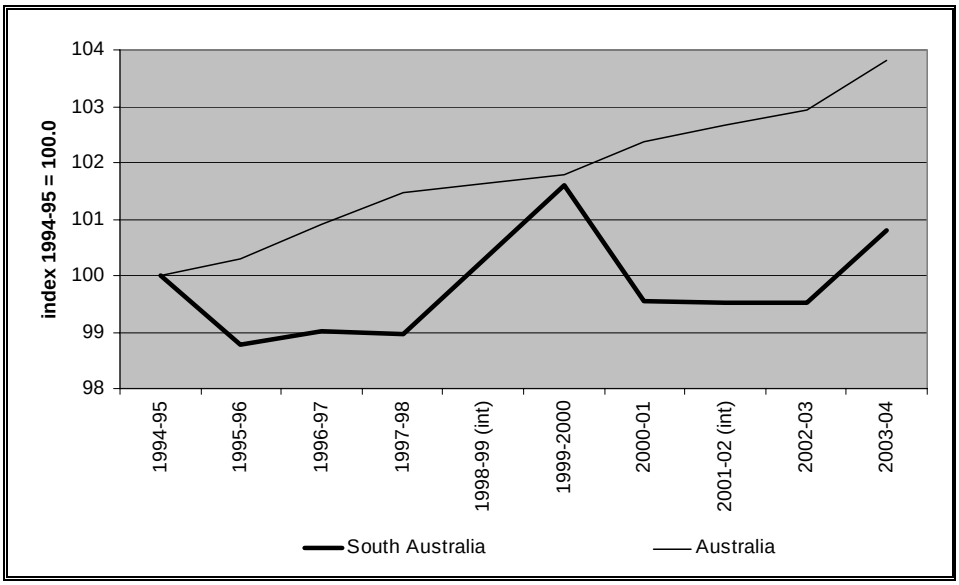
One factor that will affect labour productivity, measured on a simple hours-worked basis, is changes in the skill mix of the labour force. It will generally be the case, for instance, that a skilled tradesperson working for an hour is more productive than an apprentice working for an hour. If the proportion 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-prop12ene(t)4.9(htors fandr)-19.1(e for.7(ikeditivi levels I)22.6(t)-2.4(will))10(the

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

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

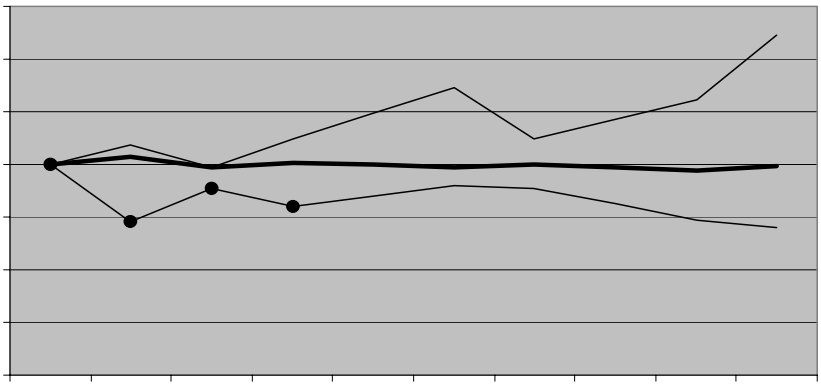


Table 2 shows that the national change in labour quality differs from South Australia's mainly for two reasons. Firstly, changes in the experience profile made a positive contribution nationally (0.5 per cent), in contrast to the negative contribution seen in South Australia (minus 1.2 per cent). Secondly, 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 historr.reflection le tdocumecountphenomeconare oe
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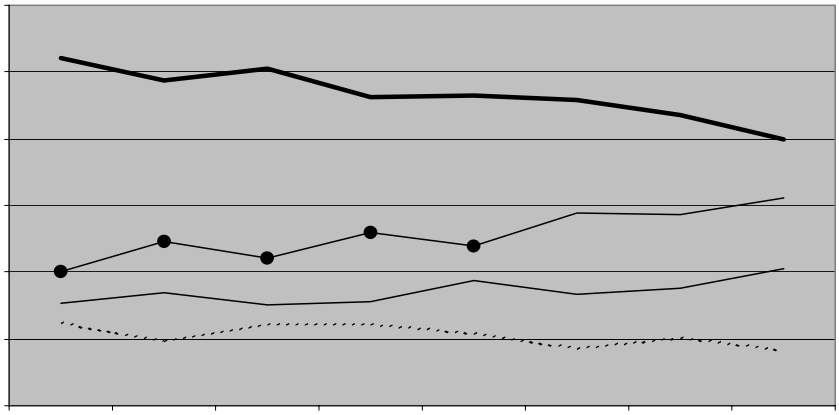
Figure 7
Share of hours worked by qualification type, South Australia



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

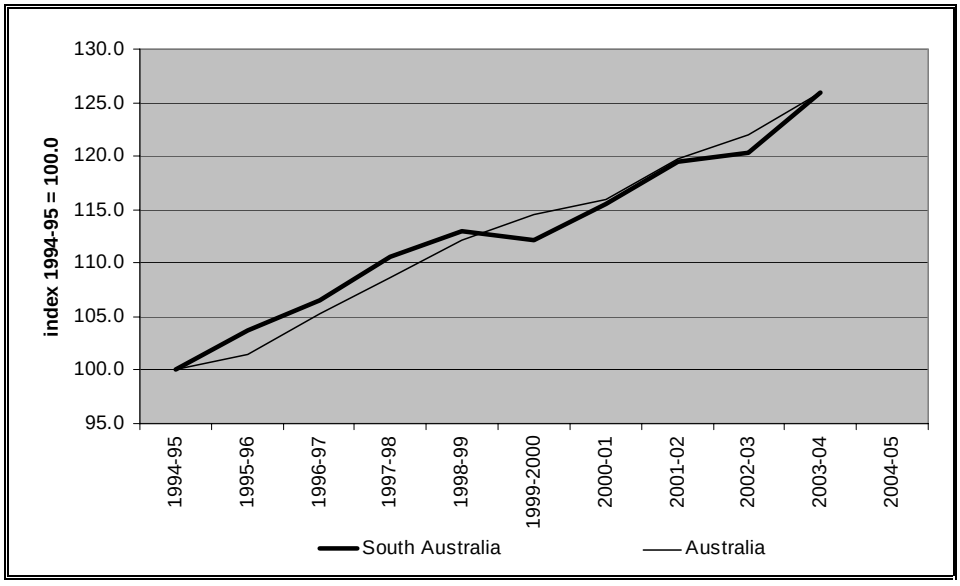


Figure 9

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.

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

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

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:

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

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:

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

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 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

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

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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.

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.

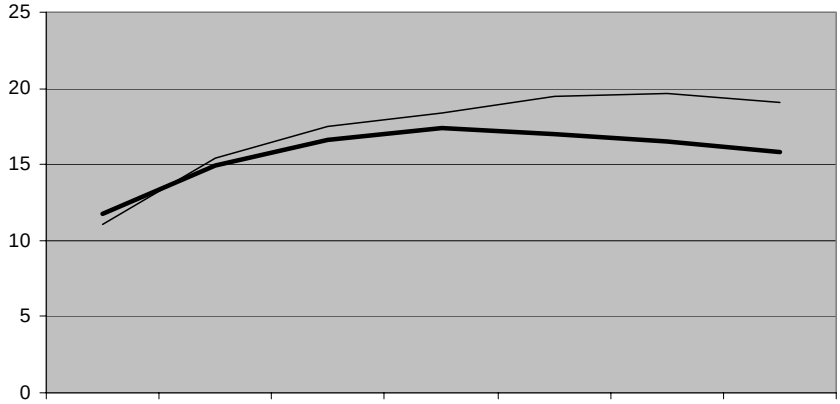
C.4 Labour quality factors in this analysis

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

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



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.

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,