The Contribution of Post-Secondary Education to Human Capital Stocks in Canada and the United States

by

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The Contribution of Post-Secondary Education to Human Capital Stocks in Canada and the United States

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1 Introduction

Total payments to labour constitute about two thirds of GDP in both Canada and the United States. This makes human capital the dominant component of total wealth in both countries. To understand the creation of wealth in these countries it is therefore essential to understand how human capital is created. Further, cross country variation in wealth or standard of living is largely dependent on variation in the quantity and value of human capital stocks. In the 1990s there was a growing difference in average real wages between Canada and the United States. This difference could be due to growing differences in the average quantities of human capital, and/or in the price of human capital in the two countries. The two sources of the difference have different implications for policy. If it is a relative decline in per capita human capital, policy makers need to understand why this is happening. Assessing this possibility is the major focus of this paper. Post-secondary education is an important contributor to the quantity of human capital. Quantifying this contribution and evaluating the post-secondary systems that produced it is therefore of major policy importance, but it raises many difficult problems.

Quantifying the post-secondary sector contribution to the human capital stock of a country depends on being able to measure the quantity of human capital. The fraction of individuals with a post-secondary education is often used as a proxy for a country's human capital stock in international comparisons. For example, the OECD report comparisons of such a measure, designated A1, which the publication characterizes as "traditionally used to proxy the stock of human capital."[1] Problems arise with all measures of human capital stocks based on observed education levels. Not least of these is that observed levels of education - especially years of education - are often better thought of as inputs rather than the output of human capital. To overcome these shortcomings, interpretable measures of total human capital stocks, independent of variation in education levels, have to be derived. The severe shortcomings of an

[1] *Education at a Glance - OECD Indicators,* OECD 1998, p. 7.

observable education measure such as the fraction of individuals with a post-secondary education as a proxy for human capital stocks is a significant motivation for this paper.

In Bowlus and Robinson (2004) and Bowlus, Liu and Robinson (2005) interpretable measures of total human capital stocks for Canada and the United States are derived that are independent of variation in observed education levels. These measures distinguish between the quantity and the price of human capital for each country. They produce quantities whose growth rates can be compared across countries without requiring international comparability in education measures. This paper examines the problems involved in measuring the contribution of post-secondary education systems to a country's total human capital stock in a way that is internationally comparable and provides estimates of the contribution of the systems in Canada and the United States. International comparability in the total stocks, however, would require further identifying assumptions and is left to future work.

In Section 2 the paper discusses the basic problem of evaluating post-secondary education systems and alternative questions that could be posed regarding their contribution. For efficiency questions it is important to distinguish between the quantity and the value of the human capital produced. In Section 3 the identification and interpretation issues for the post-secondary contribution estimates presented in the paper are discussed. An important distinction is made between homogeneous and heterogeneous human capital models. The concept of a total stock for use in aggregate analysis is dependent on some version of the homogeneous human capital model being a good approximation. This implies a single price for human capital. Evidence for this single price assumption is reviewed. Section 4 describes the data sources and Section 5 presents an initial picture of the relative contributions in Canada and the United States and the difference created by differences in the relative sizes of the university sector in the two countries. The results suggest that post-secondary schooling in the United States may add substantially more efficiency units of human capital to those making the investment than occurs in Canada and that this is related to the difference in the relative fractions of university and non-university (other) post-secondary education in the two countries.

The results indicate that the university sector exhibits substantial variation in efficiency units across levels of degree. Therefore, Section 6 examines the cross country differences at a more disaggregated level within the university sector. Although the United States has a much higher fraction of paid employees with a post-graduate degree than is the case for Canada, the fraction of the university sector with a post-graduate degree is the same in both countries. There are major cross country differences, however, in the trends in relative efficiency units of those with a post-graduate degree. In Canada there is no change from 1980 to 1995 in the difference in average efficiency units between a BA and higher degrees, whereas for the United States this difference more than doubles. This, rather than differences at the BA degree level, is the main source of the increasing divergence between Canada and the United States in the efficiency units difference between those with and without a university education.

Section 7 presents estimates of the rates of growth of human capital in Canada and the United States over the 1980-2000 period as they relate to the post-secondary systems. The total stocks are comparable across time within countries, but not across countries. Thus, the rates of growth may be compared across countries but not the absolute levels. The results show a potentially important role for the university sector differences in explaining the widening gap in living standards in the two countries. The evidence from the differences at the post-graduate level is consistent with survey evidence of a selective brain drain from Canada to the United States at the MA and PhD level. Some conclusions and future work are discussed in Section 8.

2 Evaluating a Country's Post-Secondary Education System

Following Bowlus and Robinson (2004) we characterize a country's education and on-the-job training systems as a set of human capital production functions, subject to technological change, that can be used to augment the initial human capital stock (or stocks) that a birth cohort is endowed with. Individuals are assumed to make optimal investments in human capital, given these production functions, the prices of the inputs (i.e. time costs, tuition, etc.), and the expected future path of the price (or prices) of the human capital produced. This results in some

individuals being exposed to the production functions that characterize a country's post-secondary system. Countries may differ in the fractions of their populations with this exposure and in the amount of human capital produced by the exposure. From a policy point of view the relevant issues are whether the allocation of resources to each level of post-secondary education is appropriate and whether the production of human capital at each of these levels is efficient. In providing relevant evidence there are a variety of questions that might be asked about post-secondary systems, some of which have received much more attention in the literature than others.

Questions Related to the Post-Secondary System

The most common type of question that has characterized much of the literature on schooling is the rate of return question. There is a large literature on returns to schooling at the post-secondary level, including comparisons of the returns in Canada and the United States.[2] It remains controversial whether the estimates obtained thus far in the literature are unbiased estimates of the return obtained for a random person assigned to the "treatment" of post-secondary education. However, even if they did, the relative efficiency of post-secondary systems could not be inferred from a ranking of the returns to post-secondary education, except under very restrictive assumptions. That is, the returns to post-secondary education are a function of much more than the parameters of the post-secondary human capital production function. The source of the difference in the rate of return would have to be traced in order to provide useful policy information regarding action to be taken, if any, as a result of different rates of return.

A related question is the extent to which a post-secondary system efficiently allocates resources across the different levels of post-secondary education: are marginal returns equalized across the sectors. In most countries there are a variety of levels of post-secondary education, including universities, professional schools and community colleges. The allocation of resources

[2]For some recent examples see Bar-Or *et al* (1995) and Card & Lemieux (2001).

across these levels is quite different in Canada and the United States. The United States, for example, has a much higher fraction of their workforce with a post-secondary education that have a BA degree or higher, compared to Canada. The relative efficiency of the post-secondary systems could not be inferred from a ranking of the fraction of post-secondary educated workers with a university degree, since this fraction depends on factors other than those related directly to the system's efficiency. However, resources are not efficiently allocated by the system unless the marginal returns across sectors are equal.

A variety of questions can be asked concerning the human capital stocks associated with a post-secondary education system. Individuals with post-secondary education are assumed to have more human capital than those without. The simplest human capital stock question, for which the estimates in this paper can provide an answer, is: how much more human capital does the average individual with post-secondary education have compared to the average without? If post-secondary systems differ across countries, this will not, in general, be the same for all countries. This a major problem for the use of the fraction of individuals with a post-secondary education as a proxy for human capital stocks in international comparisons. A second basic question is: given the education system in place and the choices individuals have made within this system, how much of the human capital stock, as a fraction of the total, is contained in individuals with a post-secondary education? If this fraction is relatively low for country B, does this imply an inefficient post-secondary system for country B? Again, in general, the answer would be no.

Human capital stocks by observed education level may be quantified without solving the identification problems caused by endogenous schooling that are pervasive in the rate of return literature. A variety of the comparisons using these measures do, however, require the separate identification of the price and quantity of human capital. Moreover, even though the contribution of workers with a post-secondary education to the total capital stock can be assessed without dealing with endogenous schooling problems, the more difficult question of how much of the human capital stock was actually produced by the post-secondary system cannot.

Finally, the most basic efficiency question that may be asked of a post-secondary system is: how much output is obtained from the production functions that characterize the various levels of the system? If this is less in country B than would be the output in country A from the same inputs then the post-secondary education system in country B is inefficient. This efficiency relates, however, to the technological production efficiency alone. For policy purposes, knowing if the system is inefficient in the technological production sense is important since it would direct policy efforts towards improving this productive inefficiency. However, even if country A and country B had equally efficient production functions, the system may result in different quantities of human capital being produced because of differences in other determinants of optimal human capital investments, such as the expected human capital price path. Differences for this reason would not imply any "problem" with the post-secondary system that adds a smaller total contribution to human capital stocks.

There are other important potential differences across countries that could lead to different quantities of human capital being produced even if the production functions were identical. These include differences in credit constraints, in other input prices, in the system of elementary and secondary education or in relative subsidies for the various levels of post-secondary education. These differences would be reflected in the rates of return and total stocks. Whatever the source of the difference, a good measure of the human capital stock is an essential part of measuring the contribution of a post-secondary system.

Evaluation of Post-Secondary Systems: Homogeneous vs Heterogeneous Human Capital

In this paper we adopt the idea that the education system of a country is composed of a set of production functions that produce human capital. If human capital is homogeneous, then the initial endowment of all individuals in a birth cohort can be added to form the initial human capital stock and the output from all the production functions can be added to provide the final

human capital stock of the birth cohort after optimal accumulation.[3] For international comparisons, the question: "which country has more human capital per capita ?" is well posed. It can be answered by comparing these per capita stocks. For the output of the post-secondary system, various well posed questions are possible, though in practice they may be difficult to answer. For example, the question: "how much less human capital per capita would there be if there was no post-secondary system, i.e. if those who went through that system had to choose optimal investments without access to the production functions characterizing the post-secondary system?" is well posed. It could be answered by comparing the actual final total per capita with the counterfactual total that replaces the actual total of the post-secondary graduates with what they would have in the absence of the post-secondary system.[4]

If human capital is heterogeneous, i.e. corresponding to different factors of production, the initial endowment is a portfolio of different types of human capital that cannot be added.[5] For international comparisons this presents a major difficulty. Using the fraction with post-secondary education, OECD rankings put Canada ahead of the United States in human capital per capita. Using, instead, the fraction going to university reverses the ranking. Which is correct? How much extra non-university post-secondary education compensates for a lower university fraction? If they are different factors, they are not comparable so this question cannot be answered, even if within each education level the factor is comparable across countries. With heterogeneous human capital it is possible to say that one country has more of one factor and less

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[3]Abstracting from depreciation and timing issues.

[4]In practice, of course, estimates of the counterfactual will be difficult to obtain since the initial endowments of the post-secondary graduates are likely to be different from, say, high school graduates - the usual endogenous schooling problem.

[5]Different factors are often "aggregated" for convenience in the specification of aggregate production functions. However, at the physical unit level this is an arbitrary functional form assumption that is no more meaningful than aggregating units of skilled workers and units of oil or some other raw material input. At the value level it is equally arbitrary and across time is dependent on relative prices even if all of the physical quantities that make up the aggregate are unchanged.

of another, but not that one country has more human capital in total. Wage information cannot be used to answer this question since an answer does not exist with heterogeneous human capital. In fact, if relative wages are used as weights to combine heterogeneous human capital into a human capital stock total, two countries could have their human capital stocks ranking reversed by the choice of which country's relative wages to use. Moreover, over time, rankings could be reversed by changes in the relative prices of the different types of human capital, even if the stocks of all types of human capital stayed the same in each country.

The same complications arise in a heterogeneous human capital model for evaluating the contribution of a post-secondary system. Suppose there are two types of human capital: one type is produced at the post-secondary level and the other at lower levels. The output of a post-secondary system is the amount of the second type produced. Suppose that at two points in time the same fraction of equal sized birth cohorts went to post-secondary education and that the system was equally productive in both periods - i.e. output was the same amount of this capital at both points. If the post-secondary contribution was judged by the wage difference across the two groups, and if the relative price of post-secondary human capital fell, the post-secondary system would appear to have become less productive, even though, by definition there had been no change. Policy makers would be mis-directed to look for a problem in the post-secondary sector. If human capital is heterogeneous in a way that corresponds to observed education levels, comparisons can be made within types of human capital. Provided prices and quantities can be separately identified, policy mis-direction can be avoided, whatever the path of relative prices of human capital types.

3 Identification: Homogeneous and Heterogeneous Human Capital[6]

Payments to human capital are observed in the form of wage data, where the quantities of human capital that are paid for in the form of wages are not directly observable. The wage is the

[6]See Bowlus and Robinson (2004) for a more detailed discussion of these issues.

product of a price and a quantity. This product is observed, but its two components are not. This is the fundamental under-identification property of human capital models.

Homogeneous Human Capital

In the homogeneous human capital model the hourly wage for individual *i* at time *t* is the product of the human capital price, λ_t, and the efficiency units supplied by individual *i* at time *t*

$$w_{it} = \lambda_t E_{it} .$$

Individuals with different observed "levels" of education have different average amounts of *E*. However, given the endogenous choice of schooling levels and technological change in the production of human capital, the relation between the level of schooling and the average *E* will not be constant. That is, the human capital of the average high school or university graduate today is not the same as that of twenty years ago, or even last year. This is because of different productions functions in the different years due to technological change in the production of human capital, changes in the prices of other inputs in the production of human capital, and a different selection of individuals in the various schooling levels. Without selection and technical change, relative wages between different schooling levels are constant over time because of the single price. With selection and technical change, relative wages change to reflect technological change and selection effects.

The most important feature of homogeneous human capital models for the purposes of the present paper is that the total stock of human capital is well defined. The human capital of workers with different schooling levels can be added. In addition, the fraction of the total stock contributed by workers with a post-secondary education is well defined. Once the price is identified, the quantities for all individuals can be inferred from their wage.[7] As a result, the

[7]This, of course, assumes that the market for human capital is competitive and abstracts from contracting complications. However, the deviations from wage payments reflecting spot marginal products is a less important problem for estimates of the human capital stock averaged

question of whether one country has more human capital on average than another is a well posed question which in principle can be answered. Similarly, whether the fraction of the total stock contributed by workers with a post-secondary education is larger in one country or another is a meaningful question. This is not true of heterogeneous human capital models.

Heterogeneous Human Capital

In a typical heterogeneous human capital model there are two types of human capital, skilled and unskilled, and therefore, two prices. The average wages of the two types are given by

$$w^u = \lambda^u E^u \qquad \text{and} \qquad w^s = \lambda^s E^s ,$$

where the subscripts u and s refer to unskilled and skilled, respectively. The changes over time in E^u and E^s are subject to exactly the same considerations as for different schooling levels in the homogeneous human capital case. Indeed, in applications of the heterogeneous model, the skilled and unskilled are often defined by reference to schooling levels. Unlike the homogeneous human capital model, relative skill prices can change. With no selection or technological change, changes in relative wages identify changes in relative skill prices. However, with selection or technological change, skill price changes are not identified by relative wage changes.[8] Thus either model - one with constant skill prices, or one with changing skill prices - is consistent with any change in relative wages. However, if human capital is heterogeneous, unlike the homogeneous case, the total human capital stock is not defined.

In heterogeneous human capital models, identification of the price of each type of human capital allows the quantity of that type to be inferred from the wages of that type. However, the

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over large numbers of individuals than for other estimates.

[8]The skill premium literature implicitly assumes E^u/E^s is constant. That is, it rules out selection and technological change.

quantities of the types are as different as apples and oranges and cannot be added.[9] Addition can occur within types but not across types. In fact, if the skills are identifiable by, say, education level, there is nothing to be gained from arbitrarily aggregating the different types of human capital inputs. The question of whether one country has more human capital than another is then not well posed since the totals are undefined. Comparisons could only take place within types of human capital.

Within Country Comparisons of the Contribution of the Post-Secondary Sector

One basic measure of the contribution of the post-secondary system, that is in the spirit of the OECD measure of total human capital and can be justified within the homogeneous human capital framework, is the difference in efficiency units supplied in a year by the workers with and without a post-secondary education. If this difference is large, the contribution of the post-secondary sector is large. By this measure, the contribution would increase if the number of people with post-secondary education increased, but also if the difference in the average number of efficiency units supplied by workers with and without post-secondary education increased. To identify this difference within a country at a point in time only requires the single price assumption that follows from homogeneous human capital. Identification of the price and quantity separately is not required. In a single period the price and quantity are trivially identified by normalization since the units of human capital are arbitrary.

For the total we have

$$\sum_p E_j \; - \; \sum_s E_j = (1/\lambda)[\; \sum_p y_j \; - \; \sum_s y_j] = [\; \sum_p y_j \; - \; \sum_s y_j] \; ,$$

and for the average

[9]The values at any point in time can, of course, be added, but this is a total value, depending on a particular set of prices, not a total quantity. For the questions about the human capital stock, quantity measures are required.

$$(1/n_p) \sum_p E_j - (1/n_s) \sum_s E_j = (1/\lambda)[(1/n_p) \sum_p y_j - (1/n_s) \sum_s y_j] = [(1/n_p) \sum_p y_j - (1/n_s) \sum_s y_j] ,$$

where n_p and n_s are the populations of workers with and without post-secondary education, $\sum_p$ and $\sum_s$ are the respective sums of the observations over those populations, and E_j and y_j are the efficiency units and earnings of worker j, respectively. Normalizing the price in the period to one results in an equivalence between the quantity of units supplied by the average worker with (without) post-secondary education to the average earnings of workers with (without) post-secondary education (the second equality).

To assess changes in the difference in efficiency units supplied by workers with and without a post-secondary education within a country over time would require non-trivial identification of the price and quantity since it requires the price difference between the two points in time. For the average we would have

$$[(1/n_{pt}) \sum_p E_{jt} - (1/n_{st}) \sum_s E_{jt}] - [(1/n_{p\tau}) \sum_p E_{j\tau} - (1/n_{s\tau}) \sum_s E_{j\tau}]$$

$$= (1/\lambda_t)[(1/n_{pt}) \sum_p y_{jt} - (1/n_{st}) \sum_s y_{jt}] - (1/\lambda_\tau)[(1/n_{p\tau}) \sum_p y_{j\tau} - (1/n_{s\tau}) \sum_s y_{j\tau}]$$

Clearly, if the price of human capital fell over time and everything else stayed the same, using the difference in average earnings as a measure of the contribution of the post-secondary system would indicate a decline, even though all quantities were the same. In essence, this is a difference in the average value. Of course, it may be of interest to know that the value of the output of the post-secondary system fell, but it would be wrong to attribute this to a failure of the post-secondary system. Obviously, given a sufficient change in relative prices, the relative earnings measure could imply a failure of the post-secondary system even if the system *increased* human capital per capita. It is essential, therefore, to distinguish between quantity and price.

One measure that does not suffer from this problem in using earnings information without separating prices and quantities is the percentage contribution of the post-secondary system to

total efficiency units or the percentage difference in average efficiency units between workers with and without post-secondary education. All percentage differences are independent of prices. However, since the measure is relative, care would have to be taken in making any inferences about the post-secondary sector without knowledge of what had occurred for the group with no post-secondary education.

The measures discussed thus far within the homogeneous human capital framework can all be constructed under the same identification conditions *within* human capital types if human capital is heterogeneous. If there are skilled and unskilled workers with the former produced by the post-secondary education system, then human capital is homogeneous within the post-secondary sector and may be added. The contribution, for example, of the university part of the post-secondary system to total skilled human capital or its changes over time can be calculated. These totals cannot be compared with the unskilled total, but the rate of change of skilled and unskilled human capital, and of skilled and unskilled per capita human capital can be calculated. The value of total human capital across skills and the contribution of the post-secondary sector to this total value may also be calculated using the prices at any given point, but, as noted earlier, changes in this contribution are potentially misleading indicators of the performance of the post-secondary sector. Separately identifying price and quantity within human capital type and monitoring the quantity measures will provide more useful information.

Cross Country Comparisons of the Contribution of the Post-Secondary Sector

International comparisons of human capital raise very difficult identification problems. The post-secondary systems in Canada and the United States are characterized by large differences in the form of post-secondary education. In the United States, the role of universities is much larger. Almost one half of the individuals with post-secondary education in the United States have a BA degree or higher. In Canada the fraction is closer to one quarter. The most recent OECD study using the fraction of the population with a post-secondary education, ranks Canada above the United States in human capital per worker (OECD, 2000). However, if the

fraction with a BA degree or higher had been used, the ranking would have been reversed. If BA degrees are associated with the same amount of human capital in each country, and the same is true of other post-secondary education, and if human capital is homogeneous, the question of which ranking is correct could, in principle, be answered. However, if human capital is heterogeneous a different approach is needed, based on within human capital type comparisons.

Identification issues for cross country comparison of totals or average differences in efficiency units for workers with different levels of education are the same as those for within country comparisons except for one important difference. Given the single price assumption that makes total or average comparisons meaningful, cross country comparisons also require the relative price of human capital across countries at some point in time. This could be inferred if there was a group in each country at the same point in time where the ratio of their human capital was known. At a point in time average efficiency units of workers with post-secondary education in countries *a* and *b* are given by:

$$(1/n_p^a)\sum_{pa}E_j = (1/\lambda^a)(1/n_p^a)\sum_{pa}y_j \quad \text{and} \quad (1/n_p^b)\sum_{pb}E_j = (1/\lambda^b)(1/n_p^b)\sum_{pb}y_j$$

where λ^a and λ^b are the human capital prices in countries *a* and *b* and $\sum_{pa}$ and $\sum_{pb}$ are summations over the workers with post-secondary education in countries *a* and *b*, respectively. Given earnings data for the two countries, knowing whether the average worker with a post-secondary education in country *a* has more human capital than the counterpart in country *b* requires knowledge of the relation between λ^a and λ^b. This cannot be inferred from earnings data even if prices and quantities can be separately identified in each country since the price normalization in general implies different units of human capital in the two countries.

Similarly, cross country comparisons cannot be made of the difference in the total efficiency units contributed by workers with a post-secondary education, or the difference in the average efficiency units of workers with and without a post-secondary education, without the comparable unit across countries. However, since the percentage differences within a country are

independent of prices, these may be compared across countries without additional identifying assumptions. That is, the share of a country's total efficiency units contributed by workers with post-secondary education may be compared across countries. Also, the percentage difference in average efficiency units supplied by workers with and without a post-secondary education may be compared across countries. Estimates of these differences are given in Section 5 below.

Additional comparisons that can be made across countries in the absence of a comparable unit are those involving changes over time. The percentage change over time in the total efficiency units of a country contributed by its workers with a post secondary education may be compared. This, of course, will reflect different relative growth rates of numbers of workers with a post-secondary education as well as different relative growth rates in the average efficiency units of those with and without a post-secondary education in the two countries. These may be compared separately using the change in average earnings differences. Estimates based on comparisons across time are presented in Section 5.

As for within country comparisons, if human capital is heterogeneous the relevant comparisons are those within human capital types. For cross country comparisons the same considerations apply. There is one important difference. For the comparisons requiring knowledge of the relative price of human capital across countries at a common point in time, such as whether the average Canadian worker has less human capital, the requirement becomes knowledge of the relative price across countries of all human capital types at a common point in time.

Evidence for a Single Price

The relevant comparisons of the contribution of a post-secondary system within or across countries depend on whether the single price assumption that follows from the homogeneous human capital model is a good approximation. If human capital is heterogeneous, comparisons would have to be within human capital types. Do Canadian workers earn less than American

workers because they have less human capital on average or because the price they are paid for it is lower? This could be asked within human capital types or for workers as a whole. If human capital is homogeneous, both questions are relevant. If not, only the within comparisons are well posed questions.

The identification of prices and quantities from wage data is extensively discussed in Bowlus and Robinson (2004) and Bowlus, Liu and Robinson (2005). Two basic methods are explored using Canadian and US data sets, and price and quantity series for 1975-2001 for the United States and 1980-2000 for Canada are calculated. In the following sections of this paper we adopt the homogeneous human capital framework. The main justification for this is the evidence in Bowlus and Robinson (2004) and Bowlus, Liu and Robinson (2005) that suggests that the single price assumption is a very good approximation for both Canada and the United States for the period studied.

Comparable Groups Across Countries

With homogeneous human capital, to answer the question of whether Canadian workers have less human capital on average than US workers from data on earnings requires knowledge of the relative price of human capital across countries. This could be inferred from earnings data if there was a group in each country where the ratio of their human capital was known. There are two approaches to satisfying this requirement. One approach is to assume that the initial endowment distribution of human capital for a birth cohort in both countries is the same and that workers at the same point in this distribution who only have their initial endowment can be identified for both countries. In principle, this would be workers with no exposure to human capital production functions in either country. In practice it would have to be approximated by workers with the least exposure, given mandatory schooling laws. An alternative approach is to assume that equal results on standardized international tests imply equal human capital, and to use this information in cases where the results are, in fact, equal. The problem is obviously greatly increased if human capital is heterogeneous since somehow an equivalence must be found

for each human capital type.

The literature on human capital and growth has given a great deal of attention to the problem of international comparability of human capital measures. Barro and Lee (1993, 1996), for example, constructed measures of schooling years, designed to be internationally comparable, but stressed that the measure of years did not take into account quality differences. Hanushek and Kim (1995) and Hanushek and Kimko (2000) use international test score data to address the issue of schooling and labour force quality. Coulombe, Tremblay and Marchand (2004) utilize data from the International Adult Literacy Survey, and argue that human capital measures based on these data are superior to years of schooling measures normally used in international growth regressions. The identification or interpretation problems that occur if human capital is heterogeneous receive relatively little attention in this literature. The distinction between prices and quantities also receives little attention, since the focus is on obtaining a direct measure of the quantity. However, to the extent that these measures were true quantity measures, wage data would permit an inference on the cross-country pattern of human capital prices.

4 Data Sources, Earnings and Education Level Definitions

The data source for the United States is the March Current Population Surveys (MCPS) for 1976 to 2001. The earnings data are earnings from wages and salaries from the calender year preceding the survey, covering 1975-2000. The earnings data were confined to paid employees by restricting the sample to those for whom the class of worker on the longest job in the year preceding the survey was a private or public paid employee.

Prior to the survey year 1992, the MCPS education measure was the number of years of schooling completed. After January 1992, actual degrees and diplomas were recorded. This break in the series was examined in detail in Jaeger (1997), using a matched panel of respondents that answered both forms of the education questions. Jaeger derives a recoding scheme to produce approximate consistency in four categories: dropouts, 12^{th} grade, some college and college graduates. These categories were adopted for defining the total post-secondary group (some

college and college graduates) and the BA+ group (college graduates) used in the analysis in this paper. There remains a consistency problem for the subdivision of the BA+ group into BA only and higher degrees.

Prior to January 1992, the completion of 16 years was assumed to be a BA degree and 17 years or more was a higher degree. For a measure of the combined fraction with a BA degree and higher, there is a small difference in the estimated fraction in this category between the old and new definitions. There is, however, a large break in the separation into BA only and higher degrees. For disaggregated analysis of the university sector in the United States, some adjustment is required to deal with this break. The adjustments adopted for the analysis conducted in this paper are described in detail in the Appendix.

The Canadian data are derived from the public use samples from the censuses for 1981, 1986, 1991, 1996, and 2001. The earnings data are wage and salary earnings for the year preceding the survey, as in the United States data. However, there is no variable in the Canadian data that indicates class of worker status on the longest job in the preceding year. The restriction to paid employees in the Canadian data is imposed by requiring no self-employed earnings. Given the small size of the self-employed population and the relatively small contribution of self-employed earnings to total earnings of US workers whose longest job was not self-employed, it is assumed that this difference in definition has a negligible effect on differences in mean earnings for paid employees.

The education categories are based on degrees and diplomas received, like the United States surveys after January 1992, and are consistent over time. The detailed categories in the "highest level of schooling" variable are divided into three broad groups: elementary and secondary (ESS), other non-university (ONU) and university (U). The total post-secondary group is the sum of ONU and U and the BA+ group is a subgroup of U. The BA+ group is further subdivided into BA only and post-graduate degree using the detailed categories in U. Unlike the United States, there is no consistency problem for these subdivisions as the receipt of the degree

is recorded in all years. Since the US definitions include individuals beyond 12th grade as some college, there may not be an exact correspondence between ESS and 12th grade and between ONU and some college. In particular, the United States definition of some college may include some individuals who would be defined as ESS in the Canadian definition.

For the purposes of comparison of post-secondary education across countries, Jaeger's four basic education levels were collapsed into three: no post-secondary, corresponding to Jaeger's dropouts and 12th grade; and other post-secondary and BA degree or higher corresponding to Jaeger's some college and college graduates, respectively. The three Canadian equivalents are elementary and secondary (ESS), other post-secondary (ONU and part of U below a bachelor's degree) and BA degree or higher (remainder of U). These are the categories used in Section 5. For the analysis in Section 6 the BA degree or higher group was further subdivided into those with a BA and those with a post-graduate degree.

5 Contribution of the Post-Secondary Sector: Initial Picture

The first two columns of Table 1 present the fraction of the population of paid employees with a post-secondary education for Canada and the United States, 1975-2000. In 1980, 43.74% of employees with positive earnings in Canada had a post-secondary education. This compares with 39.67% for the United States. In all years recorded for Canada in Table 1, Canada has a consistently higher fraction of its population of paid employees with a post-secondary education compared to the United States. This mirrors the results in the OECD studies for the total population. The overall gap is about four percentage points in each year reported in Table 1. The gap is evident for both males and females but is about twice the size for females. In both countries there has been a similar increase in the fraction with post-secondary education. For Canada the fraction rose from 43.74% in 1980 to 60.06% in 2000; for the United States the increase was from 39.67% to 55.03%.

The remaining columns in Table 1 present the fraction of efficiency units supplied by

individuals with a post-secondary education. This fraction is well defined only under the single price assumption. Calculation of this fraction, however, is independent of the particular price series chosen for either country since the ratio of efficiency units is equivalent to the ratio of earnings. The larger fraction of the population with a post-secondary education in Canada is not generally reflected in the fraction of efficiency units supplied by those with a post-secondary education. In total, the fraction for the United States starts about one and a half percentage points below the Canadian figure in 1980 and finishes about a percentage point higher in 2000. Thus, despite a higher fraction with post-secondary education in Canada, the evidence in Table 1 suggests that this may not have resulted in more efficiency units. Disaggregating by sex, this appears to be most pronounced for males. Only in the most recent years are the higher fractions with post-secondary education for females in Canada not clearly reflected in efficiency units.

Table 2 reports the percentage difference in average efficiency units of paid employees with and without post-secondary education. In 1980 the average Canadian full-time, full year male worker with a post-secondary education supplied 27.13% more efficiency units of human capital than the average of the same group without post-secondary education. For the United States the percentage is 40.52%. In both countries the difference increases over time, but at a faster rate for the United States. By 2000 it reaches 36.35% for Canada versus 82.86% for the United States. In all years the gap between countries is large. For full-time, full-year females there are two cross country differences. First, the gap in Canada is larger for females than for males, whereas in the United States the reverse is true. Second, Canada-United States differences are less pronounced for females. In fact, for 1980 and 1985 the gaps are similar in both countries. By 1995, however, the gap in the United States is much larger as a result of growth in the United States and none in Canada. Similar patterns to those for full-time, full-year workers are apparent for all paid employees and controlling for age differences across countries and education groups.

The results in Table 2 show that, on average, US workers with a post-secondary education have a greater difference in efficiency units than those without, compared to Canada. This is consistent with the picture in Table 1 that indicates that the larger fraction of those with a post-

secondary education in Canada compared to the United States does not translate into a larger contribution of efficiency units from those with a post-secondary education. If those without post-secondary education had the same efficiency units in both countries, this would indicate that on average a smaller addition to human is made from those passing through the Canadian post-secondary system compared to that of the United States. An obvious possibility is that the average Canadian with a post-secondary education chooses a smaller post-secondary investment. In fact, a striking difference appears between Canada and the United States when the post-secondary education group is subdivided into those with and without a BA degree or higher.

Table 3 shows the disaggregated pattern of the post-secondary sector in both countries, where post-secondary is divided into those with a university education (BA degree or higher) and those with other post-secondary education (less than a BA).[10] The fraction of paid employees with a BA or higher is much higher in the United States than in Canada. In 1980 the fraction in Canada is only 10% compared to 17% for the United States. By 2000 both countries increased their fraction with a BA degree or higher substantially, but this seven percentage point gap remained. As a result, in 2000 the United States still had a fraction with a BA degree or higher that was about 50% higher than the fraction for Canada (26% vs. 18%). This creates dramatic differences in the make up of the post-secondary group in the two countries. In the United States there is roughly an even split between university degree and other (45% vs. 55%); by contrast in Canada the non-university group strongly dominates, ranging from 77% in 1980 to 70% in 2000. This is clearly consistent with the much smaller percentage difference in per-person efficiency units between those with and without post-secondary education in Canada compared to the United States. An appropriate comparison between Canada and the United States should take this difference in the make up of the post-secondary populations in the two countries into account. Tables 4 provides an initial picture of post-secondary education with a subdivision of

[10] As noted earlier, the possession of a BA degree or higher in the United States data prior to 1992 was inferred from the number of years of schooling completed, rather than a direct indication of receipt of the degree as in the Canadian data. The post 1995 comparison is therefore the most reliable when receipt of the degree is used in the education data for both countries.

"university" and "other post-secondary" levels.

Table 2 reported the percentage differences for all post-secondary combined compared to no post-secondary education. Table 4 reports the percentage differences compared to no post-secondary education separately for individuals with a BA degree or higher and for individuals with other post-secondary education. Comparison of the two tables shows the substantial positive effect that the higher fraction of post-secondary that is at the BA degree level or higher in the US had on the differences between Canada and the United States in Table 2. For males in 1980, for example, the full-time, full-year employees with a post-secondary education in the United States had a much larger difference in efficiency units compared to those without post-secondary education than was the case for Canada (40.52% vs. 27.13%). The cross country differences are much reduced in Table 4 where the two levels of post-secondary education are separated - 18.01% vs. 15.99% in the other post-secondary group, and 60.75% vs. 54.08% in the BA or higher degree group. The growth rates in the post-secondary differentials show the same cross country patterns within post-secondary sectors as for the total: the US growth rates are strongly positive, while the Canadian growth rates are relatively flat. The dis-aggregated post-secondary sector patterns are contrasted with the total in Table 5.

Table 5 reports the amount by which the percentage difference in average efficiency units by education differs across countries. Thus, the first entry (.4935) for full-time, full-year males in 1980 indicates that there is a 49.35% difference between the 1980 value for the US difference in efficiency units for those with and without post-secondary education (Table 2, entry .4052) and the corresponding value for Canada (Table 2, entry .2713). For full-time males, the higher percentage of university in total post-secondary results in a much larger overall gap than occurs in either sub-sector. Within the sub-sectors of the post-secondary system (university and other post-secondary), the cross country differences are relatively similar to each other and both much less than the overall difference: 12.33% for university and 12.63% for other post-secondary, versus 49.35% when they are combined for 1980. The same pattern of smaller differences in the sub-sectors is true for all years, though the differences themselves grow over time.

The effect of the larger share of the BA or higher degree group in the United States is also apparent in Table 5 for females. For full-time, full year females the gap within the sub-sectors is negative in 1980 and 1985, i.e. there is a larger difference between those with either form of post-secondary education and no post-secondary education in Canada than in the US. Despite this negative difference in each sub-sector in 1985, there is a positive difference for total post-secondary because of the higher university fraction in the US. For 1985 this effect is strong enough to turn the sub-sector negative differences of 20.96% in the university sector and 13.82% in the other post-secondary sector into a positive difference of 9.26% for post-secondary as a whole. For 1980, this effect reduces the magnitude of the overall negative effect to 10.85% when the sub-sector negative effects are much larger at 33.23% for university and 30.63% for other post-secondary. For 1990 and 1995, the sub-sectors for full-time, full-year females have small positive or approximately zero gaps, but the disproportionate number in university in the US results in large overall gaps of 31.37% in 1990 and 35.64% in 1995.

6 Cross Country Differences in the University Sector

The evidence in Section 5 clearly indicates that a large part of the higher average efficiency units difference for the United States compared to Canada between workers with and without post-secondary education is due to the much larger fraction of workers with a post-secondary education in the United States that have a BA degree or higher. The cross country differences are much smaller within the sub-sectors than in the pooled total. Nevertheless, there remain important differences within sectors, particularly in the later years. There is substantial variation in efficiency units within the BA degree or higher group and the other post-secondary group within and across countries. The other post-secondary group consist of widely differing forms of post-secondary education, ranging from some university or close substitutes for university education, in the case where credits are easily transferable and the formal connection is

close, to relatively short courses leading to trade certificates.[11] The BA degree or higher group is more uniform in type of education but consists of different levels. In this section, the university group is sub-divided into those with a BA degree only and those with a post-graduate degree.

In Table 6, the fraction of various populations that has a post-graduate degree are reported for Canada and the United States. The data in Table 6 show much larger fractions in the total working population, or in the post-secondary population, that have a post-graduate degree in the United States than in Canada. As noted earlier, actual degrees were not recorded in the US data until 1992. The matching across the sample that answered both questions carried out in Jaeger (1997) indicates that the years completed measure overstates degrees actually obtained. For a total measure of BA degree and higher, the overstatement is modest. However, for post-graduate degrees alone the overstatement is large. In particular, in the matched sample, only 44% with 17 completed years of education had a masters degree or higher. Even for 18 or more years of completed education, 16% had at most a BA degree. As a result, the fractions for the United States are overstated relative to those estimated for Canada, where the data are based on receipt of the degree. Direct comparison of the levels should only be made with the United States data after 1990.

Using the data after 1990 it is still the case that the incidence of higher degrees is much higher in the United States. In the working population as a whole, 8.56% of males and 7.81% of females had a higher degree in 1995 in the United States compared to only 6.18% for males and 5.59% for females in Canada. For both sexes the United States has a fraction that is almost 40% higher. However, this may only reflect the higher fraction in the total working population, or in the post-secondary population that has a BA degree or higher, reported earlier in Table 3. Indeed, the last two columns of Table 6 show that within the university population (the BA+ group), the fractions with a post-graduate degree are the same in both countries when post-graduate degrees are measured by receipt of the degree rather than inferred from years of schooling completed.

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[11]The CEGEP system in Quebec, for example, is highly integrated with the university system, acting as a pre-requisite for most university students in Quebec.

The fractions for both countries also appear to have been relatively stable. The cross country differences in the pooled university group of BA degree or higher is, therefore, not due to any difference in the fraction of this group with post-graduate degrees.

Table 7 presents estimates of the percentage difference in efficiency units for sub-sectors of the male university group relative to each other and to the group with no post-secondary education over the 1975-2000 period. As noted earlier, there is a problem of comparability in the sub-groups before the 1991 earnings year. Table 7 reports estimates adjusted for comparability as described in the Appendix. The most striking result from Table 7 is the dramatic change over time in the United States in the difference between those with a post-graduate degree and those with a BA degree. For full-time, full year workers this difference goes from 13.42% in 1980 to 36.47% in 2000. For Canada over the same period there is a slight decline. In both countries the difference between university degree holders and those with no post-secondary education increases, but the increases for the United States are much larger. For Canada, for both degree levels there is a similar, relatively modest increase, from 45.33% in 1980 to 62.17% in 2000 for BAs and from 68.43% to 85.14% for post-graduate degrees. For the United States, the increases are much larger, especially for post-graduate degrees where the percentage difference increases from 74.45% in 1980 to 177.72% in 2000. This very large increase for post-graduate degrees is an important reason for the divergence over time across the countries in the average efficiency units difference between those with and without a university education.

Table 8 repeats the analysis of Table 7 for females. For males, the difference between university degree holders and those with no post-secondary education increased over time, but by a much larger amount for the United States. For females there is no growth for Canada at either degree level compared to strong increases in the United States at both levels. Tables 9 and 10 repeat these estimates for the 31-40 age group. For this age group, the percentage differences between university degree holders and those with no post-secondary education are generally smaller, but show the same pattern. In Canada there is a relatively modest increase in this difference for males and no increase for females, while in the United States there is a large

increase for both males and females.

The United States has a larger percentage difference in efficiency units between those with a university degree compared to no post-secondary education than is the case in Canada. In addition, this difference between education levels increases over time at a faster rate in the United States. Overall, the disaggregated analysis of the university sector indicates this pattern is not due to any cross country difference in the fraction of the university group that has a post-graduate degree, or to any change in this fraction over time. Rather, the data suggest that the primary source is the widening gap in efficiency units between workers with a post-graduate degree and those with a BA in the United States compared to Canada.

7 Changes in the Amount of Human Capital Produced by the Post-Secondary Education Sectors: Canada and the US, 1980-1995

The measures in Sections 5 & 6, both within and across countries, are limited in the information they can provide primarily because they do not require human capital price series by country or relative prices across countries. In particular, while the amount of human capital associated with any post-secondary education level *relative* to no post-secondary education can be calculated, the actual (normalized) amount of human capital, or the change in the amount over time, cannot. Human capital price series were calculated for the United States and Canada in Bowlus and Robinson (2004) and Bowlus, Liu and Robinson (2004). With these price series, (normalized) levels and changes in the average amounts of human capital for workers with any level of post-secondary education can be calculated within countries and their rates of growth compared across countries.[12] This may also be done on a cohort basis to provide more detailed information on how the output of the post-secondary system is changing over time. The results of

[12]As discussed in Section 4, levels of efficiency units cannot be compared across countries without some known equivalent groups across countries, even in the homogeneous human capital framework. However, the levels and changes within the countries only require estimated price series within countries.

this analysis are reported in this section.

Table 11 presents the growth rates of mean efficiency units, by education level, for various populations in Canada and the United States. Estimates are presented separately for all paid employees 15 years and older and for full-time, full-year workers. Cross country comparisons using all paid employees can be influenced by labour supply differences in the two countries, which are controlled for by using full-time, full-year workers. However, these comparisons are subject to the caution that they may be sensitive to differential selection effects across countries into which workers are full-time, full-year.[13]

In both countries, mean efficiency units supplied increased at all education levels. For full-time, full-year males, mean efficiency units typically increased more at higher education levels. For the United States the growth rates show a strong, monotonic increase by education level with an especially pronounced increase from the BA to the post-graduate degree. There is a similar strong increase up to the BA level for Canada, but then it stops or is reversed with a lower growth rate at the post-graduate degree level compared to the BA. For full-time, full-year United States females there is, like the males, a strong monotonic increase in the growth rates to the BA level, at which point it slows down or stops. For Canadian females, in contrast, growth rates are the same at all levels of education.

Mean efficiency units for individuals with no post-secondary education increased more in Canada than in the United States. Full-time, full-year workers aged 31-40 in Canada have about a 10 percentage point greater increase than those in the United States. For post-secondary education below a BA degree there is again a larger increase for Canada, though the gap is smaller, especially for females where there is almost no difference. At the university level, the picture is very different, with much faster growth for the United States, especially at the post-

[13] The fractions are sufficiently dissimilar in some cases to warrant some caution. The differences in the fraction that are full-time, full year in the two countries are given in Appendix Table A1.

graduate degree level. At the BA level, full-time, full-year male workers have relatively similar growth in both Canada and the United States: 30.5% in Canada vs. 37.10% in the United States for those aged 31-40, and 32.5% vs. 35.9%, respectively for those aged 15+. At the post-graduate degree level, however, there is more than a 30 percentage point faster increase in the United States. For females there is also faster growth at the post-graduate degree level in the United States, but unlike the males, there is also much faster growth at the BA degree level as well.

Overall, there is a large cross country difference in rates of growth in the post-secondary sector coming from the absence of strong growth at the post-graduate degree level for males in Canada compared to the United States, and the large increase for females at all university levels in the United States compared to females in Canada. Both countries show strong growth for females relative to males, but only in the United States is this growth larger in the university sector. The difference at the post-graduate degree level is particularly marked for both sexes. An obvious possible explanation for this difference is the relatively large brain drain from Canada to the United States at the post-graduate degree level which survey evidence suggests is concentrated in the higher ability MA and PhD graduates. Results from the Survey of 1995 Graduates Who Moved to the United States, carried out by Statistics Canada, show that MA and PhD students were over-represented in the group of graduates that moved to the United States. In fact, 12% of the PhD class of 1995 moved to the United States. Survey measures designed to measure quality of the graduates suggest that those who relocated to the United States were higher than average quality.[14]

8 Conclusions

A country's human capital stock is a major determinant of its standard of living. Much of this stock in developed countries is produced in the post-secondary education sector. It is

[14]One of the main conclusions reported in *South of the Border: Graduates from the Class of '95 Who Moved to the United States* was that "those who moved did tend to be high-quality graduates," Frank and Belair (1999), p. x.

important to evaluate the contribution of the post-secondary sector to a country's total stock of human capital, but a variety of difficult problems arise in the evaluation. The fraction of a country's labour force that has a post-secondary education, often used in cross country comparisons is a potentially misleading measure of a country's human capital. According to a recent OECD ranking, this measure puts Canada ahead of the United States in per-capita human capital. This paper examines some of the problems in evaluating the contribution of post-secondary systems and presents estimates of the relative contributions in Canada and the United States for 1975-2000.

The data from the tables in the preceding sections suggest that the fraction of a population with post-secondary education may be a misleading indicator of the relative ranking of human capital stocks in Canada and the United States. Table 1 shows that, while Canada has a higher fraction of workers with a post-secondary education, this is not generally reflected in a higher share of efficiency units supplied. The data in Table 2 are consistent with the hypothesis that post-secondary schooling in the United States has added substantially more efficiency units of human capital to those making the investment than occurs in Canada. The data in Tables 4, 5 & 6 are consistent with the hypothesis that a large part of this may be due to the larger fraction of university educated at both the BA and post-graduate degree level in the post-secondary group for the United States. In addition, the gap across countries in the efficiency units difference associated with a post-secondary education grew substantially from 1980 to 2000. The evidence in Tables 6-10 suggests that an important part of this increasing gap is due to large relative gains for those with a post-graduate degree in the United States.

Finally, using estimates of the human capital price series in each country, the results in Table 11 suggest that the post-secondary systems of both countries have resulted in increases in the mean efficiency units supplied at all levels, but especially so at the university level, and for the United States, even more so at the post-graduate degree level. Relative to the no post-secondary sector, the United States shows higher amounts of human capital per capita for those with post-secondary education than is the case for Canada. The level measures used in this paper

are not directly comparable across countries, so it may still be the case that the absolute difference in human capital between those with and without a post-secondary education in Canada is greater than in the United States and/or that Canada's workers with a post-secondary education have more human capital on average. An answer to this question depends on being able to estimate the relative price of human capital in the two countries. This is beyond the scope of the present paper and is left for future work.

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Table 1

Fraction of Individuals with Post-Secondary Education and Efficiency Units Supplied

Canada and the United States: 1975-2000

	Fraction of Paid Employees		Fraction of Efficiency Units	
	Canada	United States	Canada	United States
1975		.3610		.4588
Males		.3780		.4697
Females		.3396		.4292
1980	.4374	.3967	.5144	.5001
Males	.4287	.4078	.5038	.5104
Females	.4487	.3837	.5404	.4760
1985	.4870	.4441	.5652	.5636
Males	.4763	.4475	.5535	.5705
Females	.4999	.4403	.5901	.5495
1990	.5124	.4774	.5951	.6036
Males	.4959	.4692	.5794	.6023
Females	.5309	.4862	.6245	.6059
1995	.5688	.5288	.6520	.6641
Males	.5441	.5135	.6314	.6586
Females	.5960	.5451	.6872	.6736
2000	.6006	.5503	.6875	.6969
Males	.5725	.5307	.6660	.6911
Females	.6307	.5771	.7228	.7069

Table 2

Percentage Difference in Per-Person Efficiency Units Between Paid Employees with and without Post-Secondary Education; Canada and the United States: 1975-2000

	Males		Females		Males 31-40		Females 31-40	
	Canada	US	Canada	US	Canada	US	Canada	US
	Full-Time, Full Year Workers							
1975	-	.3967	-	.3711	-	.4180	-	.4323
1980	.2713	.4052	.3642	.3247	.2443	.3797	.4195	.3906
1985	.2927	.5004	.3605	.3939	.2457	.4682	.4045	.4080
1990	.2982	.6077	.3659	.4807	.2741	.5591	.3804	.5315
1995	.3234	.6771	.3833	.5199	.2998	.6365	.3941	.6091
2000	.3635	.8286	.3818	.6167	.3828	.8073	.4155	.6671
	All Paid Employees							
1975	-	.4577	-	.4621	-	.4737	-	.5792
1980	.3530	.5139	.4448	.4588	.2880	.4507	.4907	.4914
1985	.3631	.6397	.4397	.5504	.3005	.5652	.4682	.5265
1990	.3994	.7133	.4695	.6251	.3110	.6461	.4243	.6248
1995	.4354	.8273	.4889	.7223	.3478	.7174	.4508	.7352
2000	.4887	.9784	.5265	.8118	.4074	.8666	.4819	.7334

Table 3

Fraction of Paid Employees with and without Post-Secondary Education

that have a BA Degree or Higher; Canada and the United States: 1975-2000

	Fraction of Paid Employees with BA+						Fraction of Post-Secondary with BA+					
	Total		Males		Females		Total		Males		Females	
	Canada	US	Canada	US	Canada	US	Canada	US	Canada	US	Canada	US
1975	-	.1535	-	.1695	-	.1333	-	.4252	-	.4483	-	.3925
1980	.1008	.1699	.1108	.1862	.0879	.1509	.2305	.4283	.2584	.4566	.1960	.3934
1985	.1208	.2002	.1275	.2147	.1126	.1841	.2479	.4508	.2678	.4797	.2252	.4180
1990	.1372	.2192	.1416	.2261	.1323	.2118	.2678	.4591	.2856	.4818	.2492	.4355
1995	.1646	.2397	.1623	.2428	.1670	.2364	.2893	.4532	.2984	.4728	.2803	.4337
2000	.1832	.2604	.1757	.2590	.1913	.2619	.3051	.4732	.3068	.4881	.3033	.4587

Note:

Table 4

Percentage Difference in Per-Person Efficiency Units Between Paid Employees with Different Levels of Post-Secondary Compared to those without Post-Secondary Education; Canada and the United States: 1975-2000

	Other Post-Secondary				BA Degree or Higher			
	Males		Females		Males		Females	
	Canada	US	Canada	US	Canada	US	Canada	US
	Full-Time, Full Year Workers							
1975	-	.1913	-	.1902	-	.5850	-	.5663
1980	.1599	.1801	.2432	.1687	.5408	.6075	.7770	.5188
1985	.1635	.2174	.2221	.1914	.5844	.7383	.7697	.6084
1990	.1637	.2832	.2127	.2218	.5821	.8897	.7653	.7511
1995	.1767	.2863	.2144	.2371	.6111	1.0473	.7467	.8273
2000	.1941	.3363	.2058	.2682	.7019	1.2797	.7292	.9758
	All Paid Employees							
1975	-	.1360	-	.1444	-	.8536	-	.9539
1980	.2161	.1723	.3070	.2104	.7460	.9204	1.0101	.8418
1985	.1980	.2196	.2821	.2208	.8147	1.0953	.9819	1.0091
1990	.2303	.2752	.2934	.2421	.8222	1.1845	1.0002	1.1213
1995	.2468	.3356	.2863	.3186	.8789	1.3755	1.0088	1.2496
2000	.2825	.3804	.3065	.3535	.9545	1.6055	1.0317	1.3527

Table 5

US-Canada Differences in the Percentage Gain in Efficiency Units by Education

	Any Post-Secondary vs No Post-Secondary	BA Degree or Higher vs No Post-Secondary	Other Post-Secondary vs No Post-Secondary
	Full-Time, Full Year Male Employees		
1980	.4935	.1233	.1263
1985	.7096	.2633	.3297
1990	1.0379	.5284	.7300
1995	1.0937	.7138	.6202
2000	1.2795	.8232	.7326
	Full-Time, Full-Year Female Employees		
1980	-.1085	-.3323	-.3063
1985	.0926	-.2096	-.1382
1990	.3137	-.0186	.0428
1995	.3564	.1059	.1074
2000	.6152	.3382	.3032

Table 6

The Incidence of Post-Graduate Degrees in Selected Populations:

Canada and United States, 1980-1995

	Paid Employees		Employees with Any Post-Secondary Education		Employees with a BA Degree or Higher	
	US	Canada	US	Canada	US	Canada
	Male Employees					
1980	.0806*	.0398	.1977*	.0929	.4330*	.3596
1985	.0886*	.0443	.1979*	.0930	.4125*	.3471
1990	.0940*	.0499	.2004*	.1006	.4159*	.3521
1991	.0767	-	.1601	-	.3385	-
1995	.0827	.0573	.1610	.1052	.3406	.3527
2000	.0856	.0618	.1614	.1079	.3306	.3518
	Female Employees					
1980	.0537*	.0238	.1398*	.0531	.3555*	.2707
1985	.0675*	.0288	.1532*	.0576	.3665*	.2557
1990	.0771*	.0363	.1585*	.0683	.3639*	.2742
1991	.0612	-	.1227	-	.2903	-
1995	.0687	.0464	.1261	.0779	.2907	.2778
2000	.0781	.0559	.1367	.0887	.2981	.2922

*Prior to 1991, the US data are derived from number of years completed. These overstate the incidence of post-graduate degrees.

Table 7

Percentage Difference in Per-Person Efficiency Units in the Male University Group

Canada and the United States, 1975-2000

	BA Degree vs No Post-Secondary		Post-Graduate Degree vs No Post-Secondary		Post-Graduate Degree vs BA Degree	
	Canada	US	Canada	US*	Canada	US*
	All Male Employees					
1975	-	.7667	-	1.0334	-	.1510
1980	.5988	.8329	1.0081	1.0930	.2560	.1419
1985	.6622	.9452	1.1016	1.4140	.2644	.2410
1990	.6759	1.0171	1.0913	1.5356	.2478	.2571
1991	-	1.0190	-	1.7036	-	.3391
1995	.7213	1.0505	1.1682	2.0050	.2597	.4655
2000	.8416	1.3358	1.1626	2.1514	.1743	.3492
	Full-Time, Full-Year Male Employees					
1975	-	.5241	-	.7112	-	.1227
1980	.4533	.5380	.6843	.7445	.1589	.1342
1985	.5071	.6123	.7191	1.0053	.1407	.2437
1990	.4932	.7510	.7378	1.1847	.1638	.2477
1991	-	.7429	-	1.3037	-	.3218
1995	.5150	.7905	.7803	1.5334	.1751	.4149
2000	.6217	1.0351	.8514	1.7772	.1416	.3647

*Note: Data for 1975-1990 uses adjusted average earnings for the post-graduate degree group.

Table 8

Percentage Difference in Per-Person Efficiency Units in the Female University Group

Canada and the United States, 1975-2000

	BA Degree vs No Post-Secondary		Post-Graduate Degree vs No Post-Secondary		Post-Graduate Degree vs BA Degree	
	Canada	US	Canada	US*	Canada	US*
	All Female Employees					
1975	-	.7183	-	1.6274	-	.5291
1980	.8645	.6495	1.4026	1.3466	.2885	.4226
1985	.8479	.7989	1.3722	1.5376	.2837	.4106
1990	.8568	.9118	1.3794	1.6536	.2815	.3880
1991	-	.9465	-	1.7183	-	.3965
1995	.8634	1.0333	1.3869	1.7774	.2809	.3660
2000	.8981	1.1235	1.3552	1.8925	.2408	.3622
	Full-Time, Full-Year Female Employees					
1975	-	.4215	-	.9238	-	.3533
1980	.6822	.3915	1.0130	.8065	.1967	.2982
1985	.6857	.4751	.9848	.9168	.1774	.2994
1990	.6624	.6093	1.0188	1.1071	.2144	.3094
1991	-	.6328	-	1.1438	-	.3130
1995	.6447	.6606	.9899	1.2133	.2098	.3328
2000	.6374	.7981	.9420	1.3893	.1861	.3288

*Note: Data for 1975-1990 uses adjusted average earnings for the post-graduate degree group.

Table 9

Percentage Difference in Per-Person Efficiency Units in the Male 31-40 University Group

Canada and the United States, 1975-2000

	BA Degree vs No Post-Secondary		Post-Graduate Degree vs No Post-Secondary		Post-Graduate Degree vs BA Degree	
	Canada	US	Canada	US*	Canada	US*
	Male Employees 31-40					
1975	-	.5971	-	.6681	-	.0444
1980	.4491	.5432	.6261	.7085	.1221	.1071
1985	.5208	.6513	.6436	.9963	.0808	.2089
1990	.5415	.8232	.6344	1.1302	.0603	.1683
1991	-	.8013	-	1.3104	-	.2826
1995	.6097	.8855	.7143	1.5698	.0650	.3629
2000	.7000	1.0945	.7598	1.7280	.0352	.3025
	Full-Time, Full-Year Male Employees 31-40					
1975	-	.5111	-	.6128	-	.0673
1980	.3839	.4363	.5308	.6122	.1061	.1225
1985	.4177	.5138	.5350	.8876	.0827	.2469
1990	.4553	.6965	.5618	.9978	.0732	.1776
1991	-	.6689	-	1.1897	-	.3121
1995	.5172	.7858	.6255	1.4495	.0714	.3717
2000	.6598	.9973	.7506	1.6303	.0547	.3169

*Note: Data for 1975-1990 uses adjusted average earnings for the post-graduate degree group.

Table 10

Percentage Difference in Per-Person Efficiency Units in the Female 31-40 University Group

Canada and the United States, 1975-2000

	BA Degree vs No Post-Secondary		Post-Graduate Degree vs No Post-Secondary		Post-Graduate Degree vs BA Degree	
	Canada	US	Canada	US*	Canada	US*
	All Female Employees 31-40					
1975	-	.6453	-	1.4446	-	.4858
1980	.9546	.4663	1.2227	1.1491	.1371	.4657
1985	.8474	.6223	1.1144	1.0788	.1445	.2814
1990	.7457	.7874	1.0638	1.3772	.1822	.3300
1991	-	.8272	-	1.4884	-	.3619
1995	.8092	1.0134	1.0367	1.6378	.1258	.3101
2000	.8132	1.0072	1.0503	1.5271	.1308	.2590
	Full-Time, Full-Year Female Employees 31-40					
1975	-	.4544	-	.9104	-	.3135
1980	.7512	.4271	.9371	.7979	.1061	.2598
1985	.7033	.4766	.9202	.7620	.1273	.1933
1990	.6688	.6623	.9480	1.1209	.1673	.2759
1991	-	.7044	-	1.2065	-	.2946
1995	.6821	.8026	.8550	1.3870	.1028	.3242
2000	.7018	.9079	.9194	1.4016	.1279	.2588

*Note: Data for 1975-1990 uses adjusted average earnings for the post-graduate degree group

Table 11

Rates of Growth of Mean Efficiency Units by Education: Canada and United States, 1980-2000

	No Post-Secondary		Other Post-Secondary		BA Degree		Post-Graduate Degree	
	Canada	US	Canada	US	Canada	US	Canada	US
Males 31-40	.0681	.0168	.1374	.0986	.2530	.3801	.1560	.6236
Full-Time, Full-Year	.0882	-.0141	.1710	.0764	.3051	.3710	.2444	.6084
Males 15+	.1570	.1012	.2202	.2967	.3326	.4033	.2460	.6580
Full-Time, Full-Year	.1870	.0270	.2219	.1629	.3245	.3588	.3047	.6349
Females 31-40	.4408	.3569	.4048	.3812	.3365	.8574	.3291	.5957
Full-Time, Full-Year	.2777	.1539	.2422	.2216	.2416	.5427	.2661	.5414
Females 15+	.4332	.3707	.4326	.5327	.4589	.7646	.4049	.6896
Full-Time, Full-Year	.3583	.1890	.3172	.2902	.3221	.5365	.3104	.5727

APPENDIX

I. Analysis and Adjustment for Consistency of the US Education Variables

The results in Jaeger's (1997) Table 5 show the following comparison of the numbers that result from the alternative definitions of a BA degree or higher prior to, and after January 1992:

BA+ (old defintion: 16,17 or 18 years)	=	6444
BA+ (new: BA, MA, Professional Degree, PhD)	=	6364

Thus, although there are both losses and gains with the change in definition, the net result has an over count of only 80 (1.26%) in the old definition.

There is, however, a large discrepancy when the university group is separated into BA only and post-graduate degrees. For this case the numbers show:

BA only (old definition: 16 years)	=	3759
BA only (new definition: BA)	=	4174

and

Post-graduate Degree (old definition: 17 or 18 years)	=	2685
Post-graduate Degree (new definition: MA, Prof Degree, PhD)	=	2195

The largest mis-classification within the BA+ group is 601 of those previously classified as post-graduate degree (17 or 18 years) only had a BA and 158 of those previously classified as BA only (16 years) that in fact had a post-graduate degree.

Consider adjusting the old group to the new BA only definition. This requires adding the 601 with 17 or 18 years of schooling that only had a BA and the removal of 158 with 16 years of schooling that actually had a post-graduate degree. The removal of the 158 suggests that the

mean earnings would be lowered; the addition of the 601 could go either way. They may be slow to finish a BA, or they may have done longer BA courses. Given the relatively large base to be adjusted (3759), the overall adjustment needed for a per capita human capital calculation may be small, given the potentially offsetting effects of 17 and 18 years on the adjustment. Consider next adjusting the old group to the new post-graduate definition. This is a smaller base, so the adjustment for calculating per capita human capital for this group is likely to be important. This requires removing the 601 that only had a BA, despite 17 or 18 years of schooling, and adding the 158 that had more than a post-graduate degree, despite only 16 years of schooling.

Adjustments were made to the estimates of the per-capita earnings obtained from the old definitions for comparability with the series that uses the new definitions. The adjustments adopted were as follows. The estimates obtained for the years using the old BA degree definition (16 years) were not adjusted, given offsetting effects and a large base.

$$Av(\text{true BA degree}) = Av(16 \text{ years})$$

The estimates obtained for the years using the old post-graduate degree group (17 or 18 years) were adjusted in the following way. Assume the 601 have the average human capital of the BA group; and assume the 158 have the average human capital of the post-graduate group, then:

$$Av(17 \text{ or} 18 \text{ years}) = \beta Av(\text{true post-graduate}) + (1-\beta)Av(16 \text{ years})$$

where $1-\beta = 601/2685 = .2238$, is the estimated fraction of those with 17 or 18 years that, in fact, only had a BA. Thus, the adjusted average for the post-graduate group in the earlier years are given by:

$$Av(\text{post-graduate}) = [Av(17 \text{ or } 18 \text{ years}) - .2238Av(16 \text{ years})]/.7762.$$

II. Appendix Tables

Table A1

Fraction Full-Time, Full-Year: Canada and United States, 1980-1995

	No Post-Secondary		Other Post-Second		BA or Higher		All Post-Secondary	
	Canada	US	Canada	US	Canada	US	Canada	US
	All Male Paid Employees							
1980	.5158	.5868	.5988	.6164	.7105	.8166	.6277	.7078
1985	.5204	.6039	.5826	.6316	.7050	.8152	.6154	.7197
1990	.5106	.6276	.6023	.6488	.7131	.8031	.6339	.7231
1995	.4947	.6447	.5784	.6958	.6938	.8191	.6128	.7541
	All Female Paid Employees							
1980	.3639	.4213	.4061	.4495	.4879	.5569	.4221	.4917
1985	.3833	.4552	.4188	.4750	.4873	.6244	.4342	.5375
1990	.4076	.4842	.4546	.4991	.5256	.6196	.4723	.5516
1995	.3964	.5006	.4381	.5369	.5229	.6448	.4619	.5837
	Male Paid Employees 25-34							
1980	.6062	.6667	.6735	.7340	.7183	.8161	.6870	.7750
1985	.5833	.6801	.6413	.7438	.6806	.8222	.6525	.7845
1990	.5828	.7002	.6604	.7506	.6851	.8020	.6675	.7766
1995	.5511	.7198	.6117	.7789	.6408	.8179	.6208	.7982
	Female Paid Employees 25-34							
1980	.4102	.4571	.4629	.5444	.5324	.5841	.4820	.5634
1985	.4391	.5070	.4809	.5691	.5248	.6529	.4930	.6111
1990	.4552	.5157	.5083	.6050	.5409	.6527	.5176	.6293
1995	.4377	.5626	.4834	.5951	.5171	.6810	.4945	.6375