Working Smarter: Education and Productivity

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INTRODUCTION

Issues related to a "skills" strategy, or perhaps more accurately a "high skills" strategy, appear to be near the top of the public policy agenda. Internationally, for example, the United Kingdom's Chancellor of the Exchequer, Gordon Brown, indicated recently that he was "very much focused on the problems that arise for productivity and social cohesion if there is not a sufficient opportunity for people to get the skills necessary" (Riddell and Webster 2002). This statement was followed a few days later by the largest real increase in educational spending to occur in the UK in a few decades together with programs to increase both quality and accessibility. In Canada a similar argument seems to be motivating several public initiatives. The skills and learning agenda of the federal government's innovation strategy "rests on the principle that in the knowledge economy, prosperity depends on innovation which, in turn, depends on the investments that we make in the creativity and talents of our people."[1] Underpinning these policies is the idea that skills, produced in large part through formal education, are crucial to increasing productivity and economic competitiveness.[2]

Despite this clear policy direction, there are challenges to the value placed on education by both the individual and the country. After clarifying a few conceptual issues, I will evaluate these challenges and explore the evidence for them in relation to recent research on the link between education and productivity. I will address three sets of evidence. First, from a microeconomic perspective, I will consider the causal impact of education on individual-level earnings, which has long been considered a measure of at least marginal productivity. Then I will look at the impact of education on national productivity as reflected in economic growth per capita. Finally, I will turn to issues related to the Canadian education system (or systems, as there really are many). Since the education system generates the skills that are — barring the above-mentioned challenges — believed to be determinants of productivity, issues surrounding it are of direct relevance. Given that the focus of this paper is productivity, the discussion that follows will centre on economic/financial measures of the return

on education. This discussion can thus be seen as addressing a small set of topics, since much research argues that education has many other benefits, such as reducing incarceration rates, improving health, and developing parenting skills. Education also has pure consumption — or enjoyment — value.

Overall, education is found to have a real impact on productivity at both the individual and the national level. In particular, educational quality has a significant impact on labour market outcomes and per capita economic growth. Further, the Canadian education system, with the evidence being mostly at the elementary and secondary levels, produces students with very high outcomes by international standards, which in turn has positive implications for future productivity growth. Unfortunately, there is little evidence at the post-secondary level (which is not to say that the quality is poor, only that the evidence is lacking). There is also a lack of evidence on whether the education system is operating efficiently, which raises questions about whether educational resources are being allocated in an economically efficient manner.

BACKGROUND

Canadians are concerned about the income that they, and their communities, receive from employment, and the standard of living experienced as a result. Most aspire to real earnings increases over time as a means to improve their standard of living. Most economists argue that, for an industrialized society, the primary determinant of increasing real income per person in the long term is increasing productivity. At the level of society, productivity is commonly measured as the value of output per unit of input — for example, GDP per worker or GDP per worker hour.[3]

What we really want, to use a catchphrase, is to "work smarter." Our great-grandparents worked at least as hard as we do — certainly they worked longer hours and far more strenuously on average — but their material well-being was lower. Increased productivity has greatly increased society's standard of living. Fogel (1999) estimates that, for the United States (and Canada is not very different in this respect), the poverty line today is at a level that was met by only the top 10 percent of society a century ago. This increase is a direct result of productivity increases, and education has played a central role in raising productivity.

Working smarter involves issues not only at the individual and firm levels, but also at the national level, such as how society is organized (both formal and informal institutions), governance, government policies and property rights. These societal factors interact with those at the individual and firm levels (e.g., human capital accumulation and the willingness and ability to innovate). Education, which produces human capital, affects all levels and is a crucial determinant of productivity growth in both the medium and long terms; it is a key element of working smarter. Education allows workers to use existing physical capital more efficiently, and it drives the development and diffusion of new technologies.[4] However, it also represents a costly and far from homogeneous investment, which implies that it is possible to over- or under-invest in education, or to invest in more or less economically viable forms of human capital. Therefore, the details of the operation of the education "industry" and the quality of its output have a noticeable impact on productivity growth.[5]

THE VALUE OF EDUCATION — SOME CHALLENGES

While most pundits and policy-makers appear to believe it commonsensical that education is good for both individuals and the country, and that more is better, there are many challengers to the accepted wisdom, especially in academic and policy-development circles. Evidence supporting the "more is better" view that holds up against the arguments presented below has until recently been hard to come by and sometimes controversial. The issue is not whether education has benefits but, rather, the magnitude of its "true" benefits, the benefits relative to the costs, and the distribution of costs and benefits. There are concerns about whether common estimates of the return to education are too high, in which case society may be over-investing in this area. Other challengers ask whether the social return on education exceeds the private return sufficiently to justify increased (or sustained) subsidization, and whether the education system is being run efficiently. A sample perspective on these policy concerns comes from the UK Department of Education and Employment, which argues that there is "a limit to how many extra graduates the economy can absorb before the increased productivity they generate starts to decline" (Carvel 1997).

Is It Worth Getting More Education?

A traditional argument is that the average value, or economic return, attributed to education by policy-makers and researchers is higher than it ought to be. This view stems from the longstanding belief that the ubiquitous positive correlation observed between education and earnings is biased upwards because of "unobserved ability." The argument is that those with higher education have, on average, higher innate earning potential or "ability."[6] Their higher ability is posited to cause both higher education and higher earnings, so that some of the high earnings observed for those with higher education really result from this innate (and unobserved) ability.[7] While the value of education is rarely argued to be zero, common estimates are seen as markedly high. However, if the "true" return is low, education has serious limitations as a viable policy lever to aid disadvantaged groups, since it does not really boost earnings much. Further, a low return raises questions about the value of additional investment more generally. Among the popular proponents of extreme versions of this argument are Richard Herrnstein and Charles Murray (1994), authors of *The Bell Curve*.

A related but distinct argument that implies Canada has too many highly educated people is put forward by David Livingstone (1999) of the University of Toronto.[8] The fact that his book won the John Porter Memorial Book Award of the Canadian Sociology and Anthropology Association lends credit to Livingstone's views. He argues that Canadians are overeducated and/or underemployed relative to current employer needs. Harvey Krahn (1997) makes a similar argument. He observes that in survey data many people report that their skills are underutilized in their jobs: they are overeducated relative to labour market demand. Krahn does not, however, believe there is public support for a policy of cutting back on education (for example, reducing the number of places in post-secondary institutions), thus lending support to a policy of creating more "upper end" jobs to soak up the excess of educated workers. In a related vein,

some European researchers — for example, contributors to a collection of essays edited by Borghans and de Grip (2000) — suggest that a form of crowding out, or "bumping down," is occurring. The argument is that, increasingly, highly skilled workers are taking jobs traditionally held by less-skilled workers and that skills are being wasted. Further, they argue that this has a negative impact on the less-educated.[9]

Does a More Educated Country Benefit from the Investment?

The macroeconomic literature addresses similar issues. In an empirical study for the World Bank, Pritchett (1996) compares a number of countries and provocatively asks whether it is possible "to explain the surprising finding that more education did not lead to faster economic growth." He finds that increased educational attainment within the labour force does not affect the growth rate of output per worker. As will be discussed in a later section, a number of other studies have failed to find a robust relationship between country-level measures of either educational attainment or inputs that are correlated with per-capita economic growth, which results from productivity increases.

Are Educational Resources Allocated Appropriately?

An equally controversial issue is the allocation of resources, especially government resources, within the education and training sectors (and in public research, since it is hard to disentangle the two at the university level). For example, Paul Kedrosky (2002), of the University of British Columbia School of Business, argues in a newspaper editorial that the distribution of funding across fields of study within universities is not optimal in that it oversubsidizes fields that have low value in the labour market.[10] Much more importantly, if the education system falls short of its potential, the reduced productivity of its graduates will stay with them throughout their entire lives. Such losses in productivity, summed over a lifetime, can be substantial.

CONCEPTUAL CLARIFICATIONS

Some conceptual clarifications should be made at the outset of this discussion.

(1) In developing realistic education policies, the debate is, or should be, not about whether the *average* return on education is sufficiently large to justify the entire existing educational infrastructure, but about the value to society of incremental changes in the resources allocated for a particular educational purpose — marginal changes and *marginal* benefits.[11] What is the value to society, and to the individuals directly involved, of a 1- or 2-percent change in public spending on some aspect of education? Note that each policy change will have its own marginal benefit and cost. Further, the test of each allocation decision is not whether it has a positive value, but whether the value is greater than the next best use of the resource, which might be in health care, social services or some other part of the education system. In short, the value of the investment must exceed its opportunity cost. In its extreme form, this test cannot be implemented given our lack of knowledge about the value of all possible alternatives.[12] If we care about produc-

tivity growth, however, or good management more generally, it remains a useful guide in allocating resources across alternatives.

(2) We should be interested in *causal impacts* as well as *outcomes*. While these terms can have alternative definitions, in this context an impact is the value added, or the causal result, of a particular educational program or "treatment" (e.g., an expansion in computer science enrolment). In contrast, an outcome is simply a measurement of some variable we care about and observe following the treatment. An outcome may be caused, perhaps in part, by the program in question, but it may also be caused by factors unrelated to it. The concept of an impact implies a causal link and answers a specific question such as: How much has this program caused employment or job satisfaction to *increase* for those who participated? This is quite different from an outcome, which answers a more general question such as: What is employment, or job satisfaction, following participation? An impact measures, for example, how a program has changed the average wage or unemployment rate of its graduates. An outcome, on the other hand, simply measures the graduates' average wage or unemployment rate following the program, without saying anything about whether the program caused the ensuing outcome.[13]

In general, there is no reason why a program that graduates individuals with "good" outcomes need also have "good" impacts: those graduates might have had good outcomes even in the absence of the program; alternatively, graduates with poor outcomes might have had even worse ones without the program. Programs targeting children at risk may have graduates with "normal" or even "below normal" outcomes. However, the program's impact will be quite large if those same children would otherwise have had very poor outcomes. Although we can never know the impact of a program on an individual, average impacts can be estimated for those treated, or for subgroups of the same, and benchmarks and similar proxies for impacts can be employed. In general, estimating impacts is difficult; nevertheless, keeping the concept in mind can help in evaluating programs and policies, which is a fundamental issue in maximizing productivity growth.[14] Remarkably, although it is better to inform policy using causal impacts, many programs continue to be justified without even an estimate/assessment of their outcomes.

(3) A distinction must be made between the value of education to an *individual* and to *society* as a whole. Since education in Canada is highly subsidized — all (net) taxpayers bear the costs — we must consider both the private value and the social value of education. Of course, though we consider only economic/financial factors here, the return on education is not entirely financial.

(4) It is also useful to distinguish between *partial* and *general* equilibrium effects. This point is closely related to points (1) and (3) but I separate it out for emphasis. A policy with a particular impact on a small fraction of the population may have less impact if implemented on a large scale. Graduates of an accounting program may have high outcomes, but if the pro-

gram is expanded the average return to its graduates will almost certainly fall should demand remain constant. More generally, as a higher percentage of the population acquires a post-secondary education, the increase in supply will bid down the value of that education in the labour market, unless demand is also increasing simultaneously (as seems to be occurring in some technology fields).

EVIDENCE ON THE VALUE OF EDUCATION FOR THE INDIVIDUAL

The last decade has seen much research on estimating the "causal" impact of education on the labour market. Motivating this work has been a belief, held by many researchers and policy-makers, that the observed return on education in the labour market is much greater than the causal one. Individuals with high earnings potential both acquire more education and achieve higher wages because of their high level of pre-education ability. The observed difference in labour market outcomes, then, arises from *both* sources: the pre-existing skills, and the learned skills associated with schooling. It is difficult to identify each independently, and ignoring one makes the other appear too significant as a determinant of outcomes.[15]

A related issue is the "signalling" or "filtering" models of education where, in extreme versions, education is assumed to have no causal impact on future productivity. As discussed by Weiss (1995), in this view of the world, education serves to filter or screen people according to their pre-existing ability. Filtering may have some value to society in that it identifies high-ability workers and allows them to be assigned to appropriate jobs, but it does not have an impact on skills. Complex models of this sort allow schooling to have both signalling and human capital augmenting aspects. If the filtering component of the return to education is large, then increasing public subsidization may reduce the quality of the filter and decrease the return on education. The empirical estimates of causal impacts discussed below implicitly address this issue.

The causal impact of education in the labour market is a central issue in the study of the impact of education on productivity. While few believe that a person's gross wage for a particular hour's work reflects her productivity for that hour, in the aggregate the economic return on education reflects the value of the output associated with that education. Since this "causal impact of education" literature estimates the impact on gross wages for population subgroups, it tells us something about the increase in output — the productivity — of education.

Most estimates of outcomes come from simple ordinary least squares (OLS) multivariate regressions that take into account factors such as years of work experience and region of residence. But because they cannot be measured (or because it is impractical to measure them on a large scale), these do not include motivation or other unobserved and pre-existing factors that might cause an increase in both schooling and wages. These types of analyses suggest that the return on a year's education, in terms of employment earnings, is in the range of 7 to 15 percent, with many estimates clustering around 10 percent and women usually showing a higher return than men[16] — that is, an additional year of schooling increases pre-tax wages

by about 7 to 15 percent each and every year of a person's working life. This is a sizeable real rate of return on investment. A causal impact that is much smaller, however, puts severe limitations on education as a policy lever in generating higher standards of living and addressing equity issues.

A sizeable literature has evolved, much of which is surveyed and interpreted by Card (1995, 1999), that uses various exogenous sources of variation in educational attainment to estimate the causal impact of education using instrumental variables and statistical/econometric techniques. In this context, an instrument is some mechanism, frequently a policy or policy change, that induces people to get more (or less) education than they otherwise would. Many of the instruments follow from changes in institutional features of the education system, such as compulsory schooling laws, that cause some segment of the population to get more schooling than they otherwise would. In particular, the extra education is not correlated with the person's characteristics. This is frequently referred to as a "natural" or quasi-experiment, in contrast to a "true" random assignment experiment such as a random assignment drug trial in the medical context, which is the standard for determining causality. As Card points out, this approach builds on a long tradition in econometrics: it uses a supply-side shock to identify demand-side parameters.

Early results of this line of research were remarkable and unexpected. Point estimates of the causal impact of education were found to be at least as high as the OLS estimates, although the instrumental variable estimates usually had large standard errors and could not be said to differ statistically from the OLS ones. Importantly, however, the estimates were not lower than the OLS ones. Although many studies of this type have been conducted across both developed and developing countries, with broadly consistent results, there have been very few in the Canadian context. A notable exception is Card and Lemieux (2001). They use the post-Second World War Canadian *Veterans Rehabilitation Act* (VRA) to explore the effect of "extra" education on a cohort of workers for decades after completing school. Canadian veterans who served overseas were eligible for substantial subsidies to pursue advanced education. However, take-up of the program was close to zero among French Canadians in Quebec, because of low rates of overseas military service and a less flexible post-secondary system, whereas take-up was substantial in Ontario. The authors look at the impact of this reduction in education costs on education levels and subsequent earnings in Ontario, using Quebec as a comparison group. Sizeable increments in education are observed for the affected birth cohorts in Ontario, but not for adjacent birth cohorts in Ontario nor for the same cohorts in Quebec. Further, this spike in education is associated with a spike in earnings. Card and Lemieux estimate a causal return on the extra education in the order of 10 to 15 percent.

One interpretation of these findings is that by using instrumental variable techniques, researchers are correcting not only for the upward ability bias but also for measurement error, which causes a bias towards zero — a case of two wrongs counterbalancing each other. Thus the ability bias exists, but its impact is roughly equal to and opposite in direction from the effect of measurement error. However, Card (1995, 1999) points to a model encompassing an additional, more subtle, interpretation. If every individual has their own unique return on education and there is substantial diversity in this return,

then the instrumental variables estimate will deviate from the OLS one since it represents the average causal return among those affected by the instrument; the OLS estimate, in contrast, reflects that average correlation in the entire population.

Thus, for example, if the instrument is derived from compulsory schooling laws, it affects individuals differently. It forces some to obtain more schooling than they otherwise would, but does not affect those who would complete high school regardless of the law (see Angrist and Krueger 1991). The instrumental variables estimate is, then, the estimated causal return on education (correcting for measurement error) for those people who would have dropped out of school under the old regime but are constrained to remain in school longer by the raised compulsory schooling age. A high instrumental variables estimate implies that the subgroup in question has a high causal return on schooling but tells us little if anything about the return for other individuals, or the average for the population. In the Card and Lemieux (2001) case, the observed rate of return on the education obtained by Second World War veterans because of the *VRA* tells us only about the economic return for those who obtained the extra education as it affected them over their lifetimes. Still, a large number of such studies using different sources of variation (different supply-side policy changes) that affect different parts of the population can, together, paint a picture.

While the estimates from the instrumental variables line of research tend to be imprecise, there is little evidence that the returns are lower than the OLS ones. This implies a larger role for educational policy levers in the long run than previously believed. It appears that, for individuals, the causal private economic return is substantial. In response to work such as that by Livingstone or by Krahn mentioned earlier, while some people may feel overqualified for their jobs, *on average* education is a solid investment, and it increases productivity in the labour market.

It is worth looking at the correlation between education and three important labour market outcomes, taking into account the above discussion on the difficulties in interpreting these outcomes causally. The data are from Statistics Canada's monthly labour force surveys for the year 2000, and the variables are defined as in the survey. In Tables 1 through 3, education is presented by age group according to the highest level attained: grades 0 to 8 (i.e., less than high school), some (incomplete) high school, high-school graduate, some post-secondary, post-secondary certificate or diploma, bachelor's degree, and master's or Ph.D degree.

Table 1 presents average hourly wages by age and educational level for each gender. For both males and females, wages increase significantly with education; consistent with much previous research, the increase is greater for women than men — though the female wage level is lower. Wages also increase with age until 50 or 55, and then decline. The decline coincides with the onset of retirement; some people are, therefore, very selectively, not in the sample.

In addition to wages, employment is a crucial issue if one is concerned about output per capita. Table 2 looks at employment, either part-time or full-time, in the survey week of each of the 12 months in the sample. It is clear that the likelihood of employment increases with education for each gender and all age groups. The relationship is remarkably steep for women,

TABLE 1
Hourly Wages by Education and Age

Age\Educ	Grd 0-8	Some HS	HS Grad	Some PS	Cert	Bach	M.A./Ph.D	Total
Females								
25-29	8.81	9.80	11.66	11.98	13.57	17.05	18.49	14.19
30-34	11.02	10.26	12.92	14.37	15.38	20.12	22.37	16.00
35-39	9.84	10.94	13.50	14.82	16.32	21.99	23.25	16.30
40-44	10.23	11.26	14.08	15.31	16.55	22.08	24.27	16.27
45-49	10.13	11.80	14.59	15.46	16.82	22.40	26.03	16.82
50-54	11.02	11.79	14.79	15.41	16.80	23.26	26.14	16.94
55-59	10.38	12.04	13.89	14.40	16.78	21.90	25.41	15.77
60-64	10.03	11.81	14.43	14.11	16.33	21.07	26.73	14.87
65-69	9.58	10.79	12.75	13.22	13.26	14.50	21.61	12.96
70+	10.15	9.11	13.97	11.34	11.36	11.70	16.13	11.85
Total	10.35	11.27	13.76	14.51	15.93	20.65	23.40	16.00
Males								
25-29	13.97	13.30	14.45	13.97	16.12	19.54	21.36	16.14
30-34	13.12	14.08	16.36	16.96	18.41	22.71	24.40	18.54
35-39	14.02	15.14	17.78	18.34	20.23	25.36	26.82	20.04
40-44	14.43	16.49	18.84	19.63	21.37	26.31	28.15	20.94
45-49	15.73	17.27	20.24	22.09	22.15	27.89	29.85	22.37
50-54	16.16	17.68	20.42	22.55	22.51	28.06	31.62	22.76
55-59	16.08	17.21	20.39	19.66	21.60	25.44	31.72	21.31
60-64	14.83	16.83	19.29	21.11	20.34	25.08	30.52	20.03
65-69	12.26	12.82	15.85	19.85	16.22	22.33	23.67	16.36
70+	11.73	14.87	15.03	11.73	15.64	18.01	25.29	15.81
Total	15.00	15.90	18.07	18.49	20.07	24.52	27.90	20.07

Note: Sample sizes are 239,133 females and 251,629 males.
Source: Calculations by the author from all of Statistics Canada's 2000 labour force surveys (LFSs).

TABLE 2
Proportion Employed by Education and Age

Age\Educ	Grd 0-8	Some HS	HS Grad	Some PS	Cert	Bach	M.A./Ph.D	Total
Females								
25-29	0.23	0.47	0.70	0.68	0.81	0.83	0.83	0.75
30-34	0.40	0.53	0.72	0.70	0.79	0.83	0.85	0.75
35-39	0.39	0.60	0.73	0.72	0.80	0.81	0.85	0.75
40-44	0.47	0.63	0.76	0.77	0.82	0.82	0.83	0.76
45-49	0.45	0.60	0.74	0.75	0.81	0.84	0.90	0.75
50-54	0.37	0.52	0.68	0.71	0.74	0.81	0.84	0.67
55-59	0.28	0.42	0.54	0.56	0.58	0.61	0.70	0.50
60-64	0.13	0.23	0.28	0.31	0.35	0.25	0.45	0.26
65-69	0.03	0.06	0.07	0.13	0.09	0.16	0.26	0.07
70+	0.01	0.01	0.02	0.02	0.03	0.05	0.09	0.02
Total	0.14	0.36	0.58	0.61	0.67	0.76	0.79	0.55
Males								
25-29	0.59	0.73	0.86	0.77	0.89	0.87	0.85	0.84
30-34	0.66	0.73	0.88	0.83	0.91	0.92	0.90	0.87
35-39	0.63	0.77	0.88	0.86	0.91	0.92	0.91	0.87
40-44	0.63	0.80	0.88	0.86	0.90	0.93	0.93	0.87
45-49	0.60	0.79	0.87	0.88	0.90	0.91	0.93	0.87
50-54	0.63	0.75	0.83	0.82	0.85	0.87	0.92	0.82
55-59	0.54	0.67	0.71	0.64	0.74	0.75	0.74	0.69
60-64	0.37	0.38	0.44	0.45	0.46	0.46	0.62	0.44
65-69	0.09	0.17	0.14	0.19	0.17	0.22	0.29	0.16
70+	0.04	0.06	0.06	0.07	0.06	0.10	0.15	0.06
Total	0.31	0.59	0.75	0.73	0.79	0.81	0.79	0.70

Note: Sample sizes are 529,726 females and 486,711 males.
Source: Calculations by the author from all of Statistics Canada's 2000 labour force surveys (LFSs).

whereas men are much more attached to the labour market.

Employment is a very coarse measure in that it does not address the quantity of time supplied. Table 3 addresses this issue by looking at hours per week. In sharp contrast to the employment numbers, which represent the *probability of having a job*, hours per week *conditional on having a job* are not sensitive to educational attainment. It appears that education is associated with hourly wages and the probability of having a job, but those who have a job show very similar mean hours across education categories.

EDUCATION AND ECONOMIC GROWTH — A MACROECONOMIC PERSPECTIVE

One way of considering the total economic impact of education on society, as opposed to just the private return, is to look at the relationship between education and growth in the national economy on a per capita basis, which is a measure of productivity growth. There are many externalities, or spillovers, from education that might cause the individual and national (private and social) return to differ.

A Positive Externality from Education

One such positive externality derives from living and working in an environment with more highly educated workers. Moretti (1998) estimates the causal impact of living in cities that comprise different average levels of education. He finds that a 1-percent increase in the share of university-educated workers in a US city raises the wages of high-school dropouts in the same city by 2.2 percent. High-school graduates, those with some university education and university graduates all experience wage increases of just over 1 percent. While this externality is substantial, macroeconomists have focused on a broader picture still.

Endogenous Growth Models

An emphasis in macroeconomics for over a decade has been endogenous growth models, which see human capital leading to innovations and to the implementation of those innovations. The production and diffusion of innovation are, in turn, perceived to be central factors in the growth of a country's economy and standard of living. The central point is that if education can have even a small impact on the growth rate of living standards, over a number of years these benefits compound and generate huge increases. As we have seen, despite the posited central role of human capital in these theoretical models, most empirical researchers within this field have until recently found (at best) mixed evidence supporting the hypothesis. Most of the evidence comes from studies that use measures of the average level of schooling across countries and/or changes in schooling within countries, and then look for relationships with growth in GDP per capita (all such measures discussed below are per capita).[17] The hope is that higher levels or growth rates in education will be associated with higher growth rates in output. Of course, these studies also control for a small number of other variables, since, as noted by Hall and Jones (1997), factors such as intellectual and physical property rights remain the primary drivers of economic success levels across countries.[18]

TABLE 3
Usual Total Hours Per Week by Education and Age

Age\Educ	Grd 0-8	Some HS	HS Grad	Some PS	Cert	Bach	M.A./Ph.D	Total
Females								
25-29	34.9	34.1	35.0	33.9	35.5	36.7	37.6	35.6
30-34	34.6	33.5	34.8	34.2	34.9	35.8	36.7	35.1
35-39	35.8	33.8	34.6	34.4	34.6	34.8	36.6	34.7
40-44	35.5	35.1	35.0	34.9	35.1	35.1	36.4	35.1
45-49	37.0	35.0	35.9	35.5	35.1	35.6	36.9	35.6
50-54	35.3	34.5	35.1	34.9	34.4	35.1	36.8	34.9
55-59	33.3	32.6	33.5	34.8	33.5	33.3	34.8	33.5
60-64	33.1	30.4	32.0	33.1	32.7	30.3	33.2	32.1
65-69	29.6	29.8	28.6	24.0	25.1	25.1	26.5	27.1
70+	24.6	22.4	25.0	17.1	21.3	25.5	22.5	22.9
Total	34.5	33.9	34.8	34.4	34.7	35.4	36.5	34.9
Males								
25-29	42.9	41.8	41.7	39.9	41.2	39.9	41.0	41.0
30-34	44.6	42.7	42.6	42.0	42.3	40.9	41.7	42.1
35-39	43.0	43.3	43.3	42.7	42.3	41.1	42.3	42.5
40-44	43.3	43.4	43.2	42.6	42.4	41.6	42.9	42.7
45-49	44.1	44.1	43.0	42.3	42.4	41.6	43.0	42.7
50-54	44.1	43.7	42.1	42.3	42.0	41.4	42.8	42.4
55-59	43.3	42.6	41.6	40.6	41.5	41.6	41.3	41.8
60-64	40.8	41.5	40.8	40.6	39.8	39.7	40.5	40.5
65-69	40.0	36.2	33.3	31.7	31.6	34.2	33.9	34.6
70+	36.5	32.4	31.8	38.4	33.1	35.2	34.0	34.3
Total	42.7	42.8	42.5	41.7	41.9	41.0	42.0	42.0

Note: Sample sizes are 529,726 females and 486,711 males. Sample sizes are 280,396 females and 328,564 males.
Source: Calculations by the author from all of Statistics Canada's 2000 labour force surveys (LFSs).

Correctly measuring an economy's human capital is the central empirical problem in this exercise. Studies that have failed to find an impact for education have tended to use educational attainment, enrolment rates, or educational spending and related inputs as measures of a country's human capital. Extensive effort is put into measuring human capital. For example, Barro and Lee (1993) tried to develop better measures of educational attainment in a number of countries, but this did not give much support to the prediction that countries with a larger stock of human capital will experience higher rates of economic growth. Barro (1991) tried to include real school resources in an effort to measure quality differences, but this approach was also unsuccessful. These measures turn out to be poor proxies.

Recent empirical approaches have, however, increased critics' confidence in the empirical validity of endogenous growth models. One strand of research uses direct measures of quality and provides reasonably convincing evidence that a country's human capital is indeed an important determinant of growth. Hanushek and Kimko (2000) use measures of school quality from standardized tests administered in many countries as a method for quantifying the country's educational stock. Their data are from six sets of science and math tests written between 1965 and 1991.[19] Once these measures of actual labour force skills — that is, educational outputs — are used instead of educational inputs or

credentials, the data show a substantial, and remarkably precise, correlation between human capital and growth. Economic outcomes seem to be strongly affected by the types of factors that can be measured by standardized (though not necessarily multiple-choice) testing, but are much less affected by degrees or school spending.

Barro (2001) compares two approaches. First he focuses on a very simple measure of schooling, the fraction of each gender with completed high school or greater, and attempts to correct for measurement error in the education data by using an instrumental variables approach. He finds that the male education rate has a modest impact on the growth rate of the economies in his sample, but that the female education rate has no impact. The lack of an impact for the female variable could be the result of sizeable discrimination in many of the countries in the sample, or it could be the result of his including fertility rates in the model — female education and fertility rates are so closely related that it is hard to identify the independent effects of each. However, Barro then follows Hanushek and Kimko and introduces international standardized test-score results into the regressions. Barro's test score data differ, however, in that he uses a literacy score in some specifications, whereas Hanushek and Kimko exclusively used math and science scores since they believed them to be more internationally comparable.[20] Barro concludes: "The results suggest that the quality and quantity of schooling both matter for growth but that quality is much more important" (2001, 15).[21] Using his estimates, he then does a "back of the envelope" calculation and argues that a one-standard-deviation increase in educational attainment (about one year), where that year is of "average" quality, is associated with an annual increase in GDP of 0.44 percent. This implies a real social rate of return on education of about 7 percent.

There are, however, several arguments suggesting that 7 percent is "too big" — that it exceeds the causal impact of education.

First, as noted by Topel (1999), it is not clear that a country with very high levels of per capita income will continue to have rates of return as high as countries with low income levels. Topel does note, however, that in 1950 Canada had the world's third-highest per capita income and between 1950 and 1990 the Canadian annual economic growth rate averaged a very respectable 2.6 percent, while that of the Philippines, for example, was only 1.6 percent. So it is unclear whether there are really important diminishing returns — Romer (1990) argues that there may not be traditional diminishing returns for innovations.

Second, Hanushek and Kimko are concerned that the observed relationship between education and growth may be larger than the causal impact because the correlation could reflect both the causal impact of education on growth and causality in the other direction. This issue remains open and the exact size of the relationship is not known, but Hanushek and Kimko investigate the issue by looking at US data. In estimating the economic return on schooling in the US labour market of immigrants educated before emigrating, they observe the same positive relationship between (source-country) school quality and (US) labour market earnings. The magnitude of the relationship is somewhat reduced, however. (They also perform tests to ensure that their results are not driven by a small number of Asian countries with high growth and educational levels.) Thus it might be wise to remember that Barro's 7-percent estimate has confidence limits and is

probably slightly larger than the "true" causal impact. Also, this number comes from cross-country comparisons and represents a multi-country average that may not be the actual number for any given country.

Nevertheless, the educational quality or content embodied in a country's labour force appears to have implications for productivity, and through it growth.[22] Interestingly, the earlier inability to find a relationship is itself informative when taken together with the findings in the later work using direct measures of test scores. First, and perhaps obviously, educational content as it is valued by the labour market and as a determinant of productivity is harder to measure than first thought. High-school or university completion is far from a homogeneous good. Second, educational quality, more so than inputs or credentials, appears to matter for national economic outcomes. Also, there appears to be little evidence at the international level that school resources are highly correlated with the quality, or skill level, of the labour force. We will cover this issue in more detail when discussing the domestic economy.

GENERAL EQUILIBRIUM EFFECTS AND POLICY IMPLICATIONS — A CAVEAT

The "causal impact of education" literature supports the notion that there is a substantial private return on education. This might suggest that there is room for expanding the education sector from the perspective of the student or potential student. Heckman, Lochner and Taber (1998*a*, 1998*b*), however, point to a caveat with regard to the return across individuals. In brief, they argue that the empirical literature on causal impacts focuses exclusively on *partial* equilibrium effects — that is, it examines the impact of small changes in education on small subgroups of the population. Using primarily simulation methods as evidence, they argue that were a nation to embark on a massive program of educational upgrading, the return on education would be bid down substantially as the supply increased. This implies a nuanced interpretation of research findings in the field of causal impact.

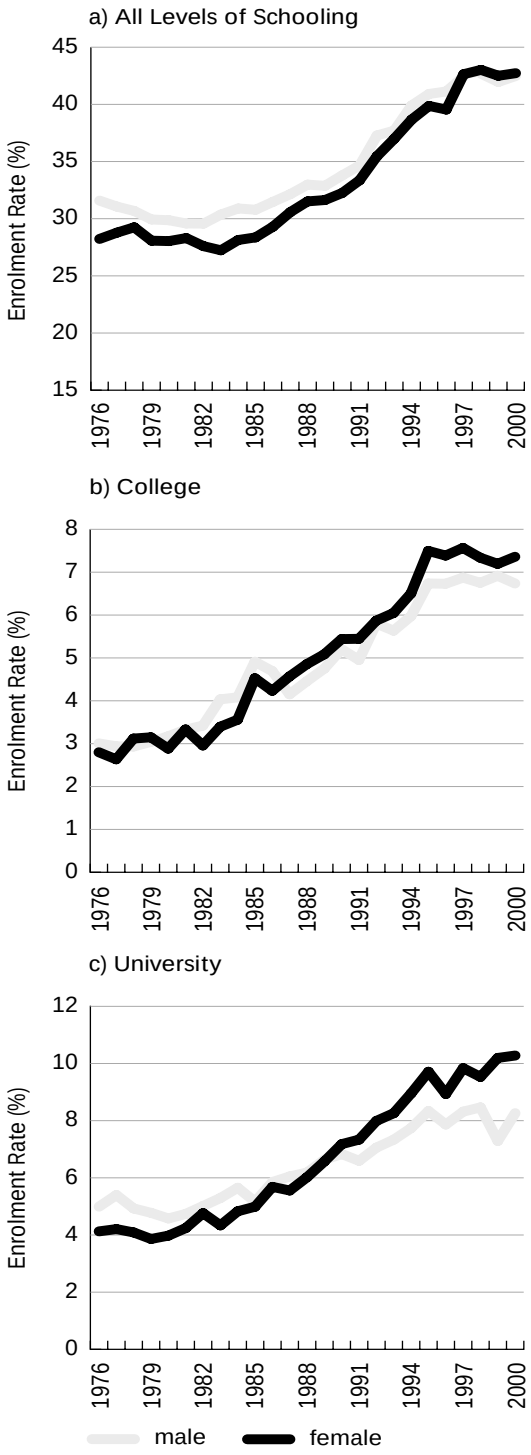
Some evidence for the general-equilibrium impact of education on rates of return is provided by Murphy, Riddell and Romer (1998), who compare the dramatic rise in the (non-causal) return on education in the United States in the 1980s and 1990s to the relatively flat profile in Canada over the same period. They find that most of the deviation between the two rates of return, in the face of similar changes in the availability of new technology, can be explained by the much larger increases in post-secondary enrolment in Canada. The price of skilled labour was bid down by a more rapidly increasing supply in Canada. From the perspective of the Canadian government this combination might lead to policy that is in keeping with Canadian values. A large-scale increase in educational enrolment can increase the national standard of living while reducing inequality — or at least preventing an increase in inequality. This is particularly important in the face of growing demand for highly educated workers. One side effect of this policy is that some highly skilled workers will undoubtedly migrate out of Canada to jurisdictions with a lower supply of, and higher wage rates for, educated workers. The fight against inequality inevitably generates conditions that foster a "brain drain." This should be seen as a cost of

a high-skills policy. Of course, the magnitude of the cost is not clear at this point.[23]

Chart 1 presents Canadian enrolment rates from 1976 to 2000 for 15- to 29-year-olds. It is clear that overall, as well as at the college and university level, the last quarter of a century has witnessed a massive increase in school attendance. Riddell and Sweetman (2000) document the same phenomenon, pointing out that this increase in supply has not decreased the wage premium associated with higher education, which has remained relatively constant in Canada.

Related work on education and wage inequality is Bedard and Ferrall's (forthcoming) comparison of wage and test-score dispersion across 11 industrialized countries. Looking at the test scores of cohorts of 13-year-olds in 1962 and 1982, they find that wider test-score dispersion in a country is correlated with greater wage inequality later in life. To my knowledge, this is the first study that looks at the dispersion of pre-labour market schooling outcomes in relation to wage inequality. It is not clear that this relationship is entirely causal; it might reflect, in whole or in part, a nation's underlying tolerance for inequality, which is reflected in the observed inequality in both education and the labour market. However, it seems reasonable to suspect that a school system, in focusing on the elite or providing extra resources to those facing educational challenges, will have a substantial influence on the inequality experienced by its society over the lifecycle of its students. Bedard and Ferrall also show that reductions in test-score dispersion within countries are associated with reductions in wage dispersion for the relevant cohorts. A particularly interesting new policy aimed at reducing inequality is Quebec's policy of providing extra resources to schools with students of low socio-economic status; see Hô (2002) for details.

CHART 1
Full-Time Enrolment Rates for Those Aged 15-29



Source: Statistics Canada's Labour Force Survey microdata; tabulations by the author.

Of course, the actual level of productivity growth also depends on factors other than, and interacting with, education. An issue that has not been sufficiently studied is the interaction between human and physical capital accumulation. Beaudry and Green (2001) argue that, compared to the United States and European countries, Canada is accumulating human capital relatively faster than physical capital, which results in decreased relative real wage growth and increased inequality. It could be argued that the increase in human capital experienced by the Canadian economy needs a concomitant increase in physical capital to allow the value of the human capital to be fully exploited and to achieve more of the potential productivity gains.

THE CANADIAN EDUCATION SYSTEM, THE LABOUR MARKET AND THE ALLOCATION OF RESOURCES

What do the above two threads of the economics literature have to say about the educational policies Canada should be pursuing if we believe that increased productivity is an important policy goal? From the causal impact literature we can deduce that individuals, on average, gain substantially from increasing their education. At the macroeconomic level it appears that educational content has a substantial impact on economic growth, but the exact magnitude of the effect for Canada's economy is far from understood. Perhaps the most significant finding is that educational content, or quality, apparently matter decisively for the macroeconomy. It appears that productivity, especially in the long run, depends upon the education system operating efficiently and allowing students to reach high skill levels. Given that education has a large impact on the wages of individuals and the output of the nation, and that the quality of education matters, the process by which educational quality is achieved becomes a prime concern for improving the nation's standard of living.

Quality Matters

Canadian microeconomic research strongly supports the "quality matters" result in the macroeconomic literature. Two recent individual-level studies of the Canadian labour market are Charette and Meng (1998) and Green and Riddell (2001). Using different Canadian sources of literacy and numeracy scores, both find that these measures explain a large fraction of earnings differences across workers, and account for a substantial fraction of the value of formal educational credentials in the Canadian labour market. Green and Riddell (2002) provide a useful discussion of the issues. Notwithstanding the importance of such skills, however, a very large fraction of earnings differentials remains unexplained. This is not overly surprising at the individual level since these tests are generic and much education is field-specific. In a somewhat different vein, Heckman and Rubinstein (2001) argue, using evidence from US data with both a battery of test scores and information on high-school equivalency status for individuals, that non-cognitive skills explain a substantial fraction of the variance in earnings. These non-cognitive skills appear to be associated with time spent in the classroom. Skills — and school quality — matter, but skills are more than that which is captured in simple numeracy and literacy tests.

Canada Has a Good (But Expensive) Education System

Since both education and its quality matter for productivity and economic growth, Canada is fortunate: it has good educational outcomes at the elementary and secondary levels. Tables 4 and 5 show Canada's rank in the Third International Math and Science Survey (TIMSS): led by Quebec, Alberta and British Columbia, it scores remarkably well in these international standardized tests. Table 6 presents material from a recently released OECD study of 15-year-olds. Canada has among the best results in the world, again with Alberta, British Columbia and Quebec leading the other provinces. It should be noted that even the provinces that score below the Canadian average do remarkably well by international standards.

One concern with the previous surveys is that they focus on high school, and the quality may not be sustained through the post-secondary level. Table 7 looks at prose literacy using results from the International Adult Literacy Survey (IALS). In looking at young adults and older adults, an interesting pattern emerges: the younger group scores higher than the older one. Moreover, consistent with the results in Tables 2 through 4, the younger group has very high scores by international standards. In contrast, the older adults score lower than the comparison countries. Canadian outcomes appear to have improved over time relative to those of other countries. However, post-secondary education supposedly involves a lot more than basic literacy and numeracy, and as far as I know there are no international comparisons of skills at the post-secondary level. Of course Canada's education system has many advantages; in particular its students are relatively healthy and have access to numerous learning resources.[24]

Some authors, such as Riddell (2001), have commented that Canada's good showing is a natural consequence of its heavy investment in education. In terms of both dollars per student and spending on education as a fraction of GDP, Canada spends perhaps the most on education of all OECD countries. Despite Canada's low productivity growth relative to the United States over the 1990s, this would appear to be a good investment for the future. However, there is little evidence that we are spending our education dollars optimally. For a detailed international comparison of education expenditures, see OECD (2001).

Improving Educational Quality

Unlike the United States, Canada has seen little debate on the allocation of resources, and the level of outcomes, within its education system.[25] Perhaps this is because the Canadian system appears to have much better outcomes on average, at least at the primary and secondary levels. It is common in discussions on quality improvements for the topic to quickly turn to resource limitations. However, it is interesting to note that there is little correlation across provinces in test-score outcomes and total spending. Although some spending is location-specific (e.g., heating, busing), one wonders how some jurisdictions attain such good outcomes with fewer resources;[26] there is also a lack of a correlation for spending on classroom instructors. Moreover, at the high-school level Quebec has among the largest class sizes in Canada, yet among the highest scores. If class size matters greatly, why is this the case? Similarly, spending on different educational resources varies widely by province. We do not really understand the effects of this spending.[27] More work needs to be done to ensure that we are using resources within the system optimally. Further, research is

TABLE 4

Average Score on Mathematics Test by Jurisdiction, Grade 8 Students TIMSS-99

Results Significantly Higher than Canada's		Results as Good as Canada's		Results Significantly Lower than Canada's	
Singapore	60	Netherlands	54	Latvia	51
Korea	59	Slovak Republic	53	Newfoundland	50
Taiwan	59	Hungary	53	United States	50
Hong Kong	58	CANADA	53	England	50
Japan	58	Slovenia	53	New Zealand	49
Quebec	57	Alberta	53	Lithuania	48
Belgium (Flemish)	56	Russia	53	Italy	48
		Australia	53	Cyprus	48
		British Columbia	52	Romania	47
		Finland	52	Moldova	47
		Czech Republic	52	Thailand	47
		Malaysia	52	Israel	47
		Ontario	52	Tunisia	45
		Bulgaria	51	Macedonia	45
				Turkey	43
				Jordan	43
				Iran	42
				Indonesia	40
				Chile	39
				Philippines	35
				Morocco	34
				South Africa	28

Note: TIMSS-99 is the Third International Math and Science Survey. The international average score is 49.
"Significantly" implies statistical significance at the 95% level.
Source: *TIMSS-Canada Report*, Robitaille and Taylor (2001).

TABLE 5

Average Score on Science Test by Jurisdiction, Grade 8 Students TIMSS-99

Results Significantly Higher than Canada's		Results as Good as Canada's		Results Significantly Lower than Canada's	
Taiwan	57	Netherlands	55	United States	52
Singapore	57	British Columbia	54	Newfoundland	51
Alberta	56	Australia	54	New Zealand	51
Hungary	55	Quebec	54	Latvia	50
Japan	55	Czech Republic	54	Italy	49
Korea	55	England	54	Malaysia	49
		Finland	54	Lithuania	49
		Slovak Republic	54	Thailand	48
		Belgium (Flemish)	54	Romania	47
		Slovenia	53	Israel	47
		CANADA	53	Cyprus	46
		Hong Kong	53	Moldova	46
		Russia	53	Macedonia	46
		Ontario	52	Jordan	45
		Bulgaria	52	Iran	45
				Indonesia	44
				Turkey	43
				Tunisia	43
				Chile	42
				Philippines	35
				Morocco	32
				South Africa	24

Note: TIMSS-99 is the Third International Math and Science Survey. The international average score is 49.
"Significantly" implies statistical significance at the 95% level.
Source: *TIMSS-Canada Report*, Robitaille and Taylor (2001).

TABLE 6

PISA Test Results by Jurisdiction, Averages and Confidence Intervals

Reading			Mathematics			Science		
Country or province	Mean	Confid. interval 95%	Country or province	Mean	Confid. Interval 95%	Country or province	Mean	Confid. Interval 95%
Alberta	550	6.5	Japan	557	10.9	Korea	552	5.4
Finland	546	5.1	Quebec	550	5.4	Japan	550	10.9
British Columbia	538	5.7	Alberta	547	6.6	Alberta	546	6.9
Quebec	536	6.0	Korea	547	5.5	Quebec	541	6.7
CANADA	534	3.1	New Zealand	537	6.3	Finland	538	4.9
Ontario	533	6.5	Finland	536	4.3	British Columbia	533	6.4
Manitoba	529	7.0	British Columbia	534	5.6	United Kingdom	532	5.3
Saskatchewan	529	5.3	Australia	533	6.9	CANADA	529	3.1
New Zealand	529	5.5	Manitoba	533	7.3	New Zealand	528	4.8
Australia	528	7.0	CANADA	533	2.8	Australia	528	6.9
Ireland	527	6.4	Switzerland	529	8.7	Manitoba	527	7.1
Korea	525	4.8	United Kingdom	529	5.0	Ontario	522	6.8
United Kingdom	523	5.1	Saskatchewan	525	5.8	Saskatchewan	522	5.9
Japan	522	10.4	Ontario	524	5.8	Austria	519	5.1
Nova Scotia	521	4.5	Belgium	520	7.8	Newfoundland	516	6.7
P.E.I.	517	4.8	France	517	5.4	Nova Scotia	516	6.0
Newfoundland	517	5.6	Austria	515	5.0	Ireland	513	6.3
Sweden	516	4.4	Denmark	514	4.9	Sweden	512	5.0
Austria	507	4.8	Iceland	514	4.5	Czech Republic	511	4.8
Belgium	507	7.1	Liechtenstein	514	13.9	P.E.I.	508	5.4
Iceland	507	2.9	Nova Scotia	513	5.6	France	500	6.3
Norway	505	5.6	P.E.I.	512	7.4	Norway	500	5.5
France	505	5.4	Sweden	510	4.9	United States	499	14.6
U.S.	504	14.0	Newfoundland	509	5.9	New Brunswick	497	4.5
New Brunswick	501	3.5	New Brunswick	506	4.4	Hungary	496	8.3
Denmark	497	4.7	Ireland	503	5.4	Iceland	496	4.3
Switzerland	494	8.4	Norway	499	5.5	Belgium	496	8.5
Spain	493	5.4	Czech Republic	498	5.5	Switzerland	496	8.8
Czech Republic	492	4.7	United States	493	15.2	Spain	491	5.9
Italy	487	5.8	Germany	490	5.0	Germany	487	4.8
Germany	484	4.9	Hungary	488	8.0	Poland	483	10.2
Liechtenstein	483	8.2	Russian Federation	478	10.9	Denmark	481	5.6
Hungary	480	7.9	Spain	476	6.2	Italy	478	6.1
Poland	479	8.9	Poland	470	10.9	Liechtenstein	476	14.1
Greece	474	9.9	Latvia	463	8.7	Greece	461	9.7
Portugal	470	9.0	Italy	457	5.8	Russian Federation	460	9.4
Russian Federation	462	8.3	Portugal	454	8.1	Latvia	460	11.0
Latvia	458	10.3	Greece	447	11.1	Portugal	459	8.0
Luxembourg	441	3.2	Luxembourg	446	4.0	Luxembourg	443	4.6
Mexico	422	6.6	Mexico	387	6.7	Mexico	422	6.3
Brazil	396	6.2	Brazil	334	7.4	Brazil	375	6.5

Note: PISA is the Programme for International Student Assessment. 95% confidence intervals provided.
Source: Human Resources Development Canada, Statistics Canada and Council of Ministers of Education, Canada (2001).

needed on curriculum development and other factors that affect the classroom. Despite the size of the education sector, we know relatively little about "best practices" in relation to labour market and other long-term outcomes. More fundamentally, we do not seem to understand the reasons for the substantial differences in outcomes across provinces.

TABLE 7
Prose Literacy Results from the International Adult Literacy Survey (IALS), Selected Countries

Age	26-35	56-65	16-65
Canada	287.3	234.1	278.8
United States	275.4	265.6	273.7
Australia	284.1	241.4	274.2
UK	275.2	235.9	266.7
Germany	284.8	256.8	275.9
Sweden	313.5	275.5	301.3

Note: Score range is 0–500.
Source: Human Resources Development Canada, OECD and Statistics Canada (2000), tables 2.1 and 3.4.

Recent, and controversial, empirical work on secondary school outcomes for some provinces has been conducted by the Fraser Institute. Perhaps the most interesting aspect of these studies is how limited the available data is and the questions that this raises about how much is actually known about the school system. The recent Ontario report (Cowley 2001) ranks 568 schools based on data provided by the province, but omits another 200 or so because the ministry of education simply did not have data on outcomes for those schools. Further, after the report was made public several of the schools complained that their numbers were incorrect. There is enormous scope for future work in understanding best practices in education as they impact on long-run outcomes including productivity, and there is enormous need for basic data collection.

Who Pays? Private and Social Returns on Education

While some work has been done in Canada on who pays for and who benefits from education, the quantity is remarkably small and many questions remain unanswered. Given the evidence on macro- and micro-level returns on education discussed above, and keeping in mind that these returns are financial only and that much of the evidence is not Canada-specific, it appears that there is reason to defend Canada's heavy subsidization of higher education. On the microeconomic side, the main caveat in using the estimates from the causal impact literature is that they all focus on gross wages or earnings and ignore direct costs. The pre-tax return is of interest since it reflects the value of education to firms. However, it does not really address the subsidization issue since it fails to take into account the increase in taxes paid, nor does it address externalities such as those measured by Moretti and discussed above. While it is not clear that taxpayers who have not attended post-secondary institutions receive sufficient indirect benefits to justify their subsidizing others to attend, the spillovers may be sufficiently great to justify an even larger subsidy.[28] We simply do not know.

Among the few attempts to measure the private and public rates of return on university education in Canada are those by Vaillancourt (1995) and Vaillancourt and Bourdeau-Primeau (2002). These authors do not take a causal approach, which, given the evidence presented above, does not appear to be a major problem. Further, they make no attempt to take a wide range of externalities into account, and therefore their estimates are best thought of as private returns and what they call public (government) returns as opposed to a full-blown social return. Their results are quite interesting: for both males and females, and in each of 1985, 1990 and 1995, the private return exceeds the public one at the bachelor's, master's and doctoral levels. Further, all sets of returns decrease as the level of education increases. There are also substantial differences in the rates of return across fields of study. However, as pointed out by Côté and Sweetman (1998), the field of study results

from students' choices and a random individual assigned to a field cannot be expected to obtain the same return as those already in the field. Still, it appears that the current distribution of students across fields may not be optimal in an economic sense — that is, it does not maximize the economic return on education for society. Of course, there are also non-financial factors to consider in thinking about the social return to each field. One would be hesitant to pursue policy on this issue in the absence of further study (the current work is a good start, but it is only a start). Clearly, issues such as these regarding the allocation of resources within the education sector have not been addressed sufficiently in Canada.

CONCLUSIONS

The evidence shows that increases in educational attainment continue to have a strong impact on productivity and that education is a worthwhile investment, even considering the high levels existing in Canada. This suggests that the current policy focus on a skills and innovation agenda is appropriate. The evidence is particularly compelling at the individual level. For the nation it appears that high-quality education is an important source of economic growth. It is interesting that measures such as math and science test scores seem to be particularly strongly related to national productivity (as measured by the rate of growth in per capita GDP), while international comparisons using graduation rates or educational spending are apparently much less robustly associated with productivity. What is surprising to many is the magnitude of the (private) return on education in terms of increased productivity, perhaps 10 to 15 percent in pre-tax terms for individuals. And Barro's rough estimate based on a cross-national average puts the social return at about 7 percent for an "average" nation (it is not clear if a highly developed economy would have a higher or lower number than the average). Though these numbers must be viewed as approximate, anything in this range represents a substantial real rate of return on investment, and suggests a key role for education policy in improving Canada's productivity and standard of living.

Fortunately, convincing evidence regarding elementary and secondary schooling indicates that Canadian youths have remarkably good educational outcomes. Further, these outcomes appear to have improved over time relative to those of other countries. Unfortunately, there has been little comparison of the quality of education at the post-secondary level across countries. There is also some evidence that Canada's education policy has implications for not only average productivity levels, but also income inequality — in fact these two issues may be linked in a fundamental way. Consequently, Canada's approach may serve to both increase mean earnings and decrease earnings variance.

There remain, however, questions about whether the education system is achieving its full potential. Some of the criticisms discussed may be justified in that regard. If the system is not operating efficiently, and if students acquire a less than optimal quality and mix of skills, the impact on their productivity and standard of living will be substantial when cumulated over a lifetime. In particular, there seems to be little correlation between resource use and outcomes across provinces. Also, at the post-secondary level it is unclear whether the distribution of students across fields of study is economically optimal. Of course, there are many other factors to be considered besides economic ones.

Most importantly — especially since ongoing improvements are desirable — there is relatively little information on the school system, and relatively little research has been conducted on the relationship between detailed school inputs and long-term individual outcomes in the Canadian context. There appears to be scope for learning more about, and improving, the system. Policy issues include the appropriate level of subsidization, the distribution of students by field of post-secondary study, and the role of education in the creation and diffusion of innovation.

NOTES

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1 From a February 12, 2002 fact sheet provided by the Prime Minister's Office, available at http://www.pm.gc.ca. Detailed documentation concerning the federal innovation strategy can be found at http://www.innovationstrategy.gc.ca

2 Concern with these issues at the provincial level is evidenced by the establishment of an Ontario Task Force on Competitiveness, Productivity and Economic Progress, which sees "educators and skill developers" as a key stakeholder group in determining the future growth of the economy. Information on this initiative can be accessed at http://www.competeprosper.ca/institute

3 GDP is a far from ideal measure for what many people intuitively consider to be the rationale for increasing productivity, which is to improve individuals' standards of living. It ignores many items that enter into many persons' utility, and includes others that are not utility-improving. GDP per hour is sometimes thought to be more consistent with people's intuitive understanding of the concept, since measures such as GDP per worker do not take into account the fact that a key item purchased with increased productivity is leisure, which is not included in GDP. Of course, sorting out voluntary leisure from involuntary leisure (e.g., unemployment) is a difficult measurement problem. See the article by Sharpe in this volume for a detailed discussion of the conceptualization and measurement of productivity.

4 I use the term "technology" here as an economist does, not as an engineer might. A production technology includes not only machinery and buildings, but also the procedures and management structure within a firm that influence the way that equipment is used, as well as the legislation and other social structures, including the labour-relations environment, that govern the firm's operation.

5 Most observers would also point to other factors, such as increasing international trade, as key drivers of productivity growth.

6 I use the term "ability" since it is commonly used in this literature. However, it does not adequately capture the concept, which is closer to "pre-existing earnings potential." It might include factors that are not usually thought of as ability such as family wealth (if it causes both education and earnings) and race (if racism impacts on both education and earnings).

7 A standard undergraduate textbook discussion of this issue is Ehrenberg and Smith (1991, pp. 320-322).

8 Though to be fair, he argues for a revolution in the nature of labour-employer relations and for broader changes in society.

9 In contrast, Brink (forthcoming), using auto mechanics as an example, argues that the skill requirements of many jobs are increasing.

10 See also responses by Embleton (2002) and Krahn (2002).

11 The program evaluation literature recently introduced the term "local average treatment effect" (LATE) to describe the causal impact on the marginal group affected by a program change. See Smith and Sweetman (2001) for an introduction to this and related concepts in the context of evaluating social programs.

12 Naturally, non-economic returns need to be taken into account in decision-making, and this principle, though more difficult to apply in non-quantitative environments, remains useful. For example, policy-makers are well aware of the change in public sentiment following an increase in education expenditures compared to the change following an increase in health-care expenditures, which are a foregone opportunity.

13 A few provinces have instituted programs that make small payments to post-secondary institutions based on the outcomes (usually unemployment rates) of their graduates. Whether the payment reflects primarily the causal impact of the institution or the quality of its incoming students remains unclear.

14 For a technical and up-to-date discussion of estimating impacts in the non-medical context see Angrist and Krueger (1999) or Heckman, LaLonde and Smith (1999). More general introductions to the topic can be found in quantitative program evaluation textbooks such as Rossi, Freeman and Lipsey (1999).

15 Ignoring such a difference causes the correlation between the observed variable and the outcome of interest to reflect the impact of the observed variable *and* the impact of the omitted variable inasmuch as the two are correlated.

16 This economics literature almost universally ignores the direct costs of education and estimates a "return" where the only cost of schooling is the opportunity cost of not being employed. Also, it is usually observed that if the hourly wage is the outcome measure the rate of return will be smaller than if annual earnings (or some other, similar measure) were used, since increased education is associated with reduced unemployment and a greater number of hours of work per year.

17 Of course, as mentioned, GDP is not an ideal measure of quality of life and related issues, but it is one of the few indicators that is standardized and reported internationally.

18 For a survey of the theoretical and early empirical literature on endogenous growth, see Romer (1990); empirical problems are highlighted by Levine and Renelt (1992) and Levine and Zervos (1993). Krueger and Lindahl (2001) provide an overview of both the micro (individual level) and traditional macro (endogenous growth) literatures and suggest that the macro results are more fragile.

19 See also Decker and Radbill (1999), who use a similar test from 1995 that was administered by 32 countries, and find similar results.

20 I believe that most researchers involved in international literacy testing would agree that early tests in literacy across languages were problematic. But they would also argue that the research underlying efforts such as the international adult literacy survey (IALS) has produced testing procedures that are extremely good and are comparable across countries and languages.

21 Another approach to the measurement-error problem is to painstakingly, and with some guesswork, correct the aggregate country-level education data. De la Fuente and Doménech (2001) pursue this approach for OECD countries and produce sensible estimates of the impact of education on national income in a non-linear model that allows differential growth rates because of "catch-up."

22 When distinguishing between outcomes and impacts, as discussed earlier, it is actually the outcomes that are of concern for the economy. It does not matter if the skills were learned at home, in school or in some other situation. However, if the school system is to have a role to play in generating good outcomes at the national level, it must offer programs with substantial impacts.

23 For a discussion of the brain drain see, for example, Finnie (2002).

24 See Tompa's article in this volume on the relationship between productivity and health.

25 Examples of the debate in the United States include Hanushek and Jorgenson (1996), Hanushek (1994), and the March 1998 issue of the Federal Reserve Bank of New York's *Economic Policy Review*. The latter consists of extremely accessible proceedings of a conference on excellence in education that address these issues in some detail.

26 Statistics Canada and Council of Ministers of Education, Canada (2000) contains all of the school statistics discussed in this section.

27 It is remarkable how little information is available on this topic in Canada, although efforts are underway to collect more, and more comparable, data across jurisdictions, as evidenced by the recent publication *Education Indicators in Canada* (Statistics Canada and Council of Ministers of Education, Canada 2000).

28 For universities, calculating the cost of education is also an ambiguous challenge since it is virtually impossible to separate the institution's teaching and research functions. Gu and Whewell (1999) point out that Canadian universities are important players in creating knowledge and promoting the diffusion of new technologies, apart from their educational role. While overall Canada lags behind other G7 countries in R&D relative to the size of its economy, the share of the nation's R&D that is conducted by universities is among the highest. Universities also play a direct role in the commercialization of technology. Both university functions, teaching and research, have a strong impact on short- and long-term productivity growth.

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