Economic Growth and Regional Income Disparities in Canada and the Northern United States

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Dans cette étude, les auteurs analysent l'évolution des disparités régionales du revenu par tête entre les provinces canadiennes et les douze États américains limitrophes. La dynamique d'accumulation du capital néo-classique est en mesure de rendre compte d'une bonne partie de la diminution observée des disparités régionales des deux côtés de la frontière. Cependant, il ressort de l'étude que les Canadiens sont plus enclins que leurs voisins Américains de demeurer dans des régions où il y a peu de travail et où la productivité est faible. Ce facteur contribue à expliquer la persistance d'un niveau relativement plus élevé de disparités de production par tête du côté Nord de la frontière.

This paper compares the evolution of regional disparities in per capita incomes in Canada and the 12 American states along Canada's southern border. The phenomenon of capital accumulation as described by the neoclassical growth model can explain much of the observed decline in regional dispersion in Canada relative to the northern states. However, it appears that Canadians are more likely than residents of the northern states to remain in regions where they do not have jobs, a factor which contributes to the persistently higher level of regional dispersion of output per capita in Canada.

INTRODUCTION

Regional disparities in per capita incomes have long been a feature of the Canadian economy. One of the first to quantify this fact was McInnis (1968), who used historical data on nominal personal income per capita for the Canadian regions to examine the evolution of relative regional disparities from 1926 to 1962. He concluded that "the trend of regional income differentials in Canada appears to have been roughly a constant; there has been neither convergence nor divergence" (McInnis 1968, p. 441). While more recent studies of relative per capita incomes in Canada, such as Swan and Serjak (1991) and Maxwell (1994), have noted a narrowing of disparities since the 1970s, regional per capita income disparities have yet to be completely eliminated, despite decades of economic growth and an active regional development policy instituted by the federal government.

Why has the process of economic growth not resulted in the elimination of regional income disparities? Has it at least contributed to their decline?

Similar questions underlie the now-voluminous literature on economic growth and convergence that has emerged over the past decade.[1] A number of contributions to this literature have explored the implications of the neoclassical growth model regarding the convergence of per capita incomes across countries and regions. Although they do not predict the complete elimination of regional income disparities, most neoclassical models do predict that the process of capital accumulation will lead to a gradual narrowing of disparities until each regional economy has reached its long-run equilibrium level of output per worker. The long-run or permanent component of regional disparities is attributed by these models to random shocks and structural differences between economies.

In this paper, after analyzing the evolution of several measures of income disparities, we examine the extent to which a standard neoclassical growth model can explain the observed evolution of regional income disparities in Canada. As part of this examination, we use parameter estimates from a growth equation derived from the neoclassical model to carry out dynamic simulations of a measure of regional dispersion. Despite its aggregate nature, the model does a surprisingly good job of predicting the time path of regional dispersion. However, it falls short when it comes to explaining the determinants of the permanent component of regional disparities, forcing us to go beyond the model as we attempt to identify the most promising directions for future research and policy regarding regional income disparities.

Finally, to help put our findings for Canada into perspective, throughout the paper we compare data for the ten Canadian provinces to that for a reference group of US states. An unusual feature of our analysis is the fact that this reference group consists not of all 50 states, nor even the 48 contiguous states, but of the 12 states along Canada's southern border: Maine, Vermont, New Hampshire, New York, Pennsylvania, Ohio, Michigan, Minnesota, North Dakota, Montana, Idaho, and Washington. As is explained in the next section of the paper, these states were chosen because of their similarities in terms of economic and physical geography to the Canadian provinces. While this choice of reference group may be unorthodox, the comparison between the two groups of regions yields some unexpected differences, with some intriguing implications for regional policy in Canada.

The Evolution of Regional Disparities in Canada and the Northern States

Have regional income disparities in Canada continued to decline into the 1990s? Are there any important differences between the behaviour of regional disparities in Canada and the northern states? To answer these questions, we look at the evolution of regional disparities in three variables over as long a time period as possible: personal income per capita from 1929 to 1995, output per capita from 1964-92, and output per worker from 1967-92.[2] The measure of dispersion used is a measure of relative dispersion, the standard deviation of the natural logarithm of each variable.[3] All three variables are measured in nominal rather than real terms, due to the difficulty of obtaining regional price deflators for the entire time period under consideration.[4]

But first, before actually looking at the data, we need to consider more carefully our choice of reference group for the Canadian provinces. The choice of US states as a reference group for the Canadian provinces should not surprise anyone. The United States and Canada share a comparable history in terms of economic development and democratic political institutions. Furthermore, they have reached a comparable degree of economic development, they are highly integrated commercially and the populations of both countries are comparable in terms of education, religion, language, and sociological factors.

However, the 50 US states constitute a much more diversified set of regional economies than the Canadian provinces from the point of view of industrial structure, geography, and climate. No

Canadian region is comparable to a southern state in the US. Furthermore, since the Civil War the convergence phenomenon in the US has been characterized by the convergence of personal income per capita in the south toward the levels in the midwest, east and west (Barro and Sala-i-Martin 1995, section 11.2). In contrast, Canadian economic development follows an east-west line and most of the population and economic activity are concentrated close to Canada's southern border.

For these reasons, we choose to define the reference group for the Canadian provinces as the 12 US states that share Canada's southern border. The border states are fairly similar in both geography and in most cases economic structure to the Canadian provinces. For example, the fishing industry is important in both Maine and the Atlantic provinces of Canada; the economies of Ontario and Quebec in Canada and the neighbouring states of New York, Pennsylvania, Ohio, and Michigan are dominated by industrial activity; the Prairie provinces and states depend heavily on agriculture; and in the Pacific Northwest, the economies of British Columbia and Washington are driven by the dynamics of the regional metropolises of Vancouver and Seattle.[5] Furthermore, the economies of these 12 states are well-integrated with those of Canada's regions. Most Canadians live close to the US border and, as McCallum (1995) has shown, the typical trade between Canada and the US is much shorter, in terms of geographical distance, than the typical trade across the Canadian regions.

From an economic point of view, however, our choice of reference group is necessarily arbitrary, as would have been the choice of any reference group for the Canadian provinces. However, by letting geography determine the reference group, the common border being the unique criterion, we have a reference group that is not arbitrary from a geographical point of view. The choice of reference is thus consistent with economic geography. As Krugman pointed out, "the subject of economic geography is important in itself; it sheds considerable light on international economics, and it is a valuable laboratory for understanding economics in general. It is also fun" (1991, p. xi).

We begin the analysis by examining the evolution of regional income disparities over a relatively long time period, 1929-95, using data on the only income measure that is available for this long time period, personal income per capita. Figure 1 displays the standard deviation across states or provinces of the logarithm of this variable. Since the province of Newfoundland did not join Canada until 1949, regional dispersion measures including and excluding Newfoundland (NFLD) are shown in the figure.

Several stylized facts emerge from Figure 1. First, regional dispersion of personal income per capita has steadily decreased in Canada since the early 1950s. In the terminology of Barro and Sala-i-Martin (1995), σ-convergence, that is, a reduction in cross-sectional dispersion, has occurred. Second, for most of the period, regional disparities in personal income per capita have been lower in the 12 US states along the 49th parallel than in Canada. It is only since 1990 that the level of regional disparities among the Canadian provinces has remained consistently below that in the northern states. Finally, there has been little change in the level of regional disparities among these states since 1945.

Because both provinces and states are open economies, when analyzing convergence it is important to draw a distinction between measures of per capita income and measures of output per capita. The two may not present exactly the same picture, since part of the capital stock of one region may be owned by residents of another, and individuals may live in one region and work in another. In addition, personal income per capita includes transfer payments from government that may serve to redistribute income across regions. The impact of this redistribution is revealed when Figure 1 is compared to Figure 2, which presents our measure of the relative dispersion across regions of nominal output per capita in Canada and the northern states.[6] Regardless

FIGURE 1
Personal Income Per Capita, SD of Logarithms

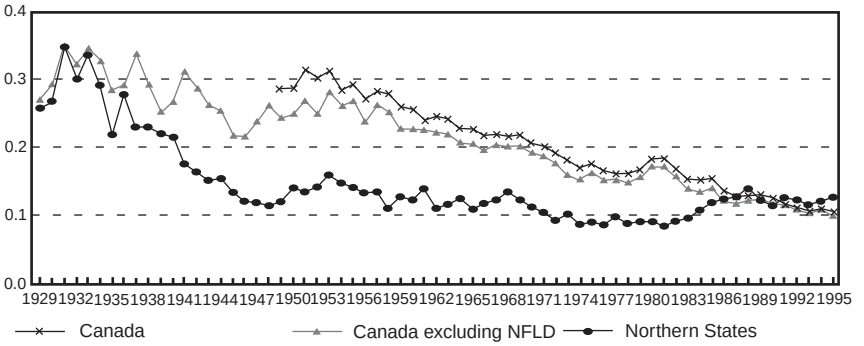


FIGURE 2
Nominal Output Per Capita, SD of Logarithms

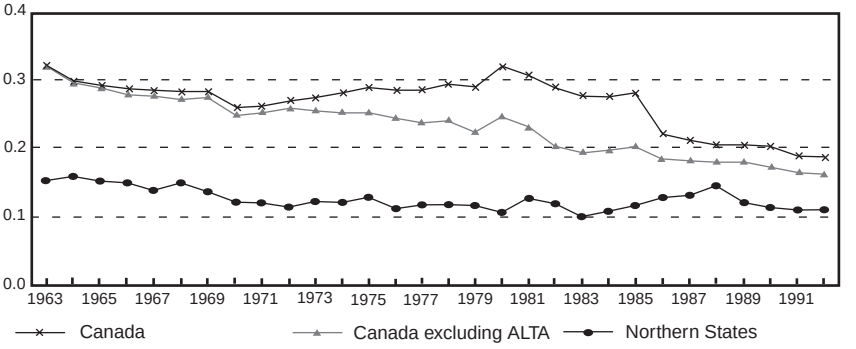
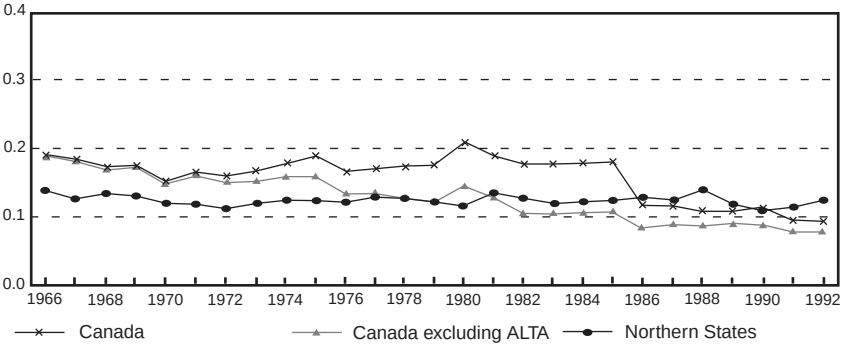


FIGURE 3
Nominal Output Per Worker, SD of Logarithms



of whether or not Alberta is excluded, it is clear from Figure 2 that since 1963, in Canada regional disparities in output per capita have been higher than those in personal income per capita, confirming that government transfer payments do play an important role in redistributing personal income across regions. No such discrepancy appears to exist for the northern US states. Moreover, although the gap between the levels of regional disparities in Canada and the northern states seems to have disappeared by 1990 for personal income per capita, a clear gap between the two sides of the border remains for output per capita.

Finally, because regional disparities in output per capita are likely to be related to regional disparities in productivity, in Figure 3 we also take a brief look at the standard deviation of the logarithm of nominal output per worker for the period 1966-92.[7] Again, there is a more noticeable decline in regional dispersion in Canada than among the northern states. Although there seems to be little difference between regional disparities in output per capita and output per worker in the northern states, in Canada regional dispersion of output per worker is considerably lower than that of output per capita. Moreover, even when Alberta is included the measures of regional dispersion of productivity in the two groups of regions have been almost the same since 1985. Thus it would appear that the observed differences between Canada and the northern states in regional disparities in output per capita cannot be explained by differences between the two countries in regional disparities in productivity. This observation raises the question of why regional disparities in output per capita remain higher in Canada than in the northern states, when disparities in both personal income per capita and output per worker are lower in Canada. We will return to this question later in the paper.

The Neoclassical Growth Model and the Long-Run Level of Regional Disparities

In the previous section, three important stylized facts were highlighted: a downward trend in, or convergence of, relative regional disparities in all three variables examined; earlier convergence of regional disparities in all three variables among the northern states than in Canada; and a persistent positive gap between Canada and the northern states in the level of regional disparities in output per capita (but not in output per worker or personal income per capita). In this section we will examine the extent to which the neoclassical growth framework can explain these stylized facts.

Not all models of economic growth predict the convergence of regional per capita incomes or output. In endogenous growth models of the type developed by Romer (1986), convergence does not occur; instead, the gap between rich and poor regions continues to widen over time. The possible divergence of per capita incomes arises as a consequence of constant returns to capital accumulation. In addition, as Galor (1996) points out, even some models that share the neoclassical features of an exogenous rate of technological change and decreasing returns to capital accumulation can give rise to long-run equilibria characterized by convergence clubs, that is, groups of regions which converge to different long-run levels of per capita income or output.

However, as Barro and Sala-i-Martin (1995) demonstrate, a wide variety of neoclassical models predict the convergence of regional levels of income per capita in the long run. To understand how this convergence comes about, first consider the process of growth in a single economy. In the long run, output (or income) per capita will grow at a constant rate that is determined by the exogenous rate of technological change. If at time t output per capita has not yet achieved this long-run growth path, the actual level of output per capita will gradually converge toward it. The mechanism that brings about this convergence is deceasing returns to the accumulation of capital, with capital broadly defined to include human, physical, public, and social capital. Initially the economy's growth rate will exceed the long-run equilibrium rate of growth, but as the

economy approaches its long-run equilibrium, the rate of growth will gradually slow down as the marginal return to the accumulation of capital decreases.

What happens if we now consider a set of economies, like the US states or the Canadian provinces? If all the economies are converging to a common long-run level of per capita output, the relative growth rates of economies during the convergence process will be determined by their initial levels of per capita output. Again as a consequence of diminishing returns to capital, an economy with a smaller initial level of output per capita than the average will have a higher than average growth rate. This case, in which all economies are converging to the same long-run equilibrium, is called *absolute convergence.* If the economies converge to different long-run equilibria, then each economy's rate of growth of output will be determined not only by its initial level of output per capita but also by the determinants of long-run equilibria that differ across economies, such as the savings rate, the rate of population growth, and the institutional (political, legal, and sociological) framework. This case of convergence to different long-run equilibria is called *conditional convergence* in the modern literature on economic growth.

Yet another concept of convergence, called *ß-convergence,* is used in empirical studies of convergence that rely on cross-section data. In these studies, ß-convergence is said to occur if one finds "a negative relation between the growth rate of income per capita and the initial level of income" (Sala-i-Martin 1996*b*). The parameter ß measures the average speed at which the poorer economies catch up to the richer ones in a sample of countries or regions, and is measured by estimating an equation of the general form

$$y_{it} = a + e^{-\beta} y_{i,t-1} + u_{it}\,, \qquad (1)$$

where y_{it} is the logarithm of output per capita in region i at time t, $y_{i,t-1}$ is the lagged value of y_{it}, and u_{it} is a random error term that reflects the random shocks to the level of output per capita. For ß-convergence to occur, the estimated speed of convergence ß must be positive. ß-convergence is said to be *conditional* if the result that the estimated ß is positive is obtained only after additional variables reflecting differences across economic units are added to equation (1). The concept of *conditional convergence* has received considerable support from recent empirical studies that use cross-section data on countries (Barro 1997, p. x), while similar cross-section techniques applied to regional data suggest that the hypothesis of *absolute convergence* is satisfied by US states, Japanese prefectures, European regions (Barro and Sala-i-Martin 1995) and the Canadian provinces (Helliwell and Chung 1991; Coulombe and Lee 1995, 1998; Lee and Coulombe 1995; Coulombe and Day 1996).[8]

How is ß-convergence related to decreases in cross-sectional convergence, also known as σ-convergence? Barro and Sala-i-Martin (1995, p. 31) show that for a set of economies that begins with a relatively high level of regional dispersion, ß-convergence is a necessary condition for σ-convergence; that is, σ-convergence will not occur unless ß-convergence holds. The σ-convergence phenomenon is likely to be more pronounced if ß-convergence is absolute rather than conditional. However, even if absolute ß-convergence holds, the existence of random shocks to the economy ensures that the long-run equilibrium level of dispersion will be non-zero. Thus, a lack of either σ-convergence or σ-divergence over a prolonged period of time does not necessarily mean that σ-convergence has not occurred; it may simply mean that the long-run equilibrium has been reached.

Returning to Figures 1 to 3, it is clear that the evolution of regional disparities in personal income per capita, output per capita, and output per worker in Canada is broadly consistent with the neoclassical model of absolute convergence. At the same time, the relative constancy of regional disparities among the northern states since the 1960s can be interpreted as an indication that regional disparities in this

region have reached their long-run equilibrium level. If the neoclassical model of absolute convergence applies to this group of 12 states as well as to the United States as a whole, then the fluctuations observed in the level of regional dispersion during this period can be explained by random shocks to the level of output in these economies.

As noted above, a number of studies have found empirical support for the model of absolute convergence in both Canada and the United States as a whole, despite the obvious differences in resource endowments and other factors that characterize the Canadian provinces and American states. However, no one has tested for absolute ß-convergence among the 12 northern states. Also, with the exception of Coulombe and Day (1996) these studies have based their conclusions solely on the estimation of the parameter ß. Drawing on the results of Barro and Sala-i-Martin (1995, sections 2.6.5 and 11.1), Coulombe and Day (1996) suggest that an additional factor that can be used to help evaluate the absolute convergence model is the ability of the model to explain the observed behaviour of the standard deviation across regions of the logarithm of output (income) per capita, the measure of relative regional dispersion examined in section two of the paper. Once ß has been estimated using equation (1), Barro and Sala-i-Martin's (1995) formula for the time path of regional dispersion can be used to generate the predicted value of the dispersion measure. This predicted value can then be compared to the actual value. Barro and Sala-i-Martin (1995) also derive a formula for calculating the long-run equilibrium value of the level of regional dispersion, which can also be compared to the actual level of regional dispersion to give some idea of how far an economy is from its predicted long-run equilibrium.[9]

From a theoretical point of view, tests for ß-convergence are probably best carried out using data on output per worker, although in the neoclassical growth model itself output per worker, output per capita, and personal income per capita are usually one and the same. However, all three variables have been used in the empirical literature on convergence,[10] as data on output per worker are usually not available for as long a time period as the other variables. In addition, data in real terms would be more appropriate than data in nominal terms. However, we are restricted in this paper to using nominal data because of the unavailability of regional price deflators for both the Canadian provinces and the northern US states throughout the entire period of our analysis.[11] This limitation of the data is mitigated somewhat by our use of a modified version of equation (1) (equation (A4) in the Technical Appendix) that is formulated in terms of deviations from the national mean, and estimated using pooled time-series cross-section data. This formulation has the advantage of netting out shocks that are common to all regions within a country, including country-wide price changes.

Regional consumer price indexes display little variation across regions, at least in Canada, and thus using equation (A4) would likely lead to similar convergence results for both nominal and real personal income per capita. Regional output deflators, however, are likely to show more variation across regions because of regional variations in the composition of output. In the absence of output deflators for the entire time period under consideration, one of the few things we can do is to present estimates for Canada that both include and exclude Alberta, the only region in our data set that relies heavily on oil production. Doing so helps us to identify the influence of the oil price shocks of the 1970s and 1980s on our estimates for Canada.

Table 1 contains our estimates of ß for Canada and the northern states for personal income per capita, output per capita, and output per worker. The first finding of interest is that the estimate of ß, the speed of convergence, is significant and positive as predicted by the neoclassical model of absolute convergence in all of the equations estimated. This result was to be expected for Canada, as both the obvious decline in regional disparities and previous empirical studies suggested that the data for the ten Canadian provinces satisfy the conditions for

absolute convergence. It was less certain for the northern states, since less convergence among these states was visible to the naked eye during the sample periods used. It should be noted that the estimates of ß obtained here are slightly higher than those obtained in many other studies, most likely because pooled time-series cross-section data were used rather than a single cross-section of data.[12]

The second interesting result in Table 1 is that the estimated speed of convergence is not always higher for Canada than for the northern states. The more obvious downward trend in the Canadian data might have led one to expect a faster speed of convergence in Canada. However, only for personal income per capita and output per worker when Alberta is excluded is this the case. For output per capita, the speed of convergence is higher in the northern states than in Canada even when Alberta is excluded from the group of Canadian provinces. These apparently anomalous results can be explained by the fact that the parameter ß does not measure the rate at which the measure of relative dispersion declines. Rather, it measures the average rate at which a poor

TABLE 1
ß-convergence estimates for pooled time-series cross-section data[a]

	Canada (A)	*Canada Excluding Alberta (B)*	*Northern States (C)*
Personal income per capita, 1950-1995			
ß	0.0370		0.0323
	(3.773)		(2.766)
R^2	0.9618		0.9353
# of observations	414		506
σ_*	0.161		0.125
Output per capita, 1964-1992			
ß	0.0231	0.0309	0.0452
	(3.131)	(3.779)	(3.077)
R^2	0.9860	0.9847	0.9355
# of observations	261	232	319
σ_*	0.157	0.125	0.113
Output per worker, 1967-1992			
ß	0.0387	0.0567	0.0398
	(2.919)	(3.500)	(2.471)
R^2	0.9605	0.9482	0.9309
# of observations	234	208	286
σ_*	0.157	0.125	0.113

Notes: [a]The numbers in parentheses are t-statistics, and R^2 is the raw-moment R^2. The estimating equation is equation (A4).

economy's level of output per capita converges to that of a rich one. Thus only in the case of personal income per capita can we unambiguously say that the rate at which poor economies converged to rich ones was higher in Canada during the sample period.

A third interesting finding is that the estimated values of the long-run level of relative regional dispersion, labeled σ_* in Table 1, are fairly close to the actual value at the end of the sample period for each of the variables examined. This correspondence is evident in Figures 4 to 8, which present the actual level of dispersion, a dynamic simulation of the predicted level of dispersion generated using Barro and Sala-i-Martin's (1995) equation and the parameter estimates, and the estimated long-run equilibrium level of dispersion for personal income per capita and output per worker. For the northern states, the actual level of dispersion of both variables fluctuates around both the predicted level and the long-run equilibrium level throughout the sample period, a result that is consistent with the hypothesis that the northern states have reached their long-run equilibrium level of regional dispersion. In the case of Canada, for output per worker *when Alberta is excluded* and personal income per capita, the actual

FIGURE 4
Variance of Personal Income Per Capita, Canada, 1950-1995

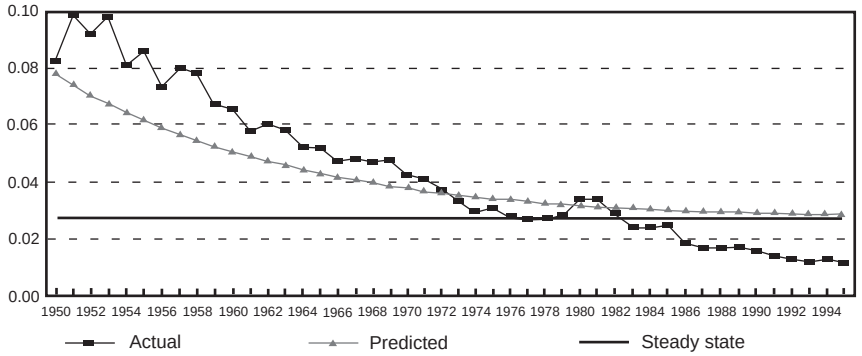


FIGURE 5
Variance of Personal Income Per Capita, Northern States, 1950-1995

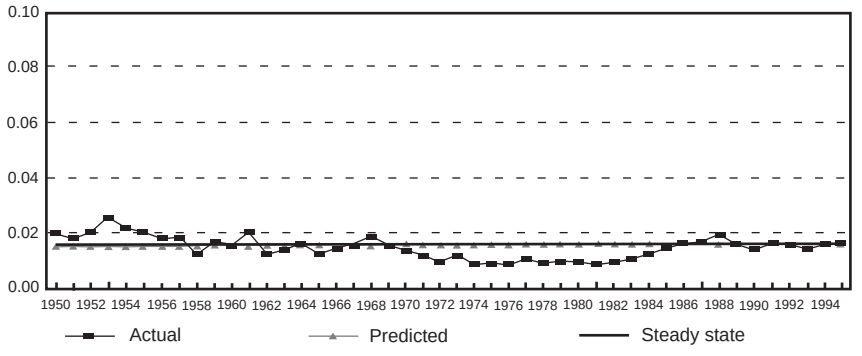


FIGURE 6
Variance of Productivity, Canada, 1967-1992

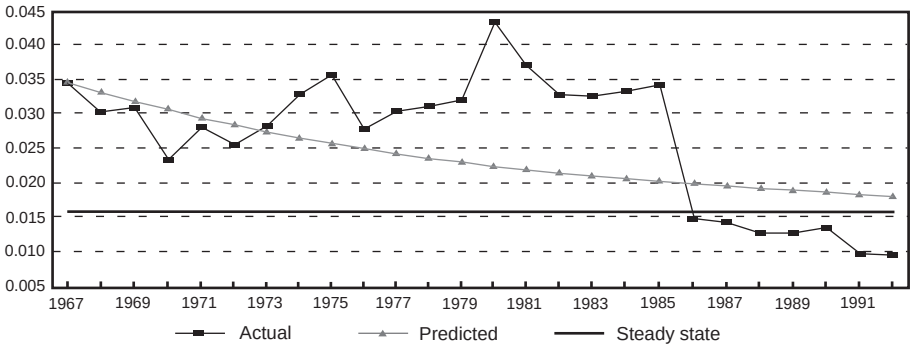


FIGURE 7
Variance of Productivity, Canada Excluding Alberta, 1967-1992

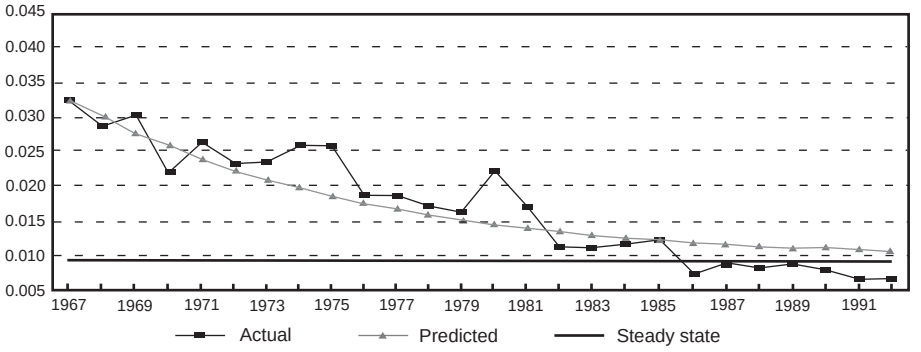
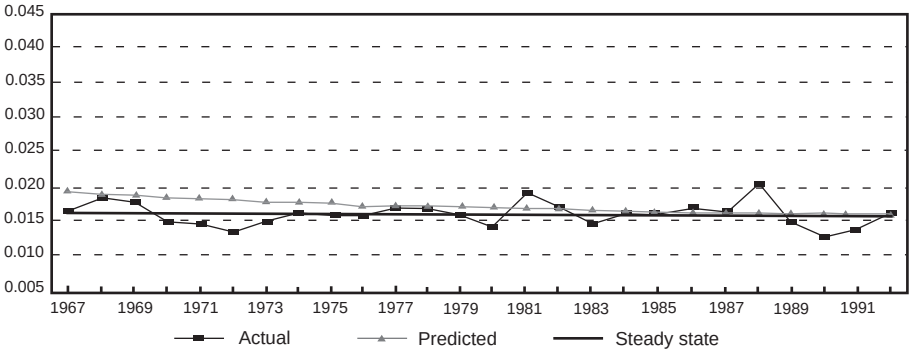


FIGURE 8
Variance of Productivity, Northern States, 1967-1992



time path of relative regional dispersion follows that predicted by the estimated model of absolute convergence quite closely as well. Canada too appears to be fairly close to its long-run equilibrium level of dispersion, although it appears to have overshot that target in the case of personal income per capita.

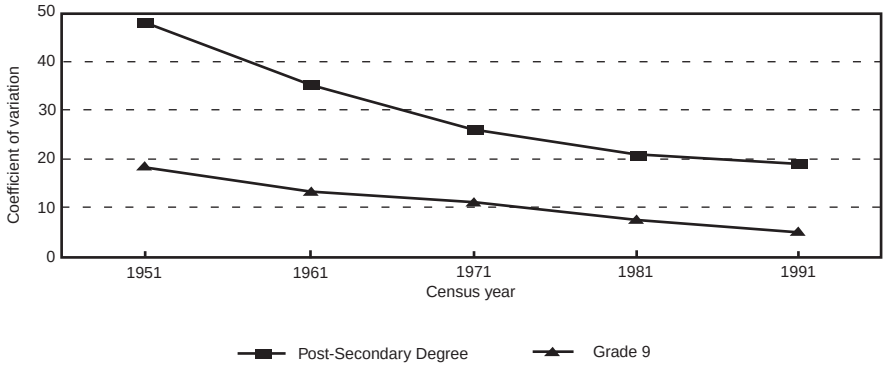
Finally, the simulation results suggest an alternative explanation for the slowdown in the process of σ-convergence observed since the 1970s among many groups of economic units. Barro and Sala-i-Martin (1995, p. 393) attributed the slowdown in σ-convergence among the 48 US states to the policies of President Ronald Reagan, but Sala-i-Martin (1996*a*) has since observed that the phenomenon seems to be a more general one that can be observed throughout the industrialized world. Since the domestic economic policies of President Reagan are unlikely to have had such a widespread effect, he proposed an increase in technology shocks as an alternative explanation. However, the simulation exercise suggests that the observed slowdown may simply be due to the fact that regional economies are close to their long-run equilibria.

Overall, these empirical results suggest that the neoclassical model of absolute convergence does a surprisingly good job of explaining the observed evolution of relative regional disparities in personal income per capita, output per capita, and output per worker in both Canada and the northern states. The surprising feature of the results is the fact that a model which assumes that all regions within a country are converging to the same long-run equilibrium can explain as well as it does the actual evolution of regional disparities among groups of regions that are known to differ in terms of their resource endowments and local government policies.[13] Since the model attributes convergence to capital accumulation and technological change, the logical conclusion to be drawn is that these mechanisms have been primarily responsible for the observed decline in relative regional income disparities in Canada.

This does not mean that government policies have not also played a role. In fact, many regional development policies in Canada over the years have been directed toward the encouragement of the accumulation of physical capital in lagging regions. Similarly, the provincial governments, aided by grants from the federal government, deserve much of the credit for the increases in human capital accumulation that have taken place in Canada since 1950, particularly in the poorer provinces. Figure 9, drawn from Coulombe (1999), shows the improvements that have occurred in the regional dispersion of two commonly-used indicators of human capital: the percentage of the population with at least a grade 9 education, and the percentage of the population with at least a postsecondary degree.[14] As Barro, Mankiw and Sala-i-Martin (1995) point out, investment in physical capital can be financed in international financial markets at the world interest rate, but investment in education is subject to a credit-market constraint because agents cannot borrow with human capital as collateral. They show that in this case, the convergence of income per capita is solely determined by the convergence of the stock of human capital. The trend in the regional dispersion of the two human capital measures clearly indicates that σ-convergence in the stock of human capital in Canada has been taking place. It is doubtful that individuals alone could have engineered such improvements in the absence of massive public investment in education at all levels. Finally, the growth of government since 1960 was accompanied by government investment in various types of public capital, such as hospitals and transportation facilities as well as schools, colleges, and universities, which may also have contributed to the reduction of regional income disparities.[15]

While the process of capital accumulation may explain the observed convergence of per capita income levels in both Canada and the northern states, one must look for differential patterns of human capital accumulation in order to explain the fact that convergence occurred much earlier in the northern states than in Canada. Goldin and Katz (1997) found

FIGURE 9
Regional Dispersion of Human Capital, Canadian Provinces



Source: Coulombe 1999.

that the growth of secondary schooling in the far west, the Great Plains, and parts of New England was phenomenal during the 1910 to 1940 period. Comparing the 14- to 17-year old enrolment rates of Canadian regions with those of states south of the border, they note that Canadian data for Ontario and British Columbia are similar, although somewhat lower than that for the US states along the border. However, the data for Quebec and the Maritime provinces, like those for the American South, show considerably lower rates of enrolment. Thus there seem to have been greater disparities in rates of human capital investment among the Canadian provinces than among the northern states.

To the extent that our estimates of the long-run level of regional dispersion are accurate, they have some interesting implications for future regional policy in Canada. First of all, in contrast to the views of Courchene (1970, 1994), government policies that redistribute income across regions have not completely overcome the Canadian economy's natural tendency toward the reduction of regional *income* disparities. The model is, however, silent regarding the possible impact of policies such as unemployment insurance on regional disparities in *unemployment rates*, since neoclassical growth models ignore unemployment. Second, once the long-run equilibrium has been reached, the only way to bring about further important decreases in the level of regional income disparities is to introduce policies that are directed toward reducing the long-run, structural component of regional disparities. The gains that remain from the process of capital accumulation and poor economies catching up to richer ones are small; therefore policies that are directed toward encouraging capital accumulation are likely to be less effective in the future than they were in the past.

These insights provided by the neoclassical model of absolute convergence are both interesting and informative. However, the model of absolute convergence does have some serious limitations. The first is its inability to explain regional disparities in unemployment rates. As Swan and Serjak (1991) point out, in relative terms disparities in unemployment rates in Canada are considerably more important than disparities in income measures, and therefore any analysis that ignores them is incomplete.

A second serious limitation is the model's inability to provide a satisfactory explanation of the structural factors underlying the long-run equilibrium level of regional income disparities. In the neoclassical model of absolute convergence, only one factor gives rise to long-run regional disparities:

random shocks to the level of output (or income) per capita (or per worker). It is unclear what policies could be designed to reduce the impact of these random shocks. Models of conditional convergence offer some improvement, as they introduce other factors underlying long-run disparities such as differences in savings rates, the rate of technological change, the rate of population growth, and the parameters of the production function. However, they do not incorporate factors that have traditionally been believed to be related to levels of regional disparities, such as barriers to labour mobility.

Thus the neoclassical model of absolute convergence is not able to explain all of the stylized facts observed earlier. It can explain the decline in relative regional dispersion in Canada, as well as the relative constancy of regional disparities in the northern states. It also provides some hints regarding where to look for an explanation for the fact that convergence occurred earlier in the northern states than in Canada. But it is unable to explain why regional disparities in output per capita remain higher in Canada than in the northern states, nor does it provide much guidance regarding how to design policies to reduce the long-run structural component of regional disparities. For answers to these questions one must go beyond the neoclassical framework, as we do in the next section of the paper.

Sources of the Structural Gap between Canada and the Northern States

The analysis of the previous sections has shown that regional disparities in output per capita in 1992 remained higher in Canada than in the northern states, although the difference in dispersion levels had been eliminated for personal income per person and productivity. This gap cannot be merely cyclical, as it has persisted throughout the sample period. Moreover, the estimated long-run levels of regional dispersion of all three variables are higher for Canada than for the northern states, except in the case of productivity. In this section, we use a standard formula to decompose the variances of personal income per capita and output per capita to help identify the sources of these gaps and thus shed further light on the sources of the structural component of regional disparities in Canada.

First, let *PI* be personal income and *P* be the total population. Then personal income per capita and output per capita can be related by the following identity:

$$\frac{PI}{P} = \frac{PI}{GDP} \cdot \frac{GDP}{P} . \qquad (2)$$

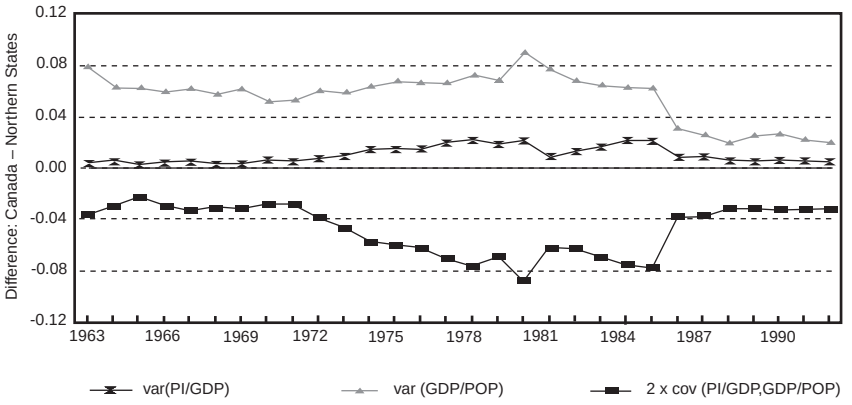
The size of the ratio *PI/GDP* will depend on, among other things, the importance of undistributed corporate profits and transfer payments to individuals.[16] If we let i_p be the log of personal income per capita, x be the log of *PI/GDP*, and y_p be the log of output per capita, then the variance of the log of personal income per capita will be given by

$$var(i_p) = var(x) + var(y_p) + 2cov(x,y_p) . \qquad (3)$$

Taking the difference between Canada and the northern states in each of these three components of the variance of the log of personal income per capita will provide some insight into the sources of the observed differences in regional dispersion in Canada and the United States.

The three components of the variance of i_p are plotted in Figure 10 for the period 1963-92. The figure shows that during this period, the large positive gap between the two countries in the regional dispersion of the log of output per capita has been largely offset by the negative contribution of the covariance between the logs of the ratio of *PI* to *GDP* and output per capita. While this covariance has been negative on both sides of the border, implying that regions with a higher level of output per capita tend to have a lower ratio of *PI* to *GDP*, it has been more negative in Canada. Canada's system of transfer payments, which helps to redistribute income from rich to poor individuals, may be one factor underlying this lower covariance. It is

FIGURE 10
Decomposition of Variance, Logarithm of PI Per Capita



interesting to note that the gap between Canada and the northern states in regional dispersion of the ratio of personal income to GDP remained fairly constant at a relatively low level throughout the 1963 to 1992 period. Thus the principal factor tending to raise regional dispersion of personal income per capita in Canada relative to that in the northern states is the higher level of dispersion in output per capita.

But what are the factors underlying the greater disparities in output per capita? To help answer this question, let *E* represent employment and *LF* represent the labour force. Then output per capita can be written as the product of three components:

$$\frac{GDP}{P} = \frac{GDP}{E} \bullet \frac{E}{LF} \bullet \frac{LF}{P} , \qquad (4)$$

where *GDP/E* is average labour productivity, *E/LF* is the employment rate (equal to one minus the unemployment rate), and *LF/P* is the rate of labour force participation of the total population. Although these three components are clearly interrelated, different economic and institutional factors are likely to affect the evolution of each. For example, as discussed in the previous section the neoclassical process of convergence implies the gradual reduction of regional disparities in productivity as a consequence of the accumulation of human and physical capital and the law of decreasing returns. The persistence of large gaps in labour productivity between regions thus implies a lag in economic development. However, large gaps between regions in employment and participation rates are better explained by factors such as the efficiency of labour market adjustment mechanisms, the labour-leisure trade-off, and household migration decisions.

After taking the logarithm of equation (4), one obtains the following decomposition of the variance of the log of output per capita (y_p):

$$var(y_p) = var(y_e) + var(e) + var(f) + 2cov(y_e,e) + 2cov(y_e,f) + 2cov(e,f) , \qquad (5)$$

where y_e is the log of output per worker, *e* is the log of the employment rate, and *f* is the log of the participation rate. We examine the difference between Canada and the northern states in the evolution of the components of this decomposition in Figures 11 and 12, for the period 1966 to 1992. Both figures, particularly the one that excludes Alberta, illustrate the gradual elimination of differences in the dispersion of labour productivity as a factor contributing

FIGURE 11
Decomposition of Variance, Logarithm of GDP Per Capita

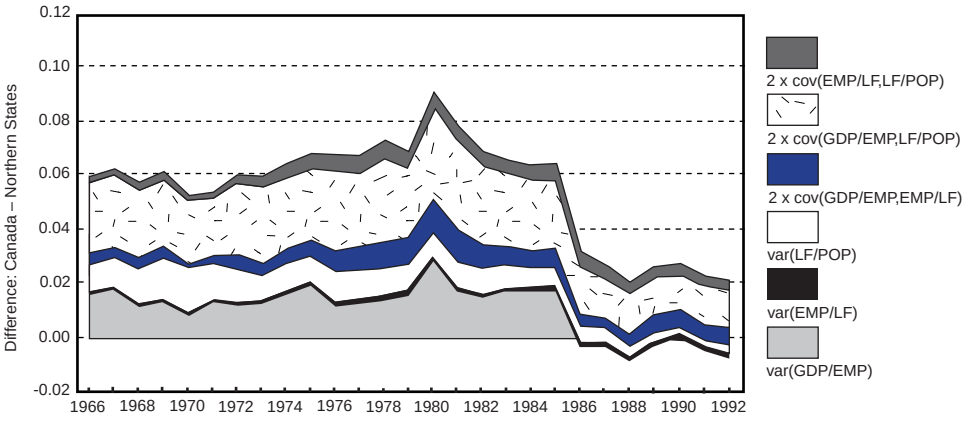
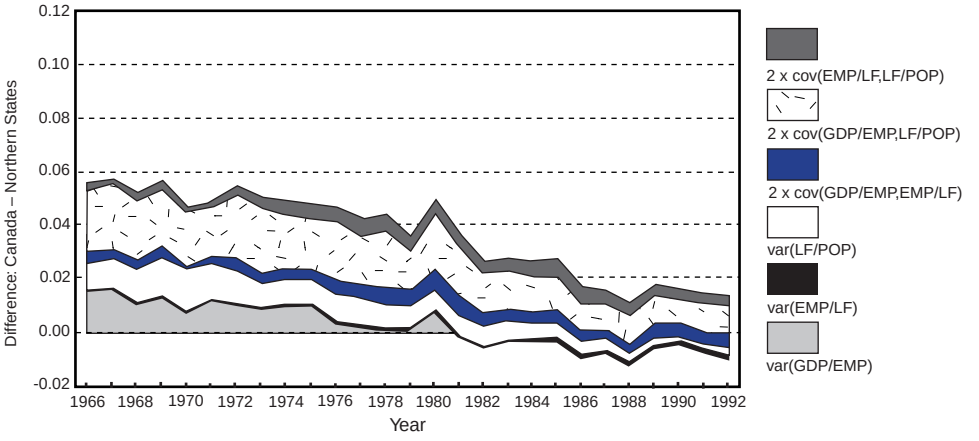


FIGURE 12
Logarithm of GDP Per Capita (Alberta Excluded)



to higher regional dispersion of output per capita in Canada. In fact, since the mid-1980s the dispersion of labour productivity has actually been lower in Canada than in the United States. The contribution of differences in the regional dispersion of employment rates has also been negligible throughout most of the period examined; differences in the regional dispersion of participation rates have played a more important role in contributing to higher regional dispersion of output per capita in Canada.

Perhaps the most interesting fact that emerges from this analysis is the importance of the covariances between the components of output per capita. Since the mid-1980s, these covariances have been responsible for most of the differences in regional dispersion of output per capita between Canada and the northern states. Moreover, the three covariances have played an important role throughout the 1966-92 period. To the extent that the northern states constitute an appropriate basis of comparison for Canada, these results provide some revealing insights into the sources of regional disparities in Canada. The relatively large positive covariances between productivity and the other two variables imply that *in contrast to the situation in the northern states, in Canada regions with low productivity tend to have lower participation rates and higher unemployment rates than regions with high productivity*. This observation is not new; what is surprising is that the same phenomenon is not observed in the northern states. In the northern states, there does not appear to be a systematic positive relationship between labour productivity and the participation rate on the one hand, and between labour productivity and the employment rate on the other. It seems unlikely that demographic factors — in particular the proportion of the population that is of working age — would be sufficient to explain this difference.

Although its contribution to the differences between Canada and the northern states is less important than that of the other two covariances, the covariance between the participation rate and the employment rate also plays a role in explaining the different levels of regional dispersion in output per capita in the two countries. While it is generally positive in both countries, its value has been higher in Canada than in the northern states throughout the period examined, implying that *relative to the northern states, in Canada the unemployment rate is systematically higher in regions with a low participation rate*.

The importance of the three covariances in explaining differences in regional disparities between Canada and the northern states suggests that what really distinguishes the economies north of the border from those that lie further south is that Canadians are more likely to remain in regions where productivity is low even if they are not working there. Similarly, they are more likely than Americans to stay in regions where the unemployment rate is high. Moreover, it is clear from Figures 11 and 12 that these appear to be long-standing tendencies, not temporary phenomena: the sum of the three covariances was almost as big in 1992 as it was in 1966.

These findings suggest that the explanation for the difference between Canada and the northern states in the level of relative regional dispersion of output per capita lies in the locational and labour force participation decisions of Canadians. Many factors potentially influence locational decisions: migration costs, climate differences, wage and unemployment rate differentials, and various government policies, among others. However, the similarities in physical geography between the Canadian provinces and the northern states suggest that moving costs and climate differences can be ruled out as important sources of differences in locational choices. Similarly, we have seen that the degree of regional dispersion of unemployment rates does not differ greatly between Canada and the northern states, leaving differences in government policies as the factor most likely to be responsible for the apparent differences in the locational choices of Canadians and residents of the northern states.[17] Among the government policies most likely to influence migration decisions are the unemployment

(now employment) insurance system, in which benefits are tied to regional unemployment rates, and intergovernmental transfer payments, which allow poorer provinces to offer a more attractive package of taxes and expenditures than would otherwise be the case. Further research is required to determine the extent to which such policies influence migration decisions in Canada, as the empirical evidence to date on this issue is mixed.[18] Similarly, further research is also required to determine whether differences between the unemployment insurance systems in Canada and the United States can explain the observed differences in the regional dispersion of participation rates.

Conclusion

This paper's investigation of the evolution of relative regional income disparities in Canada, as well as the comparison of that evolution with the evolution of relative regional income disparities in a reference group of US states, leads to a number of implications for policy. First of all, the observed decline in relative regional income disparities in Canada will no doubt be regarded positively by Canadian policymakers, particularly during the current period of budgetary restraint. Decreasing relative regional income disparities, especially if accompanied by decreasing absolute disparities, will reduce the need for specific government policies targeted toward the reduction of regional income differentials, as well as perhaps reducing some of the regional discontent that has plagued the Canadian federation. In addition, the fact that convergence has occurred over time, despite the warnings of economists such as Courchene (1970, 1994) that intergovernmental transfer payments and the design of the unemployment insurance system were likely to exacerbate regional disparities, implies that even if these policies had negative effects on the regional adjustment process, those negative effects were not strong enough to overwhelm the dynamic mechanisms that work toward the reduction of regional income disparities.

Another lesson for policymakers that arises from our examination of the neoclassical model of absolute convergence is that it would be unrealistic to expect that regional disparities will ever be completely eliminated. Even in the absolute convergence model, where all regional economies are converging to the same long-run equilibrium, random shocks to regional output per capita will ensure that relative regional dispersion is never reduced to zero. As a consequence, the demand for regional policies may never go away. In particular, the federal government cannot look forward to the prospect of equalization entitlements eventually fading away to zero. As long as the level of regional dispersion is non-zero, some provinces will be entitled to equalization payments.[19]

Finally, if the Canadian economy is indeed close to its long-run equilibrium, as our analysis suggests, then a change in the type of policy used to address regional disparities will soon be needed. Policies that promote the accumulation of human and physical capital are appropriate during the process of transition to long-run equilibrium, but will have little if any effect on regional income disparities once that equilibrium has been reached. Instead, what will be needed in the future if the government wishes to alleviate what remains of relative regional income disparities are policies directed toward the structural component of regional disparities.

Our analysis of convergence does not permit us to be very specific regarding the precise nature of the policies required to reduce the structural component of regional income disparities. The decomposition of the variance carried out in the fourth section of the paper does, however, suggest that the answer lies somewhere in the labour market behaviour of Canadians. This part of our analysis tends to support the arguments of Courchene (1970, 1994). Clearly, further research is required on this topic. Further exploration of the nature of the convergence process in Canada — whether convergence is conditional or absolute — might help to shed some light on this issue as well. Although the absolute

convergence model we estimated worked well for both Canada and the northern states, a model of conditional convergence which explicitly took account of regional differences in resource endowments and other characteristics would probably be more intuitively appealing. An attempt to incorporate labour market behaviour in such models would also be helpful.[20]

Finally, in view of the fact that the federal government and the provinces are currently renegotiating the provisions of the equalization payments system, it would be worthwhile to carry out a more in-depth examination of the implications of convergence for the equalization payments system. The fact that the per capita provincial tax bases upon which equalization entitlements depend are closely related to provincial per capita output means that reductions in the gaps between provinces will have an important impact on the magnitude of the payments the federal government must make to have-not provinces. But as has already been pointed out, the gaps are unlikely to ever be completely eliminated, meaning that equalization payments will never be reduced to zero. Moreover, the exact implications of convergence for the future evolution of equalization payments is likely to depend on whether convergence is absolute or conditional. In the former case, deviations from the common equilibrium level of output per capita will be random, and thus from year-to-year the identity of the have-not provinces may fluctuate. In the conditional convergence case the relative positions of the provinces will be fixed, and thus the same group of provinces will continue to receive equalization payments in perpetuity.

Overall, our analysis can be said to raise more questions than it answers. It is perhaps best viewed as an exercise in generating and highlighting stylized facts about relative regional income disparities in Canada. According to Mankiw (1995), stylized facts are the only scarce resources in economic research. While not all of the stylized facts examined are new, the comparison, within the neoclassical growth framework, of the evolution of relative regional income disparities in Canada with those among a novel reference group of US states has shed some new light on an old problem. Further research into some of the questions raised above will illuminate the causes of regional disparities in Canada and ultimately lead to more concrete suggestions regarding the appropriate direction for regional policy in Canada.

NOTES

We would like to thank André Plourde, Rose Anne Devlin, three anonymous referees and the editor for their helpful comments on earlier versions of this paper.

[1]See Barro and Sala-i-Martin (1995), Mankiw (1995), and Sala-i-Martin (1996*a*) for reviews of this literature.

[2]A detailed list of data sources can be found in the Data Appendix.

[3]The standard deviation of logarithms can be regarded as an approximation to the coefficient of variation of the levels of the variable in question.

[4]Regional city consumer price indexes that might be used to deflate provincial personal incomes for Canada do exist, but comparable deflators do not exist for all the US states we include in our analysis. As far as regional Gross Domestic Product (GDP) deflators are concerned, Statistics Canada's data series begin only in 1981, although provincial GDP deflators beginning in the early 1960s are available from the Conference Board of Canada. Prior to 1971, the Conference Board deflators were constructed by applying provincial industry shares to national industry deflators. For Gross State Product (GSP) in the United States, the only deflators available are also pseudo-regional deflators, constructed by the Bureau of Economic Analysis by applying state industry shares to national industry deflators. More importantly, these deflators are only available from 1977. Since the analysis of economic growth patterns requires time series that are as long as possible, we chose to work with nominal output data rather than lose up to 13 years of our sample period. It should be noted that the standard deviation of logarithms would be unchanged if national price deflators for the two countries had been used to deflate the data.

[5]The province of Alberta, which is Canada's major oil producer, is the only province that does not seem to have a direct counterpart immediately below the border. In addition, as pointed out by a referee, the economy of Washington state, the home of Boeing and Microsoft, is

much less oriented toward the exploitation of natural resources than is that of British Columbia.

[6]Because Alberta is the only important oil-producing province in Canada, shocks to the oil-producing sector have a disproportionate effect on measures of regional disparities in nominal variables in Canada. Therefore, the measure of regional dispersion for Canada is calculated both including and excluding the province of Alberta. The use of regional output deflators would eliminate the need to re-calculate the dispersion measure for Canada with Alberta excluded. However, although such deflators exist for Canada, we were unable to locate regional output deflators for the United States for the entire time period under consideration.

[7]Output per worker is not the only possible measure of labour productivity. One difficulty with it is that it does not take into account differences in labour productivity arising from differences in hours per worker. However, it was impossible to obtain average hours of work for all of the regions concerned throughout the period under consideration.

[8]However, there remains some controversy in the empirical literature on convergence. Durlauf (1996) argues that while studies using cross-section techniques tend to support the hypotheses of either absolute or conditional convergence, those that use time-series tests for convergence tend to reject the hypotheses. However, Lefebvre (1994) and Carlino and Mills (1993) use time-series tests for convergence and find evidence that convergence has occurred among the Canadian provinces in the former and the US states in the latter.

[9]See the Technical Appendix for further details.

[10]For example, see Barro and Sala-i-Martin (1995), Coulombe and Lee (1995), and Lee and Coulombe (1995).

[11]See note 4 for details regarding the availability of regional price deflators.

[12]Most of the earlier studies of ß-convergence examined convergence over a long time period by collapsing their data set to a single cross section of data. These studies generally obtained estimates of ß in the neighbourhood of 2 percent. Coulombe and Day (1996) found that the estimated speed of convergence was generally higher when pooled data were used instead.

[13]In fact, some studies, such as Lee (1997) for Canada and Carlino and Mills (1993) for the United States have obtained evidence suggesting that a model of conditional convergence would be more appropriate. However, Coulombe and Day (1996) found that a simple model of conditional convergence for Canada did not predict the time path of regional dispersion as well as the model of absolute convergence, even though standard statistical tests suggested that the model of conditional convergence was superior.

[14]The dispersion measure used is the coefficient of variation of the levels of the variable, a measure of relative dispersion. The data for 1951 to 1991 are from a Statistics Canada publication entitled *The Nation*, catalogue number 93-328.

[15]Most of the existing literature on the contribution of public sector capital to economic growth pertains to the United States and is not unanimous in its conclusions. However, Wylie (1995) obtains evidence that public capital does contribute to economic growth and productivity in the goods-producing sector in Canada.

[16]A well-known national accounting identity links personal income (*PI*) to *GDP*:

PI = GDP + income earned by Canadians from foreign assets
- income earned by foreigners from Canadian assets
- retained earnings – corporate profits taxes
- indirect business taxes – depreciation
- payroll taxes + transfer payments to individuals.

This identity is linear, however, and therefore is not well-suited to analyzing the variance of the logarithm of personal income per capita. Furthermore, it contains so many terms that an analysis of variance of personal income per capita based on this identity would be difficult to interpret. Finally, although it is possible to retrieve data on the components of PI for the Canadian provinces, we did not have comparable data for the US states.

[17]It should be noted that residents of the northern states have available to them an additional locational choice that has been ignored in our analysis: moving to a more southerly state.

[18]See Day and Winer (1994) for a review of the literature on fiscally-induced migration in Canada.

[19]Equalization payments depend on, among other things, per capita differences in the tax bases for various provincial government revenue sources. The per capita tax base in each province can in turn be related to provincial per capita output.

[20]Barro and Sala-i-Martin (1995, ch. 9) discuss the extension of the neoclassical growth model to a world in which there is labour migration.

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DATA APPENDIX

A. Canadian Data

Most of the data were retrieved from Statistics Canada's CANSIM database. The following tables contain the matrix and series identification numbers for the data retrieved from CANSIM.

	Employed, 15 and Over 1976-1992		*GDP at Market Prices* 1963-1992		*Indirect Taxes Net of Subsidies* 1963-1992	
Province	*Matrix*	*Series*	*Matrix*	*Series*	*Matrix*	*Series*
NFLD	2065	D768890	2611	D31544	2611	D12547
PEI	2066	D769857	2612	D31558	2612	D12549
NS	2067	D768616	2613	D31572	2613	D12551
NB	2068	D769890	2614	D31586	2614	D12553
QUE	2069	D769839	2615	D31600	2615	D12555
ONT	2070	D769902	2616	D31614	2616	D12557
MAN	2071	D769946	2617	D31628	2617	D12559
SASK	2072	D769967	2618	D31642	2618	D12561
ALTA	2073	D769988	2619	D31656	2619	D12563
BC	2076	D769920	6949	D44000	6949	D12565

	Labour Force, 15 and Over 1976-1992		*Population as of June 1st* 1929-1995		*Personal Income* 1926-1960	
Province	*Matrix*	*Series*	*Matrix*	*Series*	*Matrix*	*Series*
NFLD	2065	D768790	599	D31236	6662	D11701
PEI	2066	D769856	599	D31237	6662	D11702
NS	2067	D768613	599	D31238	6662	D11703
NB	2068	D770071	599	D31239	6662	D11704
QUE	2069	D769838	599	D31240	6662	D11705
ONT	2070	D769901	599	D31241	6662	D11706
MAN	2071	D769945	599	D31242	6662	D11707
SASK	2072	D769966	599	D31243	6662	D11708
ALTA	2073	D769987	599	D31244	6662	D11709
BC	2076	D769919	599	D44245	6662	D11710

	Personal Income 1961-1995	
Province	*Matrix*	*Series*
NFLD	5089	D43201
PEI	5090	D43217
NS	5091	D43233
NB	5092	D43249
QUE	5093	D43265
ONT	5094	D43281
MAN	5095	D43297
SASK	5096	D43313
ALTA	5097	D43329
BC	6965	D44450

GDP at factor cost was computed for each province by subtracting Indirect taxes net of subsidies from GDP at market prices. Data on provincial labour forces and employment for the period 1966-1975 were obtained from the data set compiled by Lee and Coulombe (1995).

B. American data

Most of data for the 12 northern US states were obtained from a data set compiled by Manfred W. Keil and Stephen L. Parente. These data were updated as follows:

1. Personal income per person: annual data for the years 1991-95 were retrieved from Stat-USA, the Department of Commerce's Internet data service, on 19 May 1997. The address of the relevant data file is http://www.stat-usa.gov/BEN/ebbl/reg/pci9196.ann.

2. Gross state product: annual data for the years 1977-92 were also retrieved from Stat-USA, on 19 May 1997, from the files fwgsp.prn, rmgsp.prn, negsp.prn, glgsp.prn, plgdp.prn, and megsp.prn.

3. Labour Force and Employment: annual averages for the years 1978-95 were retrieved on 19 May 1997 from LABSTAT, the public database of the Bureau of Labour Statistics that is accessible via the Internet at http://stats.bls.gov/blshome.html. The databank numbers are given in the table below.

4. Population: annual data on population as of July 1st from 1990-95 were retrieved from the US Census Bureau's public Internet service on 19 May 1997. The data were found in the file st9096T1.txt.

State	*Employment 1978-1992* Series	*Labour Force 1978-1992* Series
Idaho	LAUST16000005	LAUST16000006
Maine	LAUST23000005	LAUST23000006
Michigan	LAUST26000005	LAUST26000006
Minnesota	LAUST27000005	LAUST27000006
Montana	LAUST30000005	LAUST30000006
New Hampshire	LAUST33000005	LAUST33000006
New York	LAUST36000005	LAUST36000006
North Dakota	LAUST38000005	LAUST38000006
Ohio	LAUST39000005	LAUST39000006
Pennsylvania	LAUST42000005	LAUST42000006
Vermont	LAUST50000005	LAUST50000006
Washington	LAUST53000005	LAUST53000006

TECHNICAL APPENDIX

In this appendix, we explain briefly the procedure used for the analysis of ß-convergence, and the dynamic simulation exercise performed in the third section. The analysis follows Coulombe and Day (1996), which studies the relationship between ß- and σ-convergence for a broader class of estimation techniques.

Barro and Sala-i-Martin (1995, sections 2.6.5 and 11.1) have demonstrated that an approximation around the steady-state of the neoclassical growth model gives rise to an equation of the form

$$y_{it} = a_i + e^{-\beta} y_{i,t-1} + u_{it} , \tag{A1}$$

where y_{it} is the logarithm of output per worker in region i at time t; ß, a function of the parameters of the growth model, is the speed of convergence; a_i is a region-specific constant term that is a function of the steady-state level of output per effective worker, the speed of convergence, and the rate of technological change; and u_{it} is a random error term that captures the effect of transitory shocks. *Absolute convergence* occurs if regions differ from each other only in terms of their initial level of output per worker, so that the parameter a_i=a for all regions. The following expression for σ_*^2, the long-run equilibrium variance of regional disparities in output per worker in the case where all regions are identical, is derived in Barro and Sala-i-Martin (1995) :

$$\sigma_*^2 = \frac{\sigma_u^2}{1 - e^{-2\beta}} , \tag{A2}$$

where σ_u^2 is the variance of the error term u_{it} in equation (A1). This equation defines the structural or long-run component of regional disparities. It is derived from the equation defining σ_t^2, the level of regional dispersion of y_{it} at time t:

$$\sigma_t^2 = e^{-2\beta}\sigma_{t-1}^2 + \sigma_u^2, \tag{A3}$$

which follows directly from equation (A1) if one assumes that the u_{it} are independently and identically distributed for all i and t. Thus given estimates of the parameters ß and σ_u^2, it is straightforward to estimate the steady-state level of regional dispersion of output per worker, and to simulate the time-path of regional disparities.

To estimate the parameter ß, we use pooled annual time-series cross-section data and the following modified version of (A1):

$$y_{it} - M_t = e^{-\beta}(y_{i,t-1} - M_{t-1}) + v_{it}, \tag{A4}$$

where M_t is the mean of the y_{it} across regions *i* at time *t*, and v_{it} is the difference between u_{it} and the mean of u_{it} across regions *i* at time *t*. This modification thus yields an equation in terms of deviations from means. When pooled data are used, this specification has an advantage over equation (A1) because it eliminates from the data shocks that are common to all regions, such as the break in the rate of productivity growth that was observed in Canada and most developed countries in the mid-1970s. As do Barro and Sala-i-Martin, we assume that the u_{it} in equation (A1) are independently and identically normally distributed across all i and t. As a consequence, there exist cross-equation correlations between the v_{it} which are taken into account in the nonlinear least squares estimation procedure. The estimation procedure is similar to Zellner's Seemingly Unrelated Regressions Estimator, but differs from it in that the assumption that the variances of the u_{it} are the same across cross-sectional units necessitates the imposition of restrictions on the contemporaneous covariance matrix. See Coulombe and Day (1996) for further details about the estimation procedure, including the exact form of the covariance matrix.