The Causal Effect of Education on Earnings in Canada[*]

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1. Introduction

What is the economic value for an individual of acquiring a higher level of schooling? This question has long preoccupied economists and policy-makers in Canada and elsewhere. For economists, the issue is mostly a methodological question having to do with the proper measurement of the causal effect of education on earnings. On the policy side, it is increasingly important to precisely assess the benefits of education in an era where education has to compete for limited public funds with health care, industrial policy programs, and other sources of public spending.

The objective of this paper is two-fold. I will first review recent econometric studies that seek to estimate the "causal effect" of education on earnings. Ideally, this should be estimated by conducting an experiment in which we would increase the schooling of a randomly selected treatment group, and see whether future earnings of this treatment group increase relative to a control group. We will see that short of this ideal experiment, economists have tried to use a variety of "natural experiments" to estimate the causal effect of education on earnings. The second objective of the paper is to discuss how estimates of the economic return to education can be used to assess the benefits of education for the individual, the society, and the government.

2. Estimating the return to education

Much of the economic literature on the effect of education on earnings has been inspired by the seminal work of Becker (1975) and Mincer (1974) on human capital. Under this human capital approach, education is viewed as an investment in human capital that raises the future productivity of individuals in the workplace. Thinking of education as

human capital highlights the fact that like for other investments, there are both costs and benefits to the "investment" in education. The main cost of education is the value of the time individuals spend investing in education. For example, an 18 year old has the choice between working full-time in the labour market or spending few extra years in school to acquire a college or university diploma. If this individual could earn over $20,000 a year instead going to (say) university, the opportunity cost of four more year of schooling will be close to $100,000. This opportunity cost typically dominates other costs such as tuitions and other fees.

Under the human capital approach, the individual has to balance these costs against potential benefits of education. If the benefits are not large enough, the individual may decide it is not worthwhile to pursue a further degree. Of course, many other factors also play an important role in the decision to stay in school or drop out. The human capital approach helps highlight the importance of economic factors in this decision without denying the importance of other factors.

The economic "return to education" is typically estimated using a Mincer-type regression of the following form:

$$\log(y) = a + b\,S + \text{other factors} + e$$

where y is earnings (typically weekly or hourly) and S is the number of years of education. The "other factors" includes a variety of socio-economic factors observed in standard individual level data sets such as years of labour market experience, gender, marital status, geographical location, etc. The "error term" e captures all relevant factors in earnings determination that are not captured by observable variables usually available in standard individual level data sets.

Note also that the natural logarithm of earnings, instead of earnings per se, is used on the left-hand side of the equation. Using this transformation simplifies the interpretation of the return to education which is captured by the parameter b in the equation. The effect of education on the log of earnings can be though of as a percentage point effect. For instance, if b is equal to 0.07, this means that one extra year of education increases earnings by 7 percent. Using this percentage point interpretation is very useful when comparing the return to education for different countries (with different currencies) and different periods (with different costs of living).

This Mincer-type earnings equation has been estimated for hundreds of individual level data sets for a large number of countries and time periods. These individual-level data sets are typically public use files of large surveys conducted by statistical agencies like Statistics Canada. The two most popular surveys that have been used to estimate this equation in Canada are the Survey of Consumer Finances and the Census (public use sample for some of the individuals who filled the "long form" of the Census). Both data sets contain detailed information on earnings, educational achievement, and other important socio-economic factors.

A Mincer-type earnings equation is typically estimated using regression methods (ordinary least-squares to be more specific). This yields estimates of the return to education, b, as well the other parameters of the model (including the constant a and the effect of the "other factors").

Intuitively, it is easy to understand what the regression does by looking at the case where we only two groups of workers, say university and high school graduates in British Columbia. For the sake of the example, assume that university graduates earn, on

average, $ 14 an hour, while high school graduates earn, on average, $ 10 an hour. This means that university graduates with 16 years of completed schooling earn 40 percent more than high school graduates with 12 years of schooling. In other words, the return to each additional year of education beyond high school is 10 percent (40 percent divided by 4 years).

Regression methods provide a more general way to estimate the return to education by combining earnings information on all groups of workers in Canada while controlling for the impact of other factors on earnings. Controlling for these other factors is quite important to ensure we do not get biased estimates of the return to education. For example, it is well known that a higher fraction of the workforce has a university diploma in Ontario than in Quebec or the Atlantic provinces. If we fail to control for provincial differences in earnings, we will likely overstate the return to education by comparing university graduates who are disproportionately from Ontario, a high earnings province, to workers with less schooling who are disproportionately from provinces where earnings tend to be lower.

Fortunately, it is easy to control for provincial differences in earnings by simply including dummy variables for the province of residence in the earnings regression. More generally, researchers typically include a variety of variables available in standard individual level data sets in the earnings regression to make sure we do not attribute to education the effect of other factors that have not been properly controlled for.

A more serious problem is that other important factors in earnings determination are not measured in the surveys typically used to estimate the return to education. Economists have long speculated that regression estimates of the return to education are

biased because of the failure to control for measures of "productive ability". To the extent that more "able" workers tend to get more schooling than less "able" workers, regression methods may overstate the return to education by attributing to education some of the effect (on earnings) that should be attributed to "ability". In other words, we may be comparing apples to oranges by comparing the earnings of university graduates to those of high school graduates.

The basic question here is whether standard regression estimates of the return to education are accurate measures of the true *causal effect of education on earnings*. Ideally, we would like to compare the actual earnings of an individual with a given level of schooling to the earnings the same individual would get if his/her schooling level was increased by, say, one year. Consider the earnings difference under these two scenarios for a large sample of the Canadian population. The ideal estimate of the causal effect of earnings on education is simply the average value of this earnings difference under these two scenarios.

Unfortunately, we cannot observe at the same time the earnings a given individual under those two scenarios. So the best "feasible", though unrealistic, way of estimating the causal effect of education on earnings would be to run an "experiment" in which we would 1) select a group of individuals, 2) randomly divide the group into a "treatment" and a "control" group, and 3) force all individuals in the "treatment" group to acquire an extra year of education. The experimental estimate of the causal effect of education would then be obtained by contrasting the later earnings of members of the treatment and control groups. For example, if members of the treatment group later earn 8 percent

more than those in the control group, we would conclude that the causal effect of the extra year of education on earnings in 8 percent.

Since running such an experiment is not realistic, researchers have tried to exploit a variety of "natural" experiments to estimate the effect of education on earnings. The next section provides a short survey of recent estimates of the causal effect of education on earnings with a special emphasis on Canadian results.

3. Survey of recent estimates of the causal effect of education on earnings.

It would be beyond the scope of this paper to discuss in detail the dozens of papers that have attempted to estimate the causal effect of education on earnings over the last ten years. Fortunately, Card (1999, 2001), Ashenfelter and Rouse (1999) and Ashenfelter et al. (1999) provide excellent surveys of recent results in this literature.[1] These fours papers all reach the similar conclusion that the "natural experiment" estimates of the causal effect of education on earnings tend, if anything, to be *larger* than standard regression (ordinary least squares) estimates of the return to education. Most, but not all, of the studies surveyed in these papers were conducted using U.S. data.

To put the precise magnitude of the return to education in perspective, consider again the example of high school and university graduates in Canada. Recent data from the Labour Force Survey indicate that among men age 25 to 59, university graduates earn on average 33.2 percent more than high school graduates per hour of work (average hourly earnings). For women, the gap is even larger at 48.9 percent. When other factors are controlled for using regression methods, the difference increases to 39.6 percent for

[1] A formal treatment of the issue was first provided by Griliches (1977). Most of the recent studies have simply suggested new interesting applications of the ideas that were first laid out by Griliches.

men and remains essentially unchanged for women (49 percent).[2] Using the conservative assumption that it takes five years after high school graduation to obtain a bachelor's degree, these estimates imply a return in the range of 8-10 percent per year of education.[3] When a standard "Mincer-type" equation is estimated with years of education entered linearly, the estimated return to education is 6.6 percent for men and 8.5 percent for women.

If we take the conclusions of the recent literature at face value, this would suggest that the causal effect of education on earnings is probably close to 10 percent per year of education in Canada, which is quite substantial. As mentioned above, most studies that use various "natural experiments" to estimate the causal effect of education on earnings have been conducted for the United States. Fortunately, two recent Canadian studies reach similar conclusions.

The first study by Lemieux and Card (2001) looks back at the impact of education programs for returning veterans of World War II on their future civilian earnings. It is well known that in the United States, a large number of WW II veterans took advantage of the famous "GI Bill" to attend university in the late 1940s. As it turns out, a similar program was available for Canadians veterans. Under this program, the federal government paid tuition and provided a relatively generous living allowance for veterans interested in going back to school. The federal government also provided some direct

[2] These results are obtained by estimating separate log wage regression for men and women that include dummy variables for each education category (0-8 years, some high school, high school graduate, some postsecondary, postsecondary diploma, bachelor's degree, and postgraduate degree) as well as the following explanatory variables: province dummies, establishment size dummies, marital status dummy, union status dummy, a quartic in years of potential labour market experience (age-5-years of education) and a quadratic function of years of tenure.

[3] Most undergraduate programs normally take three years to be completed in Quebec and four years in other provinces. It normally takes an extra years to complete some programs like engineering. There are

financial help to universities to help them cope with this unprecedented influx of new students.[4] For instance, male enrollments at the University of Toronto *tripled* between 1945 and 1947, which puts some interesting perspective on how universities have coped in the past with much more dramatic changes than the "double-cohort" which is about to go though the Ontario university system with the impending abolition of grade 13 in high school.[5]

The "natural experiment" aspect of the program comes from the fact that this program had a very different impact in Quebec than in other parts of the country. Because relatively fewer men from Quebec served in the armed forces during WW II, this program had less impact there than in other provinces. Furthermore, the "collège classique" system was elitist and not well adapted at all for older students like returning veterans who needed the credentials to go to university. As a result, this program had virtually no impact on francophone men from Quebec. By contrast, it increased by almost half a year the average educational achievement of Ontario men born in the mid-1920s.

In this setting, the "treatment group" are men from Ontario (or other provinces but Quebec) born in the mid-1920s who benefited from the program to increase their educational achievement. The "control group" is francophone men from Quebec who did not benefit from the program. Lemieux and Card show that the resulting increment in

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also two extra years between high school and university graduation in Quebec as students must first complete two years in CEGEPs.

[4] This historical episode opened the way for the federal government involvement in higher education. As the number of veterans enrolled started plummeting in the late 1940s, so did federal transfers. Universities convinced the federal government to keep support them financially through direct transfers, which led to a jurisdictional confrontation with the Duplessis government in Quebec (Cameron, 1991).

[5] Looking at whether this episode will "crowd-out" some students out of university could be the basis for another "natural experiment" study by the time these cohorts complete university and start working full-time.

education of Ontario men later resulted in a corresponding increase in earnings. In terms of returns to education, their results indicate that each extra year of education induced by this program resulted in (at least) a 10 percent increase in earnings. By contrast, standard regression estimates of the return to education for the same group of men is of the order of 7 percent. So as in the U.S. studies, this Canadian study suggests that, if anything, standard regression estimates of the return to education understate the causal effect of education on earnings.

Sweetman (2000) studies the more recent episode of Newfoundland where an extra year was added to high school in 1983-84. It used to take a total of 11 years to complete primary and secondary school in this province. This was changed to 12 years in 1983-84. So unlike Ontario where two cohorts are about to enter university, in 1983-84 no cohort entered university in Newfoundland.

In this case, the "treatment group" are cohorts that went through high school after 1984 and had to take an extra year of education to get the same credentials. The "control group" can either be older cohorts in Newfoundland (who only needed 11 years of schooling to get a high school diploma) or individuals in neighborhing provinces who were not subjected to this change. The return to education that Sweetman obtains by exploiting this natural experiment are once again larger than standard estimates.

On the basis of the available evidence, it is reasonable to say that the causal effect of education of earnings is close to 10 percent per year of education. Of course, it is an over-simplication to state that there is only "one" return to education which is the same for everybody. So the 10 percent figure should be taken as an indication of what is the

average effect of education on earnings. For some people the return may be smaller, for others it is probably larger.

4. The return to education and public policy

Over the last decade, there has been an important research effort aimed at finding ingenious ways of estimating the causal effect of education on earnings. Is all this emphasis misplaced from a public policy perspective? Should we care so much whether this number is 0, 5 or 10 percent?

Authors such as Allen (1998) and Vaillancourt (1995) have addressed this issue in detail by making a key distinction among three types of return to education: the private return for the individual, the return for the government, and the return for society.[6] The basic idea is to conduct a cost-benefit analysis taking account of the causal effect of education on earnings as well as all the costs associated with education.

For an individual, the cost of education is the sum of explicit (tuition, books, etc.) and implicit (reduced earnings after taxes net of scholarship income) costs. As discussed earlier, the implicit cost of education associated with reduced earnings tends to be the most important cost from the individual's point of view. The benefit of education is the future extra earnings (after taxes) induced by additional education. In this cost-benefit framework, these future earnings benefits have to be discounted (relative to costs) to take account of the fact they are only coming in the future. The choice of an appropriate

[6] Allen (1998) also addresses the issue of how standard regression estimates of the return to education compare to the causal effect of education on earnings. He exploits interprovincial mobility of workers as a source of "natural experiment". Like Sweetman and Lemieux and Card, he finds that the causal effect of education on earnings is as large as standard regression estimates.

discount rate is, of course, crucial to the outcome of this exercise. Most studies tend to us a discount rate in the 3-5 percent range.

From the point of view of the government, the costs are two-fold. In Canada, governments pay for most of the direct cost of running educational institutions. Another related cost has to do with loans and grants programs. There is also the indirect cost of reduced tax revenue because individuals going to school have reduced earnings and can also take advantage of several extra tax deductions. The benefit for the government is that it collects additional tax revenues in the future since education increases earnings and, thus, taxes paid to the government.

Taxes play no role from the point of view of society, since what is a cost for the individual is an equivalent benefit for the government. Government scholarships play no role for the same reason. So in the case of society, costs include sacrificed earnings, other costs like tuition, books, etc., and direct costs of running educational institutions paid for by the government. The benefits are simply the properly discounted extra future earnings induced by education.

The results of Allen and Vaillancourt clearly indicate that when the causal effect of education on earnings is close to 10 percent, education is beneficial from both the point of view of the individual, the government, and society. By contrast, it is not as clear that education is beneficial to all three parties when the causal effect of education on earnings is around 5 percent.

From a public policy perspective, the finding that education has positive net benefits for governments is perhaps most intriguing. It basically indicates that governments more than "recoup" their investments in education because more-educated

individuals end up paying more taxes in the future. So from a pure "budget perspective", education should not be viewed as just a source of expenditures that contributes to budget deficits. In the longer run it contributes to healthy public finances by increasing tax revenue above and beyond what it costs to educate the population.[7]

This result is quite important when comparing education to industrial policies used by various levels of governments. Large tax advantages or direct subsidies are often given to firms that want to undertake various investments like opening new plants, etc. One argument often used for doing so is that these are wise investments that eventually pay for themselves since workers in the new jobs created pay more taxes and receive less employment insurance. The results presented here suggest that the wisest "industrial policy" may simply be to do more public investments in education.

From the point of view of society, positive returns to education also indicate that education contributes to economic growth. A society first sacrifices some production by educating young people instead of employing them. But this reduced production is more than offset but the fact that a more educated workforce is more productive in the future. This connection between the causal effect of education and economic growth has been explored in more details by Krueger and Lindahl (2000) who conclude that increased educational achievement in a major source of the economic growth of nations.

[7] Note that just talking about the "government" abstracts from important distributional issues between the federal and provincial governments. In Canada, provincial and local governments pay for most of the costs of education, while tax benefits are shared with the federal government. Thus, the federal government receives the highest return on its investment in education.

5. Conclusion

On the basis of existing studies, this paper argues that the causal effect of education on earnings is of the order of 10 percent per year of schooling in Canada. This result is based on studies that use various "natural experiments" to see how "exogenous" increases in education translate into increased future earnings for affect groups relative to some "control groups". The causal effect of education is large enough for education to be beneficial from the point of view of the individual, the government, and society.

While these pecuniary benefits of education are large, education has presumably many other benefits for individuals and society. I did not mention these additional factors since most of the evidence about *causal* effects of education is limited to the case of earnings. One recent example of another type of causal effect is Lochner and Moretti (2001) who show that education also reduces crime. Taking account of these additional benefits of education would presumably reinforce our conclusion about the benefits of education for the individual, the government, and society.

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