A forward-looking measure of the stock of human capital in New Zealand

Trinh Le, John Gibson and Les Oxley*
Department of Economics, University of Canterbury

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Abstract

Human capital is increasingly believed to play an important role in the growth process; however, adequately measuring its stock remains controversial. Because the estimated impact that human capital has on economic growth is sensitive to the measures or proxies of human capital, accurate and consistent measures are needed. While many measures of human capital have been developed, most rely on some proxy of educational experience and are thus plagued with limitations. In this study, we modify the lifetime labour income approach outlined by Jorgenson and Fraumeni (1989, 1992) to estimate the monetary value of the human capital stock for New Zealand. Based on data from the Census of Population, we find that the country's working human capital grew by half between 1981 and 2001, mostly due to the rise in employment level. This stock of human capital was also well over double that of physical capital in all the census years studied.

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*Address for correspondence: Department of Economics, University of Canterbury, Private Bag 4800, Christchurch, New Zealand, email: l.oxley@econ.canterbury.ac.nz. Financial support of the Marsden Fund under grant UOC108 aided completion of this paper. We are grateful to participants at the NZAE Conference, Wellington, June 2002, seminar audiences at the NZ Treasury, NZ Ministry of Economic Development and the Reserve Bank of NZ, Dorian Owen, and two anonymous referees for helpful comments.

1 Introduction

Human capital is frequently discussed but poorly measured. The origins of "education as an investment to increase future income" can be found in Adam Smith's (1776) classical *Inquiry into the Nature and Causes of the Wealth of Nations* and represent one of the basic underpinnings of classical political economy. As early as 1690, Petty provided a monetary value of aggregate human capital in Britain. As such, the concept of monetary measures of human capital is deeply and firmly rooted.

Modern theories of economic growth, including those of Romer (1986) and Jones and Manuelli (1990), also emphasise human capital. Yet the empirical support for these 'new growth' theories has been hampered by the lack of reliable measures of human capital. In his review of the empirical evidence on the 'new' economics of growth, Temple (1999) notes that "the literature uses somewhat dubious proxies of aggregate human capital." The proxies Temple alludes to estimate human capital on the basis of years of schooling or formal educational attainment levels, regardless of their actual productive capacity. de la Fuente and Doménech (2000) go somewhat further and criticise the measures of human capital used by authors such as Nehru et al. (1995) and Barro and Lee (1993, 1996) as being "plagued with measurement errors." Recently, some improvements have been made to the measurement of human capital, including de la Fuente and Doménech (2000), Cohen and Soto (2001), Barro and Lee (2001) and Wößmann (2003), yet they still suffer from some major drawbacks. In particular, by focusing on the education so far experienced, these new measures fail to capture the richness of knowledge embodied in humans.[1]

Instead of relying on some educational proxies for measuring human capital, some economists, most notably Jorgenson and Fraumeni (1989, 1992), subscribe to the lifetime earnings approach introduced by Farr (1853). Following Farr, the basic idea is to value the human capital embodied in individuals as the total income that could be generated in the labour market over their lifetime. These expected earnings contribute to an extended notion of capital, which Jorgenson and Fraumeni include in a new system of national accounts for the U.S. economy. Jorgenson and Fraumeni's method is innovative in that it simplifies the estimation process, as well as taking into account the potential value of current schooling in addition to that of existing schooling. Outside the U.S., this method has only been applied to Sweden (Ahlroth et al., 1997) and Australia (Wei, 2001), both of which find the stock of human capital to greatly exceed that of physical capital. In a related context, O'Mahony and Stevens (2004) consider the valuation of the education sector in the U.K. and U.S.

In this paper, we depart from Jorgenson and Fraumeni's assumptions that individuals make a decision over hours of work such that the marginal value of work equals that of leisure and that non-market human capital should be evaluated at the wage rate. This particular issue is contentious and has created considerable debate.[2] For example, in the extended accounts of Jorgenson and Fraumeni (1989), the imputations for the 'services' of household durable goods and the value of household production and leisure time raise

[1] See Le et al. (2003) for a recent survey of the literature on alternative measures of human capital.

[2] See Eisner (1988), Ruggles (1991), Shaikh (1994) and Hersch and Stratton (1997).

the total (real and imputed) income of households fivefold. As such, in the Jorgenson-Fraumeni accounts the labour share appears as 93% and the property share 7%. Such results and implications, we believe, have undermined its subsequent use. We argue here that full imputation of non-employment *overestimates* a country's stock of human capital. The rates of participation and employment are important indicators of an economy's performance; assuming equal value between a full-time worker and a non-participant is, from an economic point of view, not justifiable. For that reason, we exclude the human capital of those individuals who are out of employment as well as the contribution which employed individuals make outside paid work. Our approach ignores the value of human capital stocks used in non-market production, but such a restricted focus is also common in studies measuring the returns to education. The working capital of employed individuals directly participate in economic production, hence it is arguably a better measure of the country's productive capacity.

Our results provide only the fourth country-specific monetary measure of human capital and help to establish whether patterns exist for, say, the relative sizes of physical and human capital stocks in developed countries. The approach and new results presented here contrast with the 'numerous' attempts to create partial and potentially biased measures based upon educational experience. Hopefully, this will encourage others to produce time series of monetary measures of human capital for other countries to aid empirical research on the determinants of economic growth.

2 Models

We estimate human capital, namely the present value of lifetime labour income, using cross-sectional data. This approach assumes that a person aged a years with a certain level of education bases their expected earnings t years in the future on the current earnings of people of the same education and gender who are $a+t$ years old. Early applications of this framework included Houthakker (1959), Weisbrod (1961), Miller (1965) and Graham and Webb (1979). Jorgenson and Fraumeni (1989) simplify the calculations by utilising the fact that the present value of lifetime labour income for a person of given age is just their expected current annual labour income plus the present value of their expected lifetime income in the next period (where this expectation depends on survival probabilities). By backwards recursion it is possible to calculate the present value of lifetime income at each age. For example, if people retire at age 65, the present value of lifetime labour income of 64 year olds is simply their current labour income. The lifetime labour income of a 63-year-old individual is equal to their current labour income plus the present value of lifetime labour income of the 64-year-old, and so forth. This model can be extended to incorporate a growth rate in real income that is constant across ages and education levels. Formally,

$$h_a^{e_i} = W_a^{e_i} Y_a^{e_i} + S_{a,a+1}^{e_i} h_{a+1}^{e_i} d \tag{1}$$

where:

$h_a^{e_i} =$ average human capital for individuals aged a with educational attainment e_i

$W =$ probability of engaging in paid work, defined as the number of employed people over the population, or equivalently the employment rate times the labour-force participation rate

$Y =$ average current annual labour income of employed individuals

$S_{a,a+1} =$ probability of surviving one more year from age a

$d =$ $(1+g)/(1+i)$

$g =$ income growth rate

$i =$ discount rate

The model holds separately for males and females. To implement equation (1), we assume that the potential working life extends from age 18 to 64, a common age range of the work force in developed countries. We identify four levels of educational attainment: (1) unskilled (less than 12 years of schooling), (2) non-degree (including all post-school, non-degree qualifications), (3) Bachelors degree, and (4) higher degree. We apply an average growth rate of 1.5 percent and a real discount rate of 6 percent; these figures are in line with New Zealand's economic reality in the period studied.[3]

While equation (1) is likely to hold for most of the population over most of their working life, there are people enrolled in further study who, in the context of the model, are trying to jump onto a higher age-earnings profile. An important innovation of the Jorgenson and Fraumeni method is that it

[3] According to the Reserve Bank of New Zealand (2005), growth in real GDP per capita averaged 0.7% per annum in the 1984-1994 period, rising to 2.2% per annum in 1994-2004.

incorporates the extra human capital of these individuals. In contrast, previous methods assumed that people undertaking further study would remain in their current cohort of educational attainment, so their extra education would not count for anything. When the model allows further study, individuals face two possible earnings streams; one with continuous work and the other with the possibility of delaying work for further education. Hence, lifetime labour incomes for any given cohort are a linear combination of these two earnings streams, where the weights on each depend on the probability of enrolment. Formally,

$$
\begin{aligned}
H_a^{e_i} &= W_a^{e_i} Y_a^{e_i} + \{(1 - E_a^{e_i}) S_{a,a+1}^{e_i} h_{a+1}^{e_i} + E_a^{e_i} S_{a,a+1}^{e_j} h_{a+1}^{e_j}\} d \\
&\quad - \sum_{m=1}^{K^{i,j}-1} \Big(\sum_{k=1}^{K^{i,j}-m} E_a^{k(i,j)} \Big)\big(S_{a,a+m}^{e_j} W_{a+m}^{e_j} Y_{a+m}^{e_j} - S_{a,a+m}^{e_i} W_{a+m}^{e_i} Y_{a+m}^{e_i} \big) d^m \qquad (2)
\end{aligned}
$$

where

$H =$ per capita human capital that incorporates the effect of further education

$E^{e_i} =$ proportion of the population who are studying for a higher qualification

$E^{k(i,j)} =$ proportion of the population undertaking the $e_j > e_i$ qualification in its k^{th} year

$K =$ the number of years it takes to complete a qualification

The assumptions used to implement equation (2) are:[4]

[4] The last term in equation (2) captures the fact that qualifications take more than a year to complete and not all students are in their final year of study.

- Individuals can only study for a higher qualification than what they they already have. If Bachelors degree holders study for, say, an undergraduate diploma, their extra study counts for nothing. Due to the lack of information, we assume that university students who hold a Bachelors degree are studying towards a higher degree. No further enrolment is allowed for higher-degree holders, because they have reached the highest educational level;

- A higher degree takes two years to complete, conditional on holding a Bachelors degree;

- Unskilled and non-degree qualified individuals take four and three years respectively to complete a Bachelors degree;

- The study time for a non-degree qualification is two years;

- Except for certain young ages,[5] students enrolled in any qualification that requires more than one year are evenly distributed across different study stages;

- Direct costs of study are offset by part-time earnings, so that there is no need to apply negative values of current earnings while studying.[6]

[5]For example, all 18-year-old students studying for a Bachelors degree are assumed to be in their first year.

[6]This assumption bypasses the impact of student loans and of degree-specific costs on the accumulation of human capital. However, tuition fees for most degrees in New Zealand are subsidised by over 75%. Therefore, this assumption is quite reasonable. It is also a standard assumption in studies on returns to education.

3 Data description

We use data from each Census of Population from 1981 to 2001. The data are in the form of population counts within homogeneous cells classified by age, gender, educational level, employment status and income bracket. We form the data into 366 cohorts defined by 47 ages (18-64), 2 genders and 4 educational levels.[7] For each cohort we calculate the mean annual gross income of employed individuals, the labour-force participation rate, employment rate and enrolment rate.

Table 1 shows the distribution of the population aged 18-64 by gender and education. The share of university graduates increased sharply, from 4.2 percent in 1981 to 12 percent in 2001. Notably, the gender gap in education has almost disappeared. Table 2 presents the employment rate, which is defined here as the share of the population who are working for pay. On average, the probability of undertaking paid work rose by 1.3 percentage points from 1981 to 2001. While women at all education levels are increasingly likely to work for pay or to be seeking employment, the probability of men partaking in the labour force declined considerably during those 20 years.

Since New Zealand Censuses do not collect data on earnings, we have to use (gross) income as a proxy for earnings. Income in New Zealand Censuses counts all sources (except for Census 1981 which excludes superannuation). Hopefully by using only the income of employees, for whom earnings are likely to predominate, we eliminate obvious biases. The annual income for paid employees is applied to employers and self-employed persons with the

[7] Some combinations do not exist (eg. 18-year-old higher degree holders).

same gender-education-age profile. This adjustment keeps the focus on the price of labour services, because the reported income of employers and self-employed people may include returns to non-labour inputs. Since the data are in (varying) intervals, we use the mid-point of the closed intervals. For the open-ended interval at the top of the income distribution (e.g. >$100,000) the mean income is set at 30 percent above the lower bound, while for the lowest income interval it is set at 80 percent of the upper bound (recommended by Chen et al. (1991)). We distribute those who did not specify their income evenly across the income ranges.

Table 3 shows that on average, real income fell slightly from 1981 to 1986 but the trend has reversed since. This trend, however, is not universal. Over the 20-year period, unskilled individuals saw their real income stagnate, but the rest of the work force experienced rising income. There is a large income gap between university graduates and the less educated, and this gap has widened over time. The income profiles are steeper for males and for university degree holders (see Figure 1 for 2001). The volatility in the profiles for university graduates is due to the small population size of each cohort.

Enrolment data in the Census have several deficiencies. In particular, the last three censuses did not collect information on whether or not a person was studying for a qualification. Although the 1986 Census asked about student status, it did not ask for the type of qualification one was studying for; therefore, we are unable to determine from this census whether or not an enrolee was studying to improve their education profile. The 1981 Census is the only one to contain relatively satisfactory information on enrolment.

Although the model can still be run on zero enrolment, these estimates do not take into account the fact that some people withdraw from the labour force and study for a higher qualification because they expect to increase their earnings as a result. If the effect of enrolment is ignored, students' potential to contribute to the country's human capital stock will not be adequately accounted for.

Since the most recent three censuses did not ask about student status, we have to turn to another question for enrolment rates. In particular, enrolment is defined as attending study or training courses in the last week (Census 1991), attending/studying for a course at school or anywhere else in the last 7 days (Census 1996), or attending/studying for more or less than 20 hours per week at school or any other places in the last 4 weeks (Census 2001). We only consider full-time study and training, to be consistent with the 1981 and 1986 Censuses. Those who were attending full-time study or training courses over the last week (or, in Census 2001, 4 weeks) were also more likely to be students.

Census 1981 is the only one to give enrolment information by current level of study, so we apply the enrolment *pattern* from this census to the enrolment *rates* (by existing qualification) for the other censuses. For example, if 80 percent of students from the non-degree group were attending university in 1981, we assume that 80 percent of enrolees from the non-degree group in other census years were studying for a degree, while letting the overall enrolment rate fluctuate from census to census.[8] We cut off the work-study

[8]'Unskilled' includes those who have no more than a School Certificate (11 years of schooling), so in New Zealand they can not enrol for a degree before reaching 25.

phase at age 30 because educational enrolment beyond that age is negligible.

Data for the last variable, survival rates, are obtained from *New Zealand Life Tables*. Even though education tends to reduce mortality rates, the available data are only broken down to gender and age, so we assume that the probabilities of surviving do not vary with education. This assumption would understate differences in lifetime income between education levels, yet we believe that the resulting bias is trivial.[9]

4 Estimation results

4.1 Basic results

Our baseline estimates can be found in Table 4, and the results for 2001 are also displayed in the bottom panels of Figure 1. Lifetime income increases until somewhere around ages 25-30, after which it falls steadily. The peak in lifetime income occurs some ten years earlier for women than for men. A similar lag is also observed between degree holders and less qualified individuals. This is because the time devoted to further education postpones reaping the higher returns until older ages.

The shape of annual income profiles greatly influences lifetime income profiles. Lifetime income profiles are flatter for females than for males, and also flatter for unskilled and non-degree qualified individuals than for university graduates, reflecting what was observed earlier about annual income profiles.

[9] When we assume equal survival probabilities between men and women, the ratio of average lifetime income between the two genders changes marginally, from 56.9% to 56.4%.

While average annual income in 2001 was 11 percent higher than in 1981, the difference in average lifetime income is 17 percent. The major cause for this growth is the higher rate of participating in paid work. Even though annual income dropped by 5.9 percent in real terms between 1981 and 1986, lifetime income increased by 2.4 percent, thanks to the probability of undertaking paid work rising by 5 percentage points. The only decrease in per capita human capital occurred between 1986-1991, when a drop of 1.2 percent was experienced. Since 1991, both employment and real annual income have risen, improving average lifetime income consequently.

The contribution to the stock of human capital by each education and gender group is presented in Table 5. The share of unskilled individuals in the stock of human capital fell from one half of the male total in 1981 to just one third in 2001, and the proportionate decline is even greater for women. By contrast, the human capital contributed by university graduates has grown, in both relative and absolute terms. Indeed, this is to be expected, as annual income of these people improved relatively the most and that their shares of the population also grew. For example, in 1991, when the total human capital stock increased by a mere 4 percent from 1986, the capital accounted for by degree holders rose by 28 percent. While total human capital increased by 54 percent, university graduates' capital almost quadrupled during 1981-2001. This growth is due primarily to the higher employment level, since expected annual labour income in 2001 was marginally higher than in 1981.[10]

[10]Change in human capital stocks between year $y-t$ and year y is: $\sum N^y H^y - \sum N^{y-t} H^{y-t} = \sum (N^y - N^{y-t}) H^y + \sum N^{y-t}(H^y - H^{y-t})$, where the first term refers to change in numbers and the second to change in per capita lifetime earnings. Of the 53.9% increase in total human capital stocks during 1981-2001, 46.2% is due to a larger work force, leaving only 7.7% to be explained by rises in real wages.

Women contributed less than a quarter to the country's economically productive human capital in 1981, rising to 37 percent in 2001. This follows directly from the fact that women are under-represented in the labour force and that their annual labour income is only two thirds of men's.

4.2 Sensitivity analysis

Table 6 reports the effects of varying some modelling assumptions on the value of human capital. In general, the sensitivity analysis indicates certain robustness in our results. Changing the discount and growth rates to the values used by Jorgenson and Fraumeni (1992) would raise the value of the human capital stock by 14 percent while leaving the pattern across census years unchanged. A bigger change comes from excluding ages 18-24, which reduces the aggregate stock of human capital by 20 percent and lowers the per capita lifetime income by 5.8 percent. Extending the study time for each qualification by one year produces an insignificant negative effect. Ignoring the impact of enrolment would decrease the aggregate stock of human capital by 1.7 percent but understate average per capita lifetime labour income by 4.7 percent for those in the 'study' age range (individuals younger than 30 not holding a higher degree).

The biggest change results from assuming full participation, ie. assuming that labour-force participation is a choice and that non-participants should have an imputed value of human capital equal to the human capital level of similarly characterised participants. This imputation implies that when the current non-participants decide to join the labour force, their probability of getting a job and their expected earnings would be the same as those for existing participants in their gender-education-age cohort. This is a strong assumption and we believe such imputation substantially overstates a country's working stock human capital. The human capital stock value with 'full participation' presented in Table 6 is the absolute upper bound of the country's human capital stock; the extra 29 percent can *potentially* be useful, but that capital is currently idle. Be it a choice or a risk, non-participation means people's knowledge and skills are wasted through idleness and so their *effective* human capital, economically speaking, is zero. Our results are significantly lower than in other à-la-Jorgenson-Fraumeni studies, but we argue that those studies exaggerate human capital by unduly accounting for non-market human capital.[11]

4.3 Human capital and physical capital compared

Some comparisons between human and physical capital stocks for New Zealand are reported in Table 7. The value of the working human capital stock is more than double that of the physical capital stock and this ratio is rising over time.

But this comparison is rather naïve, since the human capital stock estimates are 'gross' in that maintenance costs are not deducted from labour incomes, whereas estimates of physical capital are net. However, whether maintenance costs should be deducted is controversial. On the one hand, some authors argue that physical capital estimates are net figures, so to be

[11] Jorgenson and Fraumeni (1989, 1992) also impute the time that employed individuals spend outside work (and 'maintenance' activities), the value of non-employed individuals is raised accordingly.

consistent human capital should also be net of maintenance costs. Eisner (1988), for example, criticised the income-based method for overestimating human capital by not deducting maintenance costs from gross earnings. Weisbrod (1961) attempted to account for maintenance, but he encountered many difficulties. What types of expenditures should be classified as maintenance, and how to account for economies of scale and 'public' goods when estimating per capita consumption for members in the same household are those problems that are not easily resolved. On the other hand, others maintain that consumption is an end, rather than a means, of investment and production, hence gross earnings are a more relevant variable to use when estimating human capital using a lifetime labour income approach. Net productivity is arguably a more appropriate measure of a person's value to others, whereas gross productivity is a superior estimate of his total output to the society (Graham and Webb, 1979).

By contrast, our measure of human capital is quite conservative in the sense that it excludes non-market activities, which have been found by Jorgenson and Fraumeni (1989, 1992) and Ahlroth et al. (1997) to be of significance. By imputing non-work hours at the after-tax wage rate, Jorgenson and Fraumeni (1989) find that the stock of U.S. human capital exceed that of physical capital by over ten times, whereas Ahlroth et al. observe that even their lowest estimates of the human capital stock (net of taxes, excluding leisure income) are 6-10 times higher than the stock of physical capital.

5 Biases in the estimation method

As is clear from Table 1, university graduates have increased both in number and as a proportion of the population. Any education-based measure of human capital would suggest that New Zealand human capital has grown rapidly in the last 20 years. But our measure of human capital is strictly confined to economic production; it does not estimate human capital by counting how much education the population has accumulated. Being labour market oriented, our method argues that the knowledge and skills that are not used in economic activities are useless. Indeed, educating people is not sufficient to raise the country's stock of human capital; it is necessary that those people be employed so that the knowledge and skills that they have acquired are turned into productive capital rather than being wasted through unemployment and non-participation.

However, being labour income-based, our method rests crucially on the assumption that differences in wages perfectly mirror differences in marginal productivity of labour and that productivity is a proxy for human capital. If wages vary for reasons other than changes in productivity, the results obtained from this method will be biased.

In fact, there is evidence that actual real wages diverged from 'warranted' real wages. Pre-reform (1984) real wages were believed to be overvalued because they were traditionally set on the basis of occupational relativities rather than on productivity. Some authors, including Grimes (1981) and the Reserve Bank of New Zealand (1982), assert that real-wage overvaluation was a major cause of rising unemployment. The presence of effective legislated wage floors, which can be as high as 53% of average earnings, also indicates that wages may reflect equity considerations rather than market conditions. Besides, in an attempt to fight inflation, a price and wage freeze was introduced in June 1982. Real wages then declined for the next three years and this was part of the reason why real earnings in 1986 were so low. Real wages continued to trend downward until 1990 although this trend has been slightly reversed in the second phase of the reform. Despite rising productivity, real wages fell in the first phase of the reform to ease the pressure on high unemployment at that time (Dalziel and Lattimore, 1999). According to the data gathered by Maloney and Savage (1996), productivity grew rather steadily during 1981-1994 while real wages experienced considerable fluctuations over the period. Apparently, the assumption that wages reflect labour productivity does not always hold in reality.

The fact that the equality between wages and labour productivity fails to hold casts doubts on the results of this study. If labour productivity is a good proxy for human capital, the rising productivity means that during 1981-1991, New Zealand human capital may have increased in per capita terms at a higher rate than indicated by the labour income-based measure. This may suggest that a measure of human capital based solely on labour productivity should be less biased. However, by being indices, a productivity-based measure of human capital is not always superior. The income-based approach gives a monetary value which is more meaningful than indices in comparisons with other types of capital or with human capital from other countries. Also, the income model is based on an assumption which, however controversial, is widely accepted in economics and which tends to hold reasonably well in the long term. Therefore, the lifetime labour income method has many merits of a good measure of human capital, despite the imperfections.

Nevertheless, there are a few other issues around the lifetime income approach to human capital measurement. Omitted variables obviously create a bias, since it has been well established in labour economics that gender, education and age are not sufficient to explain differences in earnings. Several important factors, including ability, family background, quality of schooling, and work experience, have been left out of the model. We would argue that this bias matters more to the results for individuals and cohorts than to the population's aggregate results. The use of cross-sectional mortality rates could create another bias. Yet for a developed country like New Zealand survival probabilities are unlikely to improve much over time. So any bias from this source should be negligible.

Women contribute disproportionately less to the stock of human capital. This does not necessarily mean that women's capital is less valuable than men's; it merely reflects the fact that women do not participate as much as men in labour market activities. If non-market activities were accounted for, women's human capital should be higher. But the way that Jorgenson and Fraumeni impute non-market activities has attracted considerable criticism. Hence, how to appropriately take account of non-economic human capital remains a challenge.

6 Conclusions

The paper presents some new results on the monetary value of human capital in New Zealand using a forward-looking, lifetime labour income approach. The mean level of human capital embodied in the population aged 18-64 was estimated to be $372,000 in 2001. Overall, the stock of working human capital grew by 54 percent in the last two decades. In 2001 prices, this reflects an increase from $551 billion in 1981 to $848 billion in 2001. The change was due primarily to the employment level, which rose by 34 percent over the period. Women's share in the total human capital stock has been rising steadily, from 24 percent in 1981 to 37 percent 20 years after. Most of this growth can be explained by the fact that the female work force almost doubled over the period, whereas the male work force increased by only 12 percent. The human capital embodied in university graduates almost quadrupled; in relative terms, their share of the total human capital stock increased from 8.8 percent to 22 percent. Compared with the physical capital stock, New Zealand's working human capital stock is well over double and this ratio has risen over time, reaching 2.7:1 in the last census year. These results stand robust to various changes in the modelling assumptions, although more extreme variations in methods could be tested. Given the current activity of other researchers in the area of measuring and valuing human capital stocks, we are optimistic that some consensus about the value of the human capital stock may soon emerge.

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Table 1: Distribution of the working-age population

	1981	**1986**	**1991**	**1996**	**2001**
Male					
Unskilled	30.2	24.9	22.3	23.4	25.1
Non-degree	16.6	21.4	23.2	20.7	17.7
Bachelors	1.9	2.3	2.7	3.4	3.9
Higher degree	0.9	1.5	1.5	1.8	2.0
Sub-total	49.6	50.1	49.7	49.3	48.7
Female					
Unskilled	35.0	30.6	26.9	26.5	26.6
Non-degree	14.0	17.0	20.4	19.9	18.6
Bachelors	1.1	1.5	2.0	3.0	4.3
Higher degree	0.3	0.8	1.0	1.3	1.8
Sub-total	50.4	49.9	50.3	50.7	51.3
Total number (thousand)	1,728.5	1,941.4	2,043.4	2,204.8	2,278.0
Change from last census		12.3	5.3	7.9	3.3

Source: New Zealand Census of Population, 1981, 1986, 1991, 1996, 2001.
Note: The population base is ages 18-64. Entries are percentages unless otherwise stated.

Figure 1: Annual and lifetime labour incomes

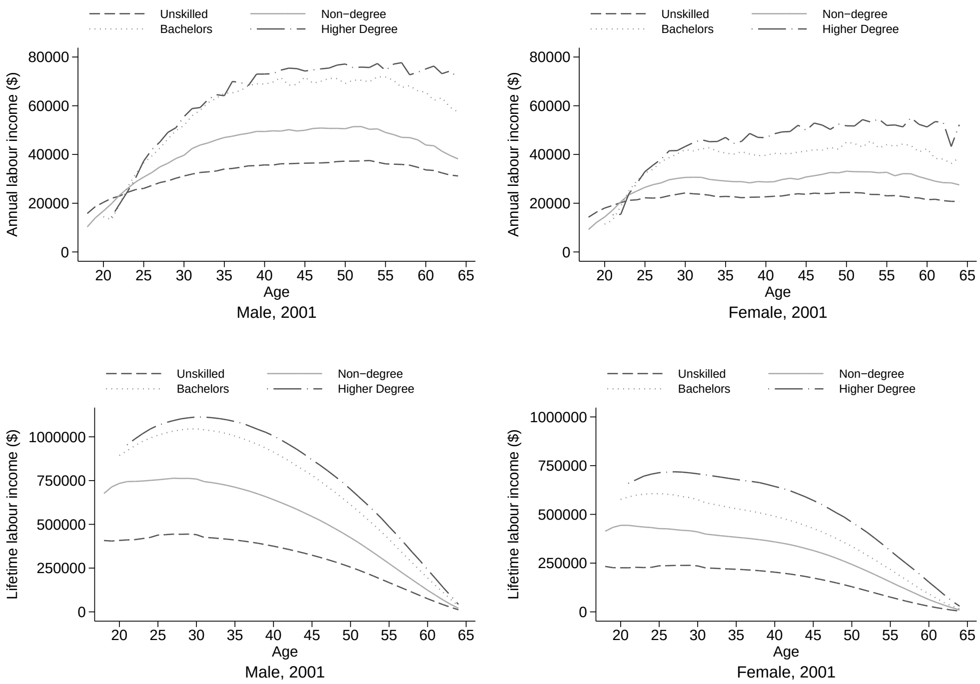

Table 2: Probabilities of undertaking paid work

	1981	1986	1991	1996	2001
Male					
Unskilled	88.0	82.1	65.3	62.7	65.1
Non-degree	89.6	88.2	78.3	80.8	83.0
Bachelors	89.4	90.3	84.7	85.7	86.9
Higher degree	93.7	93.0	89.6	87.1	88.2
Weighted average	88.7	85.4	73.2	72.8	74.3
Female					
Unskilled	40.1	51.2	46.1	47.4	50.7
Non-degree	54.0	66.3	62.9	67.7	71.3
Bachelors	57.8	72.3	71.4	75.8	78.1
Higher degree	61.8	77.2	78.6	79.1	81.5
Weighted average	44.5	57.4	54.6	57.8	61.5
Overall average	66.4	71.4	63.8	65.2	67.7
Total number (million)	1.1	1.4	1.3	1.4	1.5
Change from last census		20.8	-6.0	10.2	7.4

Note: See Table 1.

Table 3: Real annual income for employees

	1981	1986	1991	1996	2001
Male					
Unskilled	32.3	30.2	30.8	33.1	33.2
Non-degree	37.4	36.9	38.0	39.6	41.5
Bachelors	47.0	48.4	53.8	56.2	59.2
Higher degree	58.1	56.6	62.5	66.0	67.5
Weighted average	35.1	34.9	37.0	39.4	40.7
Female					
Unskilled	21.8	18.4	19.9	22.0	22.9
Non-degree	25.5	23.3	24.9	25.8	27.5
Bachelors	31.8	29.9	33.9	34.0	37.4
Higher degree	39.1	34.3	40.0	41.9	45.9
Weighted average	23.5	21.1	23.6	25.4	27.4
Overall average	31.2	29.4	31.2	33.1	34.5
Change from last census (%)		-5.9	6.4	6.0	4.3

Note: Estimates are in 2001 thousand dollars, converted using the Prevailing Weekly Wage Index PWIQ.S4329 and All Salary & Wage Rates LCIQ.SA53Z9. In 2001, NZ$1 exchanged for US$0.44 in nominal terms, or US$0.68 in PPP terms.

Table 4: Average per capita lifetime labour income

	1981	**1986**	**1991**	**1996**	**2001**
Male					
Unskilled	407.9	369.6	306.2	307.1	310.6
Non-degree	585.9	532.5	503.1	549.6	599.0
Bachelors	808.8	810.5	815.5	837.1	829.1
Higher degree	844.8	806.1	820.5	868.7	851.0
Weighted average	490.9	472.4	441.5	465.7	479.4
Female					
Unskilled	115.4	126.4	128.1	145.7	159.5
Non-degree	214.0	246.4	268.4	302.3	346.5
Bachelors	328.3	375.5	434.3	458.0	497.9
Higher degree	378.8	416.5	479.4	522.1	586.1
Weighted average	149.1	179.4	204.2	235.2	270.3
Overall average	318.6	326.2	322.2	348.8	372.1
Change from last census (%)		2.4	-1.2	8.3	6.7

Note: See Table 3.

Table 5: Aggregate value of human capital stock

	1981	**1986**	**1991**	**1996**	**2001**
Male					
Unskilled	212.8	178.8	139.6	158.7	177.5
Non-degree	168.0	221.2	238.6	250.6	241.4
Bachelors	26.8	36.6	45.4	62.8	74.4
Higher degree	13.1	22.9	25.0	34.1	38.5
Sub-total	420.8	459.6	448.7	506.2	531.9
Female					
Unskilled	69.8	75.1	70.3	85.1	96.8
Non-degree	51.6	81.5	112.0	132.6	146.6
Bachelors	6.4	10.7	18.0	30.1	48.9
Higher degree	2.0	6.5	9.5	15.1	23.5
Sub-total	129.9	173.8	209.8	262.9	315.8
Total	550.7	633.3	658.4	769.1	847.7
Change from last census (%)		15.0	4.0	16.8	10.2

Note: Estimates are in 2001 billion dollars.

Table 6: Sensitivity analysis on human capital estimates

	Per capita		Aggregate stock	
	Estimate ($thousand)	Change relative to baseline (%)	Estimate ($billion)	Change relative to baseline (%)
Baseline	372.1		847.7	
Lengthening study time[a]	372.1	-.006	847.6	-.006
Ignoring enrolment[b]	366.0	-1.65	833.7	-1.65
$g = 1.32\%$ and $i = 4.58\%$[c]	425.8	14.4	969.9	14.4
Ages 25-64 only	350.4	-5.83	677.7	-20.1
Full participation	481.0	29.3	1,095.8	29.3

Note: All estimates refer to year 2001.
[a] Lengthening study time for each qualification by one year.
[b] Applying equation (1) to all individuals. [c] These rates are used by Jorgenson and Fraumeni (1992).

Table 7: Human and physical capital stocks

	1981	**1986**	**1991**	**1996**	**2001**
Human capital	218.8	377.5	563.1	702.6	847.7
Physical capital*		169.4	214.8	264.6	309.0
Human: Physical		2.2	2.6	2.7	2.7

Note: Physical capital estimates are obtained from PC-INFOS Series SNCA.S5NK90ZZ. *Statistics not publicly available for 1981. The figure for 1985/1986 is not publicly available so the corresponding value for 1986/1987 is used here. All capital stock values are in current billion dollars.