Rate of Return to Education: A Distributional Analysis Using the LifePaths Model

by
Daniel Boothby and Geoff Rowe
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Abstract

This paper reports estimates of the distribution of individual private rates of return to undergraduate and community college education by field of study for Canada. It is important to know the dispersion of the private rate of return to post-secondary education, as well as its average level. There are very different implications for educational policy and for individual educational decisions if, for example, 40% of post-secondary graduates have negative private rates of return to their educational investment than if 10% have negative rates of return, whatever the mean level of the private rate of return. To our knowledge, there is no previous research reporting estimates of the distribution of individual private rates of return to education.

Individual rates of return were derived by comparing simulated lifetime earnings streams of pairs of individuals. Each pair was made up of a post-secondary graduate and a high school graduate 'clone'. The simulations were carried out using the LifePaths model of Statistics Canada.

Our principal finding is that there is a very wide range of outcomes, as measured by individual rates of return, within each level of study and within fields of study. The range of individual rates of return within fields of study was much wider than the range of median rates of return among fields of study within a level of study, although fields of study varied greatly in their median rates of return. The variability in rates of return was greater at the community college level than at the university undergraduate level.

Median rates of return to the bachelor's degree were 12% for men and 13% for women; for community college diplomas the median rates of return were 16% for men and 18% for women. Twenty percent of bachelor's degree graduates and thirty percent of community college graduates had negative rates of return to their investment in post-secondary education. Median rates of return by field of study and gender ranged from 5% to 23% at the undergraduate level and from 0% to 20% at the community college level. In fields of study where male and female graduates could be compared, women had higher rates of return to post-secondary education, but lower lifetime earnings.

We also compared distributions of lifetime earnings for male and female post-secondary and high school graduates. Median lifetime earnings for female and male graduates with post-secondary degrees are greater than lifetime earnings at the 75th percentile for female and male high school graduates.

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1. Introduction

This paper reports estimates of the distribution of individual private rates of return to undergraduate and community college education by field of study for Canada. It is important to know the dispersion of the private rate of return to post-secondary education, as well as its average level. There are very different implications for educational policy and for individual educational decisions if, for example, 40% of post-secondary graduates have negative private rates of return to their educational investment than if 10% have negative rates of return, whatever the mean level of the private rate of return. To our knowledge, there is no previous research reporting estimates of the distribution of private rates of return to education at an individual level.

This study is a collaborative undertaking between Statistics Canada and Human Resources Development Canada (HRDC). The estimates reported here are the result of simulations using the LifePaths model.[1] The dimensions of variability of rates of return which this paper considers are: differences of rates of return among fields of study within a level of study, gender differences in rates of return by field of study, and differences of rates of return for individuals in the same field and level of study.

Other researchers have reported rates of return by level of study, field of study and gender. Since there is no Canadian data set with long-term individual earnings histories on the one hand, and information on individuals' level and field of study on the other hand, they have not been able to estimate rates of return to post-secondary education at the individual level. In the absence of such a data set, we have simulated individual lives to provide earnings and educational histories for these individuals. We use the simulated earnings history of a post-secondary graduate (and the simulated earnings history of a high school graduate 'clone') to derive individual rates of return to post-secondary study. By tabulating individual rates of return by level and field of study, we are able to provide estimates of the distribution of individual rates of return by level of study, field of study and gender.

[1] LifePaths is an individual-level simulation model developed by the Socio-Economic Modeling Group of Statistics Canada. There are in fact a series of versions of the LifePaths model. The version used in this work was adapted from a version originally developed for analyzing student loans.

One question which is frequently addressed in the literature on returns to education is the extent to which the higher earnings of more educated individuals are not returns to education, but rather are returns to the greater innate abilities of these individuals. Our simulations cannot provide an answer to this question. By providing distributions of simulated individual lifetime earnings, we are, however, able to compare median lifetime earnings for BAs with various percentiles of lifetime earnings for high school graduates. This allows us to estimate the amount of lifetime earnings gains resulting from a 'representative' BA, given various assumptions as to where the 'representative' BA would have been located on the high school earnings scale.

The paper is organized as follows. In Section 2, we briefly review previous research in this area and state how some of the methodological issues raised in this literature are treated in our estimates. In Section 3, we discuss the methodology used in constructing our rate of return estimates, and in particular, the LifePaths model. Section 4 presents our simulation results and discusses their limitations. Section 5 interprets our results and draws conclusions.

2. Previous Research

2.1 Overview

There is a vast body of research on the income gains associated with education. Much of the recent empirical literature on this subject accepts the view of human capital theory that schooling is a form of investment in individual productive capacity.[2] This investment is comprised of the direct costs of schooling and the earnings forgone during schooling.

Once one has identified the earnings gain associated with schooling as the return on an investment, it is a natural step to use data on the earnings stream of high school graduates, on the direct costs of university education, and on the earnings streams of university graduates to compute an internal rate of return to investment in university education. Two other approaches to estimating private rates of return to schooling are the Mincer (1974) specification and the 'shortcut' method to estimating internal rates of return (Psacharopoulos, 1981).[3]

Since we use the method of calculating the internal rate of return, we will limit ourselves to discussing studies which use this method. There are few, if any, data sources that provide lifetime earnings streams for individuals and that also identify their educational level. Consequently, all published estimates of internal rates of return to post-secondary education of which we are aware construct lifetime earnings profiles using cross-sectional data on earnings by age.

Empirical estimates of rates of return to education include estimates of the private rate of return, based on the individual's earnings and the costs of education to the individual, estimates of the fiscal rate of return, based on government outlays for education and government's tax gain from

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2 An alternative view is taken in the literature on signalling. In this model, high productivity individuals invest in costly schooling in order to 'signal' their productivity level to employers. The case for this view is argued by Weiss (1995), chiefly in terms of the return to completing high school. For the purposes of calculating a private rate of return as we do here, it makes little difference whether the return is to investment in productivity-enhancing skills or to investment in a 'signal'. These differing views do matter for our view of the role of education in the labour market. In one view, schooling increases productivity, in the other view (signalling), schooling produces information which improves matching in the labour market.

3 Cohn (1997) provides a review of these three methods of estimating the rate of return to schooling and of related issues, as well as of some recent Canadian empirical results on the rate of return. As he points out (p. 194) neither the Mincer specification nor the short-cut method take the direct costs of education into account.

the higher earnings of graduates, and estimates of the social rate of return, based on all of the costs of education (both direct costs and forgone earnings) and all of the earnings gains from education. The OECD (1998) provides estimates of all three rates of return for Canada and nine other member countries.

Other recent estimates of internal rates of return to various levels of education in Canada include those of Stager (1996), who provides estimates of private rates of return by field of study for Ontario universities, and those of Vaillancourt (1996) who provides estimates of private and public (social) rates of return for various levels of education and for bachelor's and health degrees by field of study for Canada. Both of these studies, like ours, use 1991 Census data for earnings. Vaillancourt (1998) compares his estimates from the 1991 Census to his earlier estimates (Vaillancourt, 1995) from the 1986 Census.

Vaillancourt (1996) includes an extremely useful table summarizing earlier studies that provide estimates of internal rates of return to schooling for Canada or for Canadian provinces. This table gives an overview of the wide variety of data sources used, of differences in methodological detail and of the variation in results among these studies.

In the next subsection, we consider a number of methodological issues raised in previous studies of the rate of return to post-secondary education. Since our approach to estimating rates of return is different from that used in other studies, we go into somewhat more detail on these questions than, for example, Vaillancourt (1996) or Stager (1996). We also state how the methodological issues discussed here are treated in our estimates.

2.2 Methodological Issues

Before turning to the methodological issues raised in the literature on rates of return to schooling, we briefly recall how the private internal rate of return to schooling is estimated. Computing the private internal rate of return to a post-secondary degree involves finding a root r_0 of the present value polynomial in the discount rate, **r**, given by

1. $$PV = \Sigma_{t=0,\dots,T}(W_{ps,t} - W_{hs,t} - C_t)(1 + r)^{-t}$$

where PV is the present value of the post-secondary degree, computed over the time horizon $t = 0,\ldots,T$, $W_{ps,t}$ is the earnings in period t for a person who obtains the post-secondary degree, $W_{hs,t}$ is the earnings in period t for a person who does not obtain the post-secondary degree and C_t is the direct cost of the post-secondary studies in period **t**. In computations of the net present value of a post-secondary degree, the time horizon is often divided into a period of schooling, $t = 0,\ldots S$ (during which $W_{ps,t}$ is often assumed to be zero) and a post-schooling period, $t = S+1,\ldots,T$ (during which $C_t = 0$).

In previous studies of the rate of return to post-secondary education, earnings with and without a post-secondary degree, $W_{ps,t}$ and $W_{hs,t}$, are typically constructed from cross-sectional data on the average earnings by year of age for persons with the appropriate post-secondary degree and for those with a high school diploma. In our study, we carry out the internal rate of return computation at an individual level, with $W_{ps,t}$ the earnings in year t of a simulated individual post-secondary graduate and $W_{hs,t}$ the earnings in year t of the simulated individual's high school clone. The derivation of simulated earnings from 1991 Census data[4] and other details of the simulation are discussed in Section 3. In both our study and previous studies, the direct costs of post-secondary education, C_t, are derived from administrative data collected by Statistics Canada.

The methodological issues which arise in the estimation of rates of return to post-secondary education can be grouped as follows: 1) what are the appropriate measures of wages (or more broadly, benefits) to include in the computation? and (2) to what extent does the difference between the high school graduate's earnings stream (or benefits stream) and the post-secondary graduate's earnings stream (or benefits stream) actually result from the post-secondary degree? We discuss each of these groups of issues below (in Sections 2.2.1 and 2.2.2 respectively) and indicate the approaches we used in constructing our estimates.

2.2.1 Evaluating the Stream of Benefits

In principle, the appropriate measure of private returns to an educational choice is all benefits accruing to the individual less all costs accruing to the individual which result from that choice.

4 1991 Census data were the most recent available when the version of the LifePaths model used in this project was constructed.

This principle would dictate that if one uses earnings as a measure of benefits in calculating private rates of return, individual earnings should be adjusted by deducting all taxes on earnings and by adding transfer payments resulting from labour market activity.[5]

Taxes and transfers

Several of the authors cited by Vaillancourt (1996, Table 1) adjust earnings for income taxes, but none adjust for other taxes on earnings (notably, various payroll taxes) or for benefits received from employment-contingent social insurance programs such as [Un]Employment Insurance.[6] The OECD (1998) includes all social transfer payments in individual's benefits stream, and deducts payroll taxes.[7]

When our work was carried out, the LifePaths model did not simulate individuals' income taxes, payroll taxes, employment-related transfers or fringe benefits. Consequently, none of these employment-related benefits and costs were taken into account in our computations of individual rates of return to education. [8] It would be more accurate to characterize the rate of return we compute as a gross private rate of return, in that the effects of the tax and transfer system are not taken into account.

Mortality and completion of studies

5 In addition to subtracting payroll taxes paid by the individual, one should also deduct payroll taxes paid by the employer, to the extent that the incidence of these taxes is on the employee. In principle, fringe benefits such as the value of employer-funded pensions also should be included in the earnings stream. In Vaillancourt's (1996, Table 1) synoptic table, only Cousineau (1984) is reported to have included fringe benefits in the earnings stream in some estimates.

6 Presumably, the net effect of the labour-market-linked transfer system would be to decrease the rate of return to post-secondary education by partially offsetting the earnings difference between post-secondary graduates and high school graduates, since high school graduates are more likely than post-secondary graduates to receive unemployment benefits, disability benefits and so on.

7 The OECD also includes property income in its benefits stream. We find this incomprehensible, as property income either results from savings (which come from earnings which have already been taken into account) or from inheritance, which is not the result of schooling.

8 Note that if the direct costs of post-secondary education were zero, a proportional tax and transfer system would have no effect on the rate of return to post-secondary education, since the rate of return polynomial (equation 1) would be multiplied by a constant. A progressive income tax-transfer system will tend to lower the rate of return to post-secondary education. It is not clear that the combined Canadian federal and provincial system of taxes on income, including income taxes, CPP/QPP contributions and EI contributions and the associated system of transfer payments is progressive throughout the relevant range of income.

Two other issues involving the earnings streams of high school graduates and post-secondary graduates are whether they should be adjusted for mortality and whether they should be adjusted for the probability of completing studies.[9] Stager (1996) adjusts for mortality. We know of no authors who adjust for the probability of non-completion. In the simulation results reported below, we consider only individuals who survive to age 65 years or older and completed a BA or first professional degree (and their clones who completed high school, survived to age 65 or older and never enrolled in a post-secondary program).[10]

Non-pecuniary benefits and time not employed

Ideally, a comparison of benefit streams between high school graduates and post-secondary graduates should include non-pecuniary benefits. Two important types of non-pecuniary benefits are the consumption value of post-secondary education and the returns to non-market uses of time.[11] Among others, Lemelin (1998, 81-83) argues strongly that part of the return to education is flows of consumption from investment in a consumer durable good. Intangible returns of this kind are difficult to measure, and we have made no attempt to include them in the stream of benefits to post-secondary education.

The treatment of time not in the labour force poses an important problem of non-pecuniary benefits. To the extent that time not employed is the result of a voluntary labour force participation decision, this time presumably results in a benefit for the non-employed person that ought to be taken into account in deriving the net benefits stream. Since labour force participation rates rise with education, ignoring the benefits of time outside the labour force may

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9 In principle, if average earnings at various ages are used to construct the earnings streams from age 18 years onward used in the rate of return polynomial, these streams should be adjusted to reflect the probability that a "typical" individual will actually receive these earnings. Both the risk of an early death and the risk of non-completion affect the probability of receiving the earnings level associated with a post-secondary diploma or with a high school diploma at a given age.

10 In fact, we were able to simulate lifetimes of less than 65 years and non-completion of post-secondary programs. We excluded both groups from our samples for various reasons. First, non-completion and early death almost always result in a simulated negative rate of return to post-secondary studies, usually minus infinity in the case of an early death. Second, for technical reasons, we cannot assign persons who enrolled in, but did not complete, a post-secondary program, to a field of study. Third, the procedure used is the most comparable to the approaches used in most other rate of return studies. In examining our simulated distributions of rates of return, however, it should be recalled that we have excluded groups (early deaths and post-secondary non-completers) who for the most part have negative individual rates of return to their post-secondary studies.

lead to overestimates of the return to education.[12] Like other authors, (for example, Stager, 1996, Vaillancourt, 1996) we find higher rates of return to post-secondary education for women than for men. Some or all of this difference in rates of return to education by gender may be due to the failure to account for the benefits of time spent outside the labour force, in particular, for women who are not post-secondary graduates.[13]

Unemployment

Unemployment is another form of time not employed. One of the benefits of post-secondary education is to reduce the probability and duration of unemployment. Thus in our view it is appropriate to treat periods of unemployment as periods of zero benefits to human capital so that part of the return to human capital is realized as a less time spent in involuntary periods of zero benefits (unemployment).

The LifePaths model distinguished only between time employed and time not employed, so that we are unable to allocate time not employed between time unemployed and time out of the labour force. In our estimates, we make no attempt to adjust our benefits streams for the value of time out of the labour force. All time in non-employment enters as a period of zero earnings in the earnings stream.

In other studies, the earnings stream used is typically the average earnings at an age of persons with non-zero earnings at that age. This implicitly assumes that persons who had no earnings at that age had the same benefit stream as other persons at the same educational level who had

[11] The returns to non-market time may include returns to post-secondary education, for example, in quality of children.

[12] When we conducted our simulations, LifePaths distinguished only time employed and time not employed (and hours of work within time employed). If we had been able to distinguish unemployment from voluntary non-participation the problem would have been how to value the time spent voluntarily outside the labour force for high school graduates and for post-secondary graduates. One possible approach would be to assign a potential wage rate, then value voluntary non-market time at this wage. The result would have been to lower the estimated rates of return of post-secondary education to women.

[13] Labour force participation rates are higher for more educated women. Since time outside the labour force is valued at zero in the rate of return calculation, part of the measured returns to education for women are due to the higher participation rates of more educated women. Thus the rate of return calculation may overstate the rate of return for women by failing to take the value of non-market time into account.

earnings at the age, contrary to our valuation of time not employed at zero benefits.[14] One exception is Stager (1996) who adjusts earnings levels for participation rates. This adjustment is analogous to our approach.[15]

Stability over time of age-earnings profiles

In Section 3.2 below, we describe the methods used to derive individual earnings streams from cross-sectional data on age-earnings profiles. We discuss two important points related to the use of cross-sectional earnings data here.

First, past values of age-earnings profiles are used to compute a prospective rate of return. There is no guarantee, however, that these age-earnings profiles will hold into the future. For example, Beaudry and Green (2000) claim that cohort age-earnings profiles have shifted over time so as to lower the rate of return to education for university graduate men and perhaps to raise it for university graduate women.

We ignore the problem of possible shifts in the age-earnings profile because we have no way of knowing what the future holds in the way of further shifts. For similar reasons, we do not make a productivity growth adjustment to earnings profiles. In our view we might as well claim to know what future wage rates will be as claim to know what future productivity growth will be and to know the extent of skill bias in future productivity growth.

The second issue concerns the choice of period used in deriving age earnings profiles. Appleby et al. (2002) uses Survey of Consumer Finance data to show that rates of return to post-secondary education vary over time in Canada. This variability has a significant cyclical component. Rates of return to education are lowest when overall labour market conditions are strongest. Thus the choice of the data period may influence the reported rates of return.

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14 The approach used in these studies is in fact a hybrid. Persons who had no earnings in a year are implicitly assumed to have the average benefit level (measured by earnings) of persons in their age/gender/education group. Since this average is over persons with earnings, persons who had zero earnings for part of the year and positive earnings in the rest of the year are included in the average. This amounts to treating periods of no earnings as periods of zero benefits for these individuals.

15 See footnote 7 above as to why the earnings stream ought to be adjusted for the probability of receiving the average earnings at the age.

We use wage rates from the cyclical peak year 1990 (the income year for the 1990 Census) and employment rates from June 1991 (the Census month), before the full impact of the recession on employment rates. Consequently, our reported rates of return may be somewhat below the rates which would result from averaging wages and employment rates over a full cycle. For similar reasons, our results may understate the differences in rates of return among fields of study.

We conclude this discussion by pointing out that all of the points raised above concern estimation issues which are most likely to affect the average level of rates of return. We think it unlikely that changing our methods to one of the alternatives discussed above would have much effect on our estimates of the variability of rates of return among individuals.

2.2.2 Are Observed Earnings Differences the Result of Post-Secondary Education?

We turn now to the second set of methodological issues we identified above as being raised in the literature on returns to schooling. These are issues concerning the extent to which differences between the measured earnings (benefits) stream of high school graduates and the measured earnings (benefits) stream of post-secondary graduates are the result of post-secondary education. The appropriate opportunity cost for post-secondary graduates is what these graduates would have earned with a high school diploma if they had not undertaken post-secondary studies. The earnings of high school graduates may underestimate or may overestimate this opportunity cost, leading to biases in the estimated rate of return.

The problem can be posed as follows. Individuals' choices influence their level of schooling. The factors specific to individuals which lead them to continue or stop their schooling might also influence their earnings whether or not they continued school. Consequently, all or part of the observed correlation between more schooling and higher earnings might be due to factors which influence both the level of schooling and earnings, not to a causal effect of schooling on productivity.[16]

[16] In the signalling literature (see fn 2 above) schooling is taken to signal an individual's pre-existing productivity level, not to make an individual more productive. (There does not seem to be much discussion in this literature of how individuals acquire their pre-existing productivity level). Schooling is an investment which earns a return, but the return is to the production of information, not to increased productivity. In this subsection, we concentrate on research that allows for productivity-enhancing effects of schooling, but claims these effects may be overestimated or underestimated due to the endogeneity of the level of schooling.

Card (1995) offers a convenient framework for discussing the paths by which various factors might influence both schooling and earnings. He develops a model in which each individual ***i*** has a specific return to schooling b_i and an individual discount rate r_i. In his model, the individual's level of schooling $S_i = (b_i - r_i)/k$ (where k is a constant). The (logarithm of) the individual's earnings is $ln(y_i) = a_i + b_i S_i$ where a_i is an individual intercept. The individual intercept a_i and the individual return to schooling b_i are not observed. Correlation between a_i and b_i or between a_i and r_i will result in correlation between a_i and S_i. Correlation between b_i or a_i and S_i will bias the ordinary least squares estimate of the population mean $\boldsymbol{b}$ of b_i.

Since ordinary least squares estimation of the return to schooling may result in biased estimates of the return to schooling, one would like to know the size and direction of the bias. One possibility is that individuals with higher levels of schooling also have levels of unobserved factors that give them higher than average earnings at every level of schooling. Part of the return to these factors is attributed to schooling, biasing the estimated coefficient of schooling upward. Another possibility is that individuals with higher levels of schooling would have lower than average earnings at lower levels of schooling. This would bias ordinary least squares estimates of the return to schooling downward.[17]

Using the framework sketched above, Card (1995, 1999) reviews a series of studies that use various techniques to arrive at unbiased estimates of the returns to schooling and to compare them to the ordinary least squares estimates. In one of these articles, Card (1995) reviews five studies using instrumental variables techniques and three that "attempt to control for unobserved attributes". In all but one case, the return to schooling found is greater than the ordinary least squares estimate.

Card interprets this as support for Griliches' (1977) finding that ordinary least squares estimates of the return to schooling are unbiased or are biased downward. In the other article Card (1999) again concludes that the cross-sectional, ordinary least squares estimate of the return to schooling is approximately correct, that use of instruments based on the family or school system

[17] The discussion in the literature on "ability bias" is in terms of regression models of earnings, while rates of return to schooling are computed using average earnings in age/gender/level of study/field of study classes. The same considerations apply. The class averages of earnings could be constructed by regressing earnings on a

intervention would indicate downward bias of this estimate, that controlling for unobservables using other family variables indicates a small upward bias, and that the estimated returns to education vary with the observables included in the regression model (for example, family background).

Carnoy (1997) reviews recent research in the U.S. and Australia that uses data on twins and in the U.S. that uses longitudinal data. The twins studies examine the difference between ordinary least squares estimates of the coefficient of schooling and the coefficient of schooling in an intra-pair (of twins) fixed effects specification. A decrease in the coefficient of schooling from the first to the second set of estimates is interpreted as the result of taking into account omitted ability/background variables which affect the levels of both schooling and earnings.

As discussed by Carnoy (1997), results from these twins studies vary greatly. One set of authors (Ashenfelter-Krueger) shows an increase in the return to schooling from least-squares estimates to an intra-pair fixed effects specification. Two other sets of authors (Behrman et al., Miller, Mulvey, Martin) show a large decrease in the return to schooling from the least squares specification to the fixed effects specification. Miller, Mulvey, Martin, however, show an increase in the return to schooling from a least squares specification to fixed effects specification when they use an instrumental variables correction for errors in the measurement of schooling. (Ashenfelter and Krueger also use a correction of this type). (Carnoy, 1997, Table 2.1) Thus evidence from the twins studies is contradictory as to whether accounting for unobserved factors increases or decreases the return to schooling.

U.S. longitudinal data sets make it possible to control for socio-economic background and for ability using standardized test scores and high school grades. Carnoy (1997, 485-487) discusses three studies using longitudinal data sets of this type. All three suggest that background and “ability” account for a large part of the wage premium to post-secondary education, although a substantial premium remains even after these adjustments are made.[18]

series of indicators for year of age, gender, level of study and field of study. If one did so, the estimated direct effect of schooling would be subject to all of the considerations discussed here.

[18] The term “ability” is used in a very loose sense in this literature. The usual measures of “ability” are standardized tests administered in high school or high school grades. These are likely to result from family background, quality of education and so on, as well as from any “innate” ability.

Earlier research also left it unclear whether observed wage rate differentials between post-secondary graduates and high school graduates should be adjusted upwards or downwards before computing a private rate of return. For example, Blaug (1972, 68-69) cites studies which attribute about 60% of the earnings differential associated with schooling to the pure effects of schooling, with about 40% explained by background and ability. Garen (1984) finds that “those with unexpectedly large amounts of schooling…would have earned less than others if they had acquired less schooling”. Willis and Rosen (1979) also provide evidence for this ‘comparative advantage’ view. After an extensive review of research on the connection between schooling and earnings, Willis (1986, 589-590) concludes: “Given the complexity of the issues and the non-representative character of the data sets that have been employed in the literature on ability bias, it is difficult to reach firm conclusions about the magnitude or even the direction of the bias…”

In the face of uncertainty as to the correct direction in which to adjust earnings differentials, Vaillancourt (1995, 1996) adopts the agnostic approach of making no adjustment. Stager (1996) adjusts earnings of high school graduates upwards to obtain the forgone earnings during studies of university graduates. He nonetheless obtains substantial private rates of return to post-secondary education in Ontario.

Simulation of individual lifetimes, as in our study, cannot provide any information as to the part of the earnings difference between the more educated and less educated which is attributable to ability and background. It can provide an answer to questions of the following kind. Suppose that one thinks that all of the observed earnings difference between university graduates and high school graduates is due to (unobserved) differences in their earnings ability as of high school graduation. That is, university graduates earn no more than they would have earned if they had not continued their education after high school. Where does the median university graduate stand in the high school earnings distribution on this assumption? In other words, how much does unobserved ability have to contribute to lifetime earnings if it is to explain all of the earnings difference between university graduates and high school graduates? To address questions of this type, we report quartiles of undiscounted lifetime earnings after high school for our simulated university graduate, community college graduate and high school graduate populations.

3. Methodology

We now turn to a description of the methodology we used to simulate individual lifetime earnings histories and to estimate individual rates of return to post-secondary education. Our simulations used a variant of the LifePaths model. LifePaths simulates various features of individual lives, including demographic history, schooling history and work and earnings history. This study uses LifePaths to simulate prospective lifetime earnings and rates of return to post-secondary education by field of study, level of study and gender.

There are two important advantages to using the LifePaths model for this purpose. First, LifePaths allows us to obtain estimates of the distribution of prospective rates of return and lifetime earnings gains for individuals with a given post-secondary qualification. Published studies using cross-sectional data provide only the average result for a given field or level of study.

Second, LifePaths incorporates a detailed model of individual progression through the schooling system. The primary/secondary schooling portion of this model is based on data from the School Leavers Survey and the 1991 Census. The post-secondary portion is based on an individual longitudinal data set constructed from the Community College Student Information System/University Student Information System (CCSIS/USIS) administrative files maintained by Statistics Canada.[19] Since a major part of the cost of schooling is forgone earnings, more accurate estimates of time spent in schooling will improve the accuracy of estimates of the prospective rate of return to schooling.

This section is divided as follows. We begin with a brief description of the LifePaths model. We then discuss the data sources and estimation methods for those parts of the model which are most relevant to the computation of the rate of return to post-secondary education. Finally, we discuss how individual rates of return were computed using the cloning feature of the model.

19 See Chen and Oderkirk, (1997) for a description of how these individual longitudinal files were constructed for Ontario. Similar methods were used for data from the other provinces.

3.1 The LifePaths Model

The LifePaths model simulates individual lifetimes at a high level of detail. The version of the model used in the work reported here was originally developed to analyse student loan programs.

States and events

In the model, an individual's lifetime is made up of a series of states which are tracked in continuous time. The individual changes state when an event occurs. The state of an individual is best thought of as the value of a set of variables which describe the characteristics of the simulated individual.

The characteristics which make up a state are of three types. First, there are the characteristics which would describe an individual in a detailed cross-sectional survey. In LifePaths, these include (but are certainly not limited to) age, gender, province of residence, marital status, presence and number of children, spouse's and children's characteristics (if present), school enrolment status, highest educational level and educational history, field of study of degree (when relevant), potential hourly earnings rate, usual hours of work and employment status.

Second, there are characteristics which are cumulations of the value of a variable over a time period. For example, earnings to date in the year is the cumulation of earnings from the beginning of the calendar year to the time in the year to which the current state refers.

The third type of characteristic is current values of the waiting times until various future events will occur. These waiting times are the durations resulting from simulation of a series of competing duration equations, with each hazard conditioned on the current characteristics of the simulated individual (age, gender, marital and family status, education, employment status, and so on).[20]

For example, the current state may occur as of 14:35:26 of May 13, 2010. The individual may be employed in the current state. In the current state, the waiting time until the end of the

[20] The functions determining waiting times, conditioned on characteristics, are of various types. They all have a random element determined by a draw from a random number generator.

individual's current period of employment might be five years, four months, three days, seven hours, twelve minutes and twenty-seven seconds.

This does not mean that the individual's current period of employment will necessarily end five years, four months, three days, seven hours, twelve minutes and twenty-seven seconds hence. Some competing event may have a shorter waiting time, for example marriage. Marriage will then be the next event. The updating process which occurs at this event will include computation of a new waiting time until the end of employment, conditioned on the fact of being married (among other factors). Other waiting times will also be recomputed.

As we have seen, events change states. The next event is always the one with shortest waiting time. In most cases, the waiting time to an event is the result of a computation such as that described above. Certain events occur regularly, however. These include the year-end event and the birthday event. For these fixed events, the updated waiting time until their next occurrence is simply the time from the time of updating until the next occurrence of the event.

Fixed events also result in the state being updated. An obvious example of a characteristic which is updated at the birthday event is age. The change in age affects the distribution of many of the waiting times, including the waiting time until death, the waiting time until the end of the current employment period (or non-employment period, whichever is relevant), and so on.

Another type of action also can occur at an event—the output of data. For example, in our work, the annual earnings cumulation is output at the year-end event, while the present value of lifetime earnings is output at the death event (Death occurs when the shortest waiting time to the next event is the current value of the waiting time to the death event).

Cloning

Cloning is an important feature of the LifePaths model which we used in this project. This feature allows simulation of the lifetimes of two individuals whose simulated lives are identical up to some event and then diverge. In our work, for every individual who completed post-secondary education, we also created a clone who graduated from high school, but never enrolled in a post-secondary course of study. We refer to these individuals as the post-secondary (or BA or community college) graduate clone and the high school graduate clone.

The simulated lifetimes and characteristics of the post-secondary graduate clone and the high school clone are identical up to the first enrolment of the post-secondary graduate clone in a post-secondary course of study. Following this event they diverge. One important respect in which the simulated lives of these two clones remain identical, however, is that they both die at exactly the same age.[21]

3.2 LifePaths Simulation of Educational Progression and of Earnings

Having described the general structure of the LifePaths model, we now turn to a more detailed description of the two parts of the model which are most relevant to the simulation of earnings streams of post-secondary graduates and of high school graduates. These are the educational progression section and the labour market and earnings sections of the model. Other parts of the model also influence the earnings stream. For example, marital and childbearing behaviour has an important influence on the simulated labour behaviour of women. Space considerations lead us to omit detailed descriptions of these other parts of the model.

3.2.1 Educational Progression

It is convenient to divide LifePaths simulation of an individual's educational progression into two parts: secondary school graduation and post-secondary educational progression. Simulated individuals remain in the primary-secondary educational system until they either drop out or graduate. Drop-outs can return once and so have a second chance to graduate. All of these events are simulated on the basis of age and gender and drop-out status. The data used to develop the parameters for the high school graduation/non-completion section of the LifePaths educational progression model are drawn from the School-Leavers Survey.

Once an individual graduates from high school, a draw determines whether the individual will ever undertake post-secondary studies. This draw is based on gender and province of residence.

[21] The two clones also share the random component for certain other draws, including some related to employment status. As a result, there is some correlation between the annual earnings of the two clones. This correlation is greatest for men near retirement age, where it is around .4. Another spike in the correlation of the two clones' earnings occurs for both women and men immediately after high school graduation.

The only individuals of interest in our study are those who are selected to continue to post-secondary studies, and their high-school-only clones, who are created at this point. The high-school-only clones have the “ever undertake post-secondary” characteristic set to “no”; the post-secondary graduate clones have this characteristic set to “yes”.

For the post-secondary graduate clones, further draws determine the time which elapses until the individual begins post-secondary studies, the level at which these studies are undertaken, and the individual’s experience at this first level of post-secondary studies. The elements of the individual’s experience at the first level of post-secondary studies are the field of study from which the individual graduates (with non-completer as a residual field of study) and the individual’s pattern of periods of full-time study, part-time study and time spent out of school. The patterns of study vary according to the field of study at graduation.[22] These patterns are based on individual histories which were reconstructed from the CCSIS/USIS enrolment and graduation files.

Once a program of post-secondary study is completed (or not completed) the individual becomes eligible for further post-secondary study. Individuals coming from bachelor’s degree programs may move on to post-graduate programs or to community college professional programs. Individuals coming from community college professional programs may move on to bachelor’s degree programs. In our simulations, we used only individuals for whom a community college diploma or a bachelor’s degree was the highest completed level of post-secondary education.

3.2.2 Annual Earnings

An individual’s annual earnings during the year are arrived at by cumulating the individual’s hourly earnings over the hours worked during the year. Each individual is assigned an earnings multiple at the start of a new job or at a job anniversary. Hourly earnings are this individual earnings multiple times the average industrial wage. Hours worked are the outcome of the individual’s time employed during the year and the individual’s weekly hours when employed.

[22] Professional degrees were treated as a first degree in the professional field of study.

In our simulations, the average industrial wage is fixed at its 1991 level.[23] The individual's earnings multiple is drawn on the basis of gender, of the highest level of schooling completed, of time since the completion of the highest level of schooling[24] and of the field of study for post-secondary graduates, and is adjusted for the province of residence. Class medians were constructed to match those in 1991 Census data.

Individuals' earnings multiples will deviate from the median within each gender/level of study/time since completion/field of study class.[25] These individual deviations are constructed so that: 1) the dispersion of the earnings distribution grows with time following graduation matching the growth in earnings dispersion in Census data[26] 2) the individual's annual deviations are correlated over time. This second characteristic means that individuals who have a high earnings rank within their class in one year will also tend to have a high rank in following years; similarly for low earnings ranks. When an individual completes further post-secondary education, the individual moves into a new gender/level of study/time since completion/field of study class and the parameters of the earnings multiple draw change accordingly.

Clearly, the correlation over time of an individual's earnings multiples will be a crucial determinant of the distribution of rates of return to post-secondary education within a level of study/field of study/gender group. Chen and Rowe (1999) compared the earnings structure simulated for individuals in the LifePaths model over ten year periods with data from the longitudinal income tax files maintained by Statistics Canada. The time path of individual earnings in the two files appears to be quite similar.

Hours of work are assigned based on hours of work in the previous year, age, gender and other demographic characteristics and on level of studies. The data for the hours of work simulation are drawn from the 1991 Census. An individual is either employed or not employed in the LifePaths employment simulation. When the individual is employed, the time until the individual

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[23] The average industrial wage is the average industrial wage used by the Canada Pension Plan.

[24] Time since graduation is derived from age at graduation and age.

[25] Some of the classes were small, especially for higher time-since-graduation groups in which there were fewer post-secondary graduates. In certain cases, fields of study which had classes with similar median earnings were grouped prior to deriving the distribution of earnings multiples.

[26] Earnings by age in the Census are transformed into earnings by time since graduation using a set of weights derived from age at graduation by level and field of study.

ceases to be employed is simulated. Once a period of employment ends and the individual becomes jobless, the time until the beginning of the next period of employment is simulated. The simulated duration of periods of employment and of periods of joblessness depend on age, gender, other demographic characteristics and level of study. The data for duration of employment and non-employment are drawn from the LMAS and the LFS, and are reconciled to 1991 Census employment rates by age, gender, province of residence and level of schooling.

Earnings while a student are determined by a different process from the one we have just described. Two types of student earnings are simulated for persons enrolled as students: summer earnings and earnings during the school year. The LMAS is the data source for these simulations. For both types of student earnings, the amount of earnings in the year depends on gender, age and on level of study.

Tuition and other fees during studies were assigned based on administrative data collected by Statistics Canada according to the province of study, level of study and aggregated field of study.

3.3 Individual Rates of Return

3.3.1 Computation

In other rate of return studies, the estimates of wages or benefits used are based on average levels or fitted values from some data set on earnings (usually the Census or the SCF in Canadian studies). In our study, rates of return are computed for **individual** post-secondary graduates, based on a comparison with the high-school-graduate clone. Equation 1 above gives the usual formula for the net present value of prospective earnings gains due to completion of a post-secondary education. Adding an individual superscript to equation 1 gives the polynomial used in our simulations of individual rates of return to post-secondary education:

$$1'. \qquad PV^i = \Sigma_{t=0,...,T}(W_{ps,t}{}^{i} - W_{hs,t}{}^{i'} - C_t^i)(1+r)^{-t}$$

The superscript ***i*** refers to the i^{th} individual post-secondary graduate while the superscript ***i′*** refers to this individual's high school clone. The meaning of all of the variables is as described for equation 1. The problem of finding an internal rate of return becomes the problem of finding a root (or roots) r_0^i to this individual rate of return polynomial.[27]

While this approach allows us to derive distributions of rates of return, it leads to some difficulties which do not arise with aggregate data. Aggregate data has the conventional profile in which post-secondary graduates have an initial period of forgone earnings and direct costs, followed by a period of earnings gains (relative to secondary school graduates). This pattern guarantees that the rate of return polynomial (equation 1) will have a single real root.

Our simulation results show the conventional profile **on average**.[28] Nothing guarantees, however, that the **individual-level** comparisons in our simulations will have the same pattern. Two possibilities lead to difficulties: the high school clone's earnings may be greater in every period than the post-secondary graduate's earnings less direct costs or vice versa (infinite roots) or the earnings difference profile may change signs more than once (multiple real roots). We denote very high and very low rates of return (including infinite rates) as the values 10 and -10.[29]

As implemented in our work with the LifePaths model, the level of study of a post-secondary graduate is the highest post-secondary degree attained as of death and the field of study is the field of study for this highest degree. We tabulated results for graduates of community college professional programs and for BA and first university professional degree graduates. Our results are based on non-immigrants who survive until at least 65 years of age.[30]

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[27] One further difference that should be noted between our simulations and other rate of return estimates is that the time horizon in our simulations runs from high school graduation to death (since the post-secondary graduate and the high school clone are identical up to high school graduation and die at the same time), while in most estimates the time horizon is in terms of age, for example 18 years to 65 years.

[28] That is, if we take the mean of earnings in each year following high school graduation for the post-secondary graduates and the mean of earnings in each year following high school graduation for their post-secondary clones. Rates of return based on these class means are analogous to those reported by other authors. The lines labelled "LifePaths (from means)" in Table 1 report rates of return computed in this way.

[29] Experience showed that the number of multiple roots could be reduced significantly by taking each individual's earnings at time t to be earnings from $t-1$ to $t+1$ divided by two. Since this also eliminated the ambiguity as to whether discounting should apply at the beginning or the end of the period, we adopted this approach. Nevertheless, many of the individual earnings difference profiles still had more than one sign change and thus had multiple positive roots. In these cases, we chose the root which was nearest to the internal rate of return based on the aggregate results for the group being simulated.

[30] The limitation to persons surviving to age sixty-five is imposed because a very high proportion of post-secondary graduates who die before this age have very low rates of return. The limitation to the Canadian born is imposed because of difficulties in determining where immigrants received their education using Census data.

3.3.2 Outputs

In each field of study at the BA and community college levels, 1,000 graduates' lives (and 1,000 high school clones' lives) were simulated for women and for men. These simulated individuals were drawn from the birth cohort 15-24 years old in 1991. The same number of lifetimes were simulated for the overall BA and community college levels. In these latter simulations, graduates were assigned to fields of study based on the relevant distribution in the 1991 Census.

In the course of simulating each post-secondary graduate lifetime and each clone lifetime, annual earnings and the annual direct costs of post-secondary education were retained. At the death of the post-secondary graduate and the clone, these saved data were used to compute lifetime earnings at various discount rates and the rate of return to the individual graduate's post-secondary education. The results of these computations were then saved and used to produce the distributions of individual rates of return and of lifetime earnings which we present below.[31]

3.4 Interpretation of Results

At this point, it seems worth examining how our results should be interpreted. In conventional rate of return calculations, an "average" lifetime earnings profile for a post-secondary graduate is compared to an "average" lifetime earnings profile for a high school graduate. Consequently, there is no way to measure the variance of outcomes around this "average" result.

Since our simulations are carried out at an individual level, outcomes vary within a gender/level of study/field of study class. The simulations can be viewed as seeking to reproduce an "ideal experiment" in which one member of an identical pair of high school graduates continues on to post-secondary education and the other member does not.[32] In such an ideal experiment, as in our simulations, there would be variance in the outcome among the pairs.

In either the "ideal" experiment or our simulations, some of the variance in outcomes would be due to individual differences in the return to post-secondary education, some would be due to

[31] Certain other information was saved as well, for example, the duration of the post-secondary graduate's studies.

[32] In this interpretation, if the "ideal experiment" could be carried out, it would provide a measure of the accuracy of our simulations. This particular "ideal experiment" is not possible, if only because there is no available method (other than simulation) of producing pairs of identical high school graduates.

individual differences in earnings ability at the time of high school graduation and some would be due to random factors (luck or happenstance). Nothing in our simulations allows us to distinguish among these three sources of variance in outcomes.

The rate of return is widely used as a convenient and meaningful way to summarize differences in lifetime earnings profiles. We use the rate of return in this way. The ranges of rates of return we report reflect the range of outcomes in our simulations. Some part of the difference in outcomes is due to differences in returns to schooling; some part is due to the other factors mentioned. We have no direct way of evaluating the importance of each of these factors.

This situation is directly analogous to a published list of rates of return for mutual funds with similar investment strategies. There will be variance in the rate of return to these funds. Nothing in the published results tells us how much of this variance is due to differences in the skills of fund managers and how much is due to luck. An investor buying a mutual fund at random in this category can reasonably expect to obtain the median rate of return, subject to the variance captured by the variance in results among mutual fund companies.

The comparable statement for persons considering post-secondary studies in a given field of studies would be that they can expect to realize the median outcome we report, subject to the reported variance in outcomes. The analogy is not perfect, because high school graduates have some (perhaps mistaken) idea of their own skills and because individuals can influence their earnings streams directly, for example, by their labour force participation decisions.

The essential point is that our results should be interpreted as providing a range of outcomes for post-secondary graduates of a given gender in a given field of study and level of study. This range of outcomes reflects individual differences in the returns to these studies, but reflects other factors as well.

4. Results

This section is divided into three parts. The first part examines the distribution of individual rates of return to community college career programs and to university bachelor's degree programs for women and men. The second part considers rates of return for women and men by field of study and compares the distribution of lifetime earnings for women and men within fields of study. The third part compares the distribution of lifetime earnings of community college graduates and of bachelor's degree graduates with those of high school graduates.

4.1 Distribution of Rates of Return by Level of Study

Figure 1 gives the cumulative individual rate of return distribution for male and female BA graduates and community college graduates. The horizontal axis of the figure is the cumulative decile; the vertical axis is the individual rate of return. The median rate of return is 13% for female BA graduates and 12% for male BA graduates. Rates of return are higher at the median for community college graduates (18% for women, 16% for men) than for BA graduates.

Figure 1. **Rates of Return at Deciles**

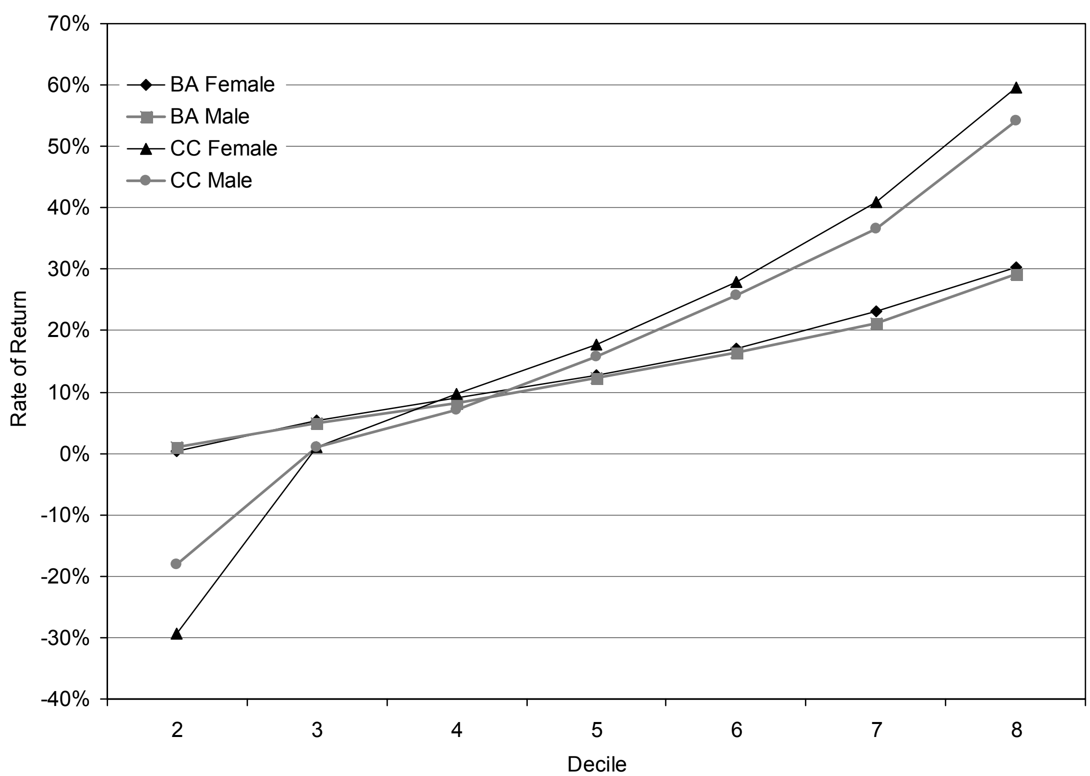


Figure 1 shows considerable variability in rates of return among individuals, with much greater variability for community college graduates than for BA graduates. Rates of return for BA graduates range from 0% at the 20th percentile to 30% at the 80th percentile, while rates of return for community college graduates are 0% at the 30th percentile and around 40% at the 70th percentile. About 20% of BA graduates and 30% of community college graduates have negative rates of return to their investment in post-secondary studies.

Table 1 compares the medians (5th decile) shown in Figure 1 to the rates of return reported in two other studies using 1991 Census data: Vaillancourt's (1996) results for Canada, and Stager's (1996) results for Ontario. The table also gives rates of return calculated from average earnings and cost profiles derived from our simulation outputs. This method (labelled "from means" in Table 1) is similar to those used by Stager and by Vaillancourt.

For BA graduates, our rates of return based on average profiles are close to those computed by Stager and by Vaillancourt. For community college graduates, our rates of return based on average profiles are considerably higher than those found by Vaillancourt. A large part of this difference may be due to the fact that Vaillancourt assumes a duration of three years for community college programs, while the longitudinal files constructed from administrative data suggest that two years is a more typical length of program.

The median rates of return shown in Table 1 are lower than the rates of return computed from average profiles. For BA graduates, the difference is around four percentage points; for community college graduates it is around eight percentage points for women and twelve percentage points for men. We suspect that the size of this difference for community college graduates is the result of a high degree of variability of outcomes for community college graduates, reflected in the high degree of variability of their individual rates of return.

Table 1. **Comparison of Rates of Return by Gender and Level of Study**

	Community College	BA
LifePaths (median)		
Women	.178	.128
Men	.157	.123
Life Paths (from means)		
Women	.259	.162
Men	.275	.146
Vaillancourt (1996)		
Women	.184	.161
Men	.163	.123
Stager (1996)		
Women	---	.176
Men	---	.138

4.2 Distribution of Rates of Return by Field of Study

The next group of figures shows the median, 30th percentile and 70th percentile of the rate of return by field of study for male and female BA and community college graduates. The fields of study shown are those which had a sufficient sample size in the 1991 Census to give meaningful results for the gender, level of study and field of study. The fields of study used are more detailed than those usually reported in estimates of rates of return by field of study. For the most part, they are close to actual programs of study, although in some cases they are more aggregated.

Figures 2.a and 2.b give results by field of study for male and female BA graduates respectively; Figures 2.c and 2.d give results by field of study for male and female community college graduates. The detailed fields of study shown in figure 2 are shown by ascending order of the median rate of return within these groups.

Figure 2a. **Median, 30th and 70th Percentiles of Rates of Return by Field of Study: BA, Female**

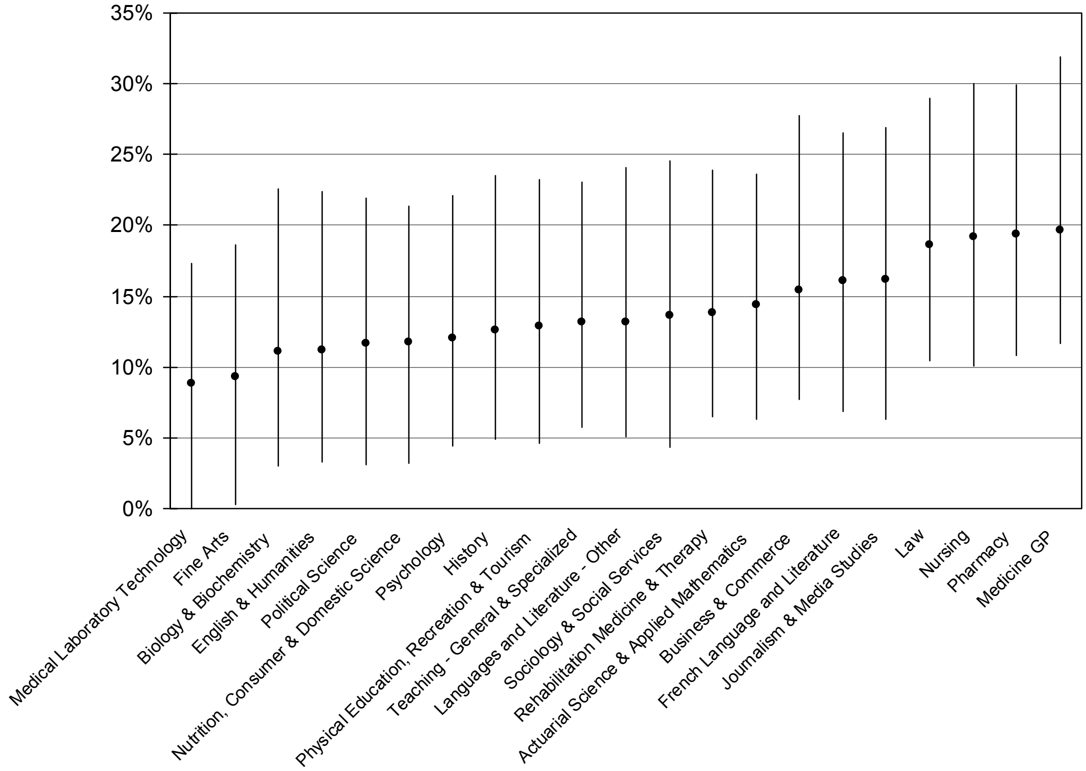


Figure 2b. **Median, 30th and 70th Percentile of Rates of Return by Field of Study: BA, Male**

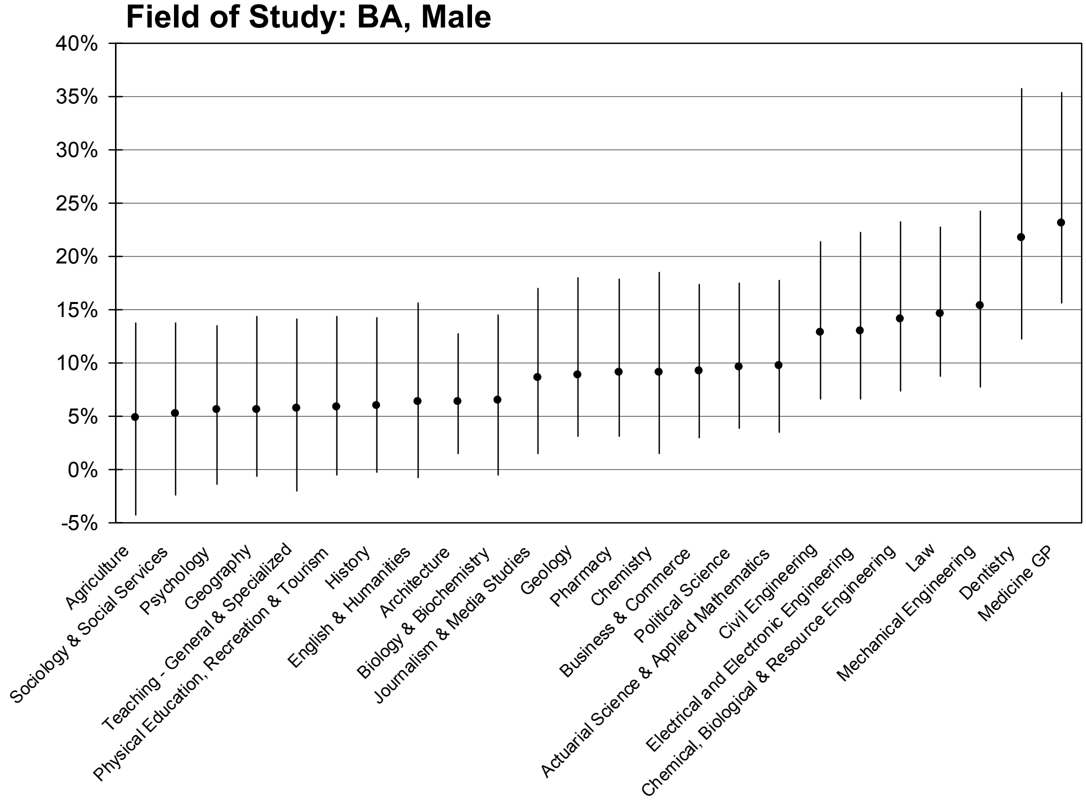


Figure 2c. **Median, 30th and 70th Percentiles of Rates of Return by Field of Study: Community College, Female**

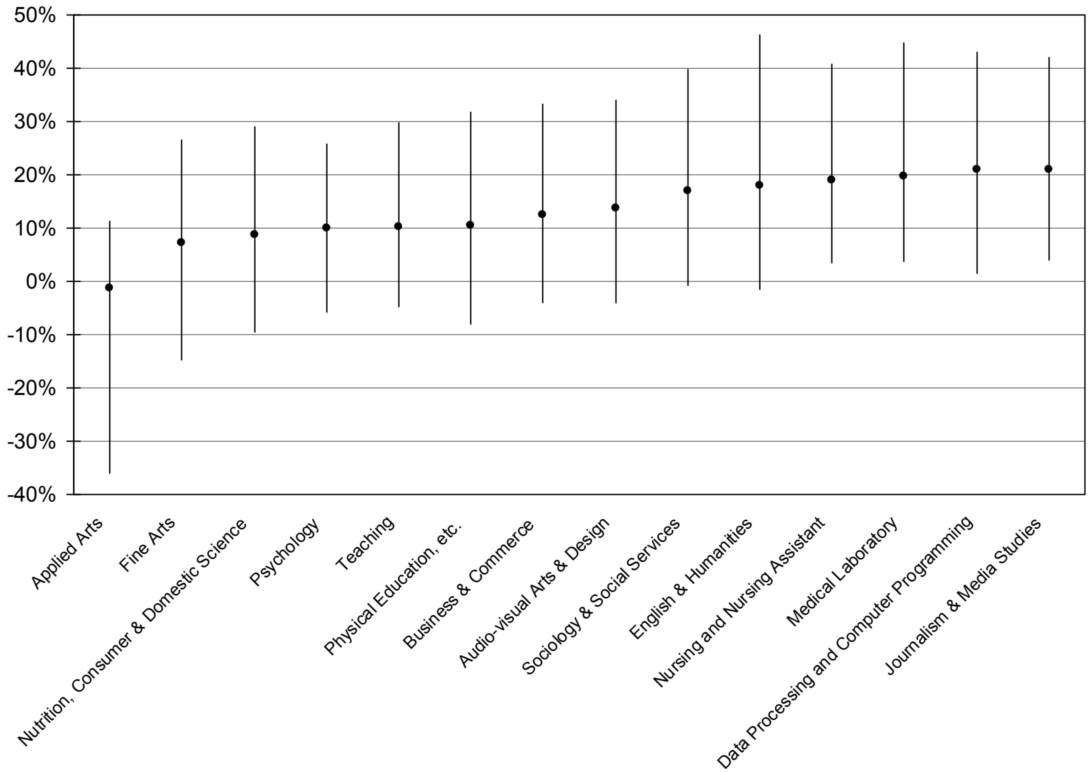
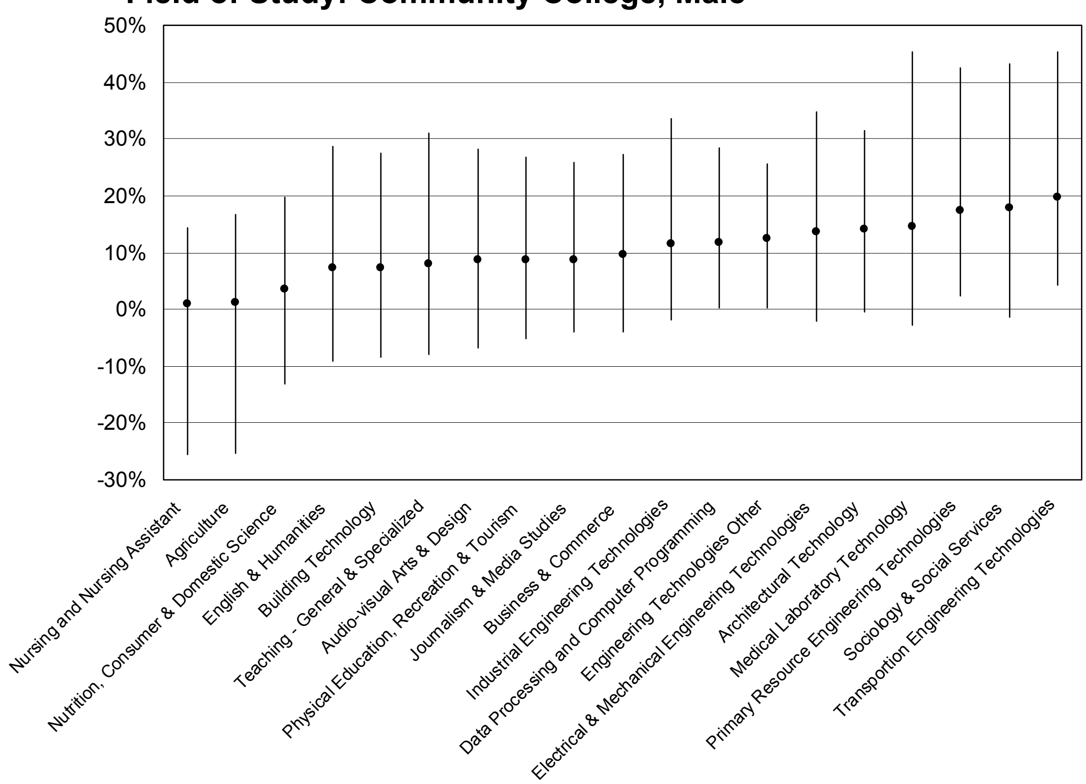


Figure 2d. **Median, 30th and 70th Percentile of Rates of Return by Field of Study: Community College, Male**



We would summarize the results by field of study for BA's (figures 2a and 2b) as follows: The median rate of return by field of study for women (Figure 2.a.) runs from 9% to 20%. Only the two fields of study with the lowest rates of return (Medical Laboratory Technology and Fine Arts) have zero rates of return at the 30th percentile. These two fields of study are also the only two in which the rate of return at the 70th percentile is less than the median rate of return for Medicine (which has the highest median rate of return). Three health professions (Pharmacy, Nursing and Medicine) and Law have median rates of return which are well above those of the next highest group of fields of study.

For men, there is a large group of fields of study with median rates of return of 5% to 6% and another large group with median rates of return of 9% to 10%. Engineering fields of study and Law have median rates of return of 13% to 15%. Finally, Dentistry and Medicine have median rates of return of over 20%. All but one of the fields of study in the group with the lowest median rates of return have a negative rate of return at the 30th percentile. Nonetheless, the rate of return at the 70th percentile for fields of study in this lowest ranking group is higher than the median rate of return for all but the highest ranking fields of study.

In Figures 2.c and 2.d, median rates of return by community college field of study for the most part range between 8% and 20%. There are three fields of study with median rates of return below 5% for men (of which one at 0%) and one with a median rate of return of 0% for women.

For BA fields of study in figures 2.a and 2.b, there is a large range in rates of return between the 30th percentile and the 70th percentile in a field of study, on the order of 15 to 20 percentage points. The range in median rates of return among fields of study is 11 percentage points for women and 13 percentage points for men. For community college fields of study in figures 2c and 2d, the distance between the rate of return at the 30th percentile and the rate at the 70th percentile in a field of study is on the order of 30 to 40 percentage points. The range of median rates of return for community college fields of study is around 20 percentage points. At both levels, the differences in individual rates of return within a field of study are large relative to the differences in rates of return between fields of study.

There are a limited number of fields of study in which the sample sizes of both women and men in the 1991 Census were sufficient to report results for both. Figure 3 compares the median rate of return for women and men in each of these fields of study. With only two exceptions, median rates of return for women were higher than median rates of return for men in these fields of study. (The two exceptions are Medicine for BA graduates and Sociology and Social Services for Community College graduates).

Figure 3a. **Median Rates of Return by Gender and Field of Study: BA**

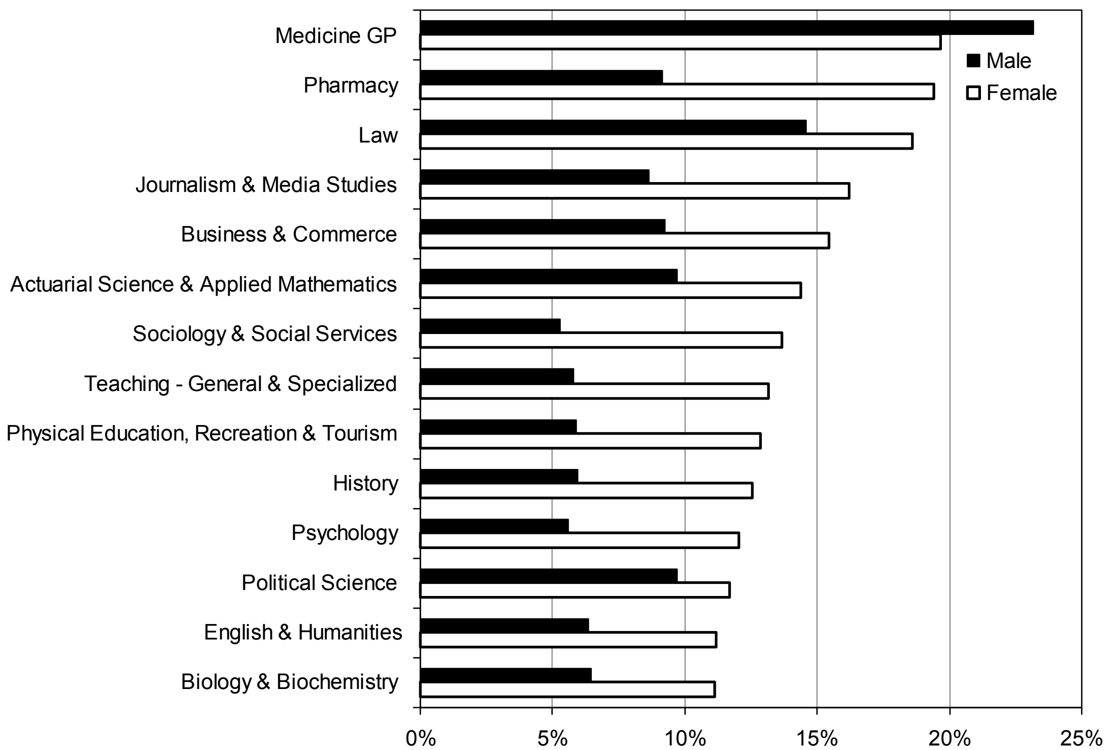
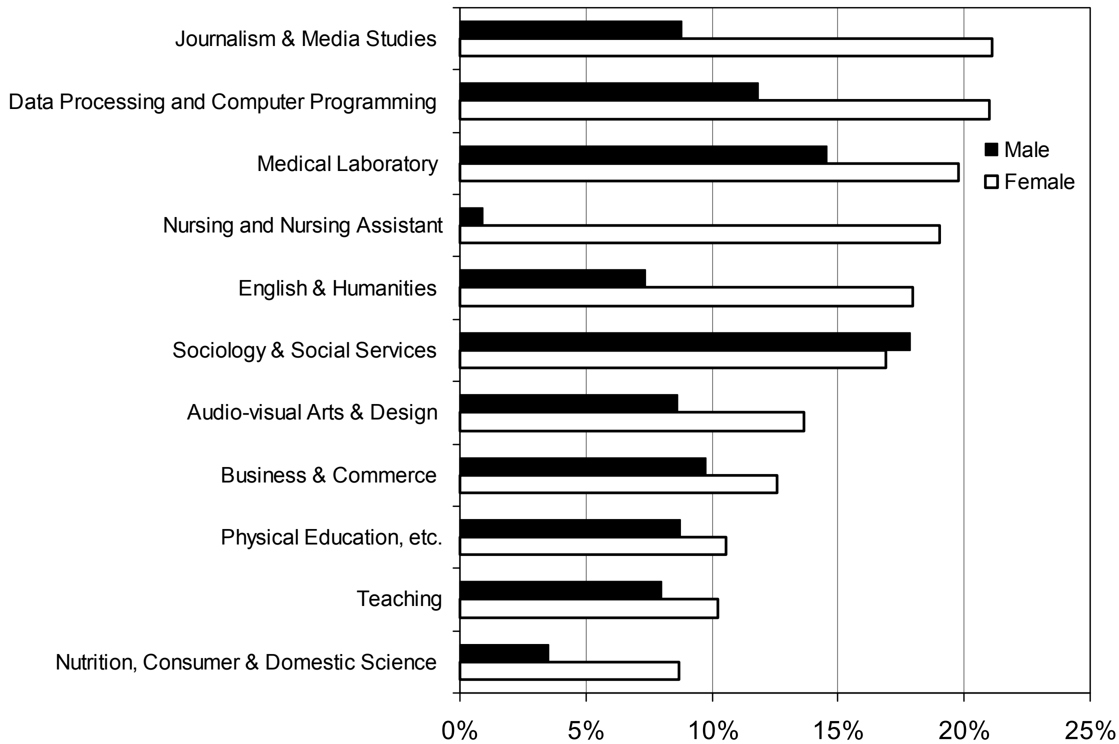


Figure 3b. **Median Rates of Return by Gender and Field of Study: Community College**



It is certainly not the case that women had higher median rates of return in these fields of study because their earnings were higher than men's. On the contrary, men's earnings were much higher. Figure 4 shows how large the gap is between the earnings of male and female post-secondary graduates in the fields of study included in Figure 3.

In Figure 4, the 75th percentile of undiscounted lifetime earnings of women in these fields of study is compared to the 50th and 25th percentiles of undiscounted lifetime earnings of men in these fields of study. In every case, lifetime earnings at the 50th percentile for men (top bar) are higher than lifetime earnings at the 75th percentile for women. In many cases, lifetime earnings at the 25th percentile for men (middle bar) are higher than at the 75th percentile for women.

Figure 4a. **Selected Lifetime Earnings Quartiles by Gender and Field of Study: BA**

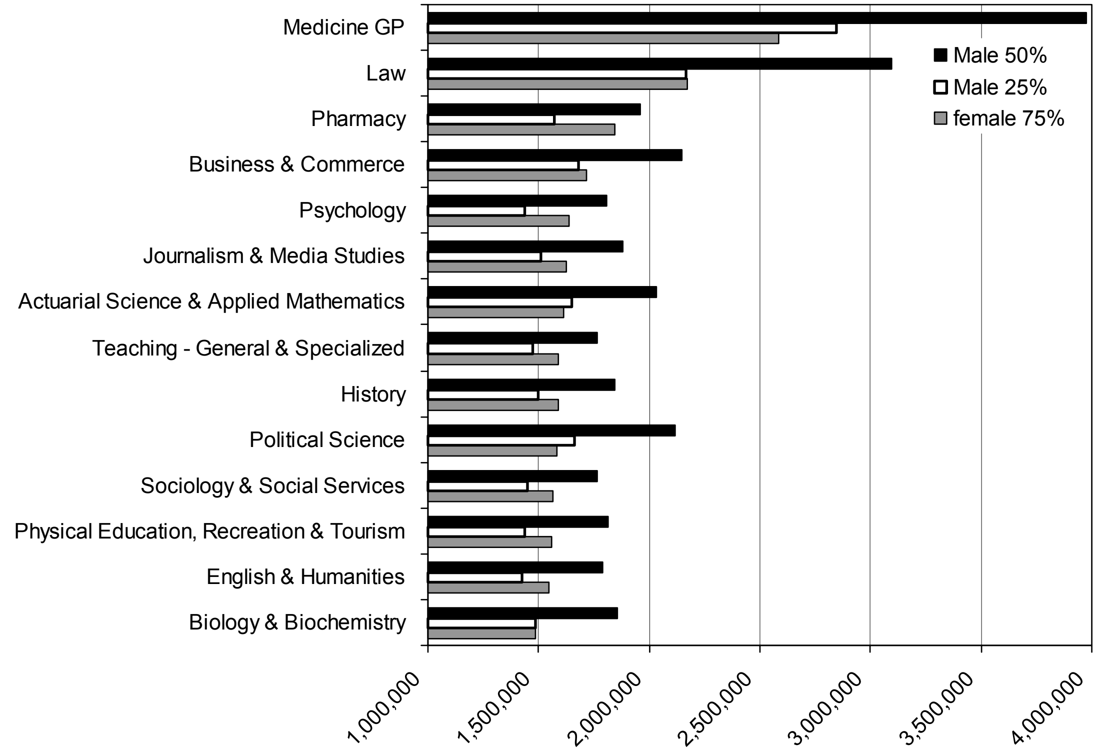


Figure 4b. **Selected Lifetime Earnings Quartiles by Gender and Field of Study: Community College**

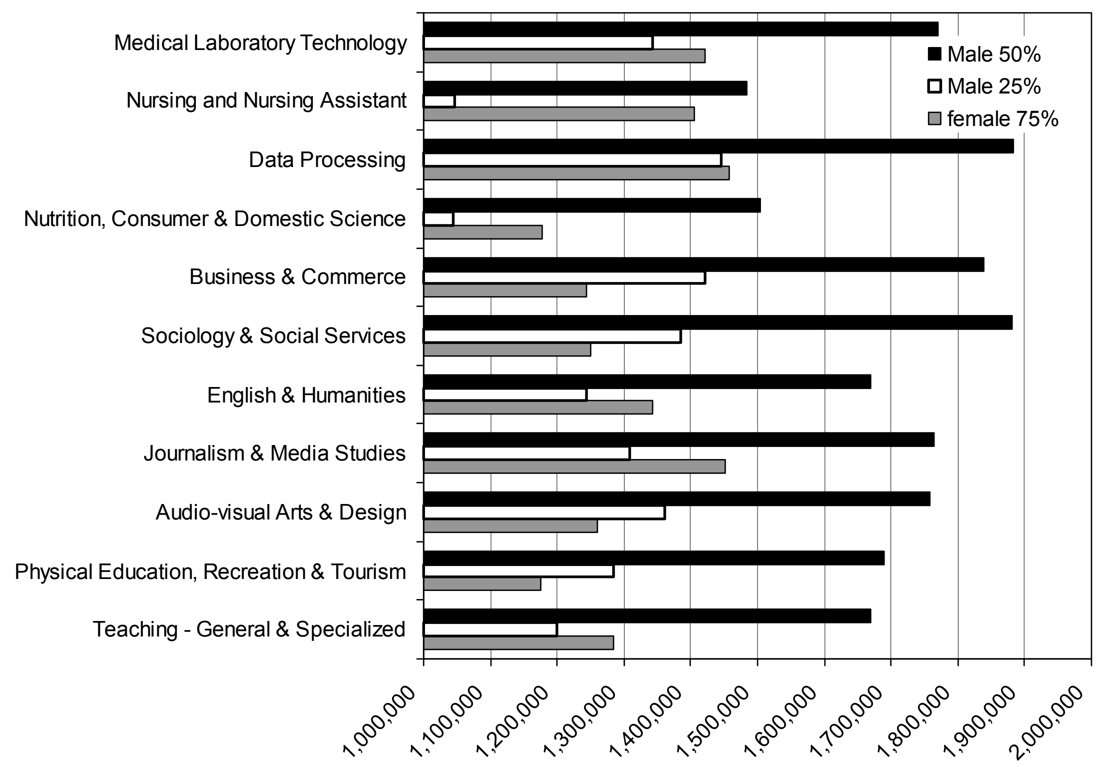


Figure 3 shows that in almost all fields of study where comparisons are possible, women have higher median rates of return than men. Figure 4 shows that women's higher rates of return are not the result of higher earnings for female than for male post-secondary graduates.

Women's rates of return to post-secondary studies are higher than men's because women have a greater earnings differential between post-secondary graduates and high school graduates than men. Rates of return are computed based on the earnings differential between post-secondary graduates and high school graduates. The greater earnings differential for women results in a higher rate of return to post-secondary studies.

4.3 Distribution of Lifetime Earnings

We now compare the distribution of lifetime earnings among our simulated post-secondary graduate population with the distribution of lifetime earnings among the simulated high school graduate clones. Figure 5a shows quartiles of the distribution of simulated undiscounted post high school lifetime earnings of female high school graduates, community college graduates and BA graduates. Figure 5b gives the same information for men. Roughly speaking, in figures 5a and 5b the 75^{th} percentile of the high school graduates' lifetime earnings distribution (about $1 million for women and $1.8 million for men) occurs at the median of community college graduates' lifetime earnings distribution and at the 25^{th} percentile of the BA graduates' lifetime earnings distribution.

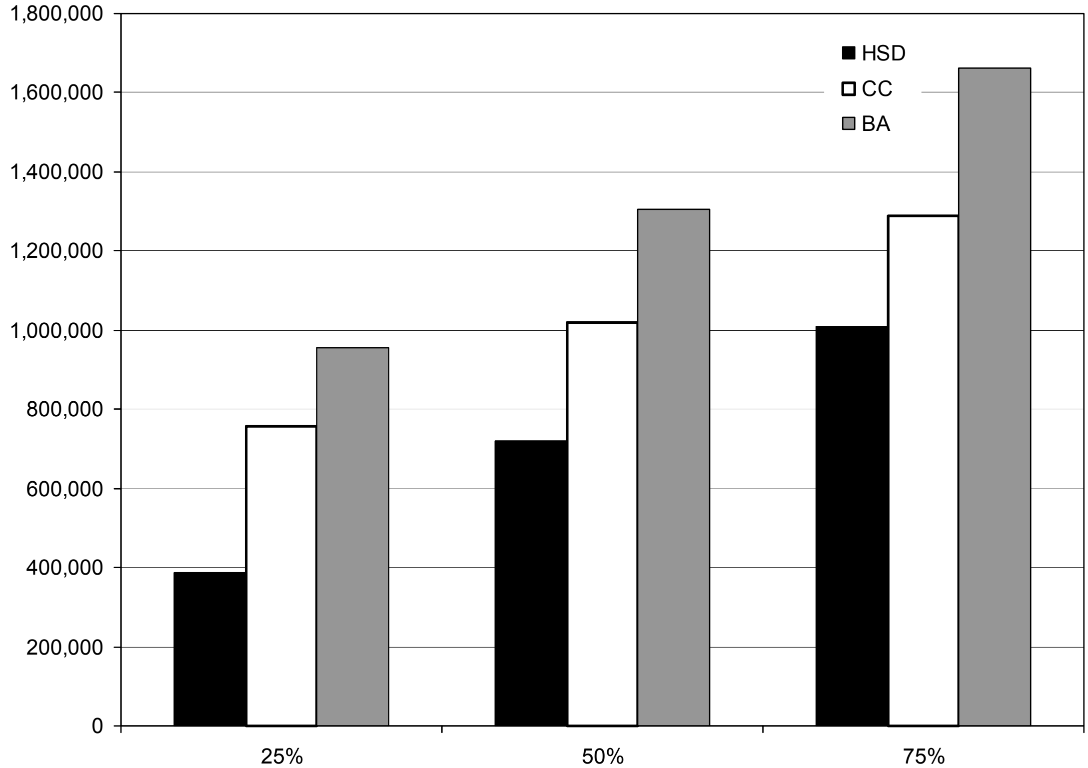


Figure 5a. **Quartiles of Lifetime Earnings—Women**

Figure 5b. **Quartiles of Lifetime Earnings—Men**

In our view, the magnitude of these differences makes it difficult to claim that schooling does not have a significant causal role in the earnings gains associated with post-secondary education. If schooling had no causal role, post-secondary graduates would have earned the same amount, whether or not they undertook a post-secondary education.[33] The results reported in Figure 5 would then imply that 75% of BA graduates would have been in the top quartile of the existing high school earnings distribution if all BA graduates had stopped their schooling after high school. Similarly, 50% of community college graduates would have been in the top quartile of the existing high school earnings distribution without their post-secondary program. This would seem to us to be an exaggerated estimate of the greater earnings abilities of post-secondary graduates without their post-secondary education.[34]

The results reported in Figure 5 do not result from estimates of a structural model that seeks to disentangle the causal effects on earnings of schooling beyond high school and of earnings ability at high school graduation. They indicate to us, however, that claims that post-secondary education has only a small causal effect on earnings place a very heavy burden on earnings ability at high school graduation as a source of the observed higher earnings of post-secondary graduates. We are skeptical that the earnings abilities of post-secondary graduates **when they finished high school** were so very much higher than those of their fellow high school graduates who did not continue their education.

[33] In a signaling interpretation of post-secondary education, the causal effect of schooling would be as a signal, identifying more productive individuals. If signaling were the only causal role of schooling, this would still require that the earnings ability distributions of the high productivity individuals who invest in a university education as a signal have its 25^{th} percentile at the 75^{th} percentile of the earnings ability distribution of the low productivity high school graduates who do not invest in this signal. All the more so if we discount earnings, since the greatest earnings differences are at older ages. We regard this as highly implausible.

[34] The qualitative results are not greatly changed at low discount rates. As discount rates increase, lifetime earnings differences between post-secondary graduates and high school graduates decrease. We chose not to report discounted lifetime earnings in Figure 5 because we had no way to choose the correct discount rate.

5. Summary of Results and Conclusions

5.1 Summary of Results

In our opinion, the most striking aspect of the simulation results we report is the very wide range of individual outcomes of post-secondary education. We found a median rate of return to a BA of 12% for men and 13% for women, but also found a negative rate of return for a fifth of all BA graduates, and at a rate of return of more than 30% for the fifth of BA graduates with the highest rate of return. The remaining three-fifths of BA graduates have rates of return between 0% and 30%.

The simulated community college graduate population has an even wider range of rates of return. Of this group, three tenths have a negative rate of return, three tenths have a rate of return of over 40% and the remaining four tenths have a rate of return between 0% and 40%. The median rates of return to community college are 18% for women and 16% for men.

We found significant differences in the median rate of return among fields of study at both the BA and community college levels. The differences in outcomes between fields of study are smaller than the differences in outcomes among individuals in a given field of study. Put otherwise, in almost every case it is better to be in the top 50% of individual rates of return in a field of study with a low median rate of return than in the bottom 30% of individual rates of return in a field of study with a high median rate of return.

This raises the question of how to interpret differences between individuals in rates of return to the same course of studies. These results are simulations, based as closely as possible on a variety of data sources. While the model results have been tested against the data, it is possible that the results are in part an artifact of the model. In particular, if the simulated correlation over time of an individual's earnings is too high, this may create an artificially high variance of the lifetime earnings distribution of individuals with similar characteristics. Simulated earnings in LifePaths over ten year periods have been compared to longitudinal income tax data by Chen and Rowe (1999). Earnings from LifePaths and tax data appear to behave similarly over time.

If one accepts that LifePaths gives a reasonably accurate picture of individual earnings over time, the next question is whether the comparison used in computing individual rates of return is appropriate. The method used compares a post-secondary graduate with a high school graduate. The high school graduate's characteristics are identical to those of the post-secondary graduate up to the point where the post-secondary graduate enrolls for post-secondary studies.

Variance in individual rates of return arises both from variance in outcomes for post-secondary graduates and variance in outcomes for their high school clones. A favourable outcome for the high school clone and an unfavourable outcome for the post-secondary graduate will result in a low individual rate of return and vice versa.

We would argue that this is the appropriate procedure. The earnings outcome of a post-secondary education is uncertain. The earnings outcome of leaving schooling after high school is also uncertain. The simulated individual rates of return reflect both of these sources of uncertainty.

For reasons discussed above (Section 2.1.2), we did not adjust the distribution of high school clones' earnings to take into account the possibility that the 'average' post-secondary graduate would have earned more (or less) than the 'average' high school graduate had the average post-secondary graduate not undertaken post-secondary studies. A simple adjustment of the mean of the "high school clones'" earnings distribution would lower the rate of return to post-secondary schooling without affecting the dispersion.

Imposing a positive correlation between the earnings rank of the post-secondary graduates and their high school clones would be likely to decrease the dispersion of individual rates of return. Imposing a negative correlation would be likely to increase the dispersion. That part of the research literature which finds that the estimated return to schooling is biased upward by "ability bias" implies a positive correlation. That part of the research literature that claims that post-secondary graduates are those who self-select for reasons of comparative advantage implies a negative correlation. We chose to impose neither a negative or positive correlation between the earnings ranks of the post-secondary graduates and their high school clones.

5.2 Implications

If one accepts that the variance in individual rates of return in our simulations is a reasonably accurate reflection of actual individual outcomes of post-secondary education, what is the source of this variance? We think it unlikely that all of this variance is due to differences in the productivity-enhancing effects of education on different individuals. In our view, some part is due to differences in other characteristics of individuals which affect their earnings potential, some part is simply the result of decisions as to time use, and some part is luck. (See Section 3.4. for a more detailed discussion of this point).

When a negative rate of return results from an individual's time use decisions or career choices, the individual presumably obtains some benefit which offsets the earnings loss. Non-pecuniary benefits of this type are not captured in our rate of return simulations.

A crucial point for policy purposes is whether individuals at the lower end of the distribution of outcomes to post-secondary education can be identified before undertaking post-secondary education. It seems unlikely that these individuals are able to identify themselves, since otherwise why should they undertake post-secondary studies? It is difficult to see how some outside authority could do any better than individuals at evaluating their likely outcomes to post-secondary education. It is very likely possible to identify **groups of individuals** with lower median rates of return and a higher risk of negative rates of return. It is likely to be difficult to identify **individuals** who will have unfavourable outcomes.

Our results indicate, for example, that some fields of study have lower median rates of return and a higher risk of unfavourable outcomes than other fields of study. Our results also indicate that in almost all comparisons of fields of study, the top half of outcomes in the field of study with the lower median rate of return is better than the bottom 30% of outcomes in the field of study with the higher median rate of return. It is also worth emphasizing that in almost all fields of study at the BA level, two thirds or more of graduates have a positive rate of return. At the community college level, this is true for all graduates and for graduates in many fields of study. In every field of study at the community college level, over 50% of graduates have a positive rate of return. Thus an "unfavourable" choice of field of study is far from being a guarantee of an unfavourable outcome, although it does increase the risks of such an outcome.

Milton Friedman's (1955, 137-143) original argument for an income-contingent repayment system for student loans was that the outcomes of education were so uncertain that private investment in education was better financed by sharing in the profits from successes than by very risky loans. Our simulation results, taken at face value, indicate that the outcomes of investment in education are far from certain, although hardly as risky as investing in mineral exploration or in technology start-ups.

The ultimate goal of this project is to assist in providing labour market information to youth. What in our results might serve as a basis for advising young people facing decisions about post-secondary education? First, that a very high percentage of graduates have positive rates of return to community college diplomas and BA's. Second, that post-secondary education is not a guarantee of a successful outcome and that outcomes differ widely among individuals. Third, that someone who thinks they have the qualities required to do well as a teacher, but not as a lawyer, may be well-advised to become a teacher, not a lawyer.

5.3 Directions for Further Research

The major finding of this study is that the results of investment in post-secondary education vary widely among individual graduates. Our results are based on individual-level simulations, not on data on lifetime earnings profiles. We are confident that if such data existed, it would also show great variance in individual results. It is also the case that earlier estimates of the rate of return to education are derived from an individual-level simulation for a representative individual, based on aggregate data.

We will concentrate here on the directions for further research that we think can be usefully explored using LifePaths or similar simulation models. These do not include research into the relation between differences in ability and background and differences in outcome. Ability and background could be formally included in LifePaths by making some assumption as to their effects (see the discussion in the preceding section). The question at issue, however, is precisely what level and direction of influence of ability and background it appropriate to assume.

One useful direction for further work is modeling the tax-transfer system within LifePaths. This would allow us to explore the effects of taxes and transfers on the level and variability of private rates of return to education.

Another useful direction for future work would involve examining the correlates of high or low rates of return. Among the questions we would seek to answer are the following: To what extent is the variance in rates of return due to variance in high school graduates' earnings and to what extent is it due to variance in post-secondary graduates' earnings? Are low individual rates of return primarily the result of low earnings rates? Or of above average lifetime duration of non-employment?

An enhancement of LifePaths which would aid greatly in addressing these questions would be to divide time not-employed between time unemployed and time out of the labour force. There is an important distinction to be made between the effects of largely voluntary participation decisions and largely involuntary passages between employment and unemployment. In our view, the primary purpose of the accounting exercise described above is to distinguish the effects of individual decisions such as field of study, labour force participation and hours of work from the effects of other factors as sources of variation in individual outcomes.

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