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About the research

The contribution of education to economic growth in Australia, 1997—2009

Tom Karmel

This paper uses a growth accounting framework to estimate the impact of increasing education levels on economic growth, based on data from the Survey of Education and Training (SET), conducted by the Australian Bureau of Statistics (ABS). This survey is particularly apt because it allows a fine classification of education levels. The paper incorporates a novel extension by estimating the impact of increasing education levels on labour supply, exploiting the fact that, particularly for women, those with higher levels of education tend to work more than those with lower levels. Not only do those with higher levels of education tend to have a greater chance of being employed, but they also tend to work longer hours.

Key messages

- Increasing education levels are contributing to improved productivity: of the order of 0.14% per annum between 1997 and 2009 (less than for the period 1968—69 to 1989—90). They will do so as long as the wage premiums associated with qualifications are maintained, noting that over the period in question the ratios of the hourly wage rates between education levels have been fairly stable.
- Increasing education levels have had a sizeable impact on the hours worked by the workforce. In fact between 2001 and 2009 this impact (of over 3% on hours worked) was larger than the improvement in labour quality. This effect was almost entirely due to increases in the number of women with degrees and postgraduate qualifications.

The research in this paper measures the effect of increasing education levels on the quality of labour and hence the level of output. As acknowledged in the paper, it does not consider any effects that changing education levels might have on technology — so called 'endogenous growth' mechanisms.

Rod Camm
Managing Director, NCVER

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Introduction[1]

Skills are typically acquired from formal education, general life experience and learning on the job. However, when policy-makers talk about 'skills' they generally use qualifications and education levels as a proxy, for the simple reason that they can be quantified. Thus when governments have designed policies to increase skill levels, they are usually couched in terms of qualifications. So we see that the Australian Government has set targets such as '40% of 25—34 year olds will have a degree by 2025' and 'there will be a doubling of diploma completions from 2009 to 2020' (Australian Department of Education, Employment and Workplace Relations [DEEWR] 2009; Council of Australian Governments [COAG] 2012).

While there is no doubt that education and training is a good thing in its own right, the motivation for increasing skill (qualification) levels is that this will produce a positive impact on productivity and hence living standards. In fact, increased skill levels also have an indirect effect on living standards through the impact on labour force participation. This is because those with higher levels of education have, on average, considerably higher labour force participation rates, although (full-time) education does delay entry into full-time work. These participation rates translate into higher levels of economic activity and hence overall living standards: there are more workers and fewer people who are economically inactive. Ken Henry (2007) talked about the three P's — productivity, participation and population. Increased population will also lead to higher levels of economic activity, but this will only flow through to higher living standards if larger populations lead to increased income per capita. However, there is little ambiguity about the direction of the impact of increased education levels on productivity and participation.

The impact of education levels on participation is reasonably straightforward. Those who are better educated find it easier to get jobs (see, for example, Kennedy & Hedley 2003), and better/higher-paid jobs. They also tend to work longer hours (in particular more full-time jobs and fewer part-time jobs). On the other hand, those remaining in full-time education longer will tend to work less while studying. Therefore an increase in education levels can be expected to result in an increase in the labour supply, as long as the increased labour supply at older ages is greater than the decrease during the years of full-time education.

The impact of education levels on productivity is a little more complicated. There are two channels here. The first is that better educated people are more skilled, and this is reflected in higher relative wages. So an increase in the proportion of people with qualifications will flow through to an improvement in the quality of labour: for the same number of hours worked the economic output will be higher.

The second channel is a little more subtle. In a world with fixed technology, output can increase only if there is an increase in factor inputs (notably labour and capital) or in the quality of these inputs. However, if technology is evolving, then more can be produced with the same inputs. In such a world, increased skills may have a role in changing technology. Technology may be 'endogenous' (that is, affected by the economy rather than something that is fixed), and education levels may be one of the influencers of technology. For example, van Zon (2001) constructs a model in which highly skilled labour can be directed to either research and development (R&D) or as an input into final output

[1] I would like to thank Alice Bednarz for her assistance in typing the equations and checking the calculations.

production. If skilled labour is directed to the former, then the economy's productive potential expands and the demand for skilled labour can increase. If it is directed to the latter, then the economy will grow because of an improvement in the quality of labour, but will eventually hit a limit as the marginal product of skilled labour falls to that of unskilled labour (research graduates driving taxis?). In such a world the demand for skilled labour essentially remains static, and so an expansion in the number of skilled people leads to a decline in their wages.[2] These alternatives are succinctly captured in Dowrick (2003), who looks at whether education leads to growth effects through changes in technology or simple-level effects on the economy's output.

The purpose of this paper is to quantify the direct impact of increasing education levels on economic growth for the period 1997—2009, abstracting from any 'endogenous growth' mechanisms. These calculations build on similar calculations made for earlier periods (Karmel 1995). Earlier, I estimated that over the period 1968—69 to 1989—90 the quality of labour increased by 13% due to improving levels of education (Karmel 1995, p.87). That is, the quantity of labour could have been reduced by 13% without affecting overall economic output. An alternative interpretation is that the change in the educational structure of the workforce explained around 0.4 percentage points of the multifactor productivity improvement of 1.4% per year between 1968—69 and 1989—90. It seems that the increase in skills levels is important, but not dominant, in explaining increases in productivity.

The data we draw on come from the Survey of Education and Training, which provides detailed educational qualification data and labour force data, including earnings. We use a particularly detailed education classification, which cross-classifies qualifications by whether the individual has completed Year 12 or not. This is to account for the large differences between certificates in terms of complexity and potential earnings.

In the next section we describe the theoretical framework, which is the one essentially used by the ABS (2001) in its estimates of multifactor productivity. The ABS's approach is to decompose the change in the output of the economy into a component that reflects changes in labour and capital inputs, and a residual. The residual is labelled the change in multifactor productivity and captures the changes in technological capacity of the economy, including those from 'endogenous growth' mechanisms.[3] Readers who are not interested in the technical details may wish to move directly to the presentation of the results. We end with a short discussion that compares the results with the earlier calculations and estimates of changes in the quality of labour published by the ABS (but based on a somewhat different methodology).

In brief, we find that the change in education levels has led to an improvement in the quality of labour, equating to a contribution to multifactor productivity of 0.14% per annum between 1997 and 2009, noting that the increase in multifactor productivity between 1997 and 2009 was an average of 0.5% per annum. While this is not as large as estimates for earlier periods (as discussed earlier), it is against a background of a decline in multifactor productivity in recent years. In addition, we found that the change in education levels led to an increase in average hours worked per head of the 15 to 64-year-old population of a little over 3% between 2001 and 2009 (which is a little higher in its effect on total output than the improvement in labour quality over the same period).

[2] There are many ways in which education can lead to 'endogenous' growth (see Dowrick 2002). One mechanism suggested by an anonymous referee is that a more educated workforce in Australia would attract increased foreign investment or encourage companies in Australia to focus on high-skill activities in Australia relative to overseas.

[3] Eslake (2011) provides a good non-technical description of the concept of productivity.

The theoretical basis

The conventional link between education and economic growth is based on the productivity-augmenting role of education. If more-educated labour is more productive than less-educated labour, and the difference in productivity reflects the effect of education, then an increase in the education levels of the workforce will lead to growth in the economy. The majority of empirical work in this area has been based on growth accounting, which ascribes economic growth to various inputs contributing to economic production.

Growth accounting has largely been developed by Schultz (1961) and Denison (1964), following the development of the neoclassical theory of growth proposed independently by Solow (1956) and Swan (1956). It is based on the idea that, if the economy can be described by a simple production function, then economic growth can be split into changes in the various inputs plus a growth residual, which is interpreted as technical change or growth due to advances in knowledge. The growth accounting methodology allows us to view education as a way of improving the stock of human capital. Increasing levels of education, by altering the mix of skilled labour to unskilled labour, raises overall productivity levels.

This is essentially the methodology used by the ABS to estimate the change in multifactor productivity. It should be noted that multifactor productivity differs fundamentally from labour productivity: the former takes into account the relationship between output and all factors of production, while the latter, the relationship between output and labour. Labour productivity can go up because of an increase in capital in the economy with no change in the 'skill' of labour, and with no change in multifactor productivity.

We explain the approach and show how education plays a part in it by assuming that there are three factors of production: educated labour (L_1), uneducated labour (L_2) and capital (K). Denote the output of the economy as

$$Y = Af(L_1, L_2, K), \tag{1}$$

where A represents technology.

Differentiating with respect to time t gives

$$\frac{dY}{dt} = f\frac{dA}{dt} + w_1\frac{dL_1}{dt} + w_2\frac{dL_2}{dt} + r\frac{dK}{dt} \tag{2}$$

where w_1, w_2 and r are the marginal products of educated labour, uneducated labour and capital, respectively.

Rearranging terms we obtain

$$\left(\frac{1}{Y}\right)\left(\frac{dY}{dt}\right)=\frac{Af}{Y}\frac{dA}{dt}\left(\frac{1}{A}\right)+\frac{w_1L_1}{Y}\frac{dL_1}{dt}\left(\frac{1}{L_1}\right)+\frac{w_2L_2}{Y}\frac{dL_2}{dt}\left(\frac{1}{L_2}\right)+\frac{rK}{Y}\frac{dK}{dt}\left(\frac{1}{K}\right) \quad (3)$$

On the assumption that factors are paid their marginal products and there are constant returns to scale, we have that w_1 is the wage rate of educated labour, w_2 is the wage rate of uneducated labour, r is the return to capital and that the factor shares of total national income are given by

$s_1=\frac{w_1L_1}{Y}$, $s_2=\frac{w_2L_2}{Y}$ and $s_k=\frac{rK}{Y}$ respectively.[4]

Then we can rewrite (3) as

$$\hat{Y}=\hat{A}+s_1\hat{L}_1+s_2\hat{L}_2+s_k\hat{K} \quad (4)$$

where ^ denotes the percentage change. We denote

$$p_i=\frac{L_i}{L} .$$

Making use of the fact that

$$\hat{p}_i=\hat{L}_i-\hat{L} ,$$

we obtain

$$\hat{Y}=\hat{A}+s_1\hat{p}_1+s_2\hat{p}_2+s_L\hat{L}+s_K\hat{K} , \quad (5)$$

where $s_L=s_1+s_2$.

Then,

$$s_1\hat{p}_1+s_2\hat{p}_2$$

provides an estimate of the contribution of education to growth, in the sense that education determines the skill structure of the workforce.

It is instructive to rewrite this in terms of wage rates relative to the average. Noting that

$$s_i=\frac{w_iL_i}{Y}=\frac{w_i}{w}s_Lp_i ,$$

where w is the average wage of all labour, and so

$$\frac{wL}{Y}=s_L ,$$

we can rewrite the education contribution as

$$s_L\left(\frac{w_1}{w}\Delta p_1+\frac{w_2}{w}\Delta p_2\right) , \quad (6)$$

where Δ indicates the (absolute) change over time.

[4] Euler's theorem states that if the production function is homogeneous of degree 1 (that is, constant returns to scale), then the product is exhausted if factors are paid their real marginal products.

Consequently, earnings data by education group are all that are required to measure the impact of changes in the educational structure of the workforce on overall growth.[5] If all the different education groups get equal earnings or if they expand at the same rate, then education will not contribute to overall growth.

We now generalise the approach to account for the differential productivity of different demographic groups. Let w_{ij} be the wage rate of the *j*th education group within the *i*th demographic group. Let L_{ij} be the corresponding labour input, say, measured in hours.

Then from equation (3) we have that the contribution of the workforce to changes in output is

$$\sum_{ij} \frac{w_{ij} L_{ij}}{Y} \hat{L}_{ij} \ . \tag{7}$$

Now

$$L_{ij} = \left(\frac{L_{ij}}{L_i} \right) \left(\frac{L_i}{L} \right) L \ ,$$

where $L_i = \sum_j L_{ij}$. Hence

$$\hat{L}_{ij} = \hat{q}_{ij} + \hat{p}_i + \hat{L} \ ,$$

where $q_{ij} = \frac{L_{ij}}{L}$ and $p_i = \frac{L_i}{L}$.

So the contribution of labour to growth is

$$\sum_{ij} \frac{w_{ij} L_{ij}}{Y} \hat{q}_{ij} + \sum_{ij} \frac{w_{ij} L_{ij}}{Y} \hat{p}_i + \sum_{ij} \frac{w_{ij} L_{ij}}{Y} \hat{L} \ . \tag{8}$$

The first term of (8) is the contribution of changes in education, the second is the contribution of changes in demographic structure and the third is the contribution of the overall change in the quantity of labour.

Define

$$v_i = \frac{\sum_j w_{ij} L_{ij}}{wL} \ ,$$

the share of the wage bill going to demographic category *i*. Then a small amount of algebraic manipulation gives the education contribution as

$$s_L \sum_i v_i \sum_j \frac{w_{ij}}{w_i} \Delta \mathrm{q}_{ij} \ . \tag{9}$$

[5] In actual practice the computations can be somewhat more complex. Denison's estimates for the United States, for example, contain a component accounting for changes in the demographic structure and include adjustments for the changes in the quality of education caused by increases in days per school year.

The other contributions to economic growth from changes in labour inputs come from changes in the demographic profile

$$s_L \sum_i \frac{w_i}{w} \Delta p_i$$

and the change in the overall quantity of labour, $s_L \hat{L}$.

Indexes of labour quality based on changes to the educational mix can be constructed by assuming that the share of national income of the group in question is 100%. That is, for the *i*th demographic group we put $s_L = 1$ and $v_i = 1$.

Then (9) simplifies to

$$\sum_j \frac{w_{ij}}{w_i} \Delta \mathrm{q}_{ij} \tag{10}$$

Thus we define the index of labour quality for the *i*th demographic group as

$$I_i^{t+1} = I_i^t \left(1 + \sum_j \frac{w_{ij}}{w_i} \Delta \mathrm{q}_{ij} \right) \tag{11}$$

Similarly, we can define indexes for aggregations of demographic groups over a set *S* (such as all females or all persons) by

$$I_{i \in S}^{t+1} = I_{i \in S}^t \left(1 + \sum_{i \in S} \left(\frac{v_i}{\sum_{i \in S} v_i} \right) \sum_j \frac{w_{ij}}{w_i} \Delta \mathrm{q}_{ij} \right) \tag{12}$$

for the aggregation of demographic groups over the set *S*.

The index reflects the idea that the productivity of the workforce will increase if the more skilled sectors (that is, those who have relatively high earnings) expand faster than the less skilled sectors. The index will only increase if different skill categories have different relative wages and the more highly paid categories expand their share of the workforce.

The index can be interpreted in a number of ways. If we think of the economy as having a single input of the labour of the demographic group being considered, then the increase in the index represents the growth in the hypothetical economy due to the changing educational mix. That is, the increase in the index weighted by the appropriate share of total income gives the contribution to overall economic growth. Alternatively, we can think of the increase in the index as representing the reduction in the quantity of the labour of the group in question that could be made without affecting overall economic output.

Changes in labour force participation

One of the ways by which increases in education levels impact on the economy is through their effect on labour force participation. Those with higher educational qualifications typically are more likely to work and work more hours (although one exception is that 'prime age' males with poor education often work long hours to compensate for a low rate of pay; another is that full-time study delays entry into the full-time workforce).

To isolate the changes in education and demographic structure on the quantity of labour, we decompose L as follows:

$$\begin{aligned} L &= \sum_{ij} L_{ij} \\ &= \sum_{ij} \frac{L_{ij}}{N_{ij}} \frac{N_{ij}}{N_i} \frac{N_i}{N} N \\ &= \sum_{ij} h_{ij} e_{ij} n_i N \end{aligned} \tag{13}$$

where N represents the population and:

h_{ij} = average hours worked by the population in education category j of demographic group i

e_{ij} = share of the population in education category j (of demographic group i), and

n_i = share of the population in demographic group i.

So

$$\hat{L} = \sum_{ij} l_{ij} \hat{h}_{ij} + \sum_{ij} l_{ij} \hat{e}_{ij} + \sum_{i} l_i \hat{n}_i + \hat{N} \ , \tag{14}$$

where $l_{ij} = \frac{L_{ij}}{L}$ and $l_i = \frac{L_i}{L}$.

The first term is an hours effect, reflecting the change in average hours worked within groups; the second term is an education effect, reflecting the impact of changing education levels on hours worked, while the third term is a demographic effect, reflecting the impact of the change in demographic structure on hours worked.

Results

The contribution of changing education to economic growth depends on two parameters: relative wages and relative average hours worked.[6] It is instructive to look at these ratios before calculating the overall contributions. We present the data for 2001 for the various age and sex demographic groups.[7] The wage rates are expressed relative to the overall rate, consistent with equation 9.

For males, for all age groups those with a degree or a diploma have higher wage rates than average, and early school leavers have wage rates lower than average. It is also interesting to note that having a certificate is not necessarily superior to completing Year 12. The table also shows that the ABS classification is not without issues, with those who have Year 12 and a certificate I/II, level undefined/unknown, having higher wage rates than the corresponding group with a certificate III/IV for some age groups; the ABS categories of level undefined/unknown make any interpretation problematic.

Table 1 Hourly wage rates relative to group average, males, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years
Postgraduate degree, graduate dip./cert.	1.70	1.18	1.18	1.16	1.26
Bachelor degree	1.28	1.22	1.15	1.16	1.20
Advanced diploma/diploma	1.21	1.05	1.07	1.09	1.20
Certificate III/IV and Year 12	1.11	0.99	0.98	1.02	1.06
Certificate III/IV and not Year 12	1.09	0.98	0.93	0.93	1.00
Certificate I/II/not defined/unknown and Year 12	0.80	1.07	1.13	1.15	0.98
Certificate I/II/not defined/unknown and not Year 12	0.91	0.86	0.87	0.90	0.87
Year 12	0.99	0.97	1.05	1.00	1.10
Early school leaver/did not go to school	0.88	0.84	0.89	0.87	0.81
Currently attending school	0.66	-	-	-	-
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Source: Derived from Survey of Education and Training, 2001.

While we see similar patterns for females, the possession of a degree is even more advantageous.

[6] It also can depend on the level of disaggregation. We use a particularly detailed educational and demographic disaggregation by comparison with, for example, the Organisation for Economic Co-operation and Development (OECD; 2003), which employs three education levels (less than senior secondary, secondary and tertiary) by gender. Aggregated data will tend to attribute less to changes in the quality of labour relative to more disaggregated data.

[7] The tables were filtered on all employed persons; the earnings variable was 'Usual weekly earnings in current (main) job or business — ranges'; the hours variable was 'Hours usually worked per week in current job or business'.

Table 2 Hourly wage rates relative to group average, females, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years
Postgraduate degree, graduate dip./cert.	1.35	1.20	1.30	1.22	1.22
Bachelor degree	1.24	1.10	1.23	1.25	1.19
Advanced diploma/diploma	1.07	1.03	1.11	1.06	1.15
Certificate III/IV and Year 12	1.00	0.92	1.00	0.86	1.07
Certificate III/IV and not Year 12	1.02	0.81	0.80	0.89	0.75
Certificate I/II/not defined/unknown and Year 12	1.36	1.13	1.49	1.10	1.19
Certificate I/II/not defined/unknown and not Year 12	0.76	1.03	0.70	0.94	0.88
Year 12	0.96	0.94	0.95	0.91	1.04
Early school leaver/did not go to school	0.89	0.88	0.82	0.87	0.88
Currently attending school	0.66	-	-	-	-
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Source: Derived from Survey of Education and Training, 2001.

Turning now to average hours worked, we present two sets of tables. The first is average hours worked per employed person and the second (which takes into account labour force participation), average hours worked per head of population. It is the second that is more relevant to our estimates because it provides the measure of employment participation, taking into account not only the proportion working but also the hours they work.

Earlier we had foreshadowed that those with higher qualifications tended to participate more in the labour market. However, table 3 suggests that this is an over-simplification, with an offsetting trend of males with low-level qualifications working long hours. So at the aggregate level the average working hours of men with a certificate III/IV and not Year 12 are only surpassed by those of men with a postgraduate qualification. This is most likely reflecting that lower-qualified men have to work longer hours to achieve an income target.

Table 3 Average weekly hours worked per employed person, males, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	Total
Postgraduate degree, graduate dip./cert.	37.6	47.7	46.4	46.0	42.6	45.8
Bachelor degree	36.2	43.4	44.9	44.6	43.1	43.4
Advanced diploma/diploma	35.1	43.5	46.5	45.2	40.9	43.7
Certificate III/IV and Year 12	40.2	43.7	45.2	44.7	42.6	43.5
Certificate III/IV and not Year 12	41.4	44.5	46.7	44.5	39.5	44.4
Certificate I/II/not defined/unknown and Year 12	36.1	43.8	38.0	41.0	43.5*	40.6
Certificate I/II/not defined/unknown and not Year 12	37.4	45.4	41.9	44.1	41.2	42.2
Year 12	29.7	42.1	43.4	45.1	40.5	37.8
Early school leaver/did not go to school	37.2	42.5	44.3	44.9	42.6	42.7
Currently attending school	9.0	-	-	-	-	9.0
Total	**31.3**	**43.4**	**45.2**	**44.9**	**41.5**	**41.9**

Notes: 1 Reporting of hours worked differs from the 2009 survey, with hours reported in single hours to 50 and in ranges above 50. Mid-points of these ranges were taken.

2 *indicates data are based on fewer than five survey respondents.

Source: Derived from the Survey of Education and Training, 2001.

We see that for men there is not a huge variation across the different educational groups, although those with post-school qualifications tend to work longer hours, and those with postgraduate qualifications work the longest hours (per head of population).

Table 4 Average weekly hours per head of population, males, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	Total
Postgraduate degree, graduate dip./cert.	36.1	44.0	44.2	42.9	32.1	41.8
Bachelor degree	30.5	39.4	41.8	41.6	28.8	38.6
Advanced diploma/diploma	26.7	41.1	42.9	41.9	28.7	38.5
Certificate III/IV and Year 12	35.4	41.4	43.2	39.4	30.0	39.3
Certificate III/IV and not Year 12	38.0	41.6	43.8	38.3	23.9	37.9
Certificate I/II/not defined/unknown and Year 12	30.1	31.3	27.8	36.4	43.5	32.1
Certificate I/II/not defined/unknown and not Year 12	29.5	35.4	31.8	35.4	26.6	31.3
Year 12	22.9	36.1	39.1	37.2	30.2	31.0
Early school leaver/did not go to school	25.9	33.8	35.6	34.2	21.1	30.6
Currently attending school	2.7					2.7
Total	**20.3**	**38.1**	**40.1**	**38.1**	**24.7**	**33.0**

Source: Derived from Survey of Education and Training, 2001.

For women, the variation in hours worked across educational qualifications is much greater, particularly when hours are expressed per head of population (tables 5 and 6).

Table 5 Average weekly hours per employed person, females, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	Total
Postgraduate degree, graduate dip./cert.	33.9*	36.0	33.7	38.5	34.2	35.7
Bachelor degree	35.0*	36.5	31.2	34.3	33.9	34.4
Advanced diploma/diploma	34.0*	32.5	29.0	32.1	27.8	31.3
Certificate III/IV and Year 12	35.2*	33.4	26.8	36.7	24.9	33.2
Certificate III/IV and not Year 12	30.8*	31.8	29.2	27.4	29.4	29.4
Certificate I/II/not defined/unknown and Year 12	32.4*	37.2	31.7	20.6	31.8	30.2
Certificate I/II/not defined/unknown and not Year 12	30.5*	20.5	31.5	29.6	31.1	28.9
Year 12	23.6*	32.4	28.9	34.6	31.3	28.3
Early school leaver/did not go to school	30.6*	28.3	27.9	30.3	26.6	28.8
Currently attending school	8.7*	-	-	-	-	8.7
Total	**25.1***	**32.5**	**29.4**	**32.0**	**28.8**	**29.8**

Notes: 1 Reporting of hours worked differs from the 2009 survey, with hours reported in single hours to 50 and in ranges above 50. Mid-points of these ranges were taken.

2 *indicates data are based on fewer than five survey respondents.

Source: Derived from the Survey of Education and Training, 2001.

Table 6 Average weekly hours per head of population, females, 2001

Type of qualification	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	Total
Postgraduate degree, graduate dip./cert.	22.8	29.5	30.7	33.0	24.3	30.1
Bachelor degree	29.9	31.1	24.4	29.2	19.6	27.9
Advanced diploma/diploma	30.9	25.6	21.4	25.8	16.5	23.9
Certificate III/IV and Year 12	30.8	24.8	18.8	25.8	11.9	25.3
Certificate III/IV and not Year 12	21.4	21.5	21.3	22.4	13.1	20.4
Certificate I/II/not defined/unknown and Year 12	25.2	17.7	20.2	11.4	19.3	18.2
Certificate I/II/not defined/unknown and not Year 12	13.2	11.0	22.2	22.7	11.5	17.1
Year 12	17.6	23.2	19.6	24.8	10.8	19.9
Early school leaver/did not go to school	14.7	15.3	17.5	18.7	8.0	15.1
Currently attending school	3.6					3.6
Total	**15.8**	**22.6**	**20.6**	**22.6**	**10.9**	**19.1**

Source: Derived from Survey of Education and Training, 2001.

Another point of note is that the average hours worked by men is significantly higher than those worked by women, irrespective of the age group and educational category.

We now move on to the primary point of the paper, which is to look at the impact of changing educational levels on economic growth. We first look at the effect on labour quality, based on equation 12 (table 7).

Our choice of years is determined by data availability. Our interest is in the period 1997—2009. However, limitations to the scope of the survey in 1997 mean that we cannot estimate the effect of changes to education on levels of hours worked between 1997 and 2001. Hence, we have made use of the 1997, 2001 and 2009 surveys.

Recall that the interpretation of these figures is that an improvement in labour quality of 5% means that the same output could be produced with 5% less labour. We see that between 1997 and 2001, the quality of labour improved very little, while between 2001 and 2009 it improved overall by around 2.7%. This is quite sizeable when judged against changes in overall labour force participation or average hours worked.

The improvements in labour quality can be translated into an impact on economic growth by weighting by the labour share of economic output (see equation 4). Over this period this stood at around 54%. Converting the improvement in labour quality to an annual equivalent and multiplying by 0.54 gives the overall annual contribution of changing education levels of 0.05% for 1997—2001 and 0.18% between 2001 and 2009. The former figure is of little consequence, while the latter is larger, but is around a half of my calculation of 0.4% for the period 1968—69 to 1989—90[8] (Karmel 1995).

While our estimate, even for 2001—09, is not particularly large, it is against a background of very flat productivity growth, according to ABS estimates. The ABS estimate of the change in multifactor productivity between 2001 and 2009 is 0.5% for 2001—09, which makes the 0.18% increase per annum look quite large.

[8] Multifactor productivity increased by an annual average of 1.4% over the period 1968—69 to 1989—90.

Table 7 Contribution of changing education levels to the quality of labour, % improvement, average weights[9]

Improvement in labour quality (%)	1997– 2001	2001–09
Males		
15–24 years	1.15	0.42
25–34 years	1.68	4.01
35–44 years	0.37	2.36
45–54 years	1.26	0.82
55–64 years	2.01	1.90
Females		
15–24 years	-0.74	0.73
25–34 years	-0.49	4.10
35–44 years	-0.19	4.72
45–54 years	0.02	3.93
55–64 years	1.61	2.47
Total improvement in labour quality (%)	**0.69**	**2.69**
Annual contribution to economic growth (%)	**0.05**	**0.18**

Source: Derived from Survey of Education and Training 1997, 2001, 2009.

Our final calculation of the importance of changing educational qualifications to economic growth is the component due to the increasing hours worked associated with increasing education levels (the second term of the right-hand side of equation 14). The calculations can only be done for 2001 and 2009 because the scope of the survey in 1997 did not cover the whole population.[10]

Table 8 Increase in hours worked attributed to changes in education levels, 2001–09, %

Increase in hours worked (%)	
Males	
15–24 years	-1.6
25–34 years	0.9
35–44 years	0.7
45–54 years	0.8
55–64 years	3.3
All males	0.8
Females	
15–24 years	2.0
25–34 years	10.1
35–44 years	5.1
45–54 years	6.3
55–64 years	12.9
All females	7.0
Total increase in hours worked (%)	**3.1**

Source: Derived from Survey of Education and Training 2001, 2009.

[9] The decomposition depends on weights for each category. In this table the weights are the average of the weights at the beginning of the period and the weights at the end of the period.

[10] Essentially the same methodology was used for the 2001, 1997 and 1993 surveys. However, the scope of the surveys differed. The 2001 survey included all persons aged 15—64 years, regardless of their employment or study status. By comparison, the 1997 survey included people aged 15—64 years who: had worked as wage or salary earners in the previous 12 months; were employed, unemployed or marginally attached to the labour force; were aged 15—20 years and still at secondary school; and were not in the labour force but were studying, or had studied in 1997.

Our calculation suggests that hours worked increased by just over 3% between 2001 and 2009 because of changes to education levels. Not surprisingly, the largest increases are for females and, indeed, the total hours worked by females increased by 7% over this period. Within the female population two groups stand out: those aged between 25 and 34 years and those between 55 and 64 years.

We see that in fact this labour force participation effect is more important than the impact on productivity. The improvement in labour quality between 2001 and 2009 was 2.7%, compared with the increase in hours worked of 3.1%.

Impact of changing weights

The calculations above are based on fixed weights. In practice the weights change over time, reflecting changes in relative wages and hours worked. The wages weights measure the wage in a category relative to the overall average. By definition therefore an expansion in the numbers of people with degrees, for example, implies that the wage of degree holders relative to the overall wage will decline. If the expansion in the number of people with degrees leads to a decline in the wages of this group relative to other groups, then the wages of degree holders relative to the overall wage will decline even further.[11] To get an idea of the impact of this phenomenon on our estimates, we re-do them using weights based on both the first and second observations. (In the earlier calculations we used the mid-point.)

Table 9 Effect of changing weights on estimates of improvements in labour quality

	1997–2001, 1997 weights	1997–2001, 2001 weights	2001–09, 2001 weights	2001–09, 2009 weights
Males				
15–24 years	0.63	1.68	-0.44	1.28
25–34 years	1.88	1.48	3.94	4.07
35–44 years	0.42	0.32	2.37	2.36
45–54 years	1.39	1.13	0.91	0.73
55–64 years	1.47	2.55	2.18	1.62
Females				
15–24 years	0.54	-2.02	1.83	-0.37
25–34 years	0.48	-1.47	4.03	4.18
35–44 years	0.16	-0.54	5.74	3.71
45–54 years	0.01	0.02	3.96	3.89
55–64 years	1.54	1.68	2.47	2.46
Overall improvement in labour quality (%)	0.88	0.52	2.81	2.56
Annual improvement in labour quality (%)	0.17	0.11	0.18	0.17
Annual contribution to economic growth (%)	0.09	0.06	0.10	0.09

Source: Derived from Survey of Education and Training 1997, 2001, 2007.

We see that there is some dilution in the estimates, especially in the period 1997—2001. However, it does seem that the overall estimates are reasonably robust to the choice of weights, although the estimates within some demographic groups are quite variable.

We can also look at the effect of choice of weights on estimates of the contribution of changes in education levels to overall hours. It turns out here that the estimates are sensitive to choice of

[11] Of course, it is possible that the demand for skills has increased, and that the wages of the more-educated increase relative to other groups. The point of the exercise is to test for robustness.

weights. Recall that our estimate based on average weights for 2001—09 showed an increase in overall hours of 3.1%. If we use 2009 weights we get a much larger estimate: 4.75%. However, if we use 2001 weights the estimate is negative (-2.1%). The reason for this is that there have been quite significant changes in the numbers of people in the various education categories, and the changes in the share of the population in the education categories and the changes in the weights (which are based on the share of hours worked) are not independent. The underlying issue is that the decomposition is only precise when there are small changes.

Thus, as well as the earlier decomposition, we undertake some simple calculations. Using 2001 data, we express overall average hours worked as the average hours worked per person in an education category as the product of average hours worked per education category multiplied by the proportion of people in that category, summed over the education categories.[12] We then use the same average hours but the later distribution of people across education categories to reflect the 2009 population. To test the sensitivity of this, we then use the 2009 averages and undertake the same calculations. Thus we have two sets of calculations, one based on the world as it was in 2001, and the other as in 2009.

The results of this exercise are presented below, together with the earlier estimate.

Table 10 Sensitivity of estimates of increase in hours worked attributable to the change in education levels, 2001–09, %

	Estimate from decomposition	Estimate holding constant 2001 average hours and demographic distribution	Estimate holding constant 2009 average hours and demographic distribution	Estimate based on average of (2) and (3)
	(1)	(2)	(3)	(4)
Males				
15–24 years	-1.6	-0.8	-1.4	-1.1
25–34 years	0.9	1.8	1.7	1.7
35–44 years	0.7	0.6	1.1	0.8
45–54 years	0.8	0.7	0.9	0.8
55–64 years	3.3	5.1	1.6	3.4
Total	0.8	1.2	0.9	1.1
Females				
15–24 years	2.0	2.4	2.6	2.5
25–34 years	10.1	9.7	15.3	12.5
35–44 years	5.1	5.3	5.9	5.6
45–54 years	6.3	5.6	6.4	6.0
55–64 years	12.9	14.0	11.1	12.6
Total	**7.0**	**6.7**	**8.2**	**7.5**
All persons	3.1	3.2	3.6	3.4

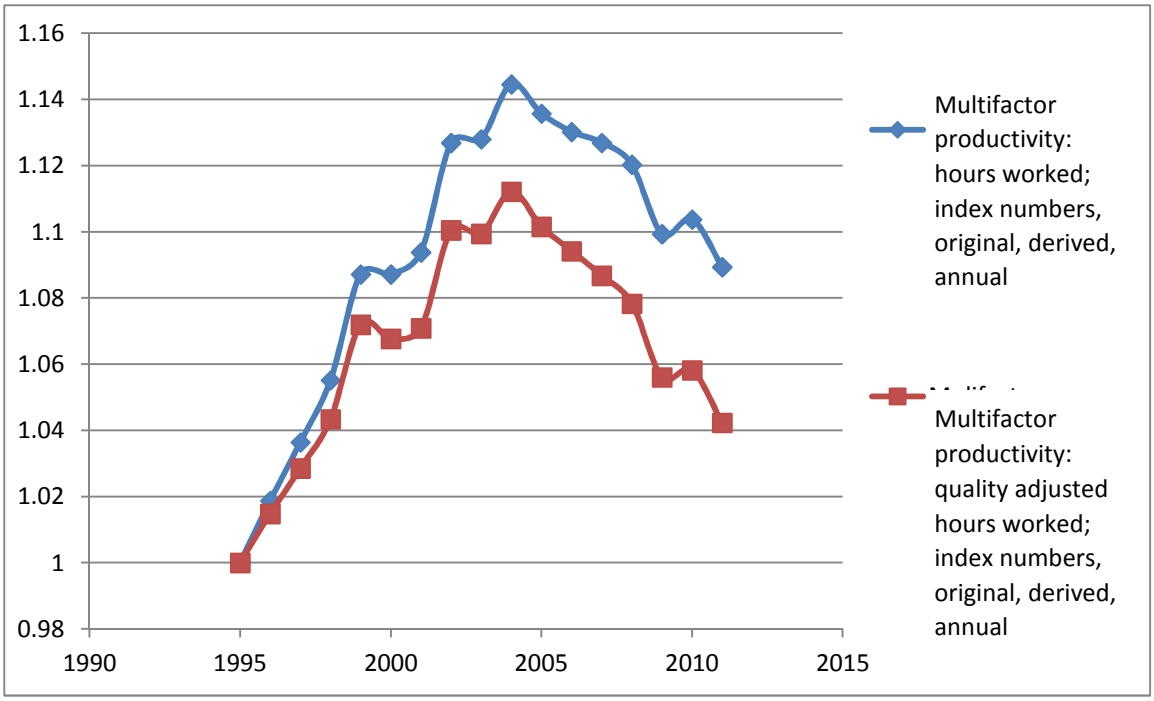
From this table it seems that our earlier estimates are quite robust and confirm that the largest percentage increase comes from women, especially the age groups 25—34 years and 55—64 years. It is interesting that the estimate is larger using the 2009 distributions of average hours and demographics than the one based on the 2001 numbers. This is hopeful, in terms of the outlook for labour force participation, as we look forward to the impact of the current expansion in education.

[12] In fact the calculations are done within each demographic group.

Discussion

Since 2001 the ABS (2001, 2011) has published experimental estimates of multifactor productivity that allow for changes in the quality of labour. The adjustments reflect more than just changes in educational levels: they also allow for changes in the average experience of the workforce. According to the ABS, multifactor productivity peaked in 2004 (irrespective of any adjustments for the quality of labour). Figure 1 shows the multifactor productivity series and the series adjusted for changes in labour quality.

Figure 1 Multifactor productivity and multifactor productivity adjusted for labour quality, 1995 = 1



The difference between the two lines shows the impact of changing labour quality and so is an estimate of the contribution of changing labour quality on multifactor productivity.

The labour quality adjustments imply that, between 1995 and 2004, the changes in education levels and average work experience explain about 0.36% per annum of the increase in multifactor productivity. The corresponding estimate for the period 2004—11 is 0.2% per annum. Since 2004 the increase in productivity due to increasing education levels has been unable to offset the decline in productivity due to other factors.

Our calculations are for the period 1997—09. Over this period the difference between the two graphs represents a contribution to multifactor productivity of 0.27%, compared with our estimate of the contribution of the increase in education qualifications to multifactor productivity of 0.05% for 1997—2001 and 0.18% for 2001—09. The (geometric) average of these is 0.14%. This would suggest that about

half of the ABS estimate of improvement in labour quality can be attributed to increasing education levels. (The remainder would be due to increases in the level of experience as the workforce ages.)[13]

However, it needs to be recognised that the growth accounting methodology is essentially descriptive in nature and has nothing to say about the role of education in changing the nature of technology (that is, 'endogenous growth'). Nevertheless it does enable us to understand the arithmetic of growth — the relative importance of changes to the inputs (labour and capital) and changes in the technology of the economy. Within this approach what emerges from the current analysis can be summarised as follows:

- Increasing education levels are contributing to productivity. They will do so as long as the wage premium associated with qualifications is maintained. Over the last decade the premiums have been fairly stable, and any change over this period is at the margin.
- However, the contribution of increasing education levels to productivity over the period 1997—2009 is rather less than for 1968—69 to 1989—90. The reason for this decline is a matter of simple arithmetic. The relative changes in the quantity of highly skilled labour were greater in the earlier period.[14] As education levels increase, almost by definition, it is more difficult to achieve the same percentage increases.
- Increasing education levels have had a sizeable impact on the size of the workforce, almost entirely due to women with degrees and postgraduate qualifications working on average more hours than their peers with lower-level qualifications. In fact between 2001 and 2009 this impact was larger than the improvement in labour quality.

Thus increasing levels of education have contributed to economic growth, through both a productivity effect and a participation effect, with the latter being particularly important.

[13] The other obvious explanation would be difference in methodology (for example, the education qualification classification) and data sources.

[14] Another factor is that wage premium for degrees dropped between the late 1960s and the late 1970s, but has been remarkably stable since then (see Karmel 2013).

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