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Population Ageing and the Accumulation of Human Capital in Australia, 1981–2001

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Analytical Services Branch

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CONTENTS

POPULATION AGEING AND THE ACCUMULATION OF HUMAN CAPITAL IN AUSTRALIA, 1981–2001

Ewa Orzechowska–Fischer and Hui Wei
Analytical Services

ABSTRACT

Population ageing is an important economic issue facing developed countries, generating many studies and debates. The analysis of population ageing and policy initiatives for addressing it requires relevant statistics. Using the experimental measurement framework for human capital developed by the Australian Bureau of Statistics, this study provides a quantitative assessment of the impact of population ageing on per capita human capital for the period 1981–2001. ABS estimates show that stocks of human capital have grown significantly over this period. However, since the early 1990's, the rate of increase has declined. Our analysis suggests that population ageing has been one of the major drivers of this deceleration of growth in per capita human capital. Negative effects of ageing were of limited magnitude as they have been to some extent counterbalanced by increasing per capita investment in education and training. As population ageing continues, maintaining growth in per capita human capital is a key issue for policy makers.

KEY WORDS: population ageing, per capita human capital, average earnings per worker, decomposition.

1. INTRODUCTION

The Australian population has been ageing for a few decades now. The median age of the population has increased by 5.8 years over the last two decades, from 31.1 years in 1981 to 36.9 years in 2001 (ABS, 2006). Due to the declining proportion of children and the skewing of the population age structure towards older ages, population ageing is projected to continue over the coming 50 years in Australia (ABS, 2005).

An ageing population implies that the labour force will contract in the future. This is because the declining proportion of children in the population who are future labour market entrants and the increasing proportion of older workers approaching their retirement ages lead to more exits than entries to the labour force. The shrinking of labour pools will have consequences for many aspects of a national economy. In Australia, implications of ageing for future economic growth and government spending have been discussed by the Productivity Commission (2005) and the Commonwealth Treasury (2007). An important aspect is the long term productive capacity of the labour force: that is, the human capital embodied in the labour force. As Australia's future economic prosperity depends largely on the growth of its human capital, it is important for policy makers and other interested parties to know how population ageing affects the human capital available for undertaking economic activities.

In response to increasing demand for statistics related to the measurement of human resources, the Australian Bureau of Statistics (ABS) has a research program on the measurement of human capital. So far, this project has produced estimates of the human capital stock for Australia, using Census data (Wei, 2004). The project is also developing a framework for measuring human capital flows, that is, an accumulation account for human capital (Wei, forthcoming). In this framework, the impact of population ageing on the human capital stock is captured through estimating the depreciation component of human capital flows. The measurement is conducted within a national accounting framework. Per capita measures of various components of human capital are compiled for sex–education–age cohorts. The aggregates of human capital are derived by applying these per capita measures to the number of persons in the corresponding cohort and adding up to produce totals.

Based on the human capital stock estimates produced by the ABS research program, this paper examines the behaviour of per capita human capital over time, focusing on the impact of population ageing. The per capita human capital, defined in this paper, is the aggregate human capital stock embodied in the working age population divided by the total number of working age persons in the economy. This is related to the average earnings per worker in an economy, a more commonly analysed statistic. However, if workers' earnings are viewed as returns to his or her human capital, then

it is not difficult to see that per capita human capital is the determinant of per capita earnings and ultimately a key determinant of per capita national income of a national economy. In this sense, per capita human capital is an important indicator of potential economic performance. The objective of this paper is to quantify the impact of population ageing on per capita human capital.

There is a variety of techniques which can be used to analyses changes over time. This paper uses a demographic approach and employs Kitagawa's (1955) decomposition technique. The choice of technique was dictated by the fact that the per capita human capital estimates are derived from the population census. For that reason, a decomposition model based on arithmetic manipulation of differences of averages was chosen. As it relies on information derived from populations, not sample data, it is not accompanied by standard errors and tests of statistical significance. Kitagawa's decomposition is used to separate observed changes in per capita human capital of two periods into components that are attributable to changes in the population age structure and educational composition. In this way, we provide a quantitative assessment of the negative contribution of population ageing and compare it with positive contribution of the educational change to the growth of per capita human capital for Australia in recent decades.

The rest of the paper is structured as follows. Section 2 gives a brief discussion of research technique applied and data used. Section 3 presents and discusses our results. Section 4 provides a conclusion of the paper.

2. METHODOLOGY AND DATA

2.1 Per capita human capital measurement

Human capital can be defined as a productive capacity embodied in individuals. As 'knowledge and skills' are the most important determinants of a person's productive capacity, human capital can also be defined as the knowledge and skills embodied in individuals. Given the measurement methods available in the relevant literature, ABS uses the Jorgenson–Fraumeni lifetime labour income approach (Jorgenson and Fraumeni, 1989) as the basis of our measurement framework for human capital. This method measures the stock of human capital as the discounted present value of expected lifetime labour market income.

In this paper, we calculate per capita human capital [1] in a given census year t as:

$$h_{\bullet\bullet}(t) = \frac{\sum_a \sum_e mi_{ae}(t)\, n_{ae}(t)}{\sum_a \sum_e n_{ae}(t)} \qquad (1)$$

where

a, e denote the discrete values of age and educational attainment variables, respectively,

$mi_{ae}(t)$ = lifetime labour income per capita for persons in the a-th age group and e-th educational category, in a given census year t; and

$n_{ae}(t)$ = the number of people in the a-th age group and e-th educational category in a given census year t.

Our study uses the human capital data base constructed from the full Australian Census data for the period 1981–2001. This data base includes the number of persons, annual incomes, unemployment and labour force participation rates, projected lifetime labour incomes for each Census year, cross-classified by sex, educational attainment and single year of age. The income variables are available both in current and constant dollars. Changes in the number of persons for each sex–education–age cohort over an accounting period are extrapolated using information on schooling and immigration variables from the Census data.

1 The notation of the per capita human capital used in this study, $h_{\bullet\bullet}(t)$, is a standard notation used in the demographic and statistical literature (Kitagawa,1955; Das Gupta,1978 and Romo,2003). It indicates that per capita human capital is aggregated over two dimensions: age and educational attainment.

2.2 Decomposition of differences in the per capita human capital of two inter-censal periods

The effects of ageing and changing educational composition on per capita human capital, have been separated using a two factor decomposition technique. As the decomposition has been conducted on the difference of averages of two inter-censal periods, Kitagawa's decomposition is chosen as an appropriate decomposition method (Kitagawa, 1955; Orzechowska–Fischer, 2005). What follows summarizes the main rationale of this technique, while its mathematical details are given in the Appendix.

The difference in per capita human capital estimates of two intercensal periods has been decomposed into components attributable to changes in the age and educational composition, ($net_{a\bullet}$ and $net_{\bullet e}$, respectively), interaction ($joint_{ae}$) and the residual component ($residual_{\bullet\bullet}$). Mathematically,

$$h_{\bullet\bullet}(t) - h_{\bullet\bullet}(t-1) = net_{a\bullet} + net_{\bullet e} + joint_{ae} + residual_{\bullet\bullet} \qquad (2)$$

The item $net_{a\bullet}$ shows how much the per capita human capital would change if there had been only changes in the age composition of the population and no changes in other factors. Correspondingly, the $net_{\bullet e}$ item indicates how much per capita human capital would change if there had been no changes in the age or other factors, but there had been changes in the educational composition of the population. The $joint_{ae}$ item is an interaction term, measuring the change in the per capita human capital that cannot be allocated to independent changes either in the age or educational composition. The residual component ($residual_{\bullet\bullet}$) estimates how much per capita human capital would change if there had been no changes in the age or educational composition of the population, but there have been changes in other factors only.

The decomposition analysis calculates the contribution of each component to the total difference between per capita human capital of two periods by holding constant at the average level either the compositional or the residual components. This has important implications for interpreting results of the decomposition analysis, as it allows us to discuss the contribution of particular components to the difference in per capita human capital estimates of two periods.

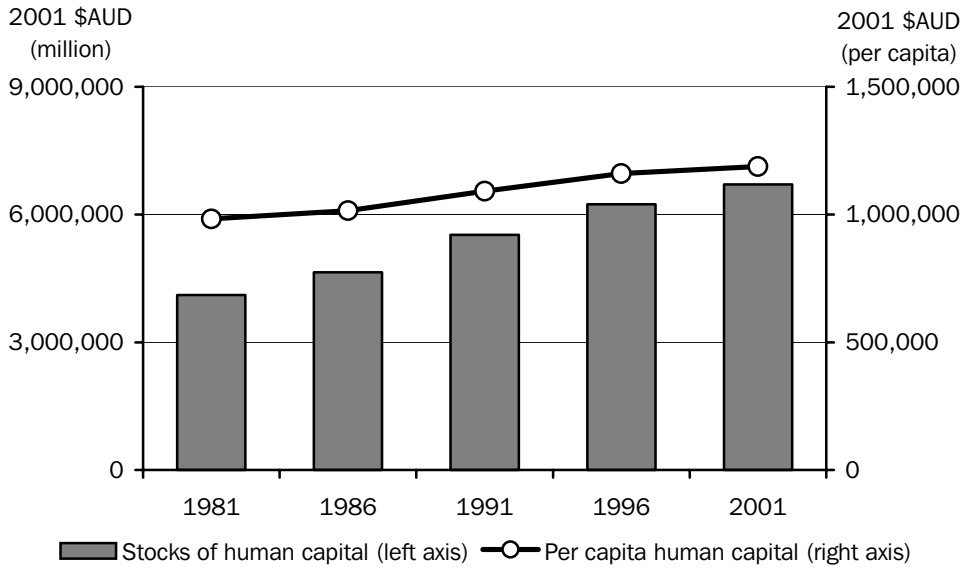
3. RESULTS

The following section presents the decomposition analysis of changes in per capita human capital for Australia between 1981 and 2001. The results of the decomposition are preceded by a brief analysis of growth of per capita human capital as well as variations in the age structure and educational attainment of the Australian census population over the period of study.

3.1 Trends in the accumulation of human capital in Australia

Human capital has been constantly growing in aggregate and per capita terms in Australia between 1981 and 2001. Figure 3.1 shows that the aggregate stock of human capital has increased by 63.2 % as compared to its 1981 level.

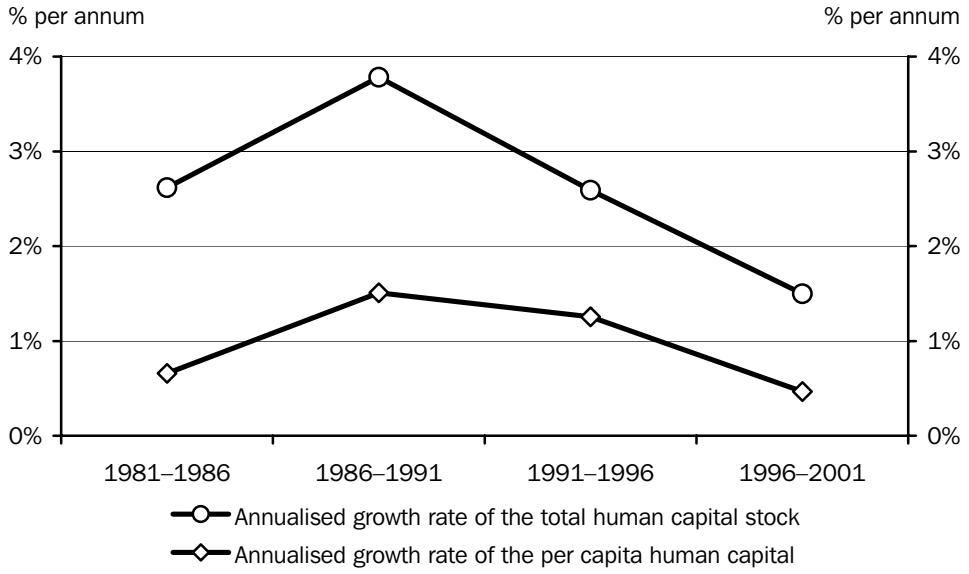
3.1 Human capital stocks and per capita human capital, Australia, 1981–2001



Over the same time, the per capita human capital rose by 21 per cent. Its growth rate remained below that of the aggregate level of human capital stock, as revealed in figure 3.2. Although increasing over the 1981–2001 period, since 1991 onwards, annualized growth rates of both per capita human capital and the aggregate stock of human capital have been growing at a slowing pace.

Why has the pace of the accumulation of human capital decelerated recently? The two major drivers of human capital are population ageing and educational attainment of the Australian labour force. We will now investigate their characteristics over the same period.

3.2 Annualized growth rates of human capital stocks and per capita human capital, Australia, 1981–2001

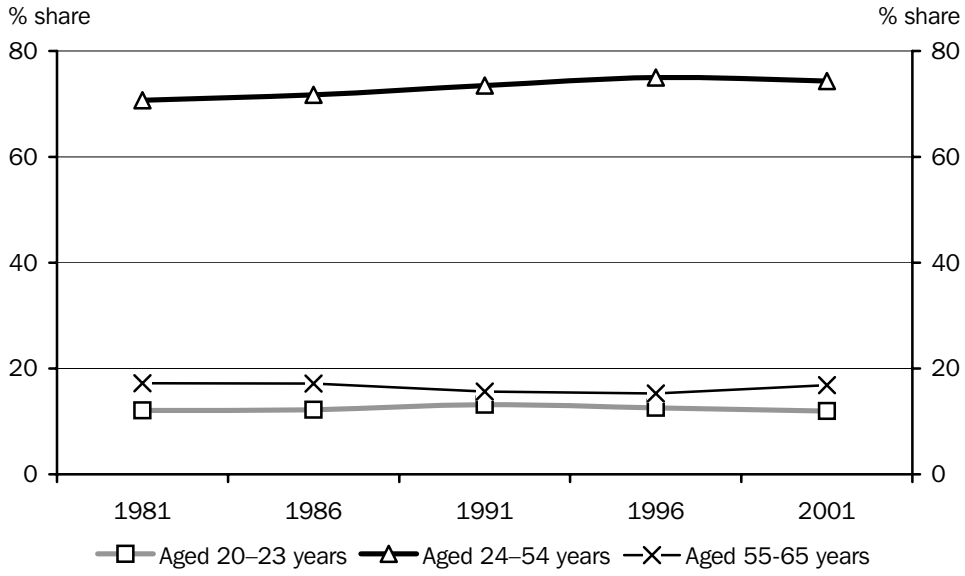


3.2 Changes in the age and educational composition of the population

Figure 3.3 illustrates changes in the age composition of the Australian population over the 1981–2001 period. It shows that, since 1991, the proportion of the youngest part of the labour force, defined in this analysis as those aged 20 to 23 years, has been declining and the proportion of the oldest group (those aged 55 to 65) has been increasing. In addition, the share of those in the working ages (aged 24–54) has declined over the 1996–2001 period.

These age-compositional changes, in particular the recently observed decline in the share of the prime working age population although limited in its magnitude (a total decrease of 0.7 percentage points), point to recent advances in ageing of the Australian population. The process of population ageing takes, in its initial stages, the form of a decline in proportion of younger and an increase in the share of older age groups. As ageing advances and already contracted younger cohorts move throughout their life cycle to older age groups, decline in the prime working age groups occurs. Data presented in the figure 3.3 indicate that the Australian population is currently entering this stage of its ageing.

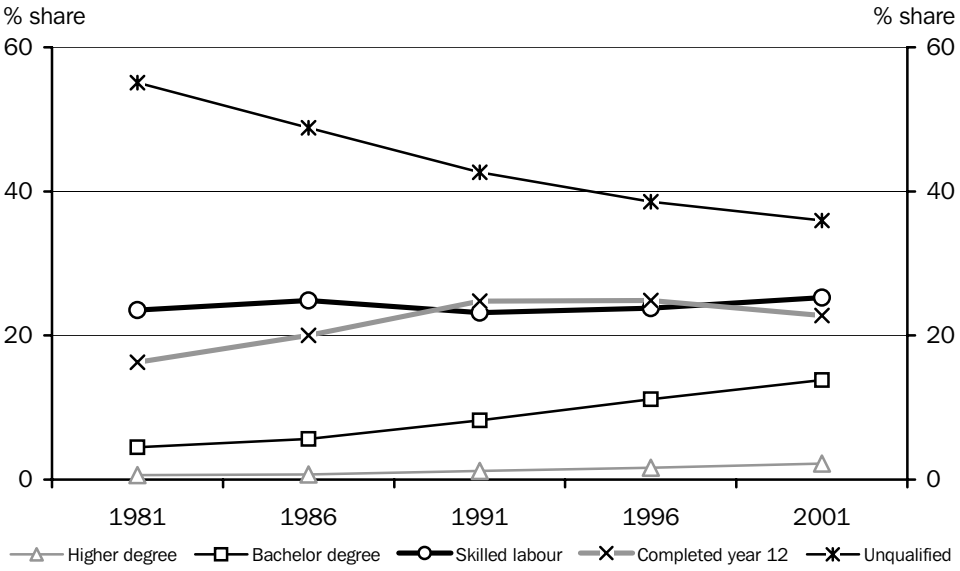
3.3 Changes in the age composition of the census population aged 20 to 65, Australia, 1981–2001



Changes in the age composition of the Australian population carry important implications for human capital formation. Firstly, the declining share of younger age groups in the population limits the pool of the new labour market entrants, who form the base for the growth of human capital. Secondly, the increased share of older age groups, which compared to the younger counterparts have a shorter span of worklife ahead of them, results in depleting the human capital stock.

The negative impact of population ageing can, to some extent, be offset by increasing the skill levels of the labour force. In the ABS human capital measurement framework, the skill level of people is measured by their educational attainment. In Australia, as figure 3.4 shows, educational attainment of the population has substantially increased over the last 20 years. Between 1981 and 2001, the proportion of bachelor degree holders nearly tripled from 4.5% in 1981 to 13.8% in 1981. At the same time, the share of those without any formal post-school qualifications dropped from 55.1% in 1981 to 36% in 2001. These changes were accompanied by an increase of the share of those completing year 12 between 1981 and 1991 followed by a slight decline between 1991 and 2001.

3.4 Changes in the educational composition of the census population aged 20 to 65, Australia, 1981–2001



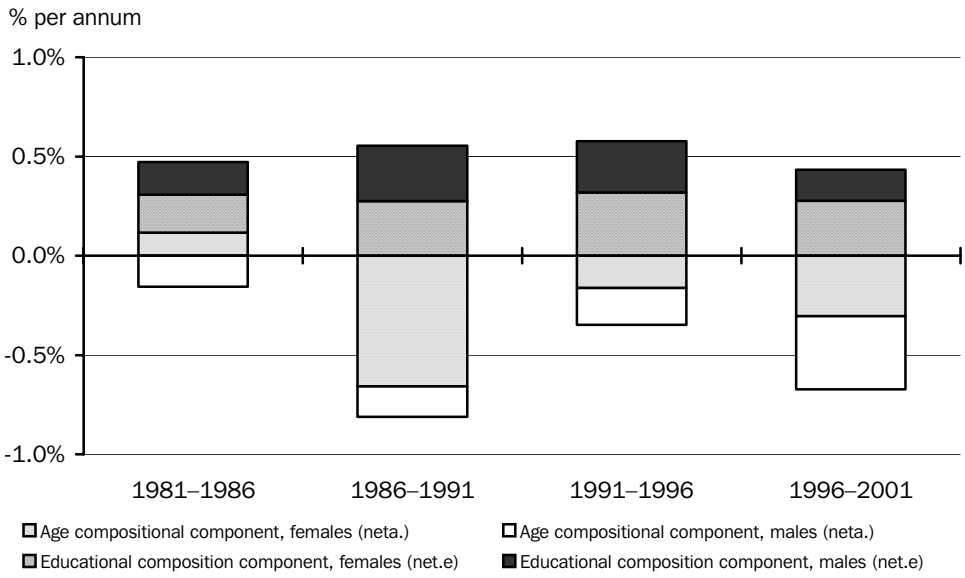
3.3 Decomposing changes in the level of human capital stocks

To what extent has ageing of the Australian population been counterbalanced by increasing educational levels over the last 20 years? Results of the decomposition, presented in this section, enabled us to disentangle the separate, independent contribution of these two factors.

Figure 3.5 shows the contribution of the population ageing against that of the educational changes to the growth of the per capita human capital for males and females. The impact of population ageing and educational change has varied over the 1981–2001 period. For males, the negative contribution of ageing was compensated by the positive contribution of the educational change for most of the research period, and the net effect on the growth of the human capital has been positive. Between 1996 and 2001 the contribution of the age-compositional changes (–0.4 per cent) outweighed the contribution due to changes in education (0.2 percent). Change in the age composition was one of the major drivers of the slow down in the male human capital growth over 1996–2001 period. For females, the picture varied slightly. Change in the age-composition seemed to have a large impact between 1986 and 1991 and between 1996 and 2001. The change between 1986 and 1991 can be attributed to a large interaction effect due to a declining of the share of skilled females with non-university post school qualifications in the prime working age population (aged 24–54 years).

Between 1996 and 2001, the decline in the share of females in prime working ages (24–54 years) had the major impact on the negative contribution of the age composition component.

3.5 Contribution of educational change against that of the population ageing to the human capital per capita annualised growth rates, Australia, 1981–2001



When comparing the cumulative contributions of population ageing and educational change over the research period, educational change can be seen as the major driver of per capita human capital growth. As shown in figure 3.6, had there been no changes in the educational composition of the population, the per capita human capital would have been 1.9% lower in 1986 and 13.1% lower in 2001 as opposed to its observed levels.

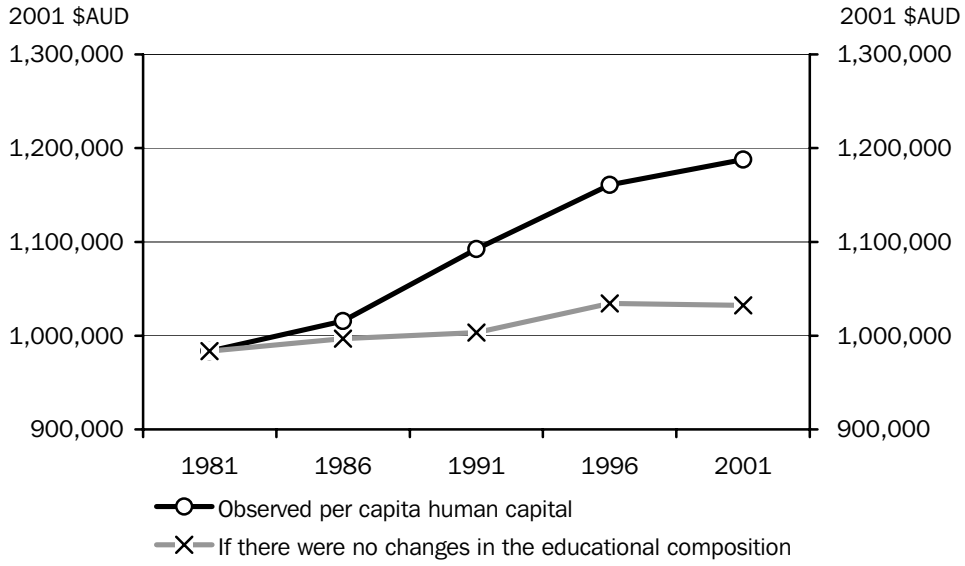
The cumulative magnitude of the impact of ageing on per capita human capital and its growth, although limited, has been increasingly negative. As figure 3.7 shows, had there been no ageing between 1981 and 2001, the per capita human capital would have been 4.1% higher in 2001 as opposed to its observed levels.

What has made the contribution of population ageing more marked recently? Investigation of the major contributors to the age-compositional component has shown that increased negative contribution of changes in the age composition between 1996 and 2001 was mostly due to the decline of 0.7 percentage points in the proportion of those in the prime working ages (aged 25–54 years). As the share of those in the prime working ages is projected to further decline in the future (ABS, 2005), we can expect that the negative contribution of ageing to levels of the per capita human capital will increase in the periods ahead.

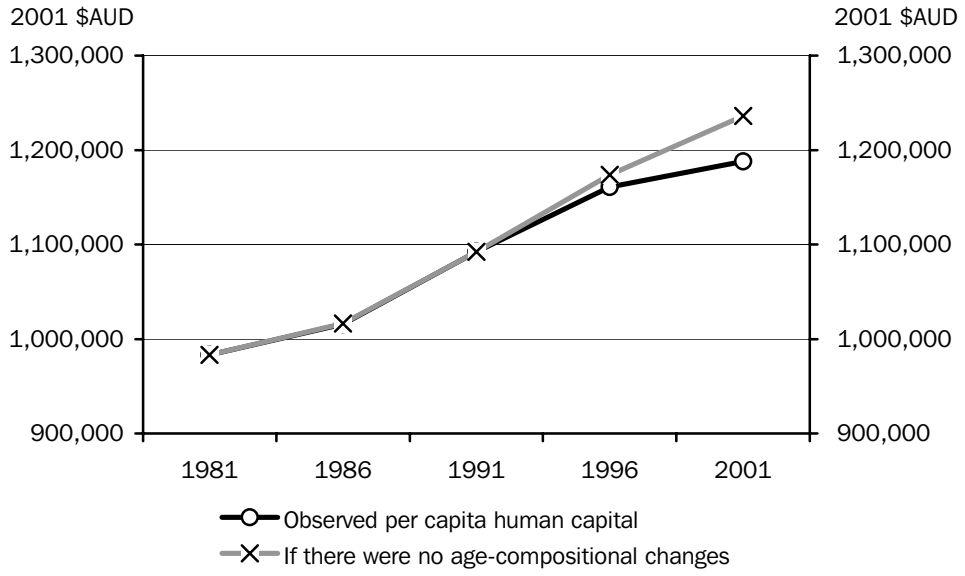
The smaller than usual positive contribution of the educational change was largely a result of the decline in the share of those completing year 12 and slowing growth in the share of bachelor degree holders. Since human capital skills are formed sequentially, skills acquired at earlier stages of life cycle such as year 12 are the prerequisite for learning more advances skills at later stages (Wei, 2007). Decline in

the share of those completing year 12 has consequences for their labour lifetime incomes, and future human capital formation. It lowers their human capital by reducing their opportunities to develop their skills further and moving to higher income thresholds.

3.6 Simulated levels of the per capita human capital under assumption of no educational composition changes, Australia, 1981–2001



3.7 Simulated levels of per capita human capital under assumption of no age-compositional changes, Australia, 1981–2001



4. CONCLUSIONS

This study employs a decomposition technique to provide a quantitative assessment of the contribution of population ageing to per capita human capital growth in Australia between 1981 and 2001. The magnitude of the effects of ageing on the growth of the per capita human capital is presented relative to the contribution of educational change – one of the major factors underlying growth of per capita human capital over the period of study.

Our analysis provides empirical evidence that population ageing has been one of the major contributors to the recently observed slow down of the growth of per capita human capital. Between 1996 and 2001, the negative contribution of population ageing outweighed the positive contribution of educational change.

With population ageing being projected to continue in the coming decades, the negative contribution of population ageing to human capital growth is likely to significantly increase in the coming years. Keeping per capita human capital both intact and growing will become a key issue for policy makers

As noted earlier in this paper, the decomposition technique applied in this study allows us to assess the independent contribution of ageing to the levels of the per capita human capital, not its causality. It is important to keep this in mind while interpreting results of this analysis.

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APPENDIX

A. TWO FACTOR DECOMPOSITION TECHNIQUE

The decomposition analysis decomposes the difference in the per capita human capital of two inter-censal periods (t and t–1) into *age–educational composition* (*combined*) and *residual* components according to equation (3):

$$h_{\bullet\bullet}(t) - h_{\bullet\bullet}(t-1) = \sum_{a=20}^{65} \sum_{e=0}^{4} \left[\frac{w_{ae}(t) + w_{ae}(t-1)}{2} \left(mi_{ae}(t) - mi_{ae}(t-1) \right) + \frac{mi_{ae}(t) + mi_{ae}(t-1)}{2} \left(w_{ae}(t) - w_{ae}(t-1) \right) \right] \quad (3)$$

where

$w_{ae}(t)$ = the age–educational composition weight for a given census year t such as:

$$w_{ae}(t) = \frac{n_{ae}(t)}{n_{\bullet\bullet}(t)} \quad (4)$$

$n_{ae}(t)$ = the number of people in the a-th age group and e-th educational category in a given census year t, and

$n_{\bullet\bullet}(t)$ = the total number of people aged 20 to 65 years across all educational categories in a given census year t such as:

$$n_{\bullet\bullet}(t) = \sum_{a=20}^{65} \sum_{e=0}^{4} n_{ae}(t) \quad (5)$$

$mi_{ae}(t)$ = the lifetime labour income for persons in the a-th age group and e-th educational category in a given census year t:

$$mi_{ae}(t) = \frac{h_{ae}(t)}{n_{ae}(t)} \quad (6)$$

$h_{ae}(t)$ = the human capital stock value for persons in the a-th age group and e-th educational category in a given census year t.

The first part of the equation on the right hand side accounts for the residual component (*residual*$_{\bullet\bullet}$); the second one stands for age–educational composition component (*combined*$_{\bullet\bullet}$).

To isolate independent contribution of age against that of the educational composition changes, the age–educational composition component has been further separated into three sub-components such as:

$$combined_{\bullet\bullet} = net_{a\bullet} + net_{\bullet e} + joint_{ae} \tag{7}$$

where

$net_{a\bullet}$ accounts for changes in the per capita human capital due to changes in the age composition only:

$$net_{a\bullet} = \sum_{a=20}^{65} \sum_{e=0}^{4} \left[\left(\frac{mi_{ae}(t) + mi_{ae}(t-1)}{2} \right) \left(\frac{w_{\bullet e}(t) + w_{\bullet e}(t-1)}{2} \right) \right] \times \left(\frac{n_{ae}(t)}{n_{\bullet e}(t)} - \frac{n_{ae}(t-1)}{n_{\bullet e}(t-1)} \right) \tag{8}$$

where

$w_{\bullet e}(t)$ = the educational composition weight such as:

$$w_{\bullet e} = \frac{n_{\bullet e}(t)}{n_{\bullet\bullet}(t)} \tag{9}$$

$n_{\bullet e}(t)$ = the number of persons across all age groups in the e-th educational category in a given census year t.

$net_{\bullet e}$ accounts for changes in the per capita human capital due to changes in the educational composition only:

$$net_{\bullet e} = \sum_{a=20}^{65} \sum_{e=0}^{4} \left[\left(\frac{mi_{ae}(t) + mi_{ae}(t-1)}{2} \right) \left(\frac{w_{a\bullet}(t) + w_{a\bullet}(t-1)}{2} \right) \right] \times \left(\frac{n_{ae}(t)}{n_{a\bullet}(t)} - \frac{n_{ae}(t-1)}{n_{a\bullet}(t-1)} \right) \tag{10}$$

where

$w_{a\bullet}(t)$ = the age composition weight such as:

$$w_{a\bullet} = \frac{n_{a\bullet}(t)}{n_{\bullet\bullet}(t)} \tag{11}$$

$n_{a\bullet}(t)$ = the number of persons across all educational categories in the a-th age group in a given census year t.

$joint_{ae}$ = an interaction term calculated using equation (12):

$$joint_{ae} = \sum_{a=20}^{65} \sum_{e=0}^{4} \left(\frac{mi_{ae}(t) + mi_{ae}(t-1)}{2} \right) \times \left[\frac{1}{2} \left(\frac{n_{ae}(t-1)}{n_{a\bullet}(t-1)} w_{a\bullet}(t) - \frac{n_{ae}(t)}{n_{a\bullet}(t)} w_{a\bullet}(t-1) \right) + \frac{1}{2} \left(\frac{n_{ae}(t-1)}{n_{\bullet e}(t-1)} w_{\bullet e}(t) - \frac{n_{ae}(t)}{n_{\bullet e}(t)} w_{\bullet e}(t-1) \right) \right] \quad (12)$$

$net_{\bullet e}$ and $net_{a\bullet}$ items are used then to calculate different scenarios of the per capita human capital growth. Human capital per capita given no age-compositional changes is calculated as follows:

$$h_{\bullet\bullet}(t) = h_{\bullet\bullet}(t-1) + net_{\bullet e} + joint_{ae} + residual_{\bullet\bullet} \quad (13)$$

Similarly, the per capita human capital given no educational composition changes is estimated in the following way:

$$h_{\bullet\bullet}(t) = h_{\bullet\bullet}(t-1) + net_{a\bullet} + joint_{ae} + residual_{\bullet\bullet} \quad (14)$$

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