Returns to Educational Investment in Canada

by

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Major Paper presented to the

Department of Economics of the University of Ottawa

in partial fulfillment of the requirements of the M.A. Degree

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Ottawa, Ontario

March 2004

1. Introduction

This paper estimates the private and social returns to education in Canada using 1996 Canada census data. Both the net present values and internal rates of return to education investment are calculated. As well, the estimated returns to education are compared across different categories of learners, such as the returns of different levels of schooling, the returns of different fields of study among bachelor degree holders, the returns for women and men, and the private returns as well as the social returns for individuals. The major results are consistent with most findings in the existing literature. The major conclusions in this paper are: education in Canada has diminishing rates of return by levels of schooling; in general, women have higher rates of return to education than men do at post-secondary levels of education; and the private rates of return to education investment are greater than the social rates of return to education. In the case of the returns to schooling by fields of study, the internal rates of return show that the highest private rate of return is obtained from health degrees for men, and from commerce degrees for women, while the net present values show that the highest private return is from health degrees for both men and women. Both internal rates of return and net present values consistently indicate that the lowest private rate of return is for humanities among both men and women.

This paper is organized as follows: section 2 reviews some existing empirical studies. Section 3 describes the data and empirical methodology used in this paper. Section 4 analyzes the major results, which are followed by conclusions in section 5.

2. Review of empirical literature

The empirical analysis of rates of return to education originated in the 1960s. Among these previous research works, some issues are reviewed as follows.

(1) Sample data set used in previous studies

Ideally, it is better to use longitudinal data to analyze returns to education. But because of the lack of longitudinal data in Canada, many studies used census data, although using cross-sectional data could cause misleading results. For example, Dickson, Milne, and Murrell (1996) used 1991 census data to estimate the benefit streams of New Brunswick university graduates. Stager (1996) used 1991 census data to estimate the returns to various university programs in Ontario. Vaillancourt (1995) used 1986 census data to estimate both the private and social rates of return to education by levels of education and by fields of study.

The estimated results could be biased as a result of using cross-sectional data. Pooling all the individuals who achieved their academic degrees at different periods of time into same estimating equation can't give us the true rates of return to education, because census data contains individual information for all age groups at the point of time when the census was conducted. The individuals who graduated at different periods of time entered the labor market under different labor market conditions, which could influence the starting earnings of individuals as well as their wage growth rates. Therefore, the estimated rates of return to education obtained using cross-sectional data may not truly reflect the benefits of human capital investment.

(2) Methodology used in previous studies

The methodology employed to estimate the returns to education is quite standard. There are two major measures used to evaluate the returns to schooling, and they are closely related to each other. One is the net present value (NPV) of additional investment in schooling, which is calculated by discounting the net benefit of investment into present value term. Another criterion is the internal rate of return (IRR), which can be treated as the interest rate on investment for which the present value of net benefit equals zero. The two criteria are not equivalent in evaluating return to education. The following example demonstrates this conclusion.

For simplification, consider two projects with one-year investment.

Project 1: $$NPV_1 = \frac{NB_1}{1+r_1} - C_1 \qquad (1)$$

Project 2: $$NPV_2 = \frac{NB_2}{1+r_2} - C_2 \qquad (2)$$

Where, NB_1 and NB_2 denote the net benefits of Project 1 and Project 2, respectively. C_1 and C_2 denote the costs of Project 1 and Project 2, respectively. r_1 and r_2 are internal rates of return of Project 1 and Project 2, respectively.

An investment with higher IRR does not mean it has higher NPV. For instance, it is possible that Project 1 has greater IRR (that means $r_1 > r_2$), in contrast, Project 2 has greater NPV at a% discount rate (that means $NPV_2 > NPV_1$)

Derived from equation (1) and (2), $r_1 > r_2$ means:

$$\frac{NB_1}{C_1} > \frac{NB_2}{C_2} \qquad (3)$$

And $NPV_2 > NPV_1$ means:

$$\frac{NB_2}{1+a} - C_2 > \frac{NB_1}{1+a} - C_1 \qquad (4)$$

Equation (3) and (4) can be met simultaneously? Yes, at least one case satisfies equation (3) and (4) at same time:

When $a = 10\%$, $NB_2 > 0.55C_2$, $NB_1 = 2\ NB_2$, and $C_1 = 1.5\ C_2$

Actually, there has been an efflorescence of arguments about NPV versus IRR. Turvey (1963) ever stated that "use of present value does, and use of an internal rate does not, involve a discount rate representing our relative evaluation of current and postponed returns and costs" (P.96). Flemming and Feldstein (1964) also pointed out that "if the minimum acceptable rate of return is greater than zero the use of the internal rate of return rule does give less weight to remoter than to nearer costs and revenues" (P.490). Thus, the choice between two criteria depends on the goal of individual's investment. If one's target is to obtain a maximum rate of growth of benefit from an investment, IRR is an appropriate criterion. Whereas, if one only cares about the net present value of the monetary benefit from an investment at a given discount rate, the NPV criterion may be preferred. Therefore, my opinion is that one should consider both criteria when makes a decision about future educational investment.

However, the internal rate of return is more often used in existing research. As far as I know, among the previous studies, only Dodge and Stager (1972), Vaillancourt and Henriques (1986), Bélanger and Lavallée (1980) discussed their results using both criteria, while many other researchers used the internal rate of return to present their conclusions.

The benefits of investment used in calculations of the returns to education are usually measured by additional earnings from educational investment. There are two major approaches to estimate these monetary benefits. One is the human capital earnings function. The basic specification of this conventional approach is:

$$\ln w_i = \beta_0 + rs + \beta_1 EXP + \beta_2 EXP^2 + \varepsilon_i$$

Where r denotes internal rate of return to education, *EXP* denotes work experience, s denotes years of schooling. Another approach is as the one used in Vaillancourt (1995). It compares earnings of different groups who obtained different levels of schooling. In the first approach, the human capital earnings function, earnings are a function of years of schooling and work experiences. The academic degree that an individual achieved has no influence on one's earnings. Since many employers screen workers based on the levels of schooling they achieved, failure to account this discrete effect of completing a specific level of schooling on earnings may bias the returns to education. Whereas in the second approach, the number of years of schooling is not taken into consideration. This may also not fully reflects the returns to education. For example, if two individuals both have same bachelor's degrees, but one spent more years to achieve the degree, the estimated return to education may be lower than the return for the one using less time to achieve the degree. Considering the importance of educational credential effect, This paper adopts the specification used in Vaillancourt (1995).

(3) Significant findings of previous studies

There are consistent conclusions within the literature about the returns to education investment in Canada.

A. Diminishing private and social returns to education by level of schooling

Many studies have found declining rates of return to education as the level of schooling increased based on data spanning the past 30 years. Dodge and Stager (1972) used 1966 data and evaluated the rates of return to education for graduate studies in science, engineering and business administration. By comparing the estimated values of the rates of return to undergraduate studies and to graduate studies, Dodge and Stager concluded that investments in graduate studies had lower returns than investments in undergraduate programs, with the exception of MBA degrees. Thus, Dodge and Stager suggested that in order to improve resource allocation, investment in graduate studies should be shifted to undergraduate studies. Vaillancourt and Bourdeau-Primeau (2002) also reported that the rates of return for master's and PhD degrees were lower than the rates of return for bachelor's degrees. Psacharopoulos (1985) explored the rates of return to education internationally. He estimated returns to education based on data from 61 countries, and also reported a declining trend in rates of return by level of schooling. Rathje and Emery (2002) estimated both private and total returns of investing in university education in Canada using pooled data from the 1986, 1991 and 1996 censuses. Their results showed declining returns by level of educational attainment as well.

B. Declining rates of return to education over time

It has been shown elsewhere that the rates of return to higher education generally declined in the 1970s, and then recovered in the 1980s. In the early 1990s, a declining trend appeared again. As Stager (1996) concluded: "the average private return for male university graduates dropped from 17.4% in 1960 to 12.2% in 1970, it had declined further by 1980 to 9.9% ...... by 1985, the private rate of return for male graduates of Ontario universities was 14%."[1] Stager (1996) reported that the estimated private rate of return for males holding bachelor's degrees was 13.8% in 1990.

This change in the rates of return to education reflected the performance of the Canadian labor market over time. Two recessions during the 1970s (1970 and 1974-75) increased the unemployment rate significantly, and this led to a decline in the rate of return to education in the 1970s. Although there was a recession in the early 1980s, the economy started recovering around 1983, and the unemployment rate decreased considerably in the 1980s. On the other hand, the transformation of the Canadian economy from a manufacturing dominated economy to a service economy in the late 1980s increased the demand for a more educated labor force. All these factors caused an increasing trend in the rate of return to educational investment. The recession that appeared in 1990-91 depressed the labor market again, thus as might have been expected, the rate of return to education showed a declining trend in the

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[1] Stager, D. A. A. (1996). Returns to investment in Ontario university education, 1960-1990, and implications for tuition fee policy. *The Canadian Journal of Higher Education*, 26(2), P.9.

early 1990s. Thus the rate of return to higher education is counter-cyclical. Similar empirical evidence was discussed by a number of researchers, such as Bar-or, Burbidge, Magee, and Robb (1995), Psacharopoulos (1989), Stager (1996), Vaillancourt and Henriques (1986) and Wanner (2000).

C. Returns to education for women and men

Another common finding in most studies is that women usually experience higher rates of return to education than men do. This may explain why university enrolment of women has been increasing over time. For example, they comprise about 60% of the student body in 1995/96.[2]

Some studies found that the gender earnings gap narrowed through time. In an early study, Ferber and McMahon (1979) investigated the changes in the returns to women's higher education investment during the 1970s in U.S., and discussed the consequences of these changes. The paper predicted that the increase in women's investment in higher levels of education and their entry into male-dominated fields of study would narrow the earnings differentials between men and women, and this would also increase women's participation rate in the labor force.

More recent studies, such as Stager (1996), Rathje and Emery (2002), Dickson, Milne, and Murrell (1996) and Vaillancourt (1995) all suggested higher returns to educational investment for women than for men. In particular, Finnie and Wannell (1996) used longitudinal data and investigated the earnings differentials between men

[2] The total number of part-time and full-time female undergraduate students was 57.4% of the total undergraduate enrollment in 1995/96. It is calculated using data from *Education in Canada*, Statistics Canada (81-229), Table 12.

and women who are university graduates and hold bachelor's degrees. The authors estimated the effects of different components on the gender earnings gap, and found that the major earnings differentials between men and women were due to differences in the labor market characteristics of men and women. Thus the gender earnings gap tended to become smaller over time.

D. Returns to education for individuals and the public.

A number of researchers reported that the private rates of return to education were greater than the social rates of return. The private returns are the monetary benefits from individuals' educational investment, and the social returns are the benefits to all private and public spending on education, including government subsidies. Psacharopoulos (1985) analyzed cross-national educational returns, and indicated that the average private return to education among developed countries was 12% for secondary school and higher education, in comparison with the social return for secondary school, which was 11%, and for the higher education level, which was 9%. Dickson, Milne and Murrell (1996) examined the returns to education spending for provincial government of New Brunswick, for the federal government and provincial government together, for university students, and for the public sector. By comparing the rates of return for these four groups, their results showed higher private returns than the social returns. Similarly, in Stager (1996), the estimated private rate of return for male university graduates in Ontario in all bachelor's degree programs was 13.8%, while the social rate of return was 10.7%. In the case of females, the private rate of return to all bachelor's degree programs was 17.6%, compared with the social return of 11.9%. From these comparisons, we also see a higher rate of return for women than that for men.

This fact was demonstrated in Vaillancourt (1995) as well, in which all social rates of return estimated either by levels of schooling or by fields of study were smaller than the relative private rates of return. Similar evidence also can be found in Vaillancourt and Bourdeau-Primeau (2002), who state "the total rates of return for bachelor's degrees are only about half the private rates of return" (P.225). This I presume is due to the inclusion of government subsidies.

E. Returns to education by different fields of study

Among existing studies, many evaluate the rates of return to education by field of study. Bélanger and Lavallée (1980) found that investing in bachelor's degrees in computer science and social work yielded higher benefits than investing in other fields of study; the private rates of return were 18.3% and 19.4%, respectively. In contrast, investing in nursing yielded the lowest rate of return (5.4%).

In Stager (1996), the estimated rates of return at Ontario universities for men in 1990 showed that holding a bachelor's degree in medicine produced the highest private rate of return (20.8%), while investing in humanities and biological sciences yielded lower private rates of return, 7.3% and 6.8% respectively. The rates of return for commerce, engineering and law were in the average range: 16.2%, 16% and 15%, respectively. For women, the private rates of return showed similar patterns. The highest return was from medicine (19.7%), and the lowest return was for humanities (14.8%).

The conclusions from Lavoie and Finnie (1999) implied results that were consistent with those of Stager (1996). They analyzed the early career earnings of university graduates in Canada, and found that graduates from computer science and health science were highly paid early in their careers, compared with graduates majoring in pure science whose earnings lagged behind. Engineers' earnings were in the middle range.

Most other studies also consistently indicated that among various fields of study, investment in health science, engineering or technical programs produced relative high rates of return, and in contrast, investment in the fine arts and humanities yielded lower rates of return. These articles include Vaillancourt and Bourdeau-Primeau (2002), Rathje and Emery (2002), Ferrer and Riddell (2002), and Vaillancourt (1995). For instance, Vaillancourt and Bourdeau-Primeau (2002) found that the highest private rates of return for men in 1990 and 1995 were in engineering (20% and 24%, respectively), and the lowest private rates of return for men in 1990 and 1995 were for the humanities (1% and –3%, respectively). Rathje and Emery (2002) found that among bachelor's degree holders, engineers received the highest benefits with a private rate of return of 9.6%. But for those who studied in fine arts, the private rate of return was -2.9%. In contrast, Vaillancourt (1995) concluded that the highest returns for men and women were from health degrees, and the lowest return, similar with other studies' conclusions, was from humanities.

F. External benefits

The external benefit refers to the benefit that is not received by the individual who invests in additional education, but accrues to other individuals. Although the rates of return are low for some programs, for society as whole, external benefits should be considered. It is hard to assess these benefits quantitatively. However, Rathje and Emery (2002) argued that since an investment in a program with a lower private rate of return would be compensated for with higher non-monetary benefits, in equilibrium, accounting for these externalities, "the total private rates of return to students would be equalized across all fields" (P.248). Therefore, they calculated the percentages of extra income that would bring rates of return up to a benchmark level (4.25%) for fields of study. Their results showed a significant externalities effects. For example, for males holding bachelor arts degrees, about 16% of the annual income was attributable to external benefits, while for males having bachelor's degrees in medicine, the percentage of annual earnings attributable to external benefits was 25.8%.

3. Description of data and methodology

(1) Data

Since the 2001 census data is currently only available in aggregate form, the latest available individual Microdata file is from the 1996 census. Thus, this paper uses the 1996 Census Public Use Microdata File (PUMF) on individuals from Statistics Canada in order to estimate the rates of return to education. According to the 1996 PUMF on individuals user documentation, "the 1996 PUMF contains data based on a 2.8% sample of population enumerated in the census."[3] It contains 792,448

[3] 1996 PUMF on individuals user documentation, P.4.

cases in total. This paper estimates the returns to education based on 412,790 observations, which include individuals who are 15 years old or over and have positive earnings.

Regarding the 1996 PUMF, some limitations should be mentioned. First, it may lead to overestimates of the rates of return to education if one were to restrict the sample to individuals with positive earnings. The returns to education for those who do not participate in the labor force market after they graduated from school would be negative, therefore it would cause upward bias to exclude these people from consideration. This concern was also mentioned in Vaillancourt (1995).

Second, it may confound the physical capital returns with the returns to education to include self-employment income in earnings. Part of the income of self-employment is not generated by an individual's human capital, but may be the gain from the investment of physical capital in the business. From this point of view, including self-employment income in the earnings estimation equation could cause upward bias in the returns from education investment. Rathje and Emery (2002) did not include self-employment incomes when they estimated the individuals earnings profiles, but this may lead to another problem. Because many professional individuals are self-employed, such as doctors and lawyers, they usually earn higher incomes than they would have earned if they were employees. Excluding these individuals from consideration could underestimate the returns to their human capital investment. In fact, Rathje and Emery (2002) obtained lower estimated rates of return to educational investment, compared with the results from other studies in which the self-employment earnings were taken into account. This was mainly due to omitting self-employed individuals in Rathje and Emery's study. Since this downward bias could be large, this paper measures an individual's earnings as the sum of one's salary and self-employment income. So, when the return to human capital investment is evaluated, it might contain an upward bias.

Third, as mentioned in section 2, it is common to use census data to estimate the rates of return in existing studies due to the lack of longitudinal data. But, using cross-sectional data could generate results that are misleading.

(2) Methodology

According to human capital theory, an individual has a concave age-earnings profile. That is, the age-earnings profile is an increasing function of age with a decreasing rate due to diminishing returns to human capital. In general, because education increases individuals' productivity, individuals with more education will earn more in their lifetime compared to those with less education. The decision to invest in education depends on whether the benefits of investing in education exceed the costs of this investment. The optimal internal rate of return is the rate at which the net present value of benefits equals zero:

$$\left[\sum_{t=a}^{T} \frac{E_t^A}{(1+r)} - \sum_{t=a}^{T} \frac{E_t^B}{(1+r)}\right] - \left[\sum_{t=0}^{a-1} \frac{E_t^B}{(1+r)} + \sum_{t=0}^{a-1} \frac{C_t}{(1+r)}\right] = 0 \qquad (5)$$

where $E^B{}_t$ is earnings without educational investment, $E^A{}_t$ is earnings with educational investment, a is the number of years of education, T is the retirement age, C_t denotes the direct costs of education in year t, and r is the internal rate of return to education.

If the internal rate is greater than the rate of return on other uses of funds, one should invest in education.

As the methodology used in Vaillancourt (1995) is the standard methodology employed to evaluate the rates of return to education investment, this paper uses it to investigate the returns to education. However, there are two differences between this paper and the existing literature. First, in Vaillancourt (1995), the direct costs were calculated without being discounted into present values. Vaillancourt did not point out the reason why he did so in his study. I presume it was for simplification. To make the calculation more realistic, this paper uses discounted present values of direct costs to calculate the returns to education investment. Second, in Vaillancourt (1995), only the internal rates of return were calculated. As discussed in section 2, both internal rate of return and net present value should be considered when one makes decision about educational investment. Since the internal rate of return is a relative concept, relying solely on it could sometimes cause the evaluation of the returns to educational investment to be misleading. Dodge and Stager (1972) pointed out this danger: "the reader is cautioned that primary attention should be given to the net present values rather than to the internal rates of return, since the former provide the more reliable comparison of returns to educational investment" (P.191). Therefore, to address this issue, in this paper both internal rates of return and net present values (at 5% and 10% discount rates) are calculated by level of schooling and by field of study.

In order to evaluate the returns to education by level of schooling or by field of study, three steps are involved. First, I estimate the earnings profile. Second, I calculate the costs of education, and third, I apply formula (5) to calculate the internal rate of return to education, r, and the net present value of investment at discount rates of 5% and 10%.

Before taking these steps, several limitations of this analysis should be kept in mind. First, in this approach, the benefits of educational investment are measured solely by one's earnings. This may lead to an underestimate of the rate of return, since there are other non-pecuniary benefits that may be obtained from the investment in education besides the benefits of additional earnings. For example, an individual after completing a higher level of education may find a more desirable job. Besides the additional earnings from the investment in education, he or she may also enjoy more favorable working conditions. This non-pecuniary benefit is likely to be considered when one makes decisions about educational investment. Omitting it from the regression could cause a downward bias to the global return of education investment. Another concern is that the omitted innate ability may be correlated with one's earnings, because part of the increased earnings of more educated individual may be attributable to his or her innate ability. If this is the case, the estimated rates of return to education will be biased upward. This is only an issue if the degree of ability bias varies across fields of study. In Dodge and Stager (1972), this concern was mentioned as well: "the estimates are only accurate to the extent that the bachelors and graduate degree holders are alike in all respects except formal education" (P.190). Constantatos and West (1991) also indicated that 35% of earnings differentials are attributed to ability. Finally, earnings can only accurately measure the benefits of educational investment in a perfectly competitive labor market, since otherwise the marginal product of labor can not be precisely reflected by the wage. Thus the estimated rates of return to education tend to be biased. In this case, the point is that the correlation between wages and education in this case would capture other effects as well, such as rents and other non-competitive factors.

A. Estimation of earnings profiles

To estimate separate equations for each level of schooling, the individuals are sorted into eight groups according to the highest level of schooling completed (HLOSP) and the highest degree, certificate or diploma obtained (DGREEP).[4] In order to estimate the earnings profile for every field of study, the samples are regrouped from 20 specific fields according to DGMFSP in 1996 census data.[5] The individuals who hold bachelor degrees are sorted into eight groups by different major fields of study (DGMFSP). These eight groups are education, humanities, social sciences, commerce, pure sciences, engineering, health sciences and other fields. The detailed definitions and classifications are listed in appendix table 1.

This paper adopts the same regression specifications used in Vaillancourt (1995) to estimate earnings profiles. For each level of schooling obtained, the regression equation takes the form:

$$\ln(earnings) = \alpha_0 + \alpha_1 Age + \alpha_2 Age^2 \qquad (6)$$

[4] HLOSP is the code used in 1996 Census Individual Microdata file. It contains the individual education information, which indicates the highest level of schooling. DGREEP is the code used in 1996 Census Individual Microdata file. It contains the information that indicates the highest degree an individual achieved.
[5] DGMFSP is the code used in 1996 Census Individual Microdata file. It contains the individual education information, which indicates fields of study.

For each group with specific level of schooling, the estimated coefficients of age reflect the additional earnings as one ages, and the quadratic form of age is used to reflect the diminishing returns to age of one's earnings profile, which assumes that $\alpha_2 < 0$. In order to account for fields of study, the regression equation takes the form:

$$\ln(earnings) = \alpha_0 + \alpha_1 Age + \alpha_2 Age^2 + \sum_{i=1}^{7} \alpha_{i3} Fields + \sum_{i=1}^{7} \alpha_{i4} Fields \times Age \tag{7}$$

The fields are modeled by a set of dummy variables called fields, and they are interacted with age in order to modify the intercepts and slopes of the earnings profiles. The estimated coefficients of the field dummy variables reflect the additional changes to initial earnings from studying in a specific field, and the estimated coefficients of the interaction variables, fields crossed with Age, represent the influences of the fields of study on the slopes of the earnings profiles.

The specifications presented above are commonly used in existing studies, although there may be some modifications. For example, Rathje and Emery (2002) adopted similar specification as the one used in Vaillancourt (1995), that is

$$\begin{aligned} \ln(income) = {} & \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 bach + \beta_4 mast + \beta_5 phD + \beta_6 medical \\ & + \left[\sum_{i=1} \beta_{7i} \text{degree} \cdot \text{field of study}\right] + \beta_8 D91 + \beta_9 D96 + \varepsilon \end{aligned}$$

Where *D91, D96* denote the years in which the income were received. *Bach, mast, PhD* and *medical* are dummy variables that denote different levels of education. Dummy variables are used in this approach to account for differences in earnings by level of schooling and field of study. Since the purpose of this paper is to estimate the returns to education by field of study only at bachelor's degree level, the interaction term (degree crossed with field of study) is not included in the specification used in this paper. Hence, for bachelor's degree, this paper estimates returns to education by field of study using equation (7), and for other levels of study, this paper estimates returns to education by level of schooling using equation (6). Moreover, since this paper sorts the observations into different groups according to the levels of schooling completed, and estimates earnings profile for each group separately, it is equivalent to use dummy variables in one equation to account for differences in earnings by level of schooling. Thus to make the estimation steps clear, this paper adopts the specification used in Vaillancourt (1995), rather than using the specification in Rathje and Emery (2002).

The regression results disaggregated by levels of schooling are presented in table 1, and the regression results that include effects by fields of study are presented in table 2. The results will be discussed below.

B. Calculate education costs

The foregone earnings quantities are estimated using regression results presented in table 1 and table 2. To account for the part-time earnings during one's studying period, foregone earnings equal two-third of the earnings of one would have earned if he or she did not go to higher level of education. For example, the foregone earnings of investing in college education with respect to completing high school diploma are obtained by multiplying the high school graduates earnings by 2/3 for the period that they would have spent studying in college. The direct costs of educational investment include tuition fees and non-fee costs, which include textbook costs and expenditures on school supplies. In calculating private costs, only tuition fees and non-fee costs are included, and no government subsidy to education is accounted for. However, in calculating the social costs, all tuition fees, non-fee costs and government subsidies are taken into account. That is, social costs include all private costs plus government subsidies. The calculated results are listed in appendix, table 2.

a. Annual costs of tuition fees

i) Elementary/secondary school tuition

In Canada, because of the compulsory education law, elementary and secondary school education are publicly supported. Therefore, no tuition fees are included for in elementary and secondary school.

ii) College Tuition

College tuition is obtained by calculating the mean of college tuition fees of ten provinces in Canada in 1995/96.[6]

iii) University tuition

The university tuition fees for all fields of study in 1995 are obtained by converting the relevant tuition fees in 1996 into 1995 dollars using consumer price index for education tuition fees.[7] The relevant tuition fees in 1996 are taken from *University Tuition Fees for Full-time Canadian Students, 1996-97 revised.* Tuition fees of major universities in each province by field of study are listed in this table. For undergraduate students, the tuition fees for education, commerce and engineering are

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[6] The college tuition fees in 10 provinces in 1995/96 are from *http://www.copse.mb.ca/en/documents/statistics/chapter_5.pdf*

[7] Consumer price index, Statistics Canada (326-0002).

calculated as the mean of the all universities' tuition fees in the relevant fields. The tuition fees for humanities and social sciences are the average tuition of all universities for studying in Arts. The tuition fee for pure science is the average tuition for science and agriculture in all universities, and for students majoring in health science, their tuition equals the mean of tuition for dentistry and medicine. For graduate students, since there is large deviation in tuition fees across different fields of study in each university, the graduate tuition fee in each university is first calculated as the mean of the lower bound value and upper bound value listed in the table, then the tuition for graduate study in Canada is obtained by taking the arithmetic mean of the calculated tuition fees in all universities.

b. Annual non-fee costs

The non-fee costs consist of textbooks and expenditures on school supplies. Because there is no relevant data available for these costs in 1995, the non-fee costs in 1985, which were used in Vaillancourt (1995), are converted into 1995 dollars by consumer price index.[8]

c. Social Costs

Compared with the private costs to schooling which refer to the individuals' own spending on education investment, the social costs are the resources borne by whole economy. It is the sum of private costs, which include tuition fees and non-fee costs paid by individuals, and government subsidies for education.

8 Consumer Price Index, Statistics Canada (326-0002).

i) Elementary and secondary costs

The available social costs for elementary and secondary schools in 1995 are the total expenditures for elementary and secondary students.[9] In order to obtain the expenditures per student for elementary and secondary school separately, the following formula are used:

$$TC = E \cdot n_e + S \cdot n_s \tag{8}$$

$$E = R \cdot S \tag{9}$$

Where *TC* is the total expenditures of elementary and secondary education. *E* is the costs per elementary students. *S* is the costs per secondary students. n_e is the number of elementary students. n_s is the number of secondary students. *R* is the cost ratio of elementary and secondary school. The enrollment information for elementary and secondary school, n_e and n_s, come from *Education in Canada,* Statistics Canada (81-229),. Table 5. The number of part-time students is multiplied by 1/3 in order to convert part-time to full-time enrollment. The cost ratio, *R*, is taken from Vaillancourt (1995), which is 0.75. The costs per elementary student and costs per secondary student are obtained by substituting these values into equation (8) and (9) and solving for unknown variable *E* and *S*.

ii) College social costs

College social costs per student in 1995 is derived by dividing total college social

[9] Education in Canada, Statistics Canada (81-229), table 61

costs by total number of college students. The total college social costs can be found in *Education in Canada,* Statistics Canada (87-229), Table 61, and enrollment information can be found in the same source, Table 12.

iii) Social costs of university

In order to calculate the social costs for each field of study at university level, the cost ratios for each field of study are assumed (see appendix table 3),[10] and the following formula is used

$$TC = \sum\sum a_{ij} X E_{ij} \tag{10}$$

Where TC is the total costs for university study. i indexes fields of study. j indexes levels of education. a_{ij} are the coefficients in appendix table 3. E_{ij} is enrollment in field i at level j. X denotes the social costs of undergraduate students who major in education, humanities, social sciences, or commerce.

The total costs for university study, TC, is obtained from *Education in Canada*, Statistics Canada (81-229), table 61. The enrollment information of undergraduate study in relevant fields is taken from the same source, table 14, 18, and the graduate enrollment information is taken from table 16, 20. The number of part-time students is multiplied by 1/3 in order to convert it to full-time enrollment. First, substitute these information into equation (10) and solve for X, then multiply X by relevant coefficients a_{ij} listed in appendix table 3 to get the social costs for each field of study.

C. Calculation of the internal rates of return to education

Both private and social rates of returns to education are calculated in this paper.

[10] It is taken from Vaillancourt (1995) due to the lack of relevant information in 1996.

As mentioned in section 3, individuals would continue investing in education until the present value of benefits from investing in education equal the present value of the costs of this investment. Hence, the private rates of return to education provide information for individuals making decisions about further educational investment, while social rates of return to education reflect the net social benefits of spending on education. The measurement of social returns may help the public sector to choose an optimal level of spending on education which might deviate from the purely private optimum. Therefore, it is important to evaluate both private and social rates of return to education.

The rates of return to education are computed by applying formula (5). The additional earnings gained from investment and foregone earnings are derived from the regression results listed in table 1 and table 2. To calculate the private rates of return to education, the net earnings are used, and to calculate the social rates of return to education, the gross earnings are used. The net earnings are the individual's after-tax earnings. They are obtained by adjusting gross earnings into after-tax income using the average income tax rate in 1995.[11] For simplification, this paper uses average income tax to compute after-tax earnings, and holds this tax rate constant over the individual's entire working life. This is not consistent with the Canadian tax system. This assumption about taxation may lead to upward biases to the returns to education for higher income level groups and downward biases to the returns to education for lower income level groups. The direct costs of educational investment

[11]The average income tax rate in 1995 is taken from *Income Tax Trends*, Statistics Canada, Table 501.

are obtained from table 2 in the appendix, which are the calculated estimates of education costs categorized by levels of schooling and by fields of study. In order to calculate the rates of return to education, the following work starting ages and retirement ages are assumed:

	Elementary completed	Secondary incomplete	Secondary complete	college	Bachelor	Health degree	Master degree	PhD
Start working age	12	15	18	21	22	24	24	28
Retirement age	64							

These assumptions all stipulate that an individual enters a higher level of schooling immediately after graduating from a lower level of education, and that there is no mortality before retirement age. The above assumption is equivalent to assume that an individual needs three years to finish secondary incomplete education after graduating from elementary school, three years to finish secondary complete education after secondary incomplete, three years to finish college education, four years to finish bachelor's degree and six years to complete a health degree after graduating from high school, two years to achieve a master's degree after completing a bachelor's degree, four years to complete PhD education after achieving a master's degree. The private costs and social costs listed in appendix table 2 are converted to present value according to relevant years needed to complete each level of education. The internal rates of return to secondary incomplete are calculated by comparing with completing elementary school. The internal rates of return to secondary complete are calculated by comparing with secondary incomplete. The internal rates of return to college and bachelor's degrees are calculated by comparing with secondary complete. The internal rates of return to master's degrees are calculated by comparing with bachelor's degrees. The internal rates of return to PhD are calculated by comparing with master's degrees. And all the internal rates of return to education by field of study are calculated by comparing with secondary complete. The resulting private and social internal rates of return by level of schooling and by field of study are presented in table 3 and table 4, respectively.

D. Calculate the net present values for education investment.

As mentioned in section 3, the net present values of educational investment are calculated as well. The net present values are calculated at both a 5% and a 10% discount rate. They reflect the net benefits (in dollar values) from the additional investment in education at a 5% or a 10% discount rate. The choice of discount rate is arbitrary among the existing literatures. For example, Rathje and Emery (2002) pointed out that " Vaillancourt and Henriques (1986) use 10 percent since it is often the choice of government agencies. Constantos and West (1991) use 6.5 percent since they feel it reflects the real rate of return to physical capital, Allen (1998) uses a 5 percent benchmark".[12] Following Rathje (2000), Rathje and Emery chose 4.25 percent as benchmark rate of return to capital investment. Because of these inconsistent choices of benchmark rates in Canada, in this paper the net present values of education investment are calculated at both 5% and 10% rates. Similar to the calculation of internal rates of return to education, the net present values of secondary incomplete are calculated by comparing with elementary school. The net present values of secondary complete are calculated by comparing with secondary incomplete. The net present values of college and bachelor's degrees are calculated by comparing

[12] Rathje, K. A., and J. C. H. Emery (2002), footnote 6.

with secondary complete. The net present values of master's degrees are calculated by comparing with bachelor's degrees. The net present values of PhD are calculated by comparing with master's degrees. And all the net present values of educational investment by field of study are calculated by comparing with secondary complete. The calculated net present values of education by level of schooling are listed in table 3, and net present values of education by field of study are shown in table 4.

4. Analysis of the major results

(1) Earnings equation regression results by levels of schooling.

Table 1. Earnings equation regression results disaggregated by levels of schooling

Levels of schooling	Men					Women				
	Constant	Age	Age^2	R^2	No. of cases	Constant	Age	Age^2	R^2	No. of cases
Elementary complete	5.387866 (54.02)	0.182669 (42.25)	-0.001846 (-40.70)	0.131	11917	6.284676 (42.78)	0.113733 (18.27)	-0.001119 (-17.29)	0.049	6758
Secondary incomplete	4.087300 (119.87)	0.258470 (136.83)	-0.002689 (-113.05)	0.399	43926	4.549935 (111.86)	0.206541 (90.39)	-0.002127 (-72.95)	0.307	31612
Secondary complete	5.168003 (112.71)	0.225091 (91.61)	-0.002430 (-78.87)	0.275	30765	5.539927 (107.54)	0.178896 (66.34)	-0.001911 (-56.82)	0.163	31729
College	5.665591 (86.47)	0.214059 (64.95)	-0.002361 (-59.67)	0.165	24683	6.568414 (104.11)	0.146939 (45.45)	-0.001627 (-41.27)	0.070	33030
Bachelor degree	5.293347 (72.52)	0.232339 (64.55)	-0.002469 (-58.29)	0.181	23493	5.819081 (70.78)	0.195695 (45.13)	-0.002150 (-39.54)	0.116	23349
Master degree	4.675340 (26.99)	0.257846 (32.73)	-0.002684 (-30.88)	0.144	7021	4.749991 (21.02)	0.245074 (22.95)	-0.002629 (-21.47)	0.110	4761
Health degree	6.738378 (21.65)	0.185145 (13.97)	-0.001843 (-13.69)	0.101	1737	6.041055 (11.74)	0.203855 (8.26)	-0.002124 (-7.496)	0.104	709
PhD	5.069410 (14.28)	0.241189 (16.5)	-0.002453 (-16.75)	0.129	1895	6.015349 (8.01)	0.192700 (5.86)	-0.002030 (-5.79)	0.060	542

Note: The numbers in the parenthesis are t-statistic

Earnings profiles are estimated for eight education groups separately. These eight sub-samples are elementary complete, secondary incomplete, secondary complete, college graduate, bachelor degree holders, health degree holders at bachelor level, Master degree holders and PhDs. The estimated coefficients are presented in table 1 for men and women separately. One result presented in table 1 seems unexpected at the first glance. The estimated coefficients for men with health degrees are very

Figure1: Earnings profile (men)

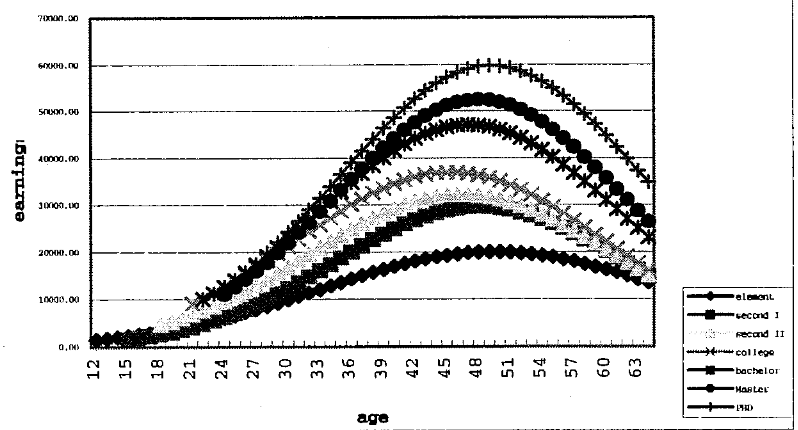
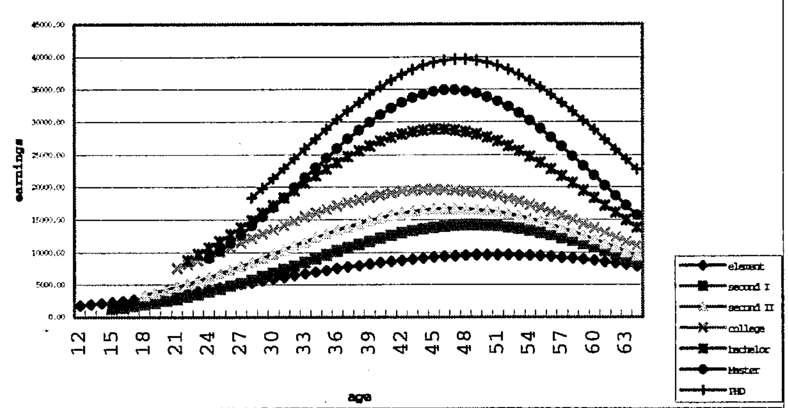
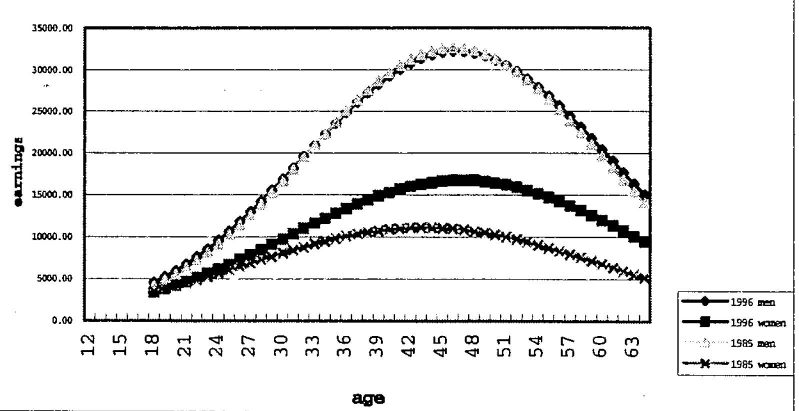


Figure2: Earnings profile (women)



Figuer 3: Earnings Profile for secondary complete
(estimated using 1986,1996 census data)



similar to those for men with elementary education. But when the estimated constant values for both groups are considered, it indicates that the starting earnings of men with health degrees is 3.86 times as the starting earnings of men with elementary education. Thus although the estimated coefficients of age and age^2 are similar for two groups, men with health degrees earn significantly higher income than men with elementary education do, the estimated results are reasonable.

The results estimated by using 1996 data are very close to those presented in Vaillancourt (1995). This indicates that the estimated earnings profiles in 1995 have patterns similar to those obtained using 1986 census data. The estimated earnings profiles obtained from 1996 census data for these subgroups are plotted in figure 1 and figure 2. The figures are consistent with the predictions of human capital theory. Individuals have diminishing rates of return to education (at least at the post-secondary level), resulting in concave age-earnings profiles, and the earnings profiles of those with more education lie above the earnings profiles of those with less education. The figures also show that earnings peak at around age 45, so individuals obtain the highest earnings when they are middle aged.

Although most of the estimated results are close to the results shown in Vaillancourt (1995), in which the rates of return to education in Canada were estimated using 1986 census data, some differences are worth pointing out. The intercepts of the men's age-earnings profiles increased compared with the intercept values estimated using 1986 census data for the following categories: secondary incomplete, secondary complete, college and bachelor's degrees. Conversely, the intercept values for these levels of schooling decreased for women. This implies that the starting earnings for men have increased over time, and the starting earnings for women declined over time for these levels of schooling.

Another difference is that the estimated coefficients of age are smaller than the corresponding results estimated using 1986 census data for men in the levels below graduate study, with the exception of the category of elementary completed. And for women, conversely, the estimated coefficients of age increased for the education levels below the graduate study. These imply that women tend to have steeper earnings profiles than before, and men tend to have flatter earnings profiles compared with the results 10 years ago. Moreover, for the education levels below graduate study, the estimated coefficients of Age^2 for women decreased compared with the results published in Vaillancourt (1995), but they increased for men. These differences indicate that compared with the estimated earnings profiles of 10 years ago, women's earnings profiles diminished faster than before, and men's earnings profiles are less concave than before. Overall, for the schooling levels below graduate study, men tend to have flatter earnings profiles in comparison with those results estimated 10 years ago, and women seem to have more concave earnings profiles. Thus, it gives us a picture in which, for the schooling levels below graduate study, the male-female wage gap became narrower for middle-aged people in 1995 compared with the gap in 1985, but the gap became wider for older workers and younger workers.

For illustrative purposes, the high school graduates earnings profiles estimated both by Vaillancourt (1995) and this paper for men and women are plotted out in figure 3. The figure consistently reflects the conclusion presented above that the gender earnings gap tends to be narrower at middle-age in 1995 compared with the gap in 1985. Since the purpose of the above comparison is to derive the relative changes in the gender earnings gap, inflation over this period can be ignored. Similar empirical evidence can be found in Ferber and McMahon (1979) and Finnie and Wannell (1996) as well. For the graduate level of study, the changes in the estimated coefficients are similar for men and women. For example, although the starting salaries for PhDs decreased for both men and women, earnings increased more each year compared with the estimated results ten years ago for both men and women. This may due to inflation (the average inflation rate over this period was 3.577%) and economic growth over time.[13] The net outcome is ambiguous.

(2) Earnings equation regression results by field of study

Table 2. Regression results by fields of study

	Men (23493 cases)			Women (23349 cases)		
Variables	Coefficients	Std. Error	t-statistics	Coefficients	Std. Error	t-statistics
(Constant)	5.447914	.104	52.323	5.871052	.098	59.949
Age	.224745	.004	56.164	.193259	.005	42.041
Age^2	-.002430	.000	-57.441	-.002115	.000	-38.536
Humanities	-.541933	.102	-5.318	-.209471	.080	-2.607
Social sciences	-.383882	.094	-4.104	-.193673	.077	-2.529
Commerce	.141286	.095	1.492	.371257	.093	3.985
Pure sciences	-.039955	.099	-.405	-.055484	.095	-.585
Engineering	.219299	.093	2.346	.580875	.183	3.183
Health sciences	-.248406	.165	-1.509	.175541	.098	1.792
Others	-.551503	.841	-.656	.286352	.742	.386
Humanities_ Age	.006617	.002	2.673	-.000525	.002	-.256
Social scien_Age	.012376	.002	5.457	.003875	.002	1.904
Commerce_Age	.001670	.002	.726	-.006235	.003	-2.423
Pure scien_Age	.001875	.002	.778	.000898	.003	.355
Engineering_Age	.000414	.002	.186	-.017977	.005	-3.313
Health_Age	.008518	.004	2.152	-.000038	.002	-.015
Others_Age	.014553	.021	.691	-.010476	.017	-.603

Note: R^2 = 0.204 (the regression for men); R^2 = 0.130 (the regression for women)

[13] The average inflation rate is calculated using the data from http://www.bankofcanada.ca/en/inflation_calc.htm

The regression results by fields of study are listed in table 2. The estimated coefficients of the dummy variables reflect intercept effects for fields, and the interacted variables, fields crossed with Age, represent the effects of studying in the specific field on the slope of earnings profile, respectively. In the case of men, the results shown in the table 2 indicate that the estimated coefficients of commerce, pure sciences and health sciences are insignificant at the 5% level of significance, while the estimates for the interacted variables of commerce, pure sciences and engineering are insignificant at the 5% level of significance. This implies that majoring in commerce or pure sciences has no significant influence on one's earnings, while studying in health sciences will increase additional earnings by 0.85% each year, and conversely, studying in engineering will increase the starting earnings by 21.9%. Studying in humanities decreases starting earnings by 54.2% and increases additional earnings by 0.67% every year for men. Majoring in social sciences seems to have higher returns than majoring in humanities for men, because it only decreases starting earnings by 38.4%, and increases earnings by 1.24% with age. Focusing on the results for women, it seems that women exhibit different patterns. Only majoring in pure sciences does not have a significant impact on either the intercept or the slope of the earnings profile for women. Although studying in health or the humanities does not affect the additional earnings each year, studying in health increases starting earnings by 17.6%, and majoring in humanities decreases starting earnings by 20.9% for women.

(3) Net present values and internal rates of return to education

A. Diminishing rates of return to education by levels of schooling

Following the methodology described in section 3, both net present values and internal rates of return to education investment are calculated, and the results are presented in table 3 and table 4. The major empirical results are consistent with most findings in previous literatures. Table 3 shows the returns to education by level of schooling. One of the findings from this table is that for both men and women, the highest private internal rate of return is obtained from completing secondary school. The internal rate of return for male high school graduates is 38.19%, while the internal rate of return for female high school graduates is 33.80%. These rates of return to human capital investment greatly exceed the rates of return to most kinds of current physical capital investment. In contrast, the net present values listed in table 3 show that the highest net private gain at a 5 % discount rate is from holding a bachelor's degree instead of graduating from high school for both males and females. For example, at a 5% discount rate, the net present value of investing in a high school education is $38,694.84 for male, whereas the net present value of graduating from university and holding a bachelor's degree is $75,850.93 for male. Thus, if one is satisfied with a 5% discount rate, the net gain is much higher for a bachelor's degree holder than for a high school graduate.

The relatively high internal rate of return to secondary complete education can be explained by the fact that the investment costs of complete secondary education are very low. Education at the elementary and secondary school levels is financed by the taxpayer in Canada. Students do not have to pay tuition for studying at these levels. Thus, the relatively low costs cause higher internal rates of return to secondary school education. Psacharopoulos (1985) found that elementary school was the most profitable investment. The key reason was also the relatively low costs of elementary education. Empirical evidence from Vaillancourt (1995) indicated the same conclusion, that is, high school graduates obtained the highest rates of return to their investment.

The results shown in table 3 also indicate that the lowest private rate of return to education is from the master's degree for both men and women. The table shows that the private rate of return to master's education is 4.72% for males and 6.32% for females. The net present values listed in the table 3 are consistent with this finding at a 5% discount rate. Males have a negative gain of -$1,772.41, and females only have $7,710.72 in net benefits.

The lowest social rate of return is obtained by spending on doctoral education. The social rates of return to a PHD are –0.94% and –1.54% for men and women, respectively. The corresponding net present values are consistent with this result. They indicate a net loss of $196,641.23 and $190,774.11 at a 5% discount rate for men and women, respectively, and a net loss of $221,092.45 and $210,433.61 at a 10% discount rate for men and women, respectively. The returns to college and bachelor education are in the middle of the range between the rate of return to high school and the rate of return to graduate study.

The above analysis shows that investment in education has diminishing rates of return as the level of schooling increases. The major reason is that both the direct costs and the opportunity costs for higher levels of education are relative high to the costs for lower levels of education. Moreover, this finding is also consistent with the view that education as a human capital investment should behave like other kinds of physical capital investment, and consequently exhibit diminishing rates of return.

Among the existing literature, most studies (such as Dodge and Stager (1972), Psacharopoulos (1985), Vaillancourt and Bourdeau-Primeau (2002), and Rathje and Emery (2002)) have consistently arrived at the same conclusion of declining rates of return to education by level of schooling. For example, Dodge and Stager (1972) found that the rate of return to graduate study was lower than the rate of return to undergraduate programs, and suggested that in order to allocate resources more efficiently, both individuals and society should re-allocate resources to lower levels of education. In Vaillancourt and Bourdeau-Primeau (2002), the estimated private rate of return to undergraduate study ranged from 17% to 20%, whereas the estimated private rates of return to master and PhD study ranged from a negative value to 12%.

The diminishing of rate of return to education by level of schooling is derived under the assumption that the benefit of investment is measured only by one's pecuniary benefits. Once the non-monetary benefits are taken into consideration, the returns to higher levels of schooling, particularly to graduate study, would increase greatly. It is commonly believed by economists that this effect applies and is internalized by the students when they make their investment choices. The knowledge obtained by investing in education has two types of benefits. One will increase an

Table 3. Internal rates of return (r) and net present values (NPV) by levels of schooling

Levels of Schooling	Private returns						Social returns					
	Men			Women			Men			Women		
	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)
Secondary incomplete	13.05	32557.04	4820.52	7.93	9115.80	-2705.73	6.55	16405.12	-17049.48	3.40	-12750.65	-26410.49
Secondary complete	38.19	38694.84	17987.92	33.80	28337.08	12159.24	9.78	24039.21	-672.12	7.24	11156.42	-7921.71
College	18.14	37896.95	12937.00	21.03	31483.53	12390.93	7.74	20161.94	-9714.24	7.07	12185.05	-10393.44
Bachelor degree	13.45	75850.93	14930.56	16.11	76340.86	21385.74	6.81	37482.50	-34678.99	7.20	38091.86	-26650.17
Master degree	4.72	-1772.41	-17575.28	6.32	7710.72	-11570.61	1.72	-42233.98	-61001.73	2.51	-30439.05	-53533.23
PHD	6.42	12924.56	-17592.87	7.61	17641.73	-9023.16	-0.94	-196641.23	-221092.45	-1.54	-190774.11	-210433.61

Table 4. Internal rates of return (r) and net present values (NPV) by fields of study

Fields of study	Private returns						Social returns					
	Men			Women			Men			Women		
	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)	r	NPV(5%)	NPV(10%)
Education	11.87	48984.64	6809.40	16.46	79787.90	22776.71	7.89	36643.81	-14271.22	10.82	74956.32	5588.62
Humanities	-0.91	-29285.11	-28524.94	11.19	34490.74	3515.69	-2.04	-60830.92	-58335.80	6.78	18492.28	-18484.27
Social sciences	12.84	86867.25	14217.60	14.72	69797.81	16841.95	9.43	83637.19	-5173.44	9.72	62406.55	-1909.32
Commerce	12.05	49551.20	7339.99	21.56	114283.21	41062.13	7.89	36643.81	-14271.22	13.98	117156.26	27671.74
Pure sciences	12.06	49602.06	7387.62	16.76	80405.32	23354.93	4.91	-1542.34	-50032.86	7.00	36770.17	-30173.02
Engineering	18.80	128092.65	39672.40	17.93	57751.05	20974.96	9.21	96518.31	-9469.78	5.74	9028.75	-32725.31
Health sciences	18.68	176165.54	50912.13	19.45	123365.39	40071.36	5.96	45215.22	-99531.61	4.43	-20456.61	-113015.15
Health degree	21.93	347673.96	107330.02	19.80	238814.48	72142.66	7.51	183514.45	-90261.03	5.79	48117.08	-134026.40

individual's potential earnings measured by the rate of return to education. Another benefit can be considered a public good, that is valuable to all of society because the product of their labor can have positive externalities. Many results stemming from research and development, such as scientific innovation and invention, soon become common knowledge, and this knowledge increases our standard of living and national prosperity greatly. More educated people tend to become more active participants in community activities, and they are more responsible to society and families. These benefits warrant investment in education from a social perspective, especially at the master's and PhD levels. Thus, once taking this consideration into account, the return to education obtained when omitting these unmeasured benefits is attenuated, and the conclusion of diminishing returns to education by level of study may not be valid.

B. Some differences between this paper and the literature

Since Vaillancourt and Bourdeau-Primeau (2002) also used 1996 census data to evaluate the rates of return to education (only at university level), one would expect the results in this paper should be similar to those results. However, although the two studies are consistent with each other in regards to the sign of estimates and the direction of the trend, the magnitude of the estimated rates of return to education at university level is different. There are several possible reasons. One is that the calculation of the cost of education employed in this paper is different from that in Vaillancourt and Bourdeau-Primeau (2002). For example, Vaillancourt and Bourdeau-Primeau converted 1993 and 1994 tuition fees into 1995 dollars using the CPI, while the tuition fees are obtained by converting 1996 tuition fees to 1995 dollars using the CPI in this paper.[14] Another difference is that Vaillancourt and Bourdeau-Primeau (2002) calculated rates of return to education without discounting direct costs into present values, while the direct costs are converted to present values in this paper, so higher rates of return would be expected.

C. Women have higher returns to education than men

The results presented in both tables 3 and table 4 reveal that women generally have higher rates of return to education than men do for post-secondary education. Empirical evidence from Finnie and Wannell (1996) showed that the earnings differential was mainly due to differences in the labor market characteristics of men and women. As time passes, these different characteristics between men and women are waning. Moreover, Finnie (2002) reported women had a tendency to shift to studying in high technology fields in recent years, which tend to be higher paid than other fields of study. Thus, more women are employed in many previously male-dominated fields today, and are paid more than they would have been paid before. The evidence discussed above in this paper demonstrates this trend as well by comparing the earnings profile estimated using 1996 census data with the results obtained 10 years ago. The evidence shows that the gender earnings gap is smaller in 1995 than it was in 1985. On the other hand, due to relatively low earnings in early years, the women's foregone earnings are smaller compared with men's foregone earnings of education. This implies relatively lower costs for women to invest in

[14] The 1993 and 1994 tuition fees were taken from Statistics Canada (81-219), table 1.
This paper obtained 1996 tuition fees from "the university tuition fees for full-time Canadian student, 1996-1997 revised"

additional education. Therefore, it is reasonable that women have higher rates of return to education than men do. This also explain the one result presented in table 4 which shows a big difference between men and women in the returns to education in humanities. For both men and women, the lowest rates of return are from studying in humanities. Since women usually have lower opportunity costs, that is, women with high school diplomas usually earn less than men with high school diplomas do, the rate of return to studying in humanities for women is higher than the rate of return for men. If the difference between foregone earnings of women and men is significantly large, the difference of rate of returns of holding bachelor's degrees in humanities for men and women could be big. Similar conclusions can be found in Ferber and McMahon (1979), Psacharopoulos (1985), stager (1996), Rathje and Emery (2002), Dickson, Milne and Murrell (1996), and Vaillancourt (1995), Vaillancourt and Bourdeau-Primeau (2002) as well.

D. Private returns are higher than social returns

The results presented in table 3 and table 4 also show that the private rates of return to education are higher than the social rates of return to education. The net present values of educational investment listed in the tables consistently show that individuals obtain higher private returns to education than the public at large earns from that person's investment. For instance, the internal rate of return from investing in college study for males is 18.14%, whereas the corresponding social rate of return is only 7.74%. The net present value at a 10% discount rate is $12,937.00 for males, while the net present value from the perspective of the public at a 10% discount rate is

-$9,714.24.

This big difference between private returns and social returns can be explained by several factors. One is the higher public cost investment in education in Canada, since the government subsidizes education significantly. The data from Statistics Canada shows that the government spending on education is about 66% of the total education expenditure.[15] The difference between private returns and social returns are particularly large for PhD degrees, health sciences and health degrees. This makes sense because the subsidies to these areas are much higher than the private expenditures invested by individuals. From another point of view, once taking the positive externalities into consideration, ideally these differences between the private returns and social returns to education are negligible. In equilibrium, a lower yield education investment could be compensated for by a higher level of external benefits. Therefore, one would expect similar private and social rates of return to schooling either by levels of education or by fields of study.

Another issue that is raised concerns university funding. As university enrollment has increased, education subsidies from the government have failed to grow at same pace. This is mainly due to the competing demands for public funds coming from health spending in Canada. Universities rely more on funding from other channels. One argument is that students should pay higher levels of tuition. As Carmichael (1999) pointed out, this will ensure an efficient and equitable investment environment. Education investors should be treated in the same way as the other investors in the

[15] Education in Canada, statistic Canada(81-229), table 62.

capital market. Students should be charged more for studying in fields with higher returns, such as health, and students should pay less for studying in fields with relatively low returns, such as humanities. The empirical evidence from Carmichael (1999), Stager (1996), Vaillancourt and Henriques (1986), and Rathje and Emery (2002) all suggested the feasibility of this policy. They argued that even if university tuition is doubled, enrollment levels and future returns to investment would not change significantly. If this policy recommendation is implemented, one can expect that the difference between private rates of return and social rates of return will narrow in the future.

E. Returns to education by fields of study

Table 4 shows the calculated returns to university bachelor's degrees by field of study. The results indicate that the highest private rate of return for men is from the health degree (21.93%), followed by engineering (18.80%) and health sciences (18.68%). The highest private rate of return for women is obtained by studying in commerce (21.56%), followed by a health degree (19.80%). The lowest private rate of return is from humanities for both men and women. The phenomenon of higher returns from engineering and health degrees can be explained by the rapid growth in high technology fields. Hence, the demand for higher skilled workers in these disciplines rose relative to supply, and the earnings increased significantly in these fields. On the other hand, since studying in these fields requires higher ability and greater effort, it is reasonable to expect relatively high earnings to compensate these efforts.

In the case of the low return to humanities, Finnie (2002) highlighted an interesting result. Finnie found that although the earnings of humanities graduates are lower at the beginning of their careers, they will catch up to the earnings in other fields in later years. He concluded as follows: "Conversely, fine arts and humanities graduates generally experienced restive gains over time and although they remained among the lowest paid at the five-year point, they were typically not so far behind as they had been two years after graduation (males in the middle cohort are an exception in this regard)" (P.190). It is also worth recalling the externality effects. Although the earnings of humanities graduates are lower, they may enjoy less pressure from their jobs compared with doctors. Therefore, once the intangible returns to education are considered, there may be similar returns to education across various fields of study.

The results for returns to schooling by field of study are robust across a number of studies. Empirical evidence from Stager (1996), Finnie and Wannell (1996), Finnie (2002), Vaillancourt and Bourdeau-Primeau (2002), Vaillancourt (1995), Rathje and Emery (2002), Ferrer and Riddell (2002) consistently indicated that computer science, health science, engineering are most financially attractive investments in education, whereas the humanities, fine arts or pure science have smallest gains from education.

5. Conclusions

People treat educational investment like other kinds of physical investment. They expect to obtain benefits from their expenditures on schooling. The private returns to education guide individuals in making their education decisions for the future, while the social returns to education should guide the public sector in deciding how to allocate resources between education and other kinds of public investment. These issues are addressed in this paper, as the private returns and social returns to education both by level of schooling and by field of study in Canada are evaluated. The 1996 Census Public Use Microdata File on individuals is used to estimate the returns to education. Individuals who are 15 years old or over and have positive earnings are sampled for this study. In order to provide a more precise comparison among the various returns to education, both internal rates of return to education and net present values of additional schooling investment are calculated in this paper.

The major findings in this paper are consistent with most previous empirical studies. One of the results from this paper is that there are diminishing returns to education as the level of schooling rises. The highest internal rate of return to schooling is obtained by finishing secondary school, and lowest internal rate of return is from graduate study among both men and women. In contrast, if one is satisfied with a 5% discount rate, the net present values of additional education indicate that the biggest gain is from investing in a bachelor's degree rather than completing secondary schooling. This suggests that when one makes an educational investment decision, both net present value and internal rate of return should be considered.

The findings in this paper are consistent with the counter-cyclical pattern of the returns to schooling, which was predicted by previous studies. For example, Stager (1996) reported that the private rate of return for male university graduates was 14% in 1985, and decreased to 13.8% in 1990. The estimated result of this paper shows that the private rate of return to bachelor's degrees is 13.45% for men in 1995. This is consistent with the predicted conclusion in other studies that the returns to education decreased in the 1990s. This paper also finds that women generally have higher returns to education than men do. It is partially due to the fact that forgone earnings for women are less than they are for men. In addition, the higher rates of return to education coupled with higher education levels for women should work to reduce the male-female wage gap. The results in this paper also show that there are higher private returns to schooling compared with the returns from a public perspective. This has repercussion for public policy, as the government provides subsidies to education, and it regulates student tuition fees. In the case of returns to schooling by fields of study, this paper concludes that health degrees and engineering yield higher internal rates of returns relative to other fields among men. For women, the highest internal rate of return is obtained from studying in commerce, whereas the humanities produces the lowest internal rate of return to education for both men and women. The corresponding net present values show that the most profitable field is a health degree, and the lowest gain is from humanities for both men and women. Although the "knowledge economy" encourages people to shift their investment to high-yield fields, rates of return after including non-pecuniary factors may be closer to each other.

Appendix Table 1

Classification for levels of schooling			
1996 Census codes		Level of schooling	Notes
HLOSP (highest level of schooling)	DGREEP (highest degree, certificate or diploma)		
2	1	Elementary complete	Grade 5-8
3	1	Secondary incomplete	Grade 9-13
4	2	Secondary complete	High school graduate
8	4	College	Non-university certificate or diploma
11	6	Bachelor degree	BA or profession degree
11	8	Health degree	Medicine, dentistry, etc. Degrees
13	9	Master degree	University: MA
14	10	PHD	University: PHD

Classification for Fields of Study		
1996 Census code		
DGMFSP(Major Field of Study)	Fields of study	Notes
1	Education	Educational, recreational and counseling services
2,3	Humanities	Fine and Applied Arts, Humanities and related fields
4	Social Sciences	Social sciences and related fields
5,6,7,8,9	Commerce	Commerce, management and business administration
10,18	Pure Sciences	Agricultural and biological sciences, mathematics and physical sciences
11,12,13,14,15	Engineering	Engineering and applied science
16,17	Health Sciences	Health professions, sciences and technologies
19	All Other	

Note: The classification of levels of schooling and fields of study refers to the documentation of 1996 Census in Canada.

Appendix Table 2

Education costs (annual amount per student)

Level of schooling and Fields of study	Private costs			Social costs	
	Tuition	Non-fee costs	Total	Social costs	Total (plus non-fee costs)
Elementary	0	138. 93	138. 93	6369. 08	6508. 01
Secondary	0	277. 87	277. 87	8492. 1	8769. 97
College	998. 6	416. 8	1415. 40	10776. 91	11193. 71
Bachelor					
Education	2753. 23	1271. 24	4024. 47	10256. 14	11527. 38
Humanities	2726. 39	1271. 24	3997. 63	10256. 14	11527. 38
Social sciences	2726. 39	1271. 24	3997. 63	10256. 14	11527. 38
Commerce	2601. 06	1271. 24	3872. 3	10256. 14	11527. 38
Pure sciences	2587. 4	1271. 24	3858. 64	20512. 28	21783. 52
Engineering	2681. 45	1271. 24	3952. 69	20512. 28	21783. 52
Health	3429. 3	1271. 24	4700. 54	51280. 7	52551. 94
All fields	2786. 46	1271. 24	4057. 70	19047. 12	20318. 36

Master					
Education				20512. 28	21783. 52
Humanities				20512. 28	21783. 52
Social sciences				20512. 28	21783. 52
Commerce				20512. 28	21783. 52
Pure sciences				30768. 42	32039. 66
Engineering				30768. 42	32039. 66
Health				30768. 42	32039. 66
All fields	3292. 34	1271. 24	4563. 58	24907. 77	26179. 01
PHD	3292. 34	1271. 24	4563. 58	61536. 84	62808. 08

Appendix table 3

Cost ratio for fields of study

	Bachelor	Master	PHD
Education	X	2X	6X
Humanities	X	2X	6X
Social sciences	X	2X	6X
Commerce	X	2X	6X
Pure science	2X	3X	6X
Engineering	2X	3X	6X
Health	5X	3X	6X

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