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Human Capital and Regional Convergence in Canada

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1. Introduction

In growth theory, convergence refers to the tendency of poor economies to grow faster than rich ones. Recently, the convergence hypothesis has received considerable support from cross-country empirical analysis for the post-WWII period (Barro and Sala-i-Martin 1995, Barro 1997). The evolution of regional economies in Canada is also characterized by convergence (Helliwell and Chung, 1991, Coulombe and Lee 1993, Lefebvre, 1994, and Helliwell, 1994).[1] The growth rates of a variety of per capita income and output measures and productivity have tended to be higher in the poor provinces than in the rich ones since 1950 and the dispersion across provinces of these economic indicators is considerably smaller today than it was after WWII. Pointing out that convergence was faster for income indicators that include government transfers, Coulombe and Lee (1995) highlight the potential role of interregional redistribution operated through the working of fiscal federalism. Lee and Coulombe (1995) show that productivity across provinces has converged even more rapidly than other income or output indicators. The analysis of Coulombe and Day (1996 and 1998) suggests that, since the mid-1980s, the dispersion of per capita income and output indicators might have reached the neighborhood of its long-run equilibrium value.

The empirical evidence of convergence suggests that the neoclassical growth framework is a good candidate to explain post-WWII regional growth patterns in Canada. Convergence to a steady state that is independent of initial conditions is a key property of the neoclassical growth framework. The further an economy is from its long-run equilibrium, the faster it grows and the growth rates asymptotically decreases to its long-run level during the transition process . The convergence property follows from the law of decreasing returns to capital accumulation. Capital tends to accumulate faster in regions where it is relatively scarce.

In this paper, we show that most of the relative growth profile of per capita income across Canadian provinces since the early 1950s could be explained by the convergence process of human capital indicators. The empirical analysis is a direct application of the 'new-neoclassical

[1]The following empirical studies focus on regional convergence in Canada: Coulombe and Day (1996 and 1998), Coulombe and Lee (1993, 1995, and 1998), Helliwell (1994), Lee and Coulombe (1995), and Lefebvre (1994).

growth' model of an open economy suggested by Barro, Mankiw and Sala-i-Martin (1995) to the analysis of regional convergence in Canada. The analysis indicates that in an open economy with perfect capital mobility, the dynamics of human capital accumulation is the driving force of growth. During the convergence process, the accumulation of physical capital is driven by the accumulation of human capital, and per capita income disparities across economies are explained by disparities in human capital stock.

Section 2 focuses on the theoretical foundations of the empirical study by highlighting the role of human capital in neoclassical growth models. Speeds of convergence of human capital indicators and per capita income measures across Canadian provinces between 1951 and 1996 are estimated in section 3. Following the traditional approach in labor economics and in growth studies, we use data on educational achievements as proxies for human capital stock. In section 4, the relative evolution across the provinces of per capita income measures are explained by the provinces` initial relative endowments of human capital. We conclude by drawing some lessons for economic policy.

2. The Role of Human Capital

From a quantitative point of view, the basic Solow-Swan framework is unable to explain adequately many stylized facts observed at the cross-country level[2]. In this section, we show why the introduction of human capital might be a solution to reconcile the neoclassical growth model with stylized facts. We first underline why it is important to increase the capital share above the accounting share of profits in national income. Then, we analyze the role of human capital accumulation in the framework of an open economy with perfect capital mobility.

2.1 The Capital Share

Traditionally, the elasticity of output with respect to capital was associated with the share of profits in national income. Data on national accountings reveal that the share of profits is approximately 1/3 of national income versus 2/3 for wages. The elasticity of output Y with respect to capital K is the exponent α in the familiar Cobb-Douglas production function:

$$Y = AK^{\alpha}(Le^{gt})^{1-\alpha},$$

where g is the growth rate of labor L in efficiency unit and A is an exogenous technological variable. This production function was specifically designed to adequately explain the invariance across time and across economies of the relative share of capital and labor in national accountings.

If the elasticity of output with respect to capital accumulation is limited to 1/3, the neoclassical growth model encounters many problems in explaining important stylized facts of economic development. Two important problems deal with the magnitudes of income gaps and rate of returns differentials. If labor is homogeneous and all economies have access to the same technology, the long-run level of output per capita is determined by the saving rate and the population growth rate. International data show that the saving rate is approximately four times higher and the population growth rate roughly 2 percentage points lower in the richer countries than in the poorer countries. Such discrepancies between savings and population growth could only account for per capita income gaps in the order of magnitude of two to one between the rich

[2] On this topic, refer to Mankiw (1995).

and the poor countries. The observed gaps often exceed 10 to one. Furthermore, the model predicts that the rate of return on capital should be 100 times higher in a country 10 times poorer than the rich ones.

According to Mankiw, Romer and Weil (1992), most of the empirical problems of the neoclassical growth model could be solved if the concept of capital is broadened to include both human and physical capital. The availability of data largely explains why the earlier formulations of the neoclassical growth model focused mainly on physical capital: Only data on physical capital accumulation are provided by the national accountings. However, on theoretical grounds, the accumulation of capital should correspond to the value of all present consumption forgone for the purpose of increasing future production. Education and on-the-job-training represent forms of investment in human capital accumulation. Since the return to human capital accumulation is implicitly incorporated in wages in national accountings, the contribution of capital accumulation to output growth is underestimated if the capital share is limited to the share of profits.

Following Barro, Mankiw and Sala-i-Martin (1995), a Cobb-Douglas production with a broad capital concept could be specified as:

$$Y = AK^{\alpha}H^{\eta}(Le^{gt})^{1-\alpha-\eta}, \qquad (1)$$

where η is the elasticity of output with respect to human capital accumulation. On steady-state, η equals the share of the implicit return to human capital. On the basis of the difference between the average wage and the minimum wage in the US, Mankiw (1995) estimates that η should be approximately 1/2. The elasticity of output with respect to the accumulation of broad capital is then around 0.8. Mankiw (1995) argues that the quantitative predictions of a neoclassical growth model with a broad capital share around 0.8 are relatively consistent with most stylized facts on economic development.

2.2 Capital Mobility in an Open Economy

It is only recently that the neoclassical growth model has been extended to capture the process of capital accumulation in an open economy with capital mobility (Cohen and Sachs, 1986, Barro, Mankiw and Sala-i-Martin, 1995). The open economy framework modifies the fundamental dynamic of capital accumulation because external borrowing breaks the connection between domestic saving and investment. If there were no limit to foreign borrowing and capital was perfectly mobile, the predictions of the neoclassical growth framework would contradict most observed facts. Capital would flow instantaneously to economies where the capital- labour ratio is smaller and all economies would converge to their steady state at an infinite rate. Not surprisingly, one of the roads followed to improve the explanatory power of the neoclassical growth framework in an open economy was to introduce a constraint on international borrowing (Cohen and Sachs, 1986).[3]

The intrinsic nature of human capital provides an intuitively appealing motivation for modeling of a constraint on international borrowing. In a seminal paper that has contributed to restore the popularity of neoclassical growth models, Barro, Mankiw and Sala-i-Martin (1995) argue that investment in human capital should be financed with domestic saving because domestic residents cannot borrow abroad with human capital, or raw labor, as collateral.[4] Human capital could hardly be financed through domestic financial markets if lenders want to secure their loans. Without public intervention, human capital investment by the young could only be financed within the family circle, which requires some forms of altruism or implicit inter-generational contracts. It is even hard to have investment in human capital fully recognized by the legal system in case of divorce and assets division. Recent graduates who benefit from public financing of their education have the incentive to default on their debt because their loan could

[3] An alternative, and sometime complementary, approach is to model adjustment costs for investment. See Barro and Sala-i-Martin (1995, section 3.5).

[4] The revival of neo-classical growth theory in the 1990s, following the development of endogenous growth models, came with the empirical and theoretical works of Mankiw, Romer and Weil (1992), Barro and Sala-i-Martin (1995), and Barro, Mankiw and Sala-i-Martin (1995).

not be secured by human capital. From a general point of view, the intrinsic problem of financing investment in human capital in a free-market economy comes from the specific nature of human capital, but it is also the result of modern institutional, political, and legal organizations. The history of human beings demonstrates that other institutional arrangements regarding property rights and political status allow for the use of human capital as collateral on loans.[5]

With a binding constraint for the financing of human capital, the complementarity between the two types of capital in the production function implies that the dynamics of human capital accumulation determines, by an unidirectional causal channel, the evolution of most important macro variables during the transitory process towards long-run equilibrium. The speed of convergence of physical capital, per capita income and output, is determined by, and equal to, the speed of convergence of human capital. If initially, the human capital/labor ratio is below its steady-state level, the physical capita/labor ratio would only gradually adjust to its steady-state value even if physical capital is perfectly mobile across regions.

Consider the example of a region where the physical capital/labor ratio is below the national average. If physical capital and labor are the only two factors of productions, one must conclude that the marginal product of capital is higher in this region than elsewhere and one would expect capital (financial capital or direct investment) to flow from the rest of the economy to this region. However in the framework set out by Barro, Mankiw and Sala-i-Martin (1995), the relative scarcity of human capital in the poor region translates by a rapid decrease in the marginal product of physical capital. Consequently, during the transition towards steady-state, the marginal product of capital is the same in the poor region than elsewhere, even if the physical-capital-labour ratio is smaller. Barro and Sala-i-Martin (1995, section 3.2.3) show that the equalization of the rate of return on physical capital across economies implies that the physical

[5] The financing of human capital accumulation in financial markets or by direct investments could be achieved without the intervention of the state in slavery or colonial regimes.

capital/output ratio will be constant during the transition process.[6] This is precisely one of Kaldor's (1963) "stylized facts" regarding economic development.

In a federal system, the centralized funding of education might relax the assumption that investment in education has to be financed by regional domestic saving. In Canada, the Federal government has established an ambitious program of interregional redistribution with the development of the welfare state in the post-WWII period. One of the purpose of interregional redistribution was to assist the provinces in the financing of higher education. But even if important resources are redistributed through the working of fiscal federalism, the dynamic process of human capital accumulation will be the driving force of regional growth if physical capital cannot be financed freely on international markets. The speed of convergence of poor provinces to the rich ones will then be determined by the incentive to invest in education in the poor provinces. As this study will show, the relatively slow speed of convergence observed at the regional level in Canada since the 1950s, despite the amounts involved in interregional redistribution, might be explained by the fact that most of the investment in education is made by young people, only a subset of the population.

Perfect capital mobility, for the financing of nonhuman capital, is one of the key premises of the Barro, Mankiw and Sala-i-Martin (1995) framework. We briefly look at the realistic nature of this assumption for the case of the Canadian provinces before testing the model empirically. On institutional grounds, one must recognize that barriers to capital mobility across provinces are practically inexistent. The Canadian financial system is mainly made up of large multi-branch banks that can redistribute savings across regions. Since regions are relatively homogeneous on cultural, political, and social grounds, Québec and the rest of Canada being a notable exception from the point of view of language, capital should flow freely to finance the most profitable investments. For a given risk, rates of return on physical capital should be equalized across regions.

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[6] Note that the discussion in Barro, Mankiw and Sala-i-Martin (1995, p. 108) regarding the evolution of the capital/ labor ratio during the transitory process is incorrect since Barro and Sala-i-Martin (1995, section 3.2.3) demonstrate algebraically the constancy of the capital/labour ratio for the case of a Cobb-Douglass production function.

From an empirical point of view, the assumption of perfect capital mobility cannot be tested directly. Since Feldstein and Horioka (1980), a common test of the assumption is to look at the correlation between investment and domestic saving across countries. If capital is not free to move geographically, one should observe a positive correlation between domestic saving and investment since the later is constraint by the former. On theoretical grounds however, this approach has been widely criticized.[7] Barro, Mankiw and Sala-i-Martin (1995) demonstrated that in their neoclassical growth framework with perfect capital mobility and a credit constraint on human capital, the Feldstein-Horioka correlation should be observed on steady-state across economies that differ only from taxation rates.

Despite the theoretical problems of the Feldstein-Horioka approach, Brown (1992) concludes that capital is more mobile across Canadian provinces than across OECD countries on the basis of a Feldstein-Horioka empirical analysis. In Appendix A, correlations between investment and domestic saving across Canadian provinces and across countries are presented for illustrative purposes. Results are compatible with Brown's (1992) findings. Contrary to what is observed at the cross-country level, correlation coefficients between domestic savings and investment are not significantly different from zero across Canadian provinces. We do not however interpret these results as an empirical proof of the assumption of perfect capital mobility across Canadian provinces. Notwithstanding our prudent interpretation of the very indirect testing of this crucial assumption, we think that perfect capital mobility is a palatable working assumption for the analysis of long-run regional growth in Canada.

[7] See for example Tesar (1991).

3. Convergence of Human Capital and Per Capita Income.

In this section, we estimate and compare the convergence speed of alternative indicators of human capital and per-capita income across Canadian provinces during the 1951-1996 period. We begin with a brief discussion of the problems associated with the measure of human capital.

3.1 The Measure of Human Capital.

As explained above, given its intrinsic nature, human capital is not exchanged in markets. That complicates the economic measurement of human capital. An ideal measure of human capital, that would include both educational achievement and on-the-job-training, does not exist and one has to rely on proxies. Fortunately, in this study, the empirical analysis relies only on relative measures, across provinces, of the stock of human capital. Most of the problems associated with the imperfect measure of human capital are then overturned. Our indexes of human capital are based on the census data that measure the percentage of the population who have at least achieved a given level of education. Even though this approach to evaluate human capital is widely used by labor economists (Romer, 1993), it is not a perfect measure and some problems associated with it need to be discussed.

One can argue that the determinant of growth dynamics is the stock of human capital of the labor force, not of the total population. Since it is practically impossible to account for the entries and exits in the labor pool, it is much tractable to construct a measure of the educational achievement of the total population.[8] As discussed by Barro and Lee (1993), it might be important to account for the quality of education, not only for the number of years at schooling. The heterogeneity of educational systems complicates the comparison of educational achievement indexes across different institutional frameworks. This problem however in not very important for comparing educational achievement across Canadian provinces since their educational systems are fairly homogeneous. Moreover, one could argue than in order to build an exact index of human capital, one should weight appropriately the different levels of

[8] However, part of the investment in human capital follows from non-market activities within the family circle and one could argue that the human capital of non-participating members is an input in the human capital accumulation process.

education. It is very difficult however to determine which weights to give to different levels of education. Barro and Lee (1993) argue that one might try to weight each level of education with its average market return. They acknowledge however that such approach might introduce a bias since, on the one hand, the level of education is likely to be positively correlated with individual skills and, on the other hand, market returns of education exclude external benefits generated by human capital.

Even though everyone concedes that on-the job-training contributes to human capital, it is very difficult to measure. Efforts spend by employers and employees for training provide information for investment flows and could not be easily compared with data on educational achievement. Even though measures of the stock of human capital acquired through on-the job-training were available, one would have to determine the appropriate weight of formal education and on-the-job-training in order to combined them in an aggregate measure of the human capital stock . This appears to be a non-palatable exercise, to say the least. Psacharopoulos and Arriagada (1986) argue that for the U.S., the number of workers participating in on-the-job-training activities is almost equal to the number of students in colleges and universities. This fact, as valuable as it is, does not provide much information on the relative weight of on-the-job-training in the production process.

When interpreting the results of the empirical part of this study, one should bear in mind the various difficulties encounter to measure the human capital stock of an economy.

3.2 A Look at the Data and σ-Convergence

The indicators of human capital come from Statistics Canada census data on educational achievement. We use all the information available on a consistent basis since 1951. Given the format of the first census questionnaires, it is possible to build an index going back to 1951 for the ten provinces based on the percentage of the population (15-years and over, 15 to 24-years, and 25-years and over, for males, females and population of both sexes) who have <u>at least</u> achieved two alternative benchmark levels of education: Grade 9 and a university degree. The data are available for the censuses of 1951, 1961 and 1971, and, since, for every five years up to 1996. Such indexes based on the percentage of the population with at least a benchmark level of

education might not be very useful for measuring the total stock of human capital in an economy. However, it is an interesting measure for our empirical analysis that focuses only on relative levels for a province, with respect to the average of the 10 provinces, of alternative indicators of human capital. For the case of the population 15-years and over, the trends in human capital indicators for the 10 provinces are depicted in Figures 1 and 2.

Insert Figures 1-2.

A clear convergence pattern emerges for the visual analysis of the two Figures.[9] On average, the provinces which were lagging behind in terms of educational achievement seem to get closer to the average during the period. The provinces which were initially better endowed tend to come back to the average. Following Barro and Sala-i-Martin (1995), the concept of σ-convergence, σ refers here to the standard-deviation of the economic indicators cross-sectional distribution, can be used to qualify the evolution through time of the dispersion of human capital indicators. σ-convergence is said to occur if the dispersion of the cross-sectional distribution tends to decrease through time.

Insert Figure 3.

The dispersion of the two human capital indicators across the provinces, shown in Figure 3, unambiguously demonstrates a tendency to decrease through time during the entire period. Regarding the indicators based on university education, the standard-deviation decreases from 45.5% in 1951 to 16.4% in 1996. Since we are using relative indexes, the standard deviation can be interpreted as a coefficient of variation and, for the actual discussion, numbers are translated in %. For the indicator based on grade 9, the standard deviation decreases from 17.5% to 4.2%.

[9] The analysis presented in section 3 is robust with respect to alternative educational achievement indexes that are available since 1971 only. The main results for the convergence of human capital indicators for alternative age groups and sexes apply to the percentage of the population with at least some post-secondary education since 1971.

The detailed analysis by province reveals some interesting facts. Provinces with higher per capita income, Ontario, and B-C, have a better educated population. In general, provinces with lower per-capita income are below average in terms of educational achievement. Nova-Scotia and Québec are however two notable exceptions regarding the university education indicator. For Québec, the evolution of the indicators based on grade 9 and university education behave asymmetrically. Regarding the grade-9 indicator, Québec behaves like the other relatively poor provinces with, initially, a below average index of human capital. The indicator gets closer to the provincial average, from 82.7% to 93.8%, between 1951 and 1996. However, form the point of view of university education, Québec's indicator starts clearly above the average, like the rich provinces. So in 1951, Québec was very well endowed in specialized labor but general or basic education was lacking. Coulombe (1998) suggests that this interesting phenomenon could be explained by the elitist nature of the educational system in Québec, before the reforms of the 1960s, and to the large exodus of the Anglophone population in the 1970s, a population typically well educated.[10]

3.3 β-convergence of Human Capital

During the transitory period toward steady-state, Barro and Sala-i-Martin (1995, chap. 2) demonstrate, from a log-linear approximation in the neighborhood of steady-state, that per-capita output (in effective units of labor) at time t, y_t, is a weighted average of its initial level y_0 and its steady-state level y^*:

$$\ln y_t = e^{-\beta t} \ln y_0 + (1 - e^{-\beta t}) \ln y^* \qquad \textbf{(2)}$$

This is the fundamental dynamic equation for the analysis of β-convergence in the neoclassical growth framework. The parameter β is the speed of convergence toward steady-state and it is a function of exogenous variables such as preferences, the depreciation rate, the rate of population growth, the rate of growth of technological progress, and the share of capital. As shown by

[10] Detail analysis of census data indicates that the better educated Quebeckers in 1951, relative to the other provinces, were the male population, 25-years and over.

Barro, Mankiw and Sala-i-Martin (1995), this equation could be used to model the evolution of per capita output in an open economy model with a broad concept of capital and a constraint on human capital financing. Under the assumptions of a Cobb-Douglas production function and a constant and exogenous world interest rate, Barro, Mankiw and Sala-i-Martin (1995) demonstrate that the production function could be modified in the following form:

$$y = Bh^{\frac{\eta}{1-\alpha}}. \qquad \textbf{(3)}$$

B, a constant term, is a function of exogenous variables (independent of the capital/labor ratio) and *h* is the human capital/labor ratio (in effective units of labor). Since the production function exhibits constant returns to scale, $\alpha+\eta$ is smaller than one and decreasing returns apply to capital accumulation. The open economy with a credit constraint on human capital behaves like a closed economy with a broad capital share of $\eta/(1-\alpha)$. It could be shown that the capital/labor ratio follows the transitory dynamics imposed by the accumulation of human capital. From equation (2) and (3), one gets the equation that describes the dynamics evolution of the human capital/labor ratio:

$$\ln h_t = e^{-\beta t}\ln h_0 + (1-e^{-\beta t})\ln h* \qquad \textbf{(4)}$$

The human capital/labor ratio at time *t*, as for output per worker, is a weighted average of its initial level h_0 and its steady-state value *h**. The evolution of the human capital/labor ratio can then be described by the same type of equation as the one usually used for estimating the convergence speed β of per-capita output. Furthermore, the predicted speed of convergence of human capital (β) is the same as the one predicted for per capita output.

The hypothesis of **conditional convergence** refers to the case when a cross-section of economies converges to different steady-state values for y^* and h^*. In this case, when estimating β-convergence, additional variables have to be included on the right-hand side of the regression equation like (5) in order to capture the steady-state determinants that differ across economies. Variables used for cross-country empirical analysis of conditional convergence are: saving rates,

growth rates of the population, and variables capturing heterogeneous social and political institutional frameworks. Barro (1997) concludes that the hypothesis of conditional convergence cannot be rejected for a large set of developed and underdeveloped countries. In this study, the empirical analysis of β-convergence for the Canadian provinces is based on the hypothesis of **absolute convergence**. In this case, the speed of convergence is estimated under the assumption that the different economies converge to identical steady-state values. For the analysis of growth patterns within regions of the same country, there is good evidence of absolute convergence for the U.S. States since 1880, for the Japanese Prefectures since 1930, and for the regions of eight European countries since 1950 (Barro and Sala-i-Martin, 1995, chapter 11). This phenomenon is interpreted as evidence that, contrary to a cross-section of countries, regions within a country share important determinants that account for different long-run equilibrium levels of economic indicators (Aghion and Howitt, 1998, section 1.5.2). In Canada, empirical studies following different methodologies, conclude that the hypothesis of absolute convergence cannot be rejected for the ten provinces for alternative indicators of per capita income, output and productivity (Coulombe and Lee (1993, 1995), Lee and Coulombe (1995), Lefebvre (1994) Coulombe and Day (1998)).

Equations (2) and (4) could be tested using a cross-section of economies, a time series of data for an economy, or by pooling time-series and cross-section observations. In this paper, for estimating the average convergence speed of various indicators across the Canadian provinces, we use a variant of the Barro and Sala-i-Martin (1991, 1992) cross-section technique proposed by Coulombe and Lee (1995) and Coulombe and Day (1996) for the purpose of increasing the degrees of freedom in the study of small samples of economies. The idea is to pool cross-section (the provinces) and time-series observations during the 1951-1996 period in order to use all the available information regarding relative regional growth. The 1951-96 sample is divided into five sub-periods. Given the change in the frequency of census observations, from 10 years to 5 years in 1971, we have to use a mix of ten-year periods and at least one five-year period in order to cover the entire period of the survey. We chose to divide the sample in four ten-year periods and one five-year period. As shown in Appendix B, the results are robust to alternative divisions of sub-periods. With five sub-periods and ten cross-section observations, we have 50 pooled

time-series and cross-sections observations. The estimated equation for the convergence speed β of the human capital indicators *h* is:

$$\frac{1}{10}\ \ln\left(\frac{h_{i,\,t+P}\ /\ H_{t+P}}{h_{i,\,t}\ /\ H_{t}}\right)\ =\ -\left(\frac{1\ -e^{\,-M\beta_h}}{M}\right)\ \ln\left(\frac{h_{i,\,t}}{H_{t}}\right)\ +\ u_i, \qquad (5)$$

where the subscript *i* denotes the province, H denotes the un-weighted provincial average[11] of the human capital indicator and u_i represents the error term. *P*, the length of the period, equals 10 when the date *t* is set to 1951, 1961, 1971, and 1981 and *P* equals 5 when t is set to 1991. *M* is set to 9, the average length of the sub-period, in the coefficient on the right-hand side, in order to obtain estimates of β that could be interpreted as annual speed of convergence. Note that the proposed estimation technique gives the same importance to the information contained in a ten-year period as that in a five-year period. Following Coulombe and Lee (1995), we exclude the common trend component by dividing the provincial indexes by the provincial average. Since both the independent and the dependant variables are measured as deviations from the sample mean, the constant term in the right hand-side of the equation equals zero. Equation (5) is first estimated using linear least-squares and then the speed of convergence β is computed from the value of the estimated coefficient following the non-linear formula specified in equation (5). Estimation results are presented in Table 1 for 18 indicators of human capital based on the percentage of the population according to the age group, the sex, and the benchmark level of education.

Insert Table 1

First, a key finding is that the null hypothesis of no-convergence (β = 0) could be rejected at the one percent level for all indicators. Thus, indicators of human capital have grown faster

[11]The empirical analysis is robust with respect with the use of the national average, i.e., the weighted provincial average, for calculating ratios in convergence equations. The use of an un-weighted provincial average follows from the well-established custom in convergence studies to give equal weight to cross-section observations.

since 1951 in the provinces that were originally less endowed in human capital. The high t-statistics for the 18 indicators illustrate the robustness of this result.

Second, it is interesting to note that the estimated speed of convergence varies considerably for alternative indicators. On theoretical ground, Barro, Mankiw and Sala-i-Martin (1995) have demonstrated that, in the framework of their open-economy neoclassical growth model with a credit constraint for the financing of human capital, the speed of convergence of per capita output and human capital should be in the interval [0,014; 0,035]. Estimated convergence speeds for the human capital indicators for the population 15 years and over and 25 years and over are in the neighborhood of the upper bracket of this interval. Convergence speeds are however much faster for the 15 to 24 years. It is also interesting to note that convergence speeds are slightly faster for the females than for the males in the 15 to 24 years. We have computed a Wald statistic to test the null hypothesis $\beta_1 = \beta_{2,}$ where β_1 and β_2 are the convergences speed of two independent samples. For this test, the Wald statistics W is defined as:

$$W = (\beta_1 - \beta_2)^2 / (V_1 + V_2)$$

where V_1 and V_2 are the estimated variances of β_1 and β_2 [12]. The Wald statistics are presented in Tables 2 and 3.

Insert Tables 2 and 3

The results regarding the comparison of the convergence speeds between the 15-24 years and the 25 years are intuitively appealing (Table 2). The null hypothesis is rejected at the 5 percent level in all cases. Thus, the convergence speeds of human capital indicators are significatively faster, from the statistical point of view, for the 15-24 years than for the 25 years and over. This indicates that, if the total population had behaved like the young people in the 15-24 years group, estimated convergence speeds for the total adult population might have been two to three times faster. Based on those findings, one could provide a new interpretation to the relative slowness of the speed of convergence estimated for alternative samples of regional and national economies as in Barro and Sala-i-Martin (1995). If investment in human capital is the driving force of the convergence process, the slowness of the catch-up process could be imputed

[12] Regarding the Wald test, refer to Greene (1993, section 4.8.3b).

to the fact that an important portion of the total population does not have a clear incentive to invest in education. The opportunity cost for investing in education is usually higher for the population over 25 years of age and the expected return of the investment decreases when people get older.

Regarding the analysis of Table 3, the null hypothesis of equality of the estimated convergence speed across sexes cannot be rejected for 5 of the 6 cases. There is one notable exception however, the convergence speed of females is two times faster for the 15-24 age group for the percentage of the population with at least grade 9.

3.4 Comparison of convergence speeds of per-capita income and human capital indicators

We use the same methodology than employed for human capital to estimate the convergence speed of per-capita income across the Canadian provinces during the 1951-1996 period. Two alternative measures of income are used: Personal income, and personal income minus government transfers.[13] The following equation was estimated using linear least-squares:

$$\frac{1}{10}\ln\left(\frac{y_{i,\,t+P}\ /\ Y_{t+P}}{y_{i,\,t}\ /\ Y_{t}}\right) = -\left(\frac{1-e^{-P\beta_y}}{P}\right)\ln\left(\frac{y_{i,\,t}}{Y_{t}}\right) + u_i \qquad (6)$$

Y is the provincial average of per-capita income indicator y and β_y is the convergence speed of income. Five-year periods are used and P is set to 5. Results are presented in Table 4.

Insert Tables 4 and 5

For the two measures of income, the null hypothesis of no-convergence is rejected at the 5 percent level. As first shown by Coulombe and Lee (1995) for the period 1961-1991, the convergence speed is slower when government transfers are subtracted from income. This was interpreted by the redistributive effect of the fiscal federalism and the tax-transfers system.

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[13] The data for personal income come from CANSIM series D11701-D11710 and those for government transfers from various series in Statistics Canada catalogue No. 13-213. Details available on request.

As predicted by Barro, Mankiw and Sala-i-Martin's (1995) framework, convergence speeds of human capital and per capita income should be equal. The Wald statistics to test for the equality between the convergence speeds of alternatives indicators of human capital on the one side, and the convergence speed of the post- and the pre-transfers measures of income on the other are presented in Table 7.

The null hypothesis is easily rejected for all the convergence speeds estimated for human capital indicators of the 15-24 years. This result is not surprising since the human capital indicators of the 15-24 years are certainly bad proxies for the overall level of human capital in a regional economy. On the other side, for the population 25 years and over, the null hypothesis of equality between the convergence speeds of income and human capital could not be rejected at the 5 percent level whatever the sex groups, the benchmark level of education, and the income measure used. The same finding applies for the population 15 years and over with one notable exception: The null hypothesis could be rejected at the 5 percent level whatever the sex group when one considers the human capital indicator based on the population with at least grade 9 on the one side and per capita income minus transfers on the other side. This result suggests that the human capital indicator based on the percentage of the population with at least grade 9 might not be an appropriate proxy for the overall level of human capital in the framework of Barro, Mankiw and Sala-i-Martin (1995).

4 The Contribution of Human Capital to Regional Growth

The purpose of the exercise is three-fold. First, the analysis of section 3 does not establish a direct relationship from human capital accumulation to the convergence of income per capita. The convergence of both human capital and per capita income might be only coincidental if, initially, the well-endowed provinces in human capital were the ones with per-capita income below the national average. By testing directly a transformed version of the production function (3), we are measuring in this section the contribution of the human capital accumulation process to the relative growth of per capita income in the 1951-1996 period. Second, we are able to provide an estimation of the elasticity of national income to human capital, i.e., the share of human capital in national income on steady-state, with a transformation of the estimated

coefficient of human capital in the production function. Third, by comparing the estimation results for alternative indicators of human capital, we can highlight which one is the best predictor of relative income growth at the regional level.

Taking the logarithm of equation (3), the per capita income of province i with respect to the provincial average could be expressed as a function of the ratio of the human capital stock of province i to the provincial average:

$$\ln\left(\frac{y_{it}}{Y_t}\right) = \left(\frac{\eta}{1-\alpha}\right) \ln\left(\frac{h_{it}}{H_t}\right) \qquad \textbf{(3')}$$

The physical capital share α is measured residually from non-wage income in the national accounts. This share, which is relatively constant through time, averaged 0.287 between 1951 and 1996.[14] The elasticity of output with respect with human capital η can be estimated by equation (3') based only on the relative measure of human capital, an interesting feature again since most of the criticisms of the measure of human capital do not apply when relative measures are used. Equation (3') is estimated by pooling time-series and cross-section observations for the ten provinces and the eight censuses between 1951 and 1996. Here again, the same importance is given to ten-years and five-years periods. As a measure of the human capital stock, we use 18 alternative indicators based on educational achievement of the two benchmark levels (grade 9 and university degree), for three age groups (15 years and over, 15-24 years, and 25 years and over), and, for both sexes, males, and females. Estimation results are presented in Table 6 for the pre- and the post-transfers measure of national income.

Insert Table 6 here

For all indicators of human capital, whatever the subgroup of the population considered, the t-statistics are very high indicating that the accumulation of human capital at the regional level has a significant effect of the convergence on the two per-capita income measures since

[14] For this calculation, we exclude agriculture incomes for which the relative contribution of profits and wages are difficult to separate. The accounting measure varies between 0.33 and 0.25 in the period under study. Data come from Statistics Canada catalogue 13-531.

1951. Many interesting findings emerge from the detailed analysis of Table 6. First, comparing the numbers between the pre- and the post transfers measures (comparing columns 1 to 3, and 2 to 4), one can see that the estimated income-share of human capital is higher for all indicators when transfers are excluded from national income. This result is not surprising since it indicates that investment in education increases the potential to earn labor income and decreases the dependency on income support programs.

Second, the estimated output-share of human capital is very high, in the neighborhood of one, when the grade-9 benchmark level of education is used as a proxy of human capital. If those estimates indicate the actual contribution of aggregate human capital investment to output growth, the sum of the coefficients α and η would be largely superior to one. In this case, the accumulation of both physical and human capital generates increasing returns. This does not mean however that increasing public investment in basic education will generate increasing returns to scale since, nowadays, virtually all Canadians reach at least grade 9. In order to generate increasing returns to scale, the human-capital/labor ratio has to be increased. A detailed analysis of census data indicates that since 1991 the standard deviation across the provinces for the population 15 to 24 years of this indicator of basic skills is extremely low, around 1.5%. Since this number is still below the standard deviation for the population 15 years and over, 4.2% in 1996, one should expect, *ceteris paribus,* further decrease in the dispersion of per capita income in Canada as the population without grade 9 eventually leaves the labor market as they get older.

Third, maybe the most important point that comes out of the analysis, is related with the points estimates of the income elasticity of human capital based on university degree (the last column). The point estimates of η for the population 15 years and over, and 25 years and over, for both sexes and male, are around 0.5 with a confidence interval at 95% typically between 0.42 and 0.57. Those estimates coincide with Mankiw's (1995) estimate of the human capital share for the US base on the gap between the minimum wage and average wage. Furthermore, regressions using this indicator of human capital provide the higher R^2; between 0.71 and 0.73. Such R^2 are very high given that the regression does not include a constant term or a dependant lagged-variable on the right-hand side. Slightly more than 70% of relative per-capita income

growth across the Canadian provinces since 1951 could then be explained by the catch up in human capital stocks as measured by the advance-education indicator. That leaves, at most, 30% for the other factors combined! This result corroborates Barro and Sala-i-Martin (1995) and Barro (1997) findings that, at the cross-country level, investment in advanced education is one of the most important determinants of long-run growth. Overall, the analysis indicates that the best proxy of human capital for the purpose of regional economic growth in Canada is the indicator based on university education of both sexes, or the males only, for the population 25 years and over, or 15 years and over. Point estimates for the female population are smaller.

Finally, if one accepts that the best proxy for the overall human capital stock is the percentage of the population with at least a university degree, the analysis suggests that regional economies are facing decreasing returns to the accumulation of broad-capital, as assumed in the neoclassical growth framework. On theoretical ground, the critical value of η is 0.71 since α is set at 0.29 from the national accounting share of profits. In an AK model of endogenous growth (see Aghion and Howitt, 1998, section 1), $\alpha+\eta$ equals 1 and the accumulation of capital is a long-run source of growth. If $\alpha+\eta$ is smaller than 1, the economy is facing decreasing returns to capital accumulation and convergence should be observed when some economies are lagging behind in terms of capital accumulation. Since convergence is observed for both the human capital stock and per capita income, the endogenous growth assumption of $\alpha+\eta=1$ should be rejected for the sake of internal consistency of the results. From the confidence intervals at 95%, one can see from Table 6 that the endogenous growth assumption is rejected for all indicators of human capital based on advance education.

5 Conclusion

The convergence of per-capita income, output and productivity indicators across the Canadian provinces in the post-WWII period is now a well-established fact. However, little empirical analysis has been done before to explain this phenomenon. The explanation matters because convergence of per capita income is consistent with alternative economic frameworks. For example, as pointed-out by Aghion and Howitt (1998, chapter 2), the Schumpeterian approach to endogenous growth, when the model is extended to capture technology transfers, is consistent with convergence across a set of economies. In order to directly relate the convergence process to neoclassical growth and decreasing returns, convergence has to be related to the dynamic accumulation process of capital. The key contribution of this paper is to show that convergence across the Canadian provinces could be explained by the dynamic accumulation of human capital as predicted by the open-economy version of the neoclassical growth framework à la Barro, Mankiw, and Sala-i-Martin (1995). By doing this, this study shed new light on an old Canadian problem. The study contributes to the understanding of regional disparities and clearly indicates directions for economic policy that would aim at alleviating the consequences of the old Canadian problem.

From a quantitative point of view, our findings suggest that the effect of human capital accumulation is not a minor factor, among others, that could explain the relative evolution of regional economies in Canada. By itself, the human capital catch-up process, based on the advance education indicator, explains roughly 70% of the relative evolution of per-capita income since 1951 across the Canadian provinces.

From this paper, a new story comes out for explaining the slow process of convergence across the Canadian provinces observed since 1951 despite the well integrated financial networks, the mobility of physical capital, and the interregional redistribution of resources. Despite the relative scarcity of physical capital in the poorer regions, capital did not flow to these regions because the availability of a well-educated population is a necessary requirement for the productivity of machines. Private markets in Toronto cannot finance the investment in advanced education by a bright young Newfoundlander because he cannot use human capital as a collateral on a loan. Since a subset only of the total population, the young, has a clear incentive to invest

in education, the catch up process of human capital is slowed-down by the stock effect of the less-educated older people who remains in the poorer provinces. One of the findings of this paper is that the convergence speed might have been two to three times faster if all persons had invested in education at the same rate as the young did.

Outside a restraint circuit, individuals have difficulty finding funds to finance their investment in education because of a credit constraint. However, within a federal state, the central government could redistribute resources that could be used to finance investment in education at the regional level. In Canada, throughout the 1950s, 1960s, and 1970s, with the rise of the welfare state and the creation of massive interregional redistribution programs, like equalization payments, unemployment-insurance and the joint-financing of public spending in education, health, and social assistance, the relatively poor provinces have been able to build a public infrastructure that could compare, in quality, with the one of the richer provinces. Coulombe and Day (1998) illustrate that, just after WWII, per capita income disparities across the Canadian provinces were much larger that the ones then observed across the US border states. Economic development seems to have spread out more evenly just south of the Canadian border. Goldin and Katz (1997) relate regional economic growth in the US in the first part of the century to the phenomenal public investment in secondary education in the Far West, the Great Plains, and parts of New England between 1910 and 1940. They show that secondary enrolments were much higher in the US border states at that time than in their Canadian provinces directly to the north. According to Coulombe and Day (1998), the gap in the dispersion index across the provinces and across the border states have gradually decreased since the 1950s. One should note that this catch-up phenomenon coincides with the set-up of the interregional redistribution scheme in Canada. The analysis in this paper does not provide a direct test of the relationship between interregional redistribution and regional convergence. However, it provides an analytical framework that stresses the unidirectional causal relationship between the financing of education and the catch-up process of human capital and per capita income of underdeveloped regions.

Migration is an important phenomenon that has to be added in further research to the analytical framework if one wants to have a more complete picture of the relationship between

human capital and regional growth in Canada.[15] The complete model has to take into consideration some important stylized facts regarding interregional migration in Canada. For example, it is well known in Canadian empirical studies on migration that the younger and better educated people in the poor provinces tend to migrate to richer provinces.[16] This phenomenon by itself can potentially slow-down the convergence process. What this study shows however is that convergence of a variety of human capital stock indicators has been observed at the regional level in Canada since 1951 despite the 'brain drain'.

From an economic policy perspective, our study emphasizes the key roles of public administration in financing education and redistributing resources at the regional level. If investment in education is the driving force of regional convergence, governments have a role to play in promoting regional development since the financing of education is constrained by institutional factors. At the individual level, the financing of education is often limited to a person's family. The government can alleviate this constraint with a variety of programs aimed at lowering the cost of education and/or lending money directly to students, or by guaranteeing loans. For local administrations (municipalities, universities, colleges and school boards) the provincial and the federal governments could redistribute resources on a geographical basis for the purpose of improving local public infrastructures. Since the young and well educated tend to migrate from the poor to the rich provinces, the redistributive function of fiscal federalism should prevent provincial governments in poor provinces from under investing in advanced education since part of the local benefits of public investment in education is lost from a regional point of view.[17] In order to achieve this goal, transfers from the federal government to the provinces should be related to the amount actually spend in education at the provincial level. But, since

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[15]Migration has been introduced in recent studies on growth (Braun, 1993 and Barro and Sala-i-Martin, 1992). Braun's (1993) Ph.D. dissertation is analyzed in Barro and Sala-i-Martin (1995, chapter 9). Those models however are not directly applicable to the study of regional growth in Canada following the analytical framework proposed in this paper.

[16] For a recent study, see Cousineau and Vaillancourt (1997).

[17] The problem of the lost of regional resources from public spending on advanced education generated by the brain drain is not new. Lacroix and Proulx (1973) estimated the loss by the poor provinces and gain by the rich ones resulting the mobility of the well educated.

1977, with the creation of the Established Programs Financing, this is not the way inter-government transfers have been designed in Canada. Recent modifications introduced with the Canadian Health and Social Transfer have done nothing to prevent the provinces from spending on health or on social security the resources transferred from the Federal government for post-secondary education. If education is the key to economic growth, education policy should be designed to provide the appropriate incentives.

References

Aghion, P., and P. Howitt, 1998, *Endogenous Growth Theory*, MIT Press, Cambridge.

Barro, R., 1997, *Determinants of economic Growth: A Cross-Country Empirical Study*, MIT Press, Cambridge.

Barro, R. and J. W. Lee, 1993, "International Comparisons of Educational Attainment", *Journal of Monetary Economics*, 32, p.363-394.

Barro, R. and X. Sala-i-Martin, 1991, "Convergence Across States and Regions", *Brookings Papers on Economic Activity*, 1, p.107-158.

_____, 1992, "Convergence", *Journal of Political Economy*, 100, p.223-251.

_____, 1995, *Economic Growth*, McGraw-Hill, New-York.

Barro, R., G. Mankiw and X. Sala-i-Martin, 1995, "Capital Mobility in Neoclassical Models of Growth", *American Economic Review*, 85, 1, pages 103-115.

Braun, J., 1993, Essays on Economic Growth and Migration", Ph.D. Dissertation, Harvard University.

Brown, D.M., 1992, "Efficiency, Capital Mobility, and the Economic Union", In *Free to Move: Strengthening the Canadian Economic Union*, C.D. Howe Institute, Toronto.

Cohen, D. and J. Sachs, 1986, "Growth and External Debt under Risk of Debt Repudiation", *European Economic Review*, 30, 3, juin, p.526-560.

Coulombe, S., 1998, "A Perspective on Regional Growth Patterns", Forthcoming, The C.D. Howe Institute.

Coulombe, S. and K. Day, 1996, "β-convergence, σ-convergence, and the Stationnary-State Level of Regional Disparities: the Case of Canada", cahier de recherche, Université d'Ottawa, no.9608E, juillet.

Coulombe, S. and K. Day, 1998, "Economic Growth and Regional Income Disparities in Canada and the Northen United States", mimeo, University of Ottawa.

Coulombe, S. and F. Lee, 1993, "Regional Economic Disparities in Canada", *University of Ottawa Research Paper* 9317E.

_____, 1995, "Convergence Across Canadian Provinces, 1961 to 1991", *Canadian Journal of Economics*, 28, 886-898.

_____, 1998, "Évolution à long terme de la convergence régionale au Canada", *L'Actualité économique - revue d'analyse économique*, 74, 5-27.

Cousineau, J. M. and F. Vaillancourt, 1997, "Regional Disparities, Mobility and labor markets in Canada", Mimeo, Université de Montréal.

Feldstein, M. and C. Horioka, 1980, "Domestic saving and international capital flows", *Economic Journal*, 90, 314-329.

Goldin, C. and L. F. Katz, 1997, "Why the United States Led in Education: Lessons from Secondary School Expansion, 1910 to 1940," Working Paper 6144, *National Bureau of Economic Research*, August.

Greene, W. H., 1993, *Econometric Analysis*, Prentice-Hall, Englewoods Cliffs.

Helliwell, J. F. and A. Chung, 1991, "Are Bigger Countries Better Off?", in R. Boadway, T. Courchene and D. Purvis, eds., *Economic Dimensions of Constitutional Change*, John Deutsch Institute, Kingston, 345-367.

Helliwell, J., 1994, "Convergence and Migration among Provinces", *PEAP Policy Study*, 94-2, Institute for Policy Analysis, University of Toronto.

Lacroix. R. and M. Proulx, 1973, "Une évaluation partielle des pertes et des gains des provinces résultant de la mobilité des étudiants et diplômés universitaires", *L'Actualité Économique*, 59, 379-402.

Lee, F. and S. Coulombe, 1995, “Regional Productivity Convergence in Canada”, *Canadian Journal of Regional Science*, 18, p. 39-56.

Lefebvre, M., 1994, “Les provinces canadiennes et la convergence: une évaluation empirique”, *Bank of Canada Research Paper* 94-10, November.

Mankiw, G., 1995, “The Growth of Nations”, *Brookings Papers on Economic Activity*, vol 1, p.275-325.

Mankiw,G., D. Romer and D. Weil, 1992, “A Contribution to the Empiric of Economic Growth”, *Quarterly Journal of Economics*, 107, p. 407-437.

Psacharopoulos, G. and A. N. Arriagada, 1986, “The Educational Composition of the labor Force: An International Comparaison”, *International Labor Review*, vol.125, no. 5, septembre-octobre.

Romer, P., 1993, “Idea Gaps and Object Gaps in Economic Development”, *Journal of Monetary Economics*, 32, 543-573.

Tesar, L.L., 1991, “Savings, investment and international capital flows”, *Journal of International Economics*, 31, p. 55-78.

Appendix A

Correlation between domestic saving and investment of Canadian provinces and countries.

The assumption of perfect capital mobility can be indirectly tested by estimating the correlation between domestic saving and investment of the Canadian provinces. If there is perfect capital mobility we should observe a correlation coefficient equal to 0. We have calculated average rates of investment and saving as a percentage of GDP for each provinces for the period 1961-1991 as well as for three sub-periods of ten years[18]. The investment rate is calculated from private investment in fix capital and inventories. The saving rate includes private and public saving. Results are presented in table 7.

Table 7: Correlation between domestic saving and investment of Canadian provinces

1961-1991	1961-70	1971-80	1981-91
ρ = -0.306 (-0.908)	ρ = -0.508 (-1.667)	ρ = -0.345 (-1.041)	ρ = -0.217 (-0.630)

ρ = correlation coefficient
T-statistics are in parenthesis

No correlation coefficient is significantly different from 0 at the 95 % confidence level (the critical value is 1.81).

We have also estimated the correlation between the average rates of domestic investment and saving as a percentage of GDP for different sets of countries[19]. Results are presented in table 8.

[18] The data are from Statistics Canada publication entitled "Provincial Economic Accounts".

[19] The data are from the following publications:
International Financial Statistics Yearbook, 1994, International Monetary Fund.
World Tables, 1995, John Hopkins University Press, published for the World Bank.

Table 8: Correlation between domestic savings and investment of countries

	# of countries	1967-93	1967-73	1974-80	1981-87	1988-93
World	121	ρ = 0.195 (2.17)	ρ = 0.512 (6.51)	ρ = 0.286 (3.25)	ρ = 0.157 (1.73)	ρ = 0.020 (0.22)*
Sub-Saharian Africa	40	ρ = -0.054 (-0.34)*	ρ = 0.302 (1.96)	ρ = 0.255 (1.62)*	ρ = -0.101 (-0.62)*	ρ = -0.331 (-2.16)
Southern Asia	5	ρ = 0.925 (4.22)	ρ = 0.949 (5.24)	ρ = 0.912 (3.86)	ρ = 0.862 (2.95)	ρ = 0.899 (3.55)
Easthern Asia and Pacific	12	ρ = 0.104 (0.33)*	ρ = -0.061 (-0.19)*	ρ = -0.081 (-0.26)*	ρ = 0.581 (2.26)	ρ = 0.412 (1.43)*
Latin America and the Carrabian	27	ρ = 0.264 (1.37)*	ρ = 0.820 (7.16)	ρ = 0.241 (1.24)*	ρ = 0.361 (1.94)	ρ = 0.495 (2.85)
Middle-East and North-Africa	9	ρ = 0.160 (0.43)*	ρ = 0.522 (1.62)*	ρ = 0.241 (0.66)*	ρ = 0.150 (0.40)*	ρ = -0.067 (-0.18)*
Europe and Mediteranean	9	ρ = 0.552 (1.75)*	ρ = 0.387 (1.12)*	ρ = 0.676 (2.43)	ρ = 0.804 (3.58)	ρ = 0.557 (1.77)*
Industrialised Countries	19	ρ = 0.873 (7.38)	ρ = 0.680 (3.83)	ρ = 0.654 (3.56)	ρ = 0.764 (4.88)	ρ = 0.712 (4.19)

ρ = correlation coefficient
T-statistics are in parenthesis

A * means that the t-statistics is smaller than the critical value which indicates that the correlation coefficient is not significantly different from 0.

Appendix B

Table 9: Human Capital Convergence Between Canadian Provinces from 1951 to 1996
(Robustness analysis; 5 year period for 1971-1976)

		Human Capital Indices	
		Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree
15 years and over	Both sexes	$\beta = 0.036$ (11.44) $R^2 = 0.73$	$\beta = 0.032$ (6.32) $R^2 = 0.44$
	Males	$\beta = 0.034$ (10.55) $R^2 = 0.69$	$\beta = 0.031$ (8.05) $R^2 = 0.56$
	Females	$\beta = 0.035$ (12.24) $R^2 = 0.75$	$\beta = 0.042$ (5.80) $R^2 = 0.39$
15 - 24 years	Both sexes	$\beta = 0.063$ (12.02) $R^2 = 0.75$	$\beta = 0.071$ (8.23) $R^2 = 0.57$
	Males	$\beta = 0.057$ (10.50) $R^2 = 0.69$	$\beta = 0.074$ (7.38) $R^2 = 0.52$
	Females	$\beta = 0.069$ (14.24) $R^2 = 0.80$	$\beta = 0.095$ (8.27) $R^2 = 0.57$
25 years and over	Both sexes	$\beta = 0.029$ (9.67) $R^2 = 0.65$	$\beta = 0.030$ (6.19) $R^2 = 0.43$
	Males	$\beta = 0.028$ (9.63) $R^2 = 0.63$	$\beta = 0.028$ (7.17) $R^2 = 0.50$
	Females	$\beta = 0.028$ (8.83) $R^2 = 0.61$	$\beta = 0.037$ (5.32) $R^2 = 0.35$

<u>Table 10</u>: Human Capital Convergence Between Canadian Provinces from 1951 to 1996
(Robustness analysis; 5 year period for 1981-1986)

		Human Capital Indices	
		Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree
15 years and over	Both sexes	$\beta = 0.034$ (11.52) $R^2 = 0.73$	$\beta = 0.027$ (6.91) $R^2 = 0.48$
	Males	$\beta = 0.033$ (10.30) $R^2 = 0.68$	$\beta = 0.028$ (8.93) $R^2 = 0.61$
	Females	$\beta = 0.033$ (12.04) $R^2 = 0.75$	$\beta = 0.036$ (6.25) $R^2 = 0.43$
15 - 24 years	Both sexes	$\beta = 0.061$ (12.04) $R^2 = 0.75$	$\beta = 0.068$ (9.66) $R^2 = 0.65$
	Males	$\beta = 0.055$ (10.32) $R^2 = 0.68$	$\beta = 0.073$ (8.45) $R^2 = 0.59$
	Females	$\beta = 0.067$ (14.55) $R^2 = 0.81$	$\beta = 0.085$ (9.56) $R^2 = 0.64$
25 years and over	Both sexes	$\beta = 0.028$ (9.29) $R^2 = 0.64$	$\beta = 0.025$ (6.82) $R^2 = 0.47$
	Males	$\beta = 0.027$ (8.77) $R^2 = 0.61$	$\beta = 0.025$ (7.33) $R^2 = 0.51$
	Females	$\beta = 0.027$ (8.63) $R^2 = 0.60$	$\beta = 0.030$ (5.40) $R^2 = 0.36$

Table 1: Human Capital Convergence Between Canadian Provinces from 1951 to 1996

		Human Capital Indices		
		Percentage of the Population with at Least Grade 9	Percentage of the Population with at Least Some Postsecondary[20]	Percentage of the Population with a University Degree
15 years and over	Both sexes	$\beta = 0.034$ (11.67) $R^2 = 0.73$	$\beta = 0.038$ (4.81) $R^2 = 0.32$	$\beta = 0.028$ (6.83) $R^2 = 0.47$
	Males	$\beta = 0.033$ (10.30) $R^2 = 0.68$	$\beta = 0.033$ (5.52) $R^2 = 0.38$	$\beta = 0.028$ (8.95) $R^2 = 0.61$
	Females	$\beta = 0.034$ (12.19) $R^2 = 0.75$	$\beta = 0.040$ (5.34) $R^2 = 0.37$	$\beta = 0.036$ (6.09) $R^2 = 0.42$
15 - 24 years	Both sexes	$\beta = 0.061$ (11.83) $R^2 = 0.74$	$\beta = 0.042$ (2.40) $R^2 = 0.11$	$\beta = 0.069$ (9.79) $R^2 = 0.65$
	Males	$\beta = 0.055$ (10.04) $R^2 = 0.67$	$\beta = 0.033$ (2.23) $R^2 = 0.09$	$\beta = 0.078$ (7.90) $R^2 = 0.55$
	Females	$\beta = 0.067$ (14.46) $R^2 = 0.81$	$\beta = 0.067$ (3.22) $R^2 = 0.17$	$\beta = 0.085$ (10.49) $R^2 = 0.68$
25 years and over	Both sexes	$\beta = 0.027$ (9.37) $R^2 = 0.64$	$\beta = 0.040$ (6.49) $R^2 = 0.46$	$\beta = 0.025$ (6.60) $R^2 = 0.46$
	Males	$\beta = 0.027$ (8.90) $R^2 = 0.61$	$\beta = 0.041$ (6.97) $R^2 = 0.49$	$\beta = 0.025$ (7.39) $R^2 = 0.51$
	Females	$\beta = 0.027$ (8.61) $R^2 = 0.60$	$\beta = 0.040$ (6.84) $R^2 = 0.49$	$\beta = 0.030$ (5.25) $R^2 = 0.35$

T-ratios are in parenthesis below each estimated speed of convergence.

[20]For this human capital index, the speed of convergence is estimated for the period 1971-1996, as the data are unavailable for 1951 and 1961.

Table 2: Wald Statistics for the Comparison of the Speed of Convergence of the 15-24 years and 25 years and over

	Human Capital Indices	
	Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree
Both sexes	W = 50.79	W = 50.16
Males	W = 30.41	W = 47.28
Females	W = 79.64	W = 52.62

Table 3: Wald Statistics for the Comparison of the Speed of Convergence of Males and Females

	Human Capital Indices	
	Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree
15 years and over	W = 0.07	W = 1.95
15-24 years	W = 4.68	W = 0.59
25 years and over	W = 0.004	W = 0.74

The Wald statistics have a Chi-Squared distribution with one degree of freedom. The critical value at a confidence level of 95% is 3.84.

Table 4: Convergence of Income Between Canadian Provinces from 1951 to 1996

Personal Income per Person	Personal Income per Person Minus Government Transfers to Persons
$\beta = 0.037$ (5.64) $R^2 = 0.26$	$\beta = 0.021$ (4.50) $R^2 = 0.18$

T-ratios are in parenthesis below each estimated speed of convergence.

Table 5: Wald Statistics for the Comparison Between the Speed of Convergence of Human Capital and Income

		Measure of Income and Human Capital Indices			
		Personal Income per Person		Personal Income per Person Minus Government Transfers to Persons	
		Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree	Percentage of the Population with at Least Grade 9	Percentage of the Population with a University Degree
15 years and over	Both sexes	W = 0.23	W = 1.84	W = 4.91	W = 1.16
	Males	W = 0.40	W = 2.09	W = 3.98	W = 1.33
	Females	W = 0.23	W = 0.01	W = 4.98	W = 4.21
15 - 24 years	Both sexes	W = 12.66	W = 18.11	W = 36.57	W = 42.04
	Males	W = 6.78	W = 21.04	W = 24.95	W = 41.53
	Females	W = 21.51	W = 37.10	W = 52.99	W = 68.05
25 years and over	Both sexes	W = 2.67	W = 3.41	W = 1.00	W = 0.38
	Males	W = 2.63	W = 3.63	W = 0.99	W = 0.41
	Females	W = 2.59	W = 0.86	W = 0.97	W = 1.49

The Wald statistics have a Chi-Squared distribution with one degree of freedom. The critical value at a confidence level of 95% is 3.84.

Table 6: Share of Human Capital in National Income (1951-1996)

		Measure of Income and Human Capital Indices			
		Personal Income per Person		Personal Income per Person Minus Government Tranfers to Persons	
		Percentage of the Population with at Least Grade 9	Percentage of the Population with University Degree	Percentage of the Population with at Least Grade 9	Percentage of the Population with University Degree
15 years and over	Both sexes	$\eta = 0.98$ (9.18) $R^2 = 0.51$ [0.77, 1.19]	$\eta = 0.39$ (13.37) $R^2 = 0.69$ [0.34, 0.45]	$\eta = 1.19$ (8.85) $R^2 = 0.49$ [0.92, 1.46]	$\eta = 0.49$ (13.87) $R^2 = 0.71$ [0.42, 0.56]
	Males	$\eta = 1.02$ (13.73) $R^2 = 0.70$ [0.87, 1.16]	$\eta = 0.40$ (13.50) $R^2 = 0.70$ [0.34, 0.46]	$\eta = 1.24$ (13.00) $R^2 = 0.68$ [1.05, 1.43]	$\eta = 0.50$ (14.23) $R^2 = 0.72$ [0.43, 0.57]
	Females	$\eta = 0.76$ (5.73) $R^2 = 0.29$ [0.50, 1.02]	$\eta = 0.34$ (11.78) $R^2 = 0.63$ [0.28, 0.40]	$\eta = 0.92$ (5.56) $R^2 = 0.27$ [0.59, 1.25]	$\eta = 0.42$ (11.77) $R^2 = 0.63$ [0.35, 0.49]
15 - 24 years	Both sexes	$\eta = 1.19$ (9.70) $R^2 = 0.54$ [0.94, 1.43]	$\eta = 0.24$ (6.43) $R^2 = 0.34$ [0.16, 0.31]	$\eta = 1.40$ (8.79) $R^2 = 0.49$ [1.08, 1.72]	$\eta = 0.29$ (6.16) $R^2 = 0.32$ [0.19, 0.38]
	Males	$\eta = 1.16$ (12.96) $R^2 = 0.68$ [0.99, 1.35]	$\eta = 0.25$ (5.92) $R^2 = 0.30$ [0.17, 0.33]	$\eta = 1.38$ (11.45) $R^2 = 0.62$ [1.14, 1.62]	$\eta = 0.31$ (5.96) $R^2 = 0.30$ [0.21, 0.42]
	Females	$\eta = 1.04$ (6.68) $R^2 = 0.36$ [0.74, 1.36]	$\eta = 0.19$ (4.63) $R^2 = 0.21$ [0.11, 0.27]	$\eta = 1.22$ (6.12) $R^2 = 0.31$ [0.83, 1.62]	$\eta = 0.23$ (4.51) $R^2 = 0.19$ [0.13, 0.32]
25 years and over	Both sexes	$\eta = 0.77$ (8.29) $R^2 = 0.46$ [0.59, 0.95]	$\eta = 0.41$ (14.26) $R^2 = 0.72$ [0.35, 0.47]	$\eta = 0.95$ (8.17) $R^2 = 0.45$ [0.72, 1.17]	$\eta = 0.51$ (14.91) $R^2 = 0.73$ [0.45, 0.58]
	Males	$\eta = 0.84$ (12.37) $R^2 = 0.66$ [0.70, 0.97]	$\eta = 0.41$ (13.58) $R^2 = 0.70$ [0.35, 0.46]	$\eta = 1.02$ (12.05) $R^2 = 0.64$ [0.86, 1.19]	$\eta = 0.51$ (14.38) $R^2 = 0.72$ [0.44, 0.58]
	Females	$\eta = 0.59$ (5.31) $R^2 = 0.26$ [0.37, 0.81]	$\eta = 0.35$ (12.60) $R^2 = 0.66$ [0.30, 0.41]	$\eta = 0.72$ (5.26) $R^2 = 0.25$ [0.45, 0.99]	$\eta = 0.44$ (12.86) $R^2 = 0.67$ [0.37, 0.51]

T-ratios are in parenthesis below each estimated share of human capital.
In brackets is the 95% confidence interval for the share of human capital.

Appendix C
Human Capital Indices[21]

15 Years and Over

Percentage of the population 15 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	31.4	46.8	51.4	39.7	38.8	53.1	48.9	44.3	54	61	46.9
1961	44.9	54.5	59.5	46.6	47.9	58.6	59.2	53.6	62.9	68.3	55.6
1971	55.6	63.1	68.4	58.8	59.2	71.9	67.9	64.3	76.2	77.2	66.3
1976	63.1	70.7	75.2	66.5	67.6	77.8	73.7	70.9	80.4	82.7	72.9
1981	69.2	75.9	79.1	71.4	72.9	81.9	77.7	76.5	86.8	86.3	77.8
1986	73	80	82.4	75.6	75.7	84.9	81.5	80.4	88.9	88.3	81.1
1991	79.2	84.3	86.4	80	79.3	88.1	84.9	83.7	90.9	90.9	84.8
1996	82.1	86.3	88.5	83	81.5	89.6	87	86.4	92.1	92.3	86.9

Percentage of men 15 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	27.3	39	44.8	32.9	36.8	49.4	44.8	39.3	49	55.8	41.9
1961	41.3	45.8	53.7	40.8	46.8	55.9	56.2	49.1	59	65	51.4
1971	53	55.7	64.1	54.5	60	71.2	66.2	60.9	74	75.6	63.5
1976	60.9	64.1	71.9	63.2	68.5	77.5	72.5	68.1	81	81.9	71
1981	67.1	70.1	76	68.5	74	82	76.9	74.5	86.2	85.9	76.1
1986	71.2	75.2	80	73.4	76.9	85.2	80.9	78.8	88.4	88.1	79.8
1991	77.6	80.3	84.2	77.8	80.2	88.3	84.6	82.2	90.5	90.8	83.7
1996	80.7	82.9	86.6	81.2	82.2	90	86.7	85.2	91.9	92.4	86

Percentage of women 15 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	35.6	55	58	46.5	40.6	56.8	53	49.9	59.8	66.4	52.2
1961	48.8	63.7	65.7	52.5	48.9	61.2	62.3	58.6	67.1	71.9	60.1
1971	58.2	70.7	72.8	62.8	58.3	72.5	69.6	67.9	78.4	78.8	69
1976	65.4	77.2	78.3	69.7	66.5	78	74.8	73.9	83.8	83.6	75.1
1981	71.3	81.6	82	74.2	71.6	81.7	78.5	78.5	87.3	86.7	79.3
1986	75	84.4	84.9	77.8	74.5	84.8	82	82.1	89.3	88.5	82.3
1991	80.8	88.1	88.3	81.9	78.5	87.9	85.1	85.2	91.3	91.1	85.8
1996	83.5	89.7	90.3	84.8	80.9	89.2	87.3	87.6	92.4	92.2	87.8

Percentage of the population 15 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	14.3	19.9	20.9	18.9	20.5	22.6	21.3	19.4	25.8	24.6	20.8
1976	23.9	29.9	30	25.7	29.1	30.9	29.3	26.8	33.4	34.4	29.3
1981	28.4	34.1	34.4	29.6	32.9	36.4	33.5	32.8	41.5	40.4	34.4
1986	31.7	38.8	39	33.7	36.4	40.8	37.4	37.1	45.5	44.5	38.5
1991	36.7	41.6	43.1	37.3	38.3	44.7	40.4	40.1	48.1	48.6	41.9
1996	41.8	44.6	47.2	41.7	42.5	48.9	44.1	43.2	51.3	52.5	45.8

[21] The data for 1951 to 1991 are from a Statistics Canada publication entitled the nation, catalogue number 93-328. The published data for 1996 were organized under a different division of levels of schooling. The consistent data for 1996 were constructed at our request by Statistics Canada. For the percentage of the population with some post-secondary education, the data are unavailable for 1951 and 1961.

Percentage of men 15 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	14.9	17.6	20	17.9	23.2	24.2	22	17.4	26.3	25.9	20.9
1976	24.9	26.5	29.6	25.3	31.7	32.8	30	24.9	36.8	36.4	29.9
1981	29.3	31.5	33.9	29.7	35.9	38.1	33.7	31.2	43.3	42	34.9
1986	32.9	35.7	39.3	33.8	39.1	42.4	37.8	35.8	47.1	46.1	39
1991	36.6	37.1	42.7	36.4	39.9	45.6	40	37.7	48.9	49.4	41.4
1996	41.6	40	46.5	40.1	43.4	49.4	43	40.2	51.5	52.5	44.8

Percentage of women 15 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	13.7	22.3	22	19.7	17.8	21	20.5	21.6	25.1	23.3	20.7
1976	22.8	33.3	30.4	26	26.4	29.1	28.6	28.8	33.9	32.5	29.2
1981	27.5	36.6	34.8	29.5	29.9	34.7	33.3	34.5	39.5	38.8	33.9
1986	30.7	41.7	38.9	33.6	33.8	39.3	37	38.4	43.8	42.9	38
1991	36.9	45.8	43.4	38	36.8	43.8	40.7	42.5	47.3	48	42.3
1996	42	49	47.9	43.1	41.6	48.4	45.2	46	51.2	52.5	46.7

Percentage of the population 15 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.5	0.8	1.3	0.9	1.9	2.6	1.3	1	1.3	2.2	1.4
1961	0.8	1.5	2.3	1.8	2.9	3.4	2.6	2	3	3.2	2.4
1971	2.1	3.2	4.1	3.4	4.6	5.3	4.6	3.5	5.5	5	4.1
1976	3.7	5.1	6	4.8	5.5	7.4	6.4	4.8	7.5	6.7	5.8
1981	4.7	6.1	7.4	6	7.1	9	7.4	6.1	9.6	8.2	7.2
1986	5.6	7.4	8.7	7.3	8.6	10.8	8.9	7.4	10.8	9.5	8.5
1991	6.6	8.5	10.4	8.4	10.3	13	10.2	8.6	11.9	11.2	9.9
1996	8.1	10.6	12.2	10.2	12.2	14.9	11.6	9.8	13.3	13.6	11.7

Percentage of men 15 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.6	1.3	1.8	1.4	3	3.6	1.9	1.4	1.9	2.9	2
1961	1.3	2.3	3.1	2.7	4.2	4.8	3.6	2.8	4.1	4.4	3.3
1971	3	4.3	5.4	4.6	6.6	7.3	6.2	4.8	7.2	6.6	5.6
1976	4.6	6.5	7.4	6	7.6	9.7	8.3	6.3	9.4	8.7	7.5
1981	5.7	7.3	8.7	7.1	9.1	11.1	8.9	7.6	11.3	10.1	8.7
1986	6.4	8.4	9.7	8.2	10.5	12.7	10.3	8.5	12.3	11.3	9.8
1991	7.2	9.1	11.1	9	12	14.6	11.1	9.5	13.2	12.9	11
1996	8.4	10.5	12.7	10.4	13.4	16.2	12.3	10.2	14.2	14.8	12.3

Percentage of women 15 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.3	0.3	0.7	0.4	0.7	1.6	0.6	0.5	0.7	1.4	0.7
1961	0.4	0.7	1.6	1	1.6	1.9	1.6	1.2	1.8	2.1	1.4
1971	1.2	2.1	2.9	2.1	2.7	3.3	3	2.2	3.7	3.3	2.7
1976	2.7	3.8	4.6	3.6	3.4	5.2	4.6	3.3	5.5	4.8	4.2
1981	3.6	4.8	6.1	5	5.1	7	6	4.7	7.7	6.3	5.6
1986	4.9	6.4	7.8	6.4	6.8	9	7.6	6.4	9.2	7.7	7.2
1991	6.1	7.9	9.7	7.8	8.7	11.4	9.3	7.8	10.6	9.7	8.9
1996	7.9	10.8	11.8	10	11.1	13.8	11	9.6	12.4	12.5	11.1

15-24 Years

Percentage of the population 15-24 years with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	42.5	56.2	59.4	49.3	43.5	68	63.3	62.4	69.7	75.9	59
1961	65.7	69.6	70.5	63.6	62.4	78.7	77.6	77.4	80.9	85.4	73.2
1971	72.6	78.1	80.7	77.8	84.5	90.9	87.9	88.4	92.7	92.1	84.6
1976	79.8	84.7	87.4	85.5	92.3	95	91.3	91.8	95.6	95.3	89.9
1981	82.9	89.2	89.3	88.8	94.1	96.5	92.3	92.5	95.8	96.1	91.8
1986	86.8	92.8	90.7	91.5	94	97.3	93.8	93.3	96	96.8	93.3
1991	94.3	95.6	94.2	94.7	93.9	97.9	95.2	94.5	96.6	97.8	95.5
1996	97.3	97.6	96.2	97	93.4	98.4	96.2	96.2	97.4	98.2	96.8

Percentage of men 15-24 years with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	37.1	47.2	52.9	42.4	42	63.2	58.2	55.7	63.9	71.5	53.4
1961	61.8	60.6	65.3	57.2	60.2	75.8	74.3	72.4	77.1	83	68.8
1971	70.2	71.8	77.8	74.4	83.8	90.5	86.8	86.3	91.5	91.1	82.4
1976	77.4	79.9	85	82.5	91.7	94.8	90.3	89.9	94.8	94.6	88.1
1981	79.5	85.1	86.9	85.7	93.4	96.2	91.1	91.2	95.3	95.4	90
1986	84.1	89.5	88.6	89.3	93	97.1	93	92.2	95.5	96.2	91.9
1991	93	93.9	92.7	93.2	92.7	97.8	94.9	94.3	96.3	97.4	94.6
1996	96.6	96.8	95.1	96.2	91.9	98.3	95.7	95.8	97.2	98	96.2

Percentage of women 15-24 years with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	48.1	65.5	65.8	55.7	45	72.8	68.3	69	75.7	80.4	64.6
1961	69.7	79.3	76	70.3	64.5	81.6	80.9	82.7	84.7	88.1	77.8
1971	75	84.7	83.6	81.4	85.3	91.3	89.1	90.5	93.8	93	86.8
1976	82.5	89.8	89.9	88.6	92.9	95.4	92.4	93.7	96.3	95.9	91.7
1981	86.4	93.3	91.7	91.8	94.8	96.8	93.4	93.8	96.6	96.8	93.5
1986	89.5	96	93	93.6	95	97.6	94.6	94.3	96.6	97.4	94.8
1991	95.7	97.5	95.6	96.1	95.2	98.1	95.6	95	97	98.1	96.4
1996	98	98.4	97.3	97.8	94.9	98.4	96.7	96.5	97.7	98.3	97.4

Percentage of the population 15-24 years with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	18.8	23.9	23.5	20	24.5	22.4	23.7	22.8	25.7	23.3	22.9
1976	27.1	29.5	29.7	22.3	32.6	26.9	27	26.1	29.9	26.5	27.8
1981	28.4	29.2	30.1	22.8	34.3	28.7	26.5	26.8	31.5	29.6	28.8
1986	29.1	34.8	34.8	28.8	39.6	33.9	31	32	33.9	33.9	33.2
1991	33.8	35.9	37.1	33.4	41.3	35.8	32.1	33.2	35.5	37.6	35.6
1996	38.8	37.6	39.5	37.8	45	37.7	33.8	33.5	36.3	39	37.9

Percentage of men 15-24 years with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	18.6	21.6	22.2	19.2	25.5	22.8	23.3	20.7	25.6	23.6	22.3
1976	25.8	26.9	29.3	21.2	32.9	26.4	26.2	23.8	29.8	26.2	26.9
1981	25.4	26.9	28.1	21.4	33.5	27.2	24.9	24.2	31.2	28.1	27.1
1986	26.1	30.8	32.8	25.7	37.3	31.5	28.5	28.8	32	31.9	30.5
1991	29.4	31.4	34.1	29.2	37.4	32.5	29.2	29.9	32.6	34.9	32.1
1996	34.3	32.6	35.5	32.8	40.6	34.2	29.8	29.5	32.9	35	33.7

Percentage of women 15-24 years with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	18.9	26.3	24.8	20.8	23.5	22	24.2	25	25.7	22.9	23.4
1976	28.5	32.4	30.1	23.5	32.3	27.5	27.9	28.5	30	26.7	28.7
1981	31.5	31.5	32.2	24.2	35.1	30.2	28.1	29.4	32	31.1	30.5
1986	32.1	38.8	37	31.9	41.9	36.4	33.5	35.3	36	36	35.9
1991	38.5	41	40.2	37.5	45.4	39.2	35.2	36.8	38.5	40.3	39.3
1996	43.4	42.5	43.6	42.8	49.6	41.2	37.9	37.7	39.7	43.1	42.2

Percentage of the population 15-24 years with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.1	0.2	0.4	0.2	0.6	1.2	0.5	0.3	0.4	0.9	0.5
1961	0.4	0.8	1.1	0.7	1.2	1.3	1.3	0.9	1.1	1	1
1971	1.8	2.9	3.3	2.5	3.1	3.5	3.9	2.9	3.7	2.8	3
1976	2.4	3.7	4.3	2.8	2.4	4	4.1	2.9	3.9	2.7	3.3
1981	2.1	3.1	4	2.8	2.9	3.8	3.6	2.6	3.9	2.3	3.1
1986	2.5	4.3	4.9	3.7	3.8	4.6	4.6	3.4	3.8	2.8	3.8
1991	2.7	4.6	5.8	4.3	4.2	5.3	4.7	3.6	4.1	3.9	4.3
1996	3.9	6.5	7.2	5.6	5.1	6.3	5.3	4.3	4.4	4.6	5.3

Percentage of men 15-24 years with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.2	0.3	0.6	0.4	1	1.6	0.7	0.4	0.5	1.2	0.7
1961	0.6	1.1	1.2	1	1.3	1.5	1.5	1.1	1.3	1.2	1.2
1971	2.1	3.2	3.5	3.1	3.6	3.9	4.5	3.2	4	3	3.4
1976	2.2	3.6	4.1	2.8	2.5	3.9	4.3	3.1	3.9	2.7	3.3
1981	2	3.1	3.6	2.6	2.8	3.5	3.4	2.4	3.7	2.1	2.9
1986	2.1	3.5	4.2	3.1	3.4	4.1	4.2	2.9	3.5	2.6	3.4
1991	1.9	3.7	4.5	3.3	3.5	4.4	4	3.2	3.6	3.6	3.6
1996	2.8	5	5.5	4	3.8	5	4.2	3.2	3.4	3.6	4.1

Percentage of women 15-24 years with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0	0.1	0.2	0.1	0.2	0.8	0.3	0.1	0.3	0.6	0.3
1961	0.3	0.5	1	0.5	1	1	1	0.7	0.9	0.9	0.8
1971	1.4	2.6	3.1	1.8	2.6	3.1	3.3	2.5	3.3	2.6	2.6
1976	2.6	3.9	4.5	2.9	2.3	4.1	3.9	2.7	3.9	2.6	3.3
1981	2.3	3.2	4.5	3	3	4.1	3.8	2.9	4.2	2.5	3.4
1986	2.9	5.1	5.6	4.3	4.1	5.2	4.9	3.9	4.2	3	4.3
1991	3.6	5.7	7.1	5.2	5	6.2	5.4	4.1	4.6	4.2	5.1
1996	5	7.9	9	7.3	6.4	7.6	6.4	5.4	5.4	5.5	6.6

25 Years and Over

Percentage of the population 25 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	27.4	44.1	49	36.7	37.2	49.4	45.1	39	49.4	57.8	43.5
1961	36.9	50.1	56.2	41.1	43.1	53.8	54.4	47.2	57.9	64.4	50.5
1971	47.7	57.3	63.9	50.9	49.4	65.3	60.8	56.2	69.9	72.4	59.4
1976	55.6	65.4	70.6	58.8	58.2	71.9	67.5	63.4	77.1	78.7	66.7
1981	63.7	71.3	75.6	65.2	65.6	77.2	73.1	71	83.1	83.4	72.9
1986	68.3	76	80	70.9	70.9	81.7	78.2	76.8	86.7	86.2	77.6
1991	74.6	81.5	84.5	76.3	76.3	85.8	82.4	81.3	89.4	89.6	82.2
1996	78.3	83.7	86.9	80	79.2	87.8	85	84.1	91	91.1	84.7

Percentage of men 25 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	24	36.7	42.6	30	35.1	46	41.3	34.8	44.8	52.7	38.8
1961	33.6	41.3	49.9	35.3	42.4	51.1	51.4	43	54.2	60.9	46.3
1971	45.1	49.3	58.7	46.1	50.5	64.4	58.8	52.2	67.5	70.3	56.3
1976	53.6	58	66.9	55.3	59.5	71.5	66.2	59.9	75.5	77.7	64.4
1981	62.2	64.7	72.2	62.3	67.3	77.4	72.1	68.8	82.7	82.9	71.3
1986	66.4	70.7	77.2	68.5	72.6	82	77.5	74.7	86.4	85.9	76.2
1991	72.7	76.7	82.2	73.8	77.4	86	82.1	79.3	89.1	89.4	80.9
1996	76.5	79.5	84.7	77.7	80.2	88.2	84.7	82.6	90.7	91.2	83.6

Percentage of women 25 years and over with at least grade 9

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	31.1	51.9	55.7	43.4	39.2	52.9	48.9	43.9	54.8	63.3	48.5
1961	40.5	59.1	62.5	46.8	43.8	56.4	57.5	51.8	61.9	68.1	54.8
1971	50.2	65.4	69.1	55.5	48.2	66.2	62.8	60.3	72.5	74.2	62.4
1976	57.6	72.7	74.3	62.3	57	72.3	68.8	66.9	78.8	79.7	69
1981	65.1	77.7	78.9	67.9	64.1	77.1	73.9	73.3	83.7	83.8	74.6
1986	70	81.1	82.6	73.3	69.3	81.4	78.8	78.7	87.2	86.5	78.9
1991	76.4	86	86.8	78.6	75.3	85.8	82.8	83.1	89.9	89.7	83.4
1996	80	87.7	89	82	78.2	87.5	85.4	85.6	91.2	91	85.8

Percentage of the population 25 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	12.3	18.3	20	18.4	18.9	22.6	20.4	18.4	25.7	25.1	20
1976	22.5	30	30.1	27	27.7	32.2	30.1	27.1	37.6	37.1	30.1
1981	28.4	35.8	35.8	32.1	32.4	38.7	35.8	34.9	45.4	43.6	36.3
1986	32.8	39.9	40.3	35.1	35.5	42.7	39.3	38.6	48.8	47	40
1991	37.6	42.9	44.5	38.2	37.7	46.5	42.3	41.7	51	50.9	43.3
1996	42.6	46.2	48.8	42.5	42	51.1	46.4	45.4	54.7	55.1	47.5

Percentage of men 25 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	13.2	15.9	19.1	17.4	22.2	24.6	21.6	16.3	26.6	26.6	20.4
1976	24.6	26.2	29.7	27.1	31.3	35	31.5	25.3	39.7	39.9	31
1981	30.9	33.1	36	33	36.9	41.7	36.7	33.7	48.3	46.2	37.7
1986	35.3	37.2	41.2	36.3	39.7	45.6	40.5	37.7	51.7	49.5	41.5
1991	38.8	38.7	44.9	38.2	40.4	48.5	42.7	39.5	52.8	52.4	43.7
1996	43.6	41.7	48.9	41.8	44	52.6	46	42.9	55.7	56.1	47.3

Percentage of women 25 years and over with at least some post-secondary education

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1971	11.2	20.8	21.1	19.4	15.6	20.6	19.2	20.5	24.9	23.4	19.7
1976	20.2	33.7	30.6	27	24.3	29.6	28.8	29	35.5	34.4	29.3
1981	25.8	38.4	35.7	31.2	28.2	36	34.9	36.2	42.5	41.1	35
1986	30.2	42.5	39.4	34.1	31.7	39.9	38	39.3	46.1	44.6	38.6
1991	36.4	46.9	44.2	38.2	35.2	44.8	42	43.8	49.3	49.4	43
1996	41.7	50.4	48.8	43.2	40.1	49.8	46.7	47.8	53.7	54.2	47.6

Percentage of the population 25 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.6	1	1.5	1.1	2.3	3	1.5	1.2	1.6	2.4	1.6
1961	1	1.7	2.7	2.2	3.4	3.9	3	2.3	3.5	3.7	2.7
1971	2.3	3.3	4.4	3.8	5.2	5.9	4.8	3.8	6.1	5.7	4.5
1976	4.3	5.6	6.6	5.6	6.6	8.5	7.2	5.5	9	8.1	6.7
1981	5.7	7.1	8.5	7.2	8.5	10.6	8.7	7.3	11.8	9.9	8.5
1986	6.8	8.3	9.8	8.3	9.8	12.5	10.2	8.6	12.8	11.1	9.8
1991	7.8	9.4	11.5	9.4	11.5	14.6	11.5	9.8	13.7	12.7	11.2
1996	9.2	11.6	13.3	11.2	13.6	16.7	13	11.1	15.3	15.4	13

Percentage of men 25 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.8	1.6	2.2	1.7	3.7	4.2	2.1	1.7	2.3	3.3	2.4
1961	1.5	2.6	3.6	3.2	5.2	5.6	4.1	3.2	4.9	5.1	3.9
1971	3.4	4.7	6.1	5.3	7.7	8.4	6.9	5.4	8.4	7.8	6.4
1976	5.7	7.5	8.7	7.4	9.6	11.7	9.8	7.5	11.7	10.7	9
1981	7.3	8.8	10.5	8.9	11.4	13.6	10.8	9.4	14.4	12.5	10.8
1986	7.9	10	11.3	9.8	12.5	15.2	12.1	10.1	15	13.4	11.7
1991	8.8	10.6	12.8	10.4	13.8	16.9	12.9	11	15.5	14.8	12.8
1996	9.9	11.9	14.3	11.9	15.4	18.5	14.2	11.8	16.6	17	14.1

Percentage of women 25 years and over with a university degree

Year	NFLD	PEI	NS	NB	Qué	Ont	Man	Sask	Alb	BC	Average
1951	0.4	0.4	0.9	0.5	0.9	1.8	0.8	0.6	0.8	1.6	0.9
1961	0.5	0.7	1.7	1.1	1.8	2.2	1.8	1.3	2	2.3	1.5
1971	1.1	1.9	2.9	2.3	2.7	3.4	2.9	2.1	3.8	3.5	2.7
1976	2.7	3.8	4.7	3.9	3.8	5.5	4.8	3.6	6.2	5.5	4.5
1981	4.1	5.4	6.7	5.6	5.7	7.8	6.6	5.3	9.1	7.5	6.4
1986	5.6	6.7	8.4	7	7.4	9.9	8.4	7.1	10.7	8.8	8
1991	6.8	8.4	10.3	8.4	9.4	12.5	10.2	8.6	12	10.7	9.7
1996	8.6	11.4	12.4	10.5	12	14.9	11.9	10.5	13.9	13.8	12

Figure 1: Relative Level of Human Capital - at Least Grade 9

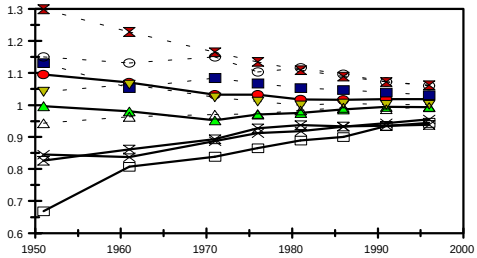

Figure 2: Relative Level of Human Capital - University degree

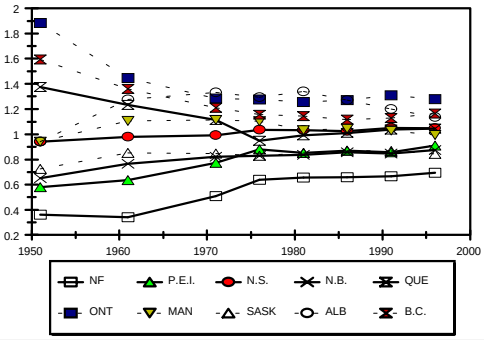

Figure 3: Regional Dispersion of Human Capital Indicators (15 years and over)