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Productivity in Australian Education between 1986/87 and 1993/94

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by

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Centre of Policy Studies
Monash University

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The Centre of Policy Studies (COPS) is a research centre at Monash University devoted to quantitative analysis of issues relevant to Australian economic policy. The Impact Project is a cooperative venture between the Australian Federal Government, Monash University and La Trobe University. COPS and Impact are operating as a single unit at Monash University with the task of constructing a new economy-wide policy model to be known as *MONASH*. This initiative is supported by the Industry Commission on behalf of the Commonwealth Government, and by several other sponsors. The views expressed herein do not necessarily represent those of any sponsor or government.

ABSTRACT

This paper attempts to estimate the change in total factor productivity (TFP) in total education services provided in Australia, between 1986/87 and 1993/94. A simple model is developed and calibrated using Australian data. TFP is estimated to have fallen by between 16 and 26 per cent depending on what is assumed about the behaviour of average quality over this period.

Keywords: education services, productivity, real output measures for education.

J.E.L. Classification numbers: I20, I29

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Productivity in Australian Education between 1986/87 and 1993/94

by

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Introduction

In the last decade or so the Australian education system has experienced major changes at all levels. At the primary and secondary levels there has been a general trend towards a contraction of the (largely) publicly provided component of this sector. By contrast, the tertiary sector (*ie*, technical and further education (TAFE) and universities) has experienced a large expansion through increased public sector funding and exports, mainly to Asia. At the same time, anecdotal evidence has fuelled a populist belief that quality at all levels of education has suffered. It is not clear what has been the behaviour of productivity over this period. It is this issue that this study will attempt to address. The paper is organised as follows. Section I develops a simple model for estimating TFP. Section II presents data and calibrates the model. Estimates are presented in Section III, and a discussion of these and concluding remarks is presented in Section IV.

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I. A Simple Model

To estimate the change in TFP it is necessary to outline a theoretical structure which explains the relationship between inputs into, and outputs of, education services. In general, the form of this relationship is captured by the following:

$$Y_t = f(I_t) \qquad (1),$$

where Y_t is the quantity of total education output at time t, f is a function with a positive first derivative, and I_t can be thought of as a function of the capital and labour used in education in year t. TFP is defined by:

$$TFP_t = Y_t / I_t \qquad (2).$$

That is, TFP at time t (TFP_t) equals total output at time t (Y_t) divided by the total factors (I_t) required to produce Y_t. Converting equation (3) to percentage change form gives

$$tfp_t = y_t - i_t \qquad (3)$$

where the lower case italicised letters represent the rate of change of the equivalent upper case variables. Equation (3) says that the percentage change from year t-1 to t equals the difference between the percentage changes in output and in total factors employed. Estimation of tfp_t requires estimates of y_t and i_t.

II. Australian Data

As this study is attempting to estimate the change in TFP between 1986/87 and 1993/94 estimates of y_t and i_t are also required over the same period.

II.1 Real Inputs

The Australian Bureau of Statistics (ABS) measures annual changes in what they refer to as real output for *Education (ANZSIC[2] 84)* in the national accounts. This subdivision comprises all units mainly engaged in providing education. This includes:

- preschool education;
- primary education;
- secondary education;
- special school education;
- higher education;
- TAFE; and
- other education (ABS 1996a, Appendix 2, para 28).

The output of these units can be regarded as providing an education service in the form of a formal qualification.

[2] Australian and New Zealand Standard Industry Classification.

The ABS measure of real output for this division is calculated by extrapolating base year gross product by the sum of

- deflated estimates of wages, salaries and supplements; and
- constant price estimates of consumption of fixed capital *ie*, depreciation (ABS 1996a, Chapter 18, Table 18.14).

This measure is essentially the sum of the real wage bill (deflated estimates of wages, salaries and supplements) and the real capital bill (constant price estimates of consumption of fixed capital). Thus, it basically measures the real value of *inputs* into education services and, as such, it does not reflect changes in real output. Consequently, it does not allow for any improvements in factor productivity *ie*, it implicitly assumes TFP growth is zero. Consequently the ABS output measure cannot reflect the impact on real output of the adoption of more capital intensive technology (*eg*, the introduction of the use of computers in education services), of increased labour productivity (*eg*, increased teaching loads) or increased capital productivity (*eg*, reducing excess capacity of physical capital such as buildings by increasing enrolments). The ABS measure of real output is, in fact, a useful measure of real inputs (I_t).

The ABS's estimate of the change in real output over the period 1986/87-1993/94 for *Education (ANZSIC 84)* is 30.67 per cent (ABS 1996c, Table 1.3, p.6). This figure will be used here as an estimate for i_t.

II.2 Real Output

Since it is not possible, for methodological reasons, to use the ABS estimates of real output for education services, an acceptable alternative must be found. Burke (1986) identifies `consequential' output, such as the impact of prolonged schooling on cognitive learning; on skills; on attitudes; on employability; and on lifetime earnings, as the first best way of measuring real education output. Given the lack of data on these outputs a `secondary' or `direct output' objective of education is participation. Participation has been used as one of a number of output proxies in international studies attempting to estimate the efficiency and productivity of education services (see Bonesrønning & Rattsø 1994; Färe *et al* 1997; Heshmati 1997; Heshmati & Kumbhakar 1997). Data on this objective is readily available. It is this measure of education output which will be used in this paper.

In considering an appropriate student proxy two immediately come to mind. Namely, the number of students enrolled or the number of students graduating. As a service is provided to *all* students whether they graduate or not, a more accurate measure of output would be the number of students enrolled.

Using student enrolments as a proxy for estimating real output will not allow for any change in quality of the services provided over time. For instance, where student enrolments have increased due to increasing class sizes, labour

productivity will be judged to have improved. However, class size is also an indicator of quality. And in this example the average quality of teaching has fallen. Verikios (1997) discusses how the ABS is exploring the possibility of adjusting for quality using data on test scores and retention rates, and how both of these proxies have limitations with respect to their use as quality adjustors. This is one reason why this study will not attempt to adjust for changes in quality. Another is that this study is only intended as a first pass at estimating the change in TFP for education services. The absence of an adjustor for quality should be borne in mind when interpreting the estimates presented later on.

Verikios (1997) also discusses the use of publications as an output proxy for the research output of universities. This data is collected by the Australian Vice-Chancellors' Committee (AVCC). The AVCC has been collecting this data from 1992 onwards. As this study is concerned with estimating TFP between 1986/87 and 1993/94 it is not possible to estimate the research output of universities using the data collected by the AVCC.

Data on student numbers at the primary, secondary, special, higher and TAFE levels of education was obtained from ABS publications. This data was for calendar years. As an estimate for the change in TFP is required in financial years (*ie*, 1986/87-1993/94) the data was converted to financial years in the following way. For the financial year 1986/87 total enrolments was defined as the average

total enrolments for the years 1986 and 1987. For the financial year 1987/88 total enrolments was defined as the average total enrolments for the years 1987 and 1988, and so on.

Table 1 lists the change in student enrolments for the School (defined here as the sum of the primary, secondary and special education sectors), Higher Education (defined here as universities) and TAFE sectors, between 1986/87 and 1993/94. It also lists the share of enrolments of each sector in total enrolments (*ie*, the sum of School, Higher Education and TAFE enrolments) in 1986/87.

II.2.1 Schools

Table 1 indicates that student enrolments in Schools grew by only 3.19 per cent between 1986/87 and 1993/94. It would be expected that student enrolments in this sector would be influenced by a number of factors. Population growth should be a major determining factor on enrolments for this sector due to the fact

Table 1:

Student Enrolments and Shares in Total Enrolments for the Schools, Higher Education and TAFE Sectors

Sector	1. Change in Enrolments between 1986/87 and 1993/94 (%)	2. Share of Total Enrolments*
1. *School*	3.19	0.6973
2. *Higher Education*	48.19	0.0910
3. *TAFE*	23.52	0.2117

* Total enrolments is the sum of enrolments for Schools, Higher Education and TAFE for 1986/87.
Sources: ABS 1987, Table 1; ABS 1988b, Table 1; ABS 1989, Table 1; ABS 1990, Table 1; ABS 1991, Table 1; ABS 1992b, Table 1; ABS 1992c, Table A1.7; ABS 1993, Table 1; ABS 1994b, Table 1; ABS 1995b, Table 1; ABS 1996b, Tables 5.7, 5.22, A5.10, A5.11, A5.22, A5.24.

that all children must (legally) attend school until the age of 16. In practical terms, this means that all children must complete primary school (all grades) and secondary school up to Year 10 (fourth grade).

In the period 1986/87-1993/94 Australia's population grew by 11.36 per cent (ABS 1997, Table 2). During this period there was a deliberate government policy to increase retention rates beyond the fourth grade of secondary school with a view towards decreasing the amount of teenagers registered as unemployed. This was quite successful with apparent retention rates of secondary school students to Year 12 rising from 48.70 per cent in 1986 to 74.60 per cent in 1994 (ABS 1991, Table 14; ABS 1994b, Table 16). This would be expected to increase the growth of student enrolments in this sector above what growth would have been in the absence of such a policy. The fact that student enrolments in the School sector grew at about one-third of the rate of population growth indicates that other factors influenced the rate of growth of this sector.

One such factor may have been the age profile of Australia's large immigration intakes during this period. Immigrants over the age of 16 are not legally obliged to attend school and therefore would not contribute to the growth of this sector but would contribute to the growth in population. Also the ageing of Australia's population would be expected to reduce the rate of growth of student enrolments in this sector below the rate of growth of the population over this time

period, by adding to the growth in the population and making no contribution to the growth of the School sector.

It seems that despite government policy to increase retention rates to Year 12, the combined effects of the ageing of the population and the age profile of the immigration intake has been to lower growth of the School sector to around one-third of the rate of growth of the population over the same period.

II.2.2 Higher Education and TAFE

By contrast, the Higher Education and TAFE sectors have grown at much higher rates than the School sector *ie*, 48.19 and 23.52 per cent respectively, versus 3.19 per cent. A number of factors has probably influenced this high relative growth. The already discussed government policy of increasing retention rates to Year 12 would have the effect of increasing the proportion of secondary students who qualify for entry into the Higher Education sector. Secondly, the high relative growth, since the mid-1980s, of (Commonwealth) government spending on Higher Education and TAFE places would have had the effect of increasing access into these sectors. Lastly, the business cycle also affects the proportion of the labour force who undertake training as opposed to employment. When the business cycle is in a boom phase employment is usually high and training is usually low. The reverse is true in a bust phase. Low employment growth since the beginning of the

1990s has probably pushed a greater proportion of the work force into training (such as Higher Education and TAFE) and out of employment.

III. Results

The change in real output will be calculated using the data presented in Table 1. An important issue with respect to this calculation is the additivity of student enrolments for the three sectors. Should a student enrolled in the School sector be given the same weight, in terms of estimating the change in real output for this item, as a student enrolled in the Higher Education sector? There may be justification for differential weights if the cost per student in different sectors is also highly differential. To check whether this is the case data on total expenditure for each sector in a given year is required.

Data on final consumption expenditure for education by all governments (*e*, Commonwealth, State and Local), and by the private sector, on all levels of education was obtained from various ABS publications (see ABS 1988a; 1992a; 1994a; and 1995a). The cost per student per sector in 1986/87 and 1993/94 was calculated by dividing total expenditures by student enrolments in each sector in these years. These dollar costs were subsequently converted to relative costs per sector. This was done by choosing the School sector as the numeraire and the

relative costs for the Higher Education and TAFE sectors were calculated accordingly. These relative costs are presented in Table 2.

Table 2:

Relative Costs Per Student Per Sector for 1986/87 and 1993/94

Sector	1. 1986/87	2. 1993/94	3. Average
1. Schools	1.0	1.0	1.0
2. Higher Education	1.9471	1.5797	1.7634
3. TAFE	0.4421	0.4620	0.4521

The relative costs presented in Table 2 suggest that the Higher Education sector is between 1.5 to two times as expensive as the School sector. This is probably explained by two factors. Firstly, the cost of labour in the Higher Education sector is much greater than for the School sector. University lecturers are paid a premium for the high level of their qualifications *eg*, Masters and Doctor of Philosophy degrees, relative to primary and high school teachers who usually only have an undergraduate degree plus a postgraduate teaching diploma. Secondly, the Higher Education sector contains a significant proportion of non-teaching staff *ie*, researchers, whereas the proportion of non-teaching staff in the schools sector *ie*, administrators, is much smaller[3].

[3] As a general rule, almost all academic university staff are required to spend approximately half of their working hours doing research. However, this condition is not strictly enforced and/or is adhered to in varying degrees at different universities. Thus, it is not possible to adjust the data on the cost per student for the Higher Education sector to account for this fact,

Table 2 also suggests that the TAFE sector is half as expensive as the School sector. The cost of labour (and capital) is roughly equal in these two sectors. But around 85 per cent of TAFE students are part time (Burke 1996) and this underestimates the cost per TAFE student to around half that of the School sector, which only had full time students over this period. It is possible to adjust the TAFE student numbers to account for this phenomenon. It will be assumed that the average part time TAFE student takes on half the number of course subjects of a full time TAFE student. Thus 85 per cent of total TAFE enrolments will be given a weight of a half while the balance will be given a weight of one. The results of these adjustments on the relative cost weights are presented in Table 3.

Table 3:

Relative Costs Per Student Per Sector for 1986/87 and 1993/94, with TAFE Enrolments Adjusted for Part Time Students

Sector	1. 1986/87	2. 1993/94	3. Average
1. Schools	1.0	1.0	1.0
2. Higher Education	1.9471	1.5797	1.7634
3. TAFE	0.7689	0.8035	0.7862

Table 3 indicates that adjusting for the high proportion of part time students in the TAFE sector increases the relative cost per TAFE student to the point where

with any degree of confidence. Further, this problem could be avoided all together if it was possible to estimate the research output of universities separately. But as explained in Section II.2 there is not enough historical data available to do this.

it approaches the relative cost per School student. This result is more in line with what is expected about the relative costs per student of these two sectors.

The concerns expressed above regarding the high proportion of part time students in the TAFE sector and how this distorts enrolments extends to their use as an output indicator (Burke 1996). For this reason `module hours' will be used instead, as it is believed that these data are more reliable in indicating the movements in students over time[4]. Total annual module hours for TAFE courses between 1986 and 1994 were obtained from the National Centre for Vocational Education Research Ltd. As per the convention adopted for student enrolments, module hours for the financial year 1986/87 were calculated as the average total module hours for the years 1986 and 1987. For the financial year 1987/88 total module hours was calculated as the average total module hours for the years 1987 and 1988, and so on. Thus, using this methodology the change in module hours between 1986/87 and 1993/94 was 29.98 per cent. This compares to the change in TAFE student enrolments over the same period of 23.52 per cent. Using module hours as an output proxy for the TAFE sector indicates slightly higher growth than using enrolments.

The marked difference in costs per student between the three sectors presents a strong case for using the relative costs per student as fixed weights for

[4] Modules (also known as subjects) make up TAFE courses. These can range from a single day to one semester (National Centre for Vocational Education Research Ltd website). They effectively measure student contact hours.

the change in student numbers in each sector. As fixed weights are required, the average of the weights for 1986/87 and 1993/94 will be used. The weights to be used are those listed in Table 3, column 3. Table 4 presents an estimate of the change in real output using these average fixed weights. These weights are applied to the actual number of students in 1986/87. For 1993/94 the weights are applied to the actual number of students for the School and Higher Education sectors. Whereas for the TAFE sector the number of students is extrapolated from 1986/87 by the change in module hours over this time period*ie*, 29.98 per cent. Once this is done, the weights are then applied to give *weighted students.* The change in the total number of weighted students between 1986/87 and 1993/94 gives an estimate of the change in real output for this period of 14.59 per cent. This is equivalent to annual average growth of 1.82 per cent. This estimate is only slightly higher than the change in total student numbers over this period *ie*, 11.59 per cent, which is presented in brackets in Table 4, column 1, row 9. Despite this, the former number has two important advantages. One, it takes account of the differences in relative costs between the three sectors and two, it uses a more reliable output proxy for the TAFE sector *ie*, module hours versus student enrolments. Thus it is more theoretically sound.

Table 4:

Two Estimates of the Change in Real Output for Education Services in Australia between 1986/87 and 1993/94

Sector	*19867/87* 1. Students^	2. Weights*	3. Weighted Students
1. Schools	3,003,136	1.0	3,003,136
2. Higher Education	391,734	1.7634	690,781
3. TAFE	911,927	0.7862	716,963
4. Total	4,306,797	na	4,410,880
	1993/94		
5. Schools	3,098,878	1.0	3,098,878
6. Higher Education	580,507	1.7634	1,023,661
7. TAFE	1,185,351 (1,126,454)#	0.7862	931,931
8. Total	4,864,735 (4,805,838)#	na	5,054,469
9. Per Cent Change	**12.95 (11.59)#**	na	**14.59**

^ These numbers are taken from the ABS publications listed under *Sources* in Table 1, row 4.
* These are the weights listed in Table 2, column 4.
# The bracketed numbers are the actual number of TAFE students in 1993/94 (row 7), the total number of students in 1993/94 using the actual number of TAFE students in that year (row 8), and the per cent change in students between 1986/87 and 1993/94 using the actual number of TAFE students in 1993/94 (row 9).

IV. Discussion and Concluding Remarks

Section II estimates that real inputs to education services grew by 30.67 per cent between 1986/87 and 1993/94. Section III estimates that real output has grown by 14.59 per cent over the same period. Thus, it seems that TFP has fallen by

around 16 per cent. However, it is appropriate to ask whether quality has remained constant during this period.

There is much anecdotal evidence that the quality of teaching has fallen in the School and Higher Education sectors over the period 1986/87-1993/94. One example of this is presented by Johnson & O'Dea (1996). They submit data on mean class size and the student-teaching staff ratio for government primary education in Victoria over this period. This data shows that mean class size has increased by around four per cent and the student-teaching staff ratio has increased by around six per cent for government primary education in Victoria. If the premise that the average quality of all sectors has fallen is accepted, how would the estimate presented here for the change in TFP be affected? Table 5 summarises three different possibilities with respect to the behaviour of quality over the period 1986/87-1993/94.

Table 5:

The Effects on Education Productivity of 3 Different Assumptions about Quality for the Period 1986/87-1993/94

Change in Quality (%)	Change in Total Factor Productivity (%)
1. *Zero*	-16.08
2. *- 10*	-26.08
3. *16.08*	Zero

If quality is lower then the amount of education service delivered is also smaller. In this scenario the estimate of the change in real output would be revised downwards. Starting from the benign premise that there has been no change in quality, would imply that, at the very least, TFP has fallen by around 16 per cent (see Table 5, row 1). Taking a pessimistic view and assuming a 10 per cent average reduction in quality across all sectors, the change in real output is revised down to 4.59 per cent. This assumes a 10 per cent reduction in quality leads to an equal 10 per cent reduction in real output. Under this scenario TFP has fallen by around 26 per cent (see Table 5, row 2).

Taking an overly optimistic view, what level of average quality improvement is required in order for there to be no change in productivity over this period? A 16.08 per cent increase in average quality will satisfy this constraint (see Table 5, row 3). That is, average quality would have to improve equal to the estimated reduction in TFP in order to reduce the difference between the change in output and inputs to zero. A 16 per cent improvement in quality seems unrealistic as it is unlikely that any observers would support the notion that average quality has increased at all. Nor is there any evidence of quality improvements in any sectors. Consequently, it can be argued that, as a minimum, productivity has fallen by around 16 per cent. Assuming a pessimistic 10 per cent reduction in average quality across all sectors indicates an upper limit of the fall in productivity of

around 26 per cent. It is likely that the true change in productivity over this period lies somewhere between these two bounds. Further, the estimates presented here suggest that real output over this period has grown half as quickly as previously thought *ie*, 14.59 per cent versus 30.67 per cent.

In conclusion, this study suggests that despite the reallocation of resources between different sectors *ie*, from primary and secondary education to tertiary education, productivity as a whole has declined. Except for the limited sensitivity analysis, there has been no serious attempt to adjust for quality in this study. However, even assuming no change in average quality suggests a significant reduction in productivity has occurred. The assumptions, with respect to quality, required to overturn this result are optimistic and would be difficult to justify as plausible. This, in itself, is an interesting result.

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