



WORKSHOP ON THE MEASUREMENT OF HUMAN CAPITAL

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Human Development and its Contribution to the Wealth Accounts in Canada

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Abstract

This paper has constructed a measure of human capital for Canada over the period 1970 to 2007 and compared it with nonhuman capital stock. It finds that aggregate human capital rose at annual rate of 1.7% in Canada for the period 1970 to 2007, and most of the growth is due to the increase in the number of individuals in the working-age population. The rising educational level of the Canadian population is also significant factor for the growth in human capital. Second, the paper finds that the aging of the Canadian population after the early the 1980s reduced the human capital growth by 0.5% per year, while the rising educational level increased the human capital growth by 0.8% per year. Third, the value of human capital exceeds the value of produced capital. But the ratio of human capital relative to produced capital declined over time. In 2007, the value of human capital is about 4 times as large as the value of produced capital. Finally, the paper finds that the level of human capital estimates is sensitive to the choice of the expected future income growth and the discount rate used to discount the future income, but the growth of the quantity and price of human capital is not sensitive to the choice.

1 Introduction

This paper develops a measure of the component of total wealth derived from the investments made in human development—commonly referred to as human capital—and provides an estimate of the level and composition of Canada’s total wealth that includes produced capital, natural capital, and human capital.

Investment in human capital is at the heart of strategies in Canada to promote economic growth in Canada and the other OECD countries (OECD, 1998, Skills Research Initiative, 2008). In the late 1990s, the Canadian Productivity Accounts (CPAs) began to assess the contribution of investment in education and training to output growth and productivity growth in Canada (Baldwin and Harchaoui 2003; Gu et. al, 2003). The CPAs constructed a measure of labour input and labour composition that focuses on differences in educational attainment and experiences of the Canadian workforce. The labour input is disaggregated by age, education attainment and class of workers (paid vs. self-employed workers). Investment in human capital, as measured by the shift in the composition of workers towards more educated and more experienced workers is found to be an important source of productivity growth. It accounted for a quarter of labour productivity growth in Canada over the last forty-five years (Baldwin and Gu, 2007).

The indices of labour composition constructed by the Canadian Productivity Accounts of Statistics Canada are an essential first step in incorporating investments in human capital into empirical studies of economic growth and national accounts. This paper represents an additional step towards the incorporation of investment in human capital in empirical studies of economic growth and national accounts (Jorgenson and Fraumeni, 1989).

In the national accounting systems of Canada and other countries, expenditures on human development and related ‘intangibles’ are all regarded as current consumption expenditures (rather than investment). This, in effect, means that outlays on education and training are all classified as consumption expenditures, either intermediate or final.

There are some historical and institutional reasons for this classification decision. The main points are: 1) the classification follows business accounting conventions; 2) human ‘capital’ resources cannot be bought and sold in the market along the lines of non-human (physical) capital. The national accounts are closely tied to market transactions, avoiding the imputation for non-market activities whenever possible. As such, human capital is not included in the national accounts.

Yet the concept of human capital has been familiar in economics for the past 40 years (e.g., Schultz, 1961a 1961b; and Becker, 1964). The concept is based on an analogy between investment in physical capital and investment in human beings and is motivated by a common economic principle. When an individual (or economic sector) undertakes expenditures, the effects of such outlays can be categorized into one of two types: 1) the benefits of the expenditures are realized in the same time period as when the outlays occur (say, a period of one year); or 2) the benefits are realized in future periods and

possibly after considerable waiting. The first type of expenditure is categorized as ‘consumption;’ the second type of expenditure is defined as ‘investment.’

This economic principle suggests that human development expenditures should be classified as investment (and appropriately accumulated into human capital stocks) because the benefits to such expenditures accrue to the individual over a lifetime.

Methodologies for measuring human capital have been developed by Jorgenson, Fraumeni (1989, 1992a, and 1992b) and Kendrick (1976). Jorgenson and Fraumeni developed the income-based approach for the measurement of human capital and estimated human capital stock as the expected future lifetime income of all individuals. Kendrick (1976) used the cost-based approach for the measurement of human capital and estimated the human capital as the accumulated value of all expenditures related to human development, such as the rearing and the cost of education.

A number of recent studies have used the income-based approach to estimate human capital for Sweden (Ahlroth et al., 1997), Australia (Wei, 2004, 2007), New Zealand (Le et al., 2005), for the U.K. (O’Mahony and Stevens, 2004), and for Norway (Greaker and Liu, 2008). This paper contributes to the recent attempts made to improve the measurement of human capital by applying the Jorgenson and Fraumeni’s income-based approach to measure human capital stock for Canada.

A number of previous studies have developed a measure of human capital for Canada. Macklem (1997) and Beach et al. (1988) calculated aggregate human wealth as the expected present value of aggregate labour income net of government expenditures. Macklem (1997) found that the value of human wealth was about 6 times as large as the value of non-human wealth over the period 1963 to 1994. The aggregate approach does not take into account the shift in the composition of the Canadian population towards more older and more educated individuals as the Jorgenson and Fraumeni’s approach does. Laroche and Méreille (2000) calculated an index of human capital as a weighted sum of the number of workers with different educational levels and experience. Unlike this paper which weights individuals with their lifetime income, Laroche and Méreille weighted the individuals with their current wage income. For the measurement of human capital, it is more appropriate to use expected lifetime income as weights.

The rest of the paper is organized as follows. The next section presents the methodologies for estimating the stock of human capital. Section 3 presents the construction of data used for estimation. Section 4 presents the results and Section 5 provides a summary of the findings.

2 Methodologies for Estimating Human Capital

In general, capital stock can be valued using two methods:

- It can be valued as the sum of additions, minus the subtractions, made over time to initial stock.
- Alternatively, capital can be valued as the net present value of the income it is able to produce over time.

The first, income-based approach is employed to estimate the value of produced capital stock; while the second, cost-based approach is used to estimate the value of most natural capital. The value of produced capital is obtained by summing up the value of investments and subtracting the depreciation of produced capital from initial capital stock. The value of natural resources is estimated as the net present value of resource rents over an assumed lifetime.

Both income-based and cost-based approaches have been used to estimate human capital. Jorgenson and Fraumeni (1989, 1992a and 1992b) used the income-based approach to estimate human capital for the U.S. as net present value of lifetime labour income for all individuals in the U.S. population, while Kendrick (1976) and Eisner (1989) used the cost-based approach to estimate investment in human capital as the cost of rearing and the cost of education, including earning forgone by students.

Jorgenson and Fraumeni (1989, 1992a and 1992b) values human capital in terms of lifetime labour income for all individuals. Using this income-based approach, they found that investment in human capital is at least four times the magnitude of investment in nonhuman capital in the United States; moreover, the value of human capital stock is over eleven times the value of physical or non-human capital. More recently, the income-based approach was used to estimate human capital for Sweden (Ahlroth et al. 1997), Australia (Wei, 2004, 2007), and New Zealand (Le, Gibson and Oxley, 2005). Those studies confirmed the findings for the U.S. and found that the value of human capital is significantly greater than the value of non-human capital stock. In a related context, O'Mahony and Stevens, (2004) estimated the value of the education sector for the U.K, and Ervik, Holmoy and Hgeland (2003) estimated the value of the education sector for Norway.

Kendrick (1976) and Eisner (1989) used the cost-based approach to estimate investment in human capital. The investment in human capital includes the cost of rearing and the cost of education, including earning forgone by students. The data on investment in human capital is then aggregated using the perpetual inventory method to derive estimates of human capital stock. More recently, the cost approach was used by Kokkinen (2008) to construct a measure of human capital stock for Finland in an empirical analysis of human capital and economic growth.

In addition to those approaches, previous empirical studies have used a large number of proxy measures of human capital, including educational attainment, average years of schooling, and literacy scores (e.g. Barro and Lee, 1996, Coulombe and Tremblay, 2006, and for a review see, OECD, 1998).

2.1 *The Income-based Approach to Human Capital Measurement*

Jorgenson and Fraumeni (1989, 1992a, and 1992b) developed the income-based approach for the measurement of human capital and estimates human capital stock as the expected future lifetime income of all individuals. The essential idea behind this approach is to treat all individuals of the Canadian population as human assets with “prices” given by their lifetime labour income. The approach can be illustrated by comparing human capital with physical capital. For physical assets, asset prices can be observed directly from market transaction in investment goods; the user cost of capital services are derived using the user cost of capital equation. For human capital, wage rates correspond to the user cost of capital and can be observed from transactions in labour markets; lifetime labour incomes correspond to asset prices of tangible capital, and are derived by calculating the net present value of these wage rates over lifetime.

To construct lifetime labour incomes and human capital embodied in the individuals of the Canadian population, we will exclude the value of non-market activities and focus on the human capital embodied in the working-age population, aged 15 to 74. The extended accounts of Jorgenson and Fraumeni include the value of non-market activities and value human capital embodied in all individuals. The value of non-market activities is based on the assumption that individuals allocate time between work and non-market activities such that the marginal value is equalized between the two types of activities. The issue of the valuation of non-market activities is controversial. Furthermore, it can be argued that human capital embodied in the working-age population is more relevant if we would like to measure the productive capacities of the Canadian population. As such, we will exclude the value of non-market activities in our measure of human capital and focus on the human capital of the working-age population.

We estimate lifetime labour income for all individuals using cross-sectional data. We assume that expected incomes in future periods are equal to the incomes of individuals of the same gender and education, with age that the individual will have in the future time period, adjusted for increases in real income. The lifetime incomes can be calculated by a backward recursion, starting with age 74 which is assumed to be the oldest age before retirement. The expected income for a person of a given age is their current labour income plus their expected lifetime income in the next periods times survival probabilities. For example, the present value of lifetime income of 74 year olds is their current labour income. The lifetime income of 73 year olds is equal to their current labour income plus the present value of lifetime income of the 74 year-year-old, adjusted for increases in real income. Formally, we use the following equation for estimating average human capital per capita for a cohort of individuals with gender s , age a , and educational attainment e :

$$(1) \quad h_{e,a} = w_{1,a}^e y_{1,a}^e + w_{2,a}^e y_{2,a}^e + sr_{a,a+1} h_{e,a+1} (1+g)/(1+r),$$

where,

$h_{e,a}$ = average human capital or average lifetime income per capita for individuals with age a and educational attainment e ;

$w_{1,a}^e$ = probability of engaging in paid employment for individuals with age a and educational attainment e , defined as the number of paid workers over the population for that cohort;

$y_{1,a}^e$ = annual labour compensation of paid workers with age a and educational attainment e ;

$w_{2,a}^e$ = probability of engaging in self-employment for individuals with age a and educational attainment e , defined as the number of self-employed workers over the population for that cohort;

$y_{2,a}^e$ = annual labour compensation of self-employed workers with age a and educational attainment e ;

$sr_{a,a+1}$ = the probability of surviving one more year from age a ; and

g = real income growth rate;

r = discount rate.

The equation holds separately for males and females. We will assume that the average growth rate of real income is equal to labour productivity growth in the Canadian business sector, which is 1.7% per year for our estimation period 1970 to 2007. We will set the real discount rate equal to 5.1%, which is the weighted average of real rates of return to equity and debt (Baldwin and Gu 2007).

During their working life, individuals may pursue further studies to increase its earnings. To incorporate the extra human capital of those individuals, backward recursion (1) needs to be modified as (Jorgenson and Fraumeni, 1989, 1992a, 1992b; Le, Gibson, and Oxley, 2005; Wei, 2004):

$$(2) \quad h_{e,a} = w_{1,a}^e y_{1,a}^e + w_{2,a}^e y_{2,a}^e + (1 - senr_a^e) sr_{a,a+1} h_{e,a+1} (1+g) / (1+r) + \sum_{m=1}^{M_e} (senr_a^e / M_e) sr_{a,a+m} h_{e+1,a+m} (1+g)^m / (1+r)^m ,$$

where,

$senr_a^e$ =school enrolment rate defined as the proportion of individuals with educational attainment e who are studying for a higher educational attainment $e+1$; and

M_e = number of years that the individuals with educational level e spend to complete a higher educational level $e+1$.

When individuals pursue further studies, they face two possible earnings streams; one with the current educational attainment e , and the other with the higher educational attainment $e+1$ with a delay due to schooling. Average human capital per capita among a cohort of the individuals is a weighted sum of these two earnings streams, with weights being the probability of school enrolment.

In equation (2), we make the assumption that students enrolled in an educational level are evenly distributed across different study years, except for certain young ages. For example, 18 year-old students studying for a Bachelors degree are assumed to be in their first year. 19-year-old students studying for a Bachelors degree are assumed to be in their second year.¹

To estimate human capital for Canada, we have classified the individuals in the Canadian population into five educational levels: 0-8 years of schooling, some or completed high school, some or completed post-secondary school, Bachelors degree, and Masters degree or above. We will assume that individuals with 0-8 years of schooling spend 3 years to complete the next education level (some or completed high school). The individuals with some or completed high school spend 2 years to complete some or completed post-secondary education. The individuals with some or completed post-secondary education spend 4 years to complete a Bachelors degree. The individuals with a Bachelors degree spend 2 years to complete a Masters degree or above.

The stock of human capital in current dollars is the sum of lifetime labour incomes for all individuals in the working-age population. The stock of human capital in constant dollars is constructed from data on the number of individuals in the population and average lifetime income per capita, cross-classified by gender, age, education. Using Tornqvist aggregation², the growth rate of aggregate human capital stock is calculated as a weighted sum of the growth rates of the number of individuals across different categories of population:

$$(3) \quad \Delta \ln K = \sum_s \sum_e \sum_a \bar{v}_{s,e,a} \Delta \ln L_{s,e,a} ,$$

where K denotes the volume indices of aggregate human capital stock, $L_{s,e,a}$ the number of individuals with gender s , age a , and educational level e , and Δ denotes a first difference, or change between two consecutive periods, for example:

¹ In our empirical analysis, we find that this additional change to the assumption of even distribution of students across different school years has little effect on the estimated stock of human capital for Canada.

² Diewert (1976) shows that Torqvist index is an exact index number.

$$(4) \quad \Delta \ln K = \ln K(t) - \ln K(t-1).$$

The weights are given by the average share of each category of population in the nominal value of aggregate human capital stock:

$$(5) \quad \bar{v}_{s,e,a} = \frac{1}{2} [v_{s,e,a}(t) + v_{s,e,a}(t-1)], \quad v_{s,e,a} = \frac{h_{s,e,a} L_{s,e,a}}{\sum_s \sum_e \sum_a h_{s,e,a} L_{s,e,a}},$$

where $\{h_{s,e,a}\}$ is the set of average lifetime labour income of different types of the individuals, cross-classified by gender, age and education calculated using equation (2).

The aggregate human capital stock is a weighted sum of the number of individuals in the population, cross-classified by gender, age and education, using their lifetime income as weights. The difference between the growth of this weighted population counts and the growth of un-weighted population counts reflects the compositional change of human capital. The compositional effect is positive if there is a shift in the composition of the population towards younger and more educated individuals with higher expected lifetime income. Formally, the composition of aggregate human capital is calculated as aggregate human capital per capita:

$$(6) \quad CK = K / L,$$

where L is the number of individuals in the population.

To examine the contribution to the compositional change of aggregate human capital stock from population characteristics such as gender, age, and education separately, we construct the partial indices of aggregate human capital stock corresponding to those characteristics. For example, a partial index of the volume of aggregate human capital stock corresponding to gender, is defined as follows:

$$(7) \quad \begin{aligned} \Delta \ln K^{sex} &= \sum_s \bar{v}_s \Delta \ln L_s \\ &= \sum_s \bar{v}_s \Delta \ln \left(\sum_e \sum_a L_{s,e,a} \right), \end{aligned}$$

where:

$$\begin{aligned} \bar{v}_s &= \frac{1}{2} [v_s(t) + v_s(t-1)], \\ v_s &= \sum_e \sum_a v_{s,e,a}. \end{aligned}$$

The partial volume index corresponding to gender captures the shift of the population between the two genders alone. Similarly the partial volume indices for education and age measure the shift between age groups, or between educational levels.

The difference between the growth of the partial indices of aggregate human capital for each characteristic (gender, age and education) and the growth of the number of individuals in the population measures the effect of that characteristic on the composition change of human capital.

2.2 The Cost-based Approach to Human Capital Measurement

The cost-based approach to estimating human capital stocks and flows is, in effect, similar to that often used to estimate physical capital stocks and flows. The approach estimates the stock of human capital as the accumulated value of the expenditures spent on those items defined as investment in human capital.

The cost-based approach was used by Kendrick (1976) and Eisner (1985) to estimate human capital stock for the U.S. Kendrick (1976) included in investments in human capital the following items: the costs of rearing, expenditure on health and safety, mobility, education and training, plus earnings forgone by students attending school.

It is relatively easy to measure adequately most forms of investment in human capital using various data sources at Statistics Canada. Public and private spending on formal education is relatively well documented. Spending by enterprises on job-related training programmes is also possible to quantify.

The work of Mincer (1962) shows that informal on-the-job training contains an implicit investment aspect as workers accept lower wages in order to gain working experience. Indeed, 'education' results not only from schooling and training, but also from general experience both at work and in leisure-time activities. But the expenditures related to informal on-the-job training are not readily available.

The cost-based approach to measuring human capital is useful for cost-benefit analysis of human capital expenditures (e.g., Stager, 1996; Vaillancourt, 1995). The approach provides a measure of flow of investments in human capital. When combined with the income-based measure of human capital, the cost-based measure provides a measure of a rate of return to investment in human capital. However, there are several limitations with this approach.

The first limitation concerns the decision criteria used to split human resource expenditures into a consumption flow component and investment flow component. For example, Kendrick (1976) assumed that all costs of raising children to the age of fourteen are human capital investment. This contradicts Bowman (1962) who argued that those costs should not be treated as investment unless men are slaves. There is a similar

problem with determining the contributions to human capital of different types of investments. The lack of empirical evidence led Kendrick to attribute 50 percent of household expenditures on health and safety as human capital investment and the other 50 percent as consumption.

The second limitation of the cost-based approach relates to the choice of depreciation rates for human capital. The choice of depreciation for measuring human capital is essentially arbitrary due to lack of empirical evidence. Kendrick used the modified double declining balance method. In contrast, Eisner used the straight-line depreciation to estimate human capital stock.

Finally, there is the choice of deflators that can be used to deflate expenditures related to human capital investment.

For the rest of the paper, we will apply the income-based approach to estimate human capital in Canada. Our future research will apply the cost-based approach to estimate human capital in Canada.

3 Data Sources and Data Construction

To construct aggregate human capital in Canada, we have cross-classified the individuals in the working-age population by 2 genders, 60 ages (15 to 74) and 5 educational levels (primary, secondary, post-secondary, Bachelors degree, and Masters degree or above) for a total of 600 groups of individuals. We will then develop a database on labour market activities and school enrolment for those individuals. The data base includes population counts, paid employment, self-employment, school enrolment, and annual labour compensation of paid workers.

The construction of those data is based on monthly Labour Force Survey (LFS) from 1976 to 2007 and Census of Population for the years 1971, 1981, 1986, 1991, 1996, 2001, and 2006.

The data on the number of individuals, paid employment, self-employment, school enrolment are obtained from the Labour Force Survey for the period 1976 to 2007, and obtained from the Census of Populations for the years before 1976.

The data on annual earnings of paid workers are obtained from the Labour Force Survey for the period 1997 to 2007, as the LFS started to collect data on hourly earnings of paid workers beginning in 1997. For the years before 1997, the hourly earnings are derived from a linear interpolation of the two adjacent Censuses.

The earnings of self-employed workers are not available from the LFS and Censuses. To estimate the annual earnings of self-employed workers, we assume that the hourly earnings of self-employed workers are equal to that of paid workers with the same level of education and experience.

The data on annual earnings of paid workers and self-employed workers are all benchmarked to annual labour compensation in the Canadian Productivity Accounts of Statistics Canada.³ The data thus estimated reflects the annual labour compensation of paid workers and self-employed workers.

In January 1990, the LFS revised the questions related to educational attainments of the respondents. From 1976 to 1989, post-secondary education was limited to education that normally requires high-school graduation. After 1990, post-secondary education included any education that could be counted towards a degree, certificate or diploma from educational institutions. The change caused a reallocation of respondents from secondary to post-secondary education. To ensure the data is consistent over time, we have combined the secondary education and post-secondary education in one category for the pre-1990 LFS data and used the information on secondary and post-secondary education from the Censuses to split the LFS data for that period.

The data on survival rates are obtained from “Life Tables, Canada, Provinces and Territories” published by Statistics Canada. While education tends to increase the survival rates, no such data exists for Canada. We will assume the survival rates do not vary across educational levels and depend on age and gender only.

4 Empirical Results

In this section we will first summarize the data that is used for calculating the lifetime income and aggregate human capital, which includes the distribution of the working age population across different individual characteristics (gender, age and education), employment rates and enrolment rates. We will then present our estimates of aggregate human capital stock and compare human wealth with non-human wealth.

4.1 Summary of the Data

Table 1 presents the distribution of working-age population aged 15 to 74 for the selected years 1970, 1980, 1990, 2000, and 2007.

The share of women in the working-age population was virtually unchanged over the period 1970 to 2007. Over the period, the share of women was slightly larger than that of men.

Levels of education in the Canadian population have risen steadily since the 1970s. The share of the working-age population with a postsecondary education rose from 20.4% in

³ Labour compensation as defined for the productivity program includes all payments in cash or in kind that Canadian producers make to workers in return for their services. It includes labour income such as wages and salaries (including bonuses, tips, taxable allowances and backpay), supplementary income of paid workers (various employer contributions) and the implicit labour income of self-employed workers.

1970 to 39.8% in 2007. Over the same period, the share of the individuals with a Bachelors degree climbed from 4.1% to 14.1%, and the share of the individuals with a Masters degree or above increased from 1.1% to 6.1%.

The share of the Canadian population by age group has changed substantially since 1970. The 1970-1980 period was characterised by the entry of younger individuals for the 15-34 group—the post-war baby-boomers to the Canadian population. The trend towards a younger population reversed itself in the early 1980s, when the baby-boomers entered the 35-44 age group. Between 1980 and 2007, the share of the population for the 15-34 age group dropped from 50.2% to 35.4%. Over the same period, the share of the population for the 35-54 group increased from 30.2% to 40.2%, and for the 55-74 group from 19.6% to 24.4%.

Tables 2 and 3 present the rates of paid employment and self-employment, defined as the number of persons employed as a percentage of the working-age population aged 15 to 74. As shown in table 2, the ratio of paid workers to the working-age population increased from 48.8% to 58.9% over the period 1970 to 2007. The rise in the rate of paid employment over the period was due to the dramatic increase in the employment rate for women. The employment rate for men declined slightly over the period.

The rate of paid employment rose for the persons with secondary or post-secondary education for the period 1970 to 2007. It declined dramatically for the persons with less than high school, reflecting the deteriorating labour market condition for those less educated population. The rate of paid employment for the persons with a Bachelors degree experienced little change, while the rate of paid employment for persons with a Masters degree or above declined over the period.

The changes in the paid employment rate differ across age group. The rate of paid employment rose for the younger and prime-age population over time. For the older population, the employment rate declined before 2000 and increased thereafter.

Table 3 presents the share of the working-age population that are self employed. The share of self-employment changed little over the period 1970 to 2007, for both men and women. But the self-employment rate was higher for men than for women. The rate of self-employment increase with education levels for the post-1990 period. The self-employment rate was higher among more-educated individuals than among less-educated individuals. For the 1970s and 1980s, the self-employment rate was the highest for persons with the least education and highest educational attainment.

The estimation of life-time income and aggregate human capital requires data on enrolment for formal schooling by gender, age and education. A summary of the enrolment rates, defined as the share of persons who attended school is presented in table 4. We have included enrolment in both full time and part-time studies in the estimation.⁴

⁴ We will examine the effect of excluding part-time students on the estimated human capital measure.

Over the period 1970 to 2007, the share of persons aged 15 to 74 showed a little change, which is a net result of rising enrolment rates for women and declining enrolment rates for men. The enrolment rate increased across all age groups. Over the period 1970 to 2007, the enrolment rate increased from 30.5% to 35.7% for the younger population, and it increased from 1.7% to 3.4% for the prime age population. The number of older persons aged 55 and over who attend school was very small, but it increased over time.

4.2 Aggregate Human Capital Stock

In this section, we will present our estimates of aggregate human capital stock. We will discuss the relative importance of human capital stock for subgroups of persons by gender, age and education levels in the next section.

The results of applying Jorgenson and Fraumeni's methodology, that is, of estimating the annual growth rates of aggregate human capital stock are summarized in Table 5. Figure 1 plots the indices of human capital and population counts and human capital per capita.

The index of aggregate human capital is obtained as the weighted sum of the number of individuals in the population cross-classified by gender, age and education, using their lifetime income as weights. The table contains the average growth rate of this weighted population counts with average lifetime income as weights, and the average growth rate of un-weighted population counts. The difference between the two is the average growth rate of human capital per capita which reflects the effect of compositional change. Human capital per capita will increase if there is a shift of the Canadian population towards more educated and younger individuals with higher lifetime labour income. We also include the marginal effect of each factor on the compositional change of human capital in the table.

Over the period 1970 to 2007, aggregate human capital rose at annual rate of 1.7% in Canada. Most of the growth in human capital is due to the increase in the number of individuals in the working-age population aged 15 to 74. Of the 1.7% growth in the human capital, 1.5 percentage points is due to the growth in the working-age population, the remainder 0.2 percentage points is due to the effect of the compositional shift or the growth in human capital per capita.

The growth of aggregate human capital was the highest in the 1970s that coincided with the entry of baby-boomers to the working-age population and the increase in the education levels of the Canadian population in the period. The growth of aggregate human capital slowed after 1980 due to a slower growth and the aging of the working-age population. The aging of the working-age population has a negative effect on the growth of human capital per capita as a result of a shift towards the older individuals with lower lifetime income.

The relative effect of age, gender and education on the composition change of human capital is presented in the bottom half of Table 5. Rising education attainment in the

Canadian population makes a positive contribution to the growth in aggregate human capital. It contributed 0.9% to annual growth in human capital stock over the period 1970 to 2007.

The ageing of the Canadian population after the early 1980s made a negative contribution to the growth in the human capital stock, and it lowered the annual growth in human capital by 0.5% in the 1980-2000 period and 0.6% in the 2000-2007 period.⁵

There is a little change in the share of women in the working-age population over time. As such, it has no effect on the growth in human capital stock.

4.3 Human Capital Stock by Gender, Education and Age Group

Table 6 presents the expected lifetime income per capita by types of individuals in the working-age population. The average lifetime income per capita is used as weights to weight the number of individuals in the population to derive a measure of aggregate human capital.

A number of general features are apparent from the table. First, the average lifetime income per capita rose from 99.0 thousand dollars in 1970 to 652.6 thousand dollars in 2007, a 6.6-fold increase during the period. The growth in average life-time income was much faster for women than for men. In 1970, the average lifetime income for women was 30.4% of that for men. In 2007, the average lifetime income for women reached 64.3% of that for men.

Second, the average lifetime income is higher for more-educated persons than for less-educated persons. The average lifetime income for the persons with less than high school had the slowest growth.

Third, the average lifetime income of young persons was higher than that of older persons due to the longer remaining working life for younger persons. The growth of lifetime income was the highest for the prime age individuals.

Table 7 shows the annual growth of human capital for individuals of each gender, five educational levels and three age groups. Over period 1970 to 1980, the growth of human capital was similar for women and men. After 1980, the growth of human capital embodied in women was higher than that in men.

The growth of human capital in more-educated individuals was higher than that in less-educated individuals. The human capital in individuals with less than high school actually declined at a rate of 4.2% per year over the period 1970 to 2007.

⁵ Boothby and et al. (2003) discussed the effect of the aging of the Canadian population on the skill level of the working-age population in Canada.

Table 8 decomposes the growth of aggregate human capital into contributions from persons of each gender, from persons of five education levels and from persons of three age groups. Before 1980, 0.8 percentage points or about one quarter of the growth in aggregate human capital was due to the growth in human capital in women. After 1980, the importance of women in the growth of aggregate human capital increased dramatically. For the recent period 2000 to 2007, 45 percent of the growth of aggregate human capital can be attributed to the growth of human capital in women.

The growth of aggregate human capital in Canada was entirely due to the growth of human capital in individuals with at least post-secondary education over the period 1970 to 2007. The contribution of persons with less than post-secondary education to the growth in aggregate human capital was small in the 1970s and negative after 1980.

Human capital increased for all age groups, but the relative importance of each age group in the overall human capital growth changed over time. In the 1970s, most of the growth in aggregate human capital was due to the growth in human capital in younger persons, as a result of the entry of post-war baby boomers to the working-age population. In the period 1980 to 2000, most of the growth in aggregate human capital was due to the growth of human capital in prime age individuals as the baby boomers reached the prime age. In the period after 2000, the growth of human capital in younger persons was again the most important contributors to the growth of aggregate human capital, as the children of baby boomers or “echo babies” reached the working age.

4.4 The Contribution of Human Wealth to the Wealth Accounts

In this section, we will present an account of full wealth in Canada. The value of full wealth is defined as the sum of produced capital and natural wealth as calculated by the National Balance Sheets Accounts (CANSIM table 378-0005), and our estimates of human wealth. The produced capital in the National Balance Sheets Accounts includes residential structures, non-residential structures, machinery & equipment, consumer durables and inventories. The natural wealth includes land and natural resources (timber, energy resources and minerals).

We present the estimates of human wealth, produced capital and natural capital for the period 1970 to 2007 in current prices in Table 9 and in constant dollars in Table 10. We have also plotted the share of human wealth, produced capital and natural wealth in Figure 2. The largest component of full wealth in Canada is human wealth, followed by produced capital and natural capital. Human wealth accounted for 70% of full wealth in 2007, while produced capital and natural capital accounted for 17% and 13% respectively in that year.

Over the last forty years, the share of human capital in full wealth declined slightly while the share of produced capital and natural capital increased. The share of human capital declined from 78% in 1975 to 70% in 2007, while the share of produced capital increased from 15% to 17% and the share of natural capital increased from 8% to 13%.

The value of human capital exceeds the value of produced capital. But the ratio of human capital relative to produced capital declined over time. In 2007, the value of human capital is about 4 times as large as the value of produced capital. In 1970, the ratio of human capital to produced capital was 5.6.

The growth of human capital in constant prices was slower than the growth of produced assets, as shown in Table 10.⁶ For the period 1970 to 2007, human capital in constant prices increased 1.7% per year, while produced capital in constant prices rose at 2.8% per year.

The growth rate of the price index is similar for human capital and produced capital. Over the period 1970 to 2007, the price index of human capital rose by 4.6% per year, while the price index of produced capital increased at a rate of 4.9% per year.

4.5 Sensitivity Analysis

The estimates of lifetime income and aggregate human capital stock depend on the expected future real income growth and the discount rate used to discount the future income. In the estimates presented above, we have assumed that the expected future real income growth is equal to average labour productivity growth in the Canadian business sector, and the discount rate is equal to the weighted average of the rates of return to equity and debt.

In this section, we will examine the sensitivity of the human capital estimates to alternative assumptions about the real income growth and the real discount rate. The results are presented in table 11.

We find that the changes in the expected future income growth and the discount rate have a significant effect on the level of human capital, but have a little effect on the growth rate in the quantity and price of human capital. As is obvious from equation (2) for calculating the lifetime income, the effect of an increase in the real income growth on the level of human capital is similar to the effect of a decline in the discount rate. Our results show that a one-percentage-point increase in the real income growth or a one-percentage-point decline in the discount rate increases the value of human capital stock by 15% in 2007. On average, the change increases the level of human capital stock by 16 percent for the period 1970 to 2007. The results in table 11 also shows that a one-percentage-point decline in the real income growth or a one-percentage-point increase in the discount rate reduces the level of human capital stock by 12% in 2007, and on average the change

⁶ The National Balance Sheets Accounts of Statistics Canada are presented in current prices only. We have used the price deflators of capital stock for residential and non-residential assets to deflate the stock of produced assets in the National Balance Sheets. The price deflator for natural wealth is not available. As such, we will only compare the growth rates of human capital and produced capital.

reduces the level of human capital stock by 13 percent a year for the period 1970 to 2007.⁷

In the estimates of human capital stock presented so far, we have included both full time and part time studies in the estimation of enrolment rates. When we exclude the part time studies from the estimation of enrolment, we find that this has a little effect on the level and growth of human capital stock estimates.

5 Conclusions

This paper has constructed a measure of human capital for Canada over the period 1970 to 2007 and compared it with nonhuman capital stock. Our findings are summarized as follows.

First, aggregate human capital rose at annual rate of 1.7% in Canada for the period 1970 to 2007, and most of the growth is due to the increase in the number of individuals in the working-age population aged 15 to 74. The rising educational level of the Canadian population is also significant factor for the growth in human capital. Of the 1.7% growth in human capital in the period 1970 to 2007, 1.5 percentage points is due to the growth in the working-age population, the remainder 0.2 percentage points is due to the effect of the compositional shift of human capital (e.g., aging and rising education levels of the Canadian population) or the growth in human capital per capita.

Second, the aging of Canadian population has a negative effect on the growth of human capital while the rising educational levels has a positive effect on the growth of human capital. Our estimates show that the aging of the Canadian population after the early the 1980s reduced the human capital growth by 0.5% per year, while the rising educational level increased the human capital growth by 0.8% per year.

Third, the value of human capital exceeds the value of produced capital. But the ratio of human capital relative to produced capital declined over time. In 2007, the value of human capital is about 4 times as large as the value of produced capital. In 1970, the ratio of human capital to produced capital was 5.6.

Fourth, the growth of human capital in constant prices was slower than the growth of produced assets, but the growth rate of the price index of human capital is similar to that of produced capital. Over the period 1970 to 2007, human capital in constant prices increased 1.7% per year, while produced capital in constant prices rose at 2.8% per year. The price index of human capital rose by 4.6% per year, while the price index of produced capital increased at a rate of 4.9% per year.

⁷ Wei (2004) also found that changes in real income growth rate and discount rate have a significant effect on the level of human capital stock.

Fifth, the level of human capital estimates is sensitive to the choice of the expected future income growth and the discount rate used to discount the future income, but the growth of the quantity and price of human capital is not sensitive to the choice.

This paper has focused on the estimates of human capital using income-based approach of Jorgenson and Fraumeni. The next step of our research is to estimate human capital stock using the cost-based approach.

References

- Ahlroth, S., A. Björklund & A. Forslund (1997), “The Output of the Swedish Education Sector”, *Review of Income & Wealth*, 43(1), pp.89-104.
- Baldwin J.R. and W. Gu (2007), “Long-term Productivity Growth in Canada and the U.S.”, *the Canadian Productivity Review*, Statistics Canada.
- Baldwin J.R. and T.M. Harchaoui (eds.) (2003), *Productivity Growth in Canada-2002*, Catalogue 15-204-XPE, Statistics Canada.
- Barro, R.J. and Lee Jong Wha (1996), “International Measures of Schooling Years and Schooling Quality,” *American Economic Review*, vol. 86(2), pp. 363-394.
- Beach, C.M., R.W. Boadway, and N. Bruce (1988), “Taxation and Savings in Canada”, Ottawa: Economic Council of Canada.
- Becker, G. S. (1964), *Human Capital: a Theoretical and Empirical Analysis, with Special Reference to Education*, Columbia University Press: New York.
- Boothby D., J. Dubois, M. Fougère, and B. Rainville (2003), “Labour Market Implications of an Aging Population”, Skills Research Initiative, Working paper A-01, Government of Canada. Ottawa.
- Bowman, M.J. (1962), *Economics of Education*, *HEW Bulletin 5*.
- Coulombe, Serge and Jean-François Tremblay (2006), “Human Capital and Canadian Provincial Standards of Living”, Statistics Canada, Catalogue no. 89-552-MIE, no. 14
- Diewert, W.E. (1976), “Exact and Superlative Index Numbers”, *Journal of Econometrics*, 4:115-45
- Ederer, P. (2006), *The European Human Capital Index*, Brussels: The Lisbon Council.
- Eisner, R. (1985), “The Total Incomes System of Accounts”, *Survey of Current Business*, 65 (1), 24–48.
- Greaker, M. and G. Liu (2008), “Measuring the Stock of Human Capital for Norway: A Lifetime Labour Income Approach”, paper presented at the OECD Workshop on the Measurement of Human Capital.
- Gu, W. et al. (2003), “The Changing Composition of the Canadian Workforce and its Impact on Productivity Growth”, in Baldwin J.R. and T.M. Harchaoui (eds.), *Productivity Growth in Canada-2002*, Catalogue 15-204-XPE, Statistics Canada.

Jorgenson, D. W. and B. M. Fraumeni (1989), “The Accumulation of Human and Nonhuman Capital, 1948–1984”, In R. E. Lipsey and H. S. Tice (eds.), *The Measurement of Savings, Investment and Wealth* (pp. 227–282). Chicago, I.L.: The University of Chicago Press.

Jorgenson, D. W. and B. M. Fraumeni (1992a), “The Output of the Education Sector”, In Z. Griliches (Ed.), *Output Measurement in the Services Sector* (pp. 303–338). Chicago, I.L.: The University of Chicago Press.

Jorgenson, D. W. and B. M. Fraumeni (1992b), “Investment in Education and U.S. Economic Growth”, *Scandinavian Journal of Economics*, 94, pp. 51-70.

Jorgenson, D. W., B. M. Fraumeni, and M.S. Christian (2006), “A Human Capital Approach to Measuring the Output of Education for the U.S”, Bureau of Economic Analysis.

Kendrick, J. (1976), *The Formation and Stocks of Total Capital*. New York, N.Y.: Columbia University Press for NBER.

Kokkinen (2008), “Human Capital and Finland’s Economic Growth n 1910 – 2000”, paper presented at the 30th IARIW conference, Portoroz, Slovenia.

Laroche, M. and M Merette (2000), “Measuring Human Capital In canada”, Department of Finance, Ottawa, Canada.

Le, T., J. Gibson, and L. Oxley (2002), “A Forward Looking Measure of the Stock of Human capital in New Zealand”, Paper presented at the NZAE conference, Wellington,

Le, T., J. Gibson, and L. Oxley (2003), “Cost- and Income-based Measures of Human Capital”, *Journal of Economic Survey*.

Macklem, R. T. (1997), “Aggregate Wealth in Canada”, *Canadian Journal of Economics*, 30(1), 152–168.

Mincer, J. (1962), “On-the-job Training: Costs, Returns and Some Implications”, *Journal of Political Economy*, 70(5), pp.50-79

OECD (1998), *Human Capital Investment: an International Comparison*. Paris: OECD.

O’Mahony, M. and P.A. Stevens (2004), “International Comparisons of Performance in the Provision of Public Services: Outcome Based Measures for Education”, National Institute of Economic and Social Research, London, U.K.

Shultz, T.W. (1961a), “Investment in Human Capital”, *American Economic Review*, 51 (1), 1–17.

Shultz, T. W. (1961b), “Investment in Human Capital”, *American Economic Review*, 51 (5), 1035–1039.

Skills Research Initiative (2008), “Skills for Innovation and Growth – Overview of Key Findings and Policy Implications of the Skills Research Initiative”, Ottawa. Canada

Smith, Robert (2008), “Measuring the Sustainability of Well-Being: a Capital Approach”, paper presented at the 30th IARIW conference, Portoroz, Slovenia.

Stager, D.A.A. (1996), “Returns to Investment in Ontario University Education, 1960-1990”, *The Canadian Journal of Higher Education*, XXVI(2), 1-22.

Statistics Canada, “Life Tables, Canada, Provinces and Territories”, Catalogue 84-537, various issues.

Vaillancourt, F. (1995), “The Private and Total Returns to Education in Canada, 1985”, *The Canadian Journal of Economics*, 28(3), 532-554.

Wei, H. (2004), “Measuring the Stock of Human Capital for Australia: a Lifetime Labour Income Approach” ,Australian Bureau of Statistics Research Paper.

Wei, H. (2007), “Measuring Australia’s Human Capital Development: The Role of Post-School Education and the Impact of Population Ageing”, *Statistical Journal of the IAOS* 24, 183-191.

World Bank (2006), *Where is the Wealth of Nations? Measuring Capital for the 21st Century*. Washington, D.C.

Table 1. Share of the Working-age Population (%)

	1970	1980	1990	2000	2007
<i>Gender</i>					
Male	49.3	49.8	49.7	49.9	49.8
Female	50.7	50.2	50.3	50.1	50.2
<i>Educational Attainment</i>					
Primary Education	35.0	20.9	13.0	8.5	5.8
Secondary Education	39.4	44.6	44.2	37.6	34.2
Post-secondary Education	20.4	26.0	31.5	37.8	39.8
Bachelors Degree	4.1	5.9	7.8	10.9	14.1
Masters Degree or Above	1.1	2.6	3.5	5.2	6.1
<i>Age Group</i>					
Young, 15-34	49.0	50.2	44.0	36.7	35.4
Prime Age, 35-54	32.8	30.2	35.2	41.9	40.2
Older, 55-74	18.2	19.6	20.8	21.4	24.4

Table 2. Probabilities of Paid Employment (%)

	1970	1980	1990	2000	2007
All individuals	48.8	54.6	56.7	56.3	58.9
<i>Gender</i>					
Male	65.5	66.0	63.0	60.7	62.3
Female	32.5	43.3	50.5	51.8	55.6
<i>Educational Attainment</i>					
Primary Education	39.5	35.2	28.6	21.6	23.2
Secondary Education	48.3	53.4	53.8	51.1	53.1
Post-secondary Education	59.6	65.6	66.2	63.7	64.4
Bachelors Degree	70.3	73.6	74.0	70.0	69.0
Masters Degree or Above	76.9	78.2	73.7	67.5	66.4
<i>Age Group</i>					
Young, 15-34	50.7	60.3	63.5	61.3	63.2
Prime Age, 35-54	55.4	62.3	67.8	68.5	71.3
Older, 55-74	31.6	28.0	23.4	23.8	32.3

Table 3. Probabilities of Self-Employment (%)

	1970	1980	1990	2000	2007
All individuals	6.1	5.2	5.6	6.2	5.6
<i>Gender</i>					
Male	7.7	6.8	7.1	7.4	6.7
Female	4.5	3.6	4.1	5.0	4.6
<i>Educational Attainment</i>					
Primary Education	8.0	6.8	5.7	4.8	4.3
Secondary Education	5.7	4.8	5.4	5.7	4.9
Post-secondary Education	4.1	4.6	5.4	6.3	5.8
Bachelors Degree	3.5	4.6	5.8	6.4	6.2
Masters Degree or Above	8.6	7.6	9.9	10.4	8.9
<i>Age Group</i>					
Young, 15-34	4.3	4.0	4.3	4.1	3.4
Prime Age, 35-54	8.4	7.3	7.5	8.3	7.5
Older, 55-74	6.9	5.1	5.0	5.6	5.9

Table 4. Enrolment Rates (%)

	1970	1980	1990	2000	2007
All individuals	15.4	13.1	13.6	14.1	14.1
<i>Gender</i>					
Male	16.9	13.5	13.2	13.5	13.4
Female	13.8	12.7	13.9	14.7	14.8
<i>Educational Attainment</i>					
Primary Education	5.2	3.7	4.5	6.2	8.4
Secondary Education	24.7	17.2	15.9	18.2	19.4
Post-secondary Education	15.5	14.4	15.4	14.0	12.8
Bachelors Degree	15.1	12.5	10.8	9.3	9.7
Masters Degree or Above	10.2	7.2	7.1	7.8	8.6
<i>Age Group</i>					
Young, 15-34	30.5	24.8	27.7	34.3	35.7
Prime Age, 35-54	1.7	2.0	3.7	3.3	3.4
Older, 55-74	0.2	0.2	0.3	0.5	0.6

Table 5. Average Annual Growth in Human Capital, Working-age Population and Human Capital per Capita (%)

	1970-2007	1970-1980	1980-2000	2000-2007
Human capital stock	1.7	3.0	1.2	1.1
Working-age population	1.5	2.1	1.2	1.3
Human capital per capita	0.2	0.9	0.0	-0.2
First-order indices of human capital per capita				
Gender	0.0	0.0	0.0	0.0
Education	0.9	1.4	0.8	0.6
Age	-0.4	-0.1	-0.5	-0.6

Table 6. Average Lifetime Labour Income per Capita

	1970	1980	1990	2000	2007
All individuals	99.0	245.9	460.9	518.8	652.6
<i>Gender</i>					
Male	153.1	352.5	603.6	654.0	794.9
Female	46.5	140.2	320.0	384.4	511.2
<i>Educational Attainment</i>					
Primary Education	51.4	86.3	141.2	152.6	218.5
Secondary Education	106.9	238.6	399.2	463.5	579.0
Post-secondary Education	137.6	328.0	574.4	569.6	675.5
Bachelors Degree	194.7	405.4	722.4	713.0	848.7
Masters Degree or Above	256.2	472.2	832.4	743.5	874.7
<i>Age Group</i>					
Young, 15-34	150.2	359.8	697.5	831.8	1057.7
Prime Age, 35-54	69.8	197.4	410.8	479.2	628.5
Older, 55-74	14.2	28.4	46.0	60.9	104.9

Note: Estimates in 000s dollars.

Table 7. Average Annual Growth of Human Capital by Types of Individuals (%)

	1970-2007	1970-1980	1980-2000	2000-2007
All individuals	1.7	3.0	1.2	1.1
<i>Gender</i>				
Male	1.6	3.1	1.2	1.0
Female	1.8	3.0	1.4	1.2
<i>Educational attainment</i>				
Primary	-4.2	-4.8	-4.4	-2.8
Secondary	0.5	2.9	-0.3	-0.4
Some or completed post-secondary	2.6	4.4	2.3	0.9
Bachelors degree	4.1	5.8	3.4	4.0
Masters degree or above	5.1	9.7	3.7	2.5
<i>Age group</i>				
Young, 15-34	1.0	3.0	0.0	1.0
Prime Age, 35-54	3.0	3.2	3.7	0.8
Older, 55-74	3.5	3.5	2.8	5.2

Table 8. Contribution to the Annual Growth of Aggregate Human Capital by Types of Individuals (%)

	1970-2007	1970-1980	1980-2000	2000-2007
Aggregate human capital stock	1.7	3.0	1.2	1.1
<i>Gender</i>				
Male	1.1	2.2	0.8	0.6
Female	0.6	0.8	0.5	0.5
<i>Educational attainment</i>				
Primary	-0.3	-0.5	-0.2	-0.1
Secondary	0.3	1.3	-0.1	-0.1
Some or completed post-secondary	0.9	1.4	0.9	0.4
Bachelors degree	0.5	0.5	0.4	0.7
Masters degree or above	0.3	0.4	0.2	0.2
<i>Age group</i>				
Young, 15-34	0.7	2.3	0.0	0.6
Prime Age, 35-54	0.9	0.7	1.2	0.3
Older, 55-74	0.1	0.1	0.1	0.2

Table 9. National Wealth in Billions of Current Dollars

Year	Full Wealth	Produced Assets	Natural Wealth	Human Wealth
1970		253		1,426
1971		280		1,615
1972		315		1,804
1973		371		2,044
1974		456		2,400
1975	3,565	523	274	2,768
1976	4,050	581	327	3,142
1977	4,386	644	361	3,381
1978	4,752	721	418	3,614
1979	5,295	823	541	3,931
1980	5,985	933	679	4,373
1981	6,849	1,055	687	5,107
1982	7,368	1,134	689	5,545
1983	7,645	1,185	749	5,711
1984	8,177	1,252	766	6,159
1985	8,632	1,335	749	6,547
1986	9,089	1,435	666	6,988
1987	9,743	1,544	741	7,457
1988	10,526	1,673	810	8,043
1989	11,265	1,800	899	8,566
1990	12,128	1,887	927	9,314
1991	12,570	1,922	885	9,763
1992	12,701	1,954	888	9,859
1993	12,598	2,027	907	9,665
1994	12,877	2,116	979	9,782
1995	13,345	2,179	1,038	10,127
1996	13,623	2,242	1,139	10,243
1997	14,088	2,340	1,212	10,536
1998	14,545	2,448	1,223	10,874
1999	15,171	2,566	1,352	11,253
2000	16,091	2,701	1,621	11,769
2001	16,681	2,811	1,623	12,246
2002	17,296	2,952	1,692	12,651
2003	18,007	3,072	1,858	13,077
2004	19,215	3,257	2,106	13,852
2005	20,489	3,455	2,457	14,576
2006	21,819	3,698	2,721	15,400
2007	23,093	3,956	2,947	16,189

Note: Estimates of natural wealth are not available before 1975.

Table 10. Produced Capital and Human Capital in Billions of 2002 Constant Dollars

Year	Produced Assets		Human Wealth	
	Quantity	Price	Quantity	Price
1970	1,127	0.22	7,135	0.20
1971	1,176	0.24	7,399	0.22
1972	1,220	0.26	7,668	0.24
1973	1,275	0.29	7,941	0.26
1974	1,351	0.34	8,215	0.29
1975	1,403	0.37	8,490	0.33
1976	1,471	0.40	8,763	0.36
1977	1,544	0.42	9,019	0.37
1978	1,612	0.45	9,221	0.39
1979	1,696	0.49	9,432	0.42
1980	1,749	0.53	9,676	0.45
1981	1,799	0.59	9,847	0.52
1982	1,818	0.62	10,018	0.55
1983	1,849	0.64	10,165	0.56
1984	1,902	0.66	10,291	0.60
1985	1,960	0.68	10,423	0.63
1986	2,016	0.71	10,552	0.66
1987	2,083	0.74	10,690	0.70
1988	2,167	0.77	10,811	0.74
1989	2,253	0.80	10,938	0.78
1990	2,304	0.82	11,031	0.84
1991	2,360	0.81	11,159	0.87
1992	2,374	0.82	11,303	0.87
1993	2,413	0.84	11,451	0.84
1994	2,455	0.86	11,611	0.84
1995	2,491	0.88	11,767	0.86
1996	2,524	0.89	11,880	0.86
1997	2,586	0.90	12,037	0.88
1998	2,649	0.92	12,120	0.90
1999	2,733	0.94	12,207	0.92
2000	2,810	0.96	12,370	0.95
2001	2,854	0.98	12,539	0.98
2002	2,921	1.01	12,651	1.00
2003	2,977	1.03	12,792	1.02
2004	3,044	1.07	12,893	1.07
2005	3,099	1.11	13,056	1.12
2006	3,157	1.17	13,191	1.17
2007	3,219	1.23	13,320	1.22
Average Annual growth (%)				
1970-2007	2.8	4.6	1.7	4.9
1970-1980	4.4	8.6	3.0	8.2
1980-2000	2.4	2.9	1.2	3.7
2000-2007	1.9	3.5	1.1	3.5

Table 11. Sensitivity Analysis on Aggregate Human Capital Estimates

	Human Capital in Current Prices in 2007		Growth in Quantity of Human Capital		Growth in Price of Human Capital	
	Billion dollars	Relative to baseline (%)	Annual growth 1970-2007 (%)	% difference with baseline	Annual growth, 1970-2007 (%)	% difference with baseline
Baseline estimate (g=1.7%, r=5.1%)	16,189		1.7		4.9	
Changes in real income growth with r=5.1%						
g=0.7%	14,235	87.9	1.8	0.1	4.9	0.0
g=2.7%	18,587	114.8	1.6	-0.1	4.9	0.0
Changes in real discount rate with g=1.7%						
r=4.1%	18,531	114.5	1.6	-0.1	4.9	0.0
r=6.1%	14,306	88.4	1.8	0.1	4.9	0.0
Full time enrolment only	15,683	96.9	1.7	0.0	5.0	0.2

Figure 1. Indices of human capital, working -age population and human capital per capita in Canada

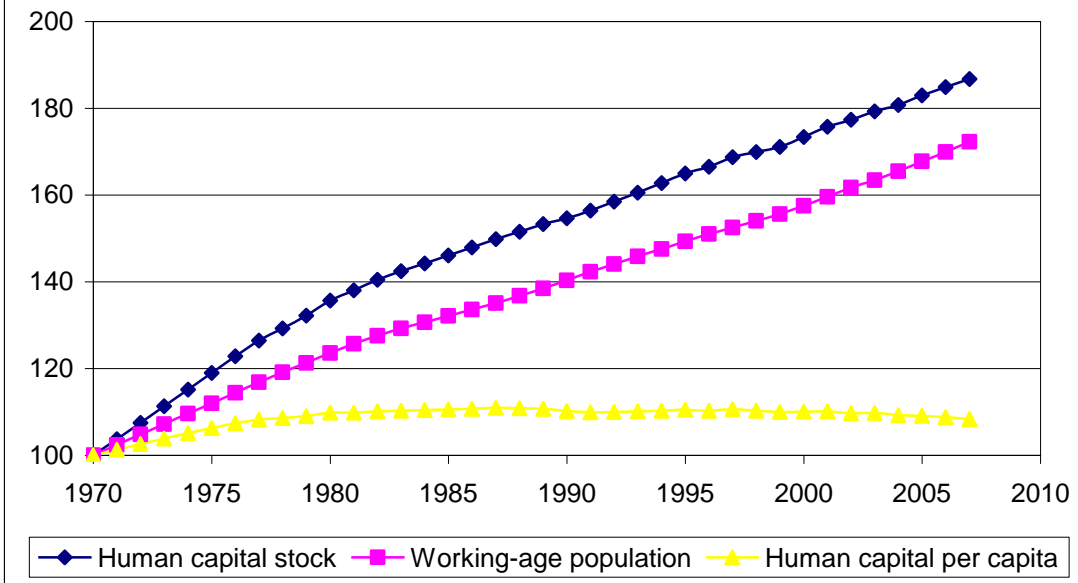


Figure 2. The distribution of total wealth in Canada (%)

