World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:3, No:7, 2009

Regional Convergence in per Capita Personal Income in the US and Canada

Ilona Shiller

***Abstract*—**This study examines regional convergence in per capita personal income in the US and Canada. We find that the disparity in real per capita income levels across US states (Canadian provinces) has declined, but income levels are not identical. Income levels become more aligned once costs of living are accounted for in relative per capita income series. US states (Canadian provinces) converge at an annual rate of between 1.3% and 2.04% (between 2.15% and 2.37%). A pattern of σ and β-convergence in per capita personal income across regions evident over the entire sample period, is reversed over 1979-1989 (1976-1990) period. The reversal may be due to sectoral or region-specific shocks that have highly persistent effects. The latter explanation might be true for half of the US and most of Canada.

***Keywords*—**regional convergence, regional disparities, per capita income.

I. Introduction

THE convergence hypothesis is a popular tenet in modern discussions in macroeconomics and international finance. It derives from the fundamental properties of the neoclassical single-sector growth model, and its assumptions of diminishing returns to scale. Recently there has been increasing attention paid to the question of whether economies exhibit a tendency to diverge or converge over time. Though much of the literature is concerned with the convergence or divergence of national economies there have also been a number of studies conducted at the regional level, in particular for the regions of the European Union (see, for example, [9]).

This study examines regional convergence in per capita income across US states and Canadian provinces. The US sample extends from 1929 to 2003, whereas the Canadian sample extends from 1951 to 1990. Alaska, Hawaii, and the District of Columbia (DC) are excluded from most empirical analysis of per capita income convergence across US states. Alaska and Hawaii are excluded due to their geographical isolation, whereas DC is excluded due to the mismatch between earned and generated residential personal income. Nunavut is excluded from the analysis because it was not in existence during the tested time period.

The renewed interest in the topic of regional disparities can be explained by at least three phenomena. First, due to the recent availability of regional data the relevant empirical studies can now be performed. Second, endogenous growth models, which can explain convergence as well as divergence among different groups of nations and within different regions of a country, are now popular in mainstream macroeconomics. Third, many growth and development related issues have recently emerged at the forefront of economic and political problems. Many of these issues have direct implications for regional studies. For example, even if North American economic integration is expected to make the whole region more prosperous, there is an increasing concern that an integrated North American market may exacerbate the problems of regional imbalance and inequality.

This study examines if real per capita personal income in the US and Canada has converged? We present three concepts of convergence and empirically test them. The study is organized as follows. Introduction is in section I. Section II discusses the notion of convergence, and briefly touches upon sources of income convergence/divergence. Data and test results are presented in section III. Finally, the results are discussed in the conclusion**.**

Ilona Shiller is with the University of New Brunswick, Faculty of Business Administration, PO Box 4400, NB, E3B 5A3 Canada (phone: 506-458-7339; fax: 506-453-4869; e-mail: ishiller@unb.ca).

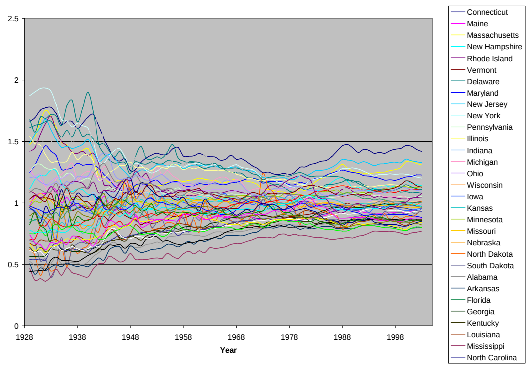
II. The Notion of Convergence

Some economists argue that the notion of convergence is a disequilibrium phenomenon. That is, the convergence hypothesis assumes that regions are initially out of equilibrium. Over time, however, factors will migrate across regions to achieve equilibrium. The convergence hypothesis states that regions tend to gravitate towards their steady state level of growth over time.

Fig. 1 (Panels A and B) depicts regional per capita income relative to the national per capita personal income across states (provinces). Data are in logarithms. The log of the relative per capita personal income differs widely across regions in the beginning of our sample periods. In 1930, per capita income in New York, Connecticut, California, and Nevada exceeds the national average by 90.26%, 69.30%, 63.05%, and 53.13% respectively. Per capita income in Mississippi, Arkansas, South Carolina, and North Carolina falls short of the national average by 62.87%, 58.09%, 55.33%, and 46.32% respectively. In Canada, per capita personal income in British Columbia and Ontario is more than 18% above the national average in 1951. In contrast, per capita income in Newfoundland, Prince Edward Island, and New Brunswick is 51.74%, 45.21%, and 33.06% below the national average in 1951. Thus, divergence in per capita personal income across US states (Canadian provinces) is evident in the beginning of our samples. However, this pattern is reversed over time and we can observe a trend toward convergence of regional per capita incomes. Per capita personal incomes became more aligned at the end of our sample periods. In 2003, per capita income in New York, Connecticut, California, and Nevada exceeds the national average by 20.15%, 41.83%, 10.87%, and 2.71% respectively. Per capita income in Mississippi, Arkansas, South Carolina, and North Carolina falls short of the national average by 22.97%, 20.21%, 14.15%, and 7.24% respectively. In Canada, per capita personal income in British Columbia and Ontario is only 13.37% and 1.14% above the national average in 1990. In contrast, per capita income in Newfoundland, Prince Edward Island, and New Brunswick is only 28.57%, 26.45%, and 23.10% below the national average in 1990.

Why do regional personal incomes vary or converge?

A. Real per capita income as a percentage of US average



B. Real per capita income as a percentage of Canadian average

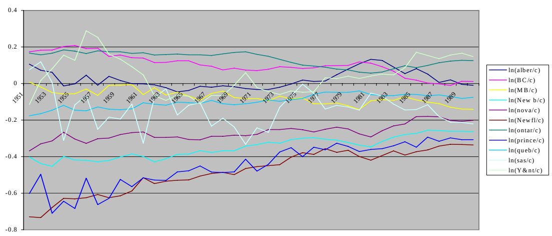


Fig. I Real per capita income as a percentage of average income

How does the theory explain this phenomenon? To answer these questions we identify potential sources of income convergence or divergence. There are two sources of income convergence: one specified by models of growth and another by models of trade.

The neoclassical Solow growth model, with diminishing returns to capital, argues that additional factor inputs yield smaller increments to output in regions with higher incomes than they do in regions with lower incomes. The pace of income convergence in the growth model significantly increases because labour and capital mobility speeds up the rate at which any differences in factor returns will tend to be migrated away over time. The neoclassical Heckscher-Ohlin trade model argues that incomes of regions vary because of differing factor endowments and factor prices. Economic integration and liberalized trade in goods leads to income convergence through factor price equalization. The problem with the factor price equalization (FPE) or convergence in the micro sense is that it describes outcomes in the steady state equilibrium but does not say anything about factor prices in the adjustment phase to steady state. The FPE theorem also holds under restrictive assumptions of zero trade barriers, identical linear homogeneous technology and preferences across regions, and all regions producing all products. The same models can explain why regions diverge.

Under the neoclassical growth model, assumptions of decreasing returns and factor mobility have to hold. The models of growth based on increasing returns in physical or human capital externalities, advanced by Paul Romer and Robert Lucas respectively, predict the possibility of income divergence. In these models, lack of knowledge increases the returns to human capital in regions with a lot of physical capital. Additionally, due to the external economies of scale the returns to skilled workers may be higher in locations with large concentration of skilled workers. The prediction of these models is that skilled workers will migrate to the locations with other skilled workers and income differences will increase over time.

Trade models, based on the increasing returns argument advanced by Paul Krugman, also predict the possibility of income divergence through the divergence in industrial structure or in factor endowments. If high-tech, high-wage industries are subject to external economies, then the opening up of trade will cause the concentration of all high-tech, high wage industries in few regions. This in turn causes regional incomes to diverge as the remaining regions are left with only the low-tech, low-wage industries. Micro convergence achieved through the FPE may not result in macro convergence of per capita regional personal income because macro convergence is a function of convergence not only in factor prices but also in factor quantities.

Per capita income could also vary across regions due to interregional differences in labour force participation that yield differences in the ratio of workers to population; per capita income would vary by region even if the factor returns were identical. Per capita income variations can be caused by the regional variations in the industry mix, which means that even if factor returns are equalized within industries and workers with identical skills and work effort receive the same level of compensation across different regions, average returns across workers can vary by region. People, in addition, may sort themselves by region in terms of the human capital they bring to the market. Moreover, another possible reason to explain why personal income varies is that regions differ in terms of the amenities and comforts offered. Differences in the cost of living and those between worker characteristics can also account for variability of personal provincial income.

Only in the case where the variations in factor returns are larger than the previously mentioned differences suggest will there be an incentive for the factor migration that tends to equalize factor returns across regions. Regional disparities may be a cause of concern due to either equity or efficiency considerations. From the point of equity, regional disparities may cause output to be unfairly divided. From the point of efficiency, regional disparities may cause resources to be inefficiently allocated. Regions in Canada and the US are heterogeneous, in resource endowments and accesses to markets [14].

There are three concepts of convergence. The first concept of convergence is referred to as σ-convergence. This occurs when the cross-sectional dispersion decreases over time. σ-convergence is measured using the cross-sectional standard deviation of the logarithm of per capita income. The stochastic neoclassical model predicts that the long-run value of the dispersion index (represented by the standard deviation of the logarithm of per capita income) is a function of the variance of random shocks and of the speed of convergence. If the current dispersion index exceeds its steady state value, the dispersion index will monotonically decline at a smooth rate equal to the convergence rate, beta, and ultimately approach its steady state value.

A second concept includes β-convergence. β-convergence occurs when initially poor regions grow faster than their rich counterparts. This type of convergence would imply that the poor regions eventually catch up with the rich regions. The unconditional convergence parameter β is calculated by regressing the growth rate in per capita income on the initial level of per capita income. This type of convergence can be analysed with various techniques. In general, either linear or non-linear regressions are involved. A significantly negative slope coefficient value implies unconditional convergence in the β-sense. A test of conditional convergence includes additional information to account for the difference between the average income level across regions and the individual region's steady-state income level. The calculated β-value is called the conditional β-estimate.

Some of the significant differences between σ and β-convergence are the following. β-convergence is measured between two time periods, while σ-convergence is measured over time. The β-coefficient is able to predict not only the speed of convergence but also whether the cross-sectional dispersion will fall or rise over time. β-convergence is a necessary but not a sufficient condition for σ-convergence. The cross-sectional dispersion can be affected by external shocks, which would cause the σ-coefficient to increase in spite of a positive β-coefficient.

The final concept of convergence is referred to as stochastic convergence. Bernard and Quah have developed a definition of convergence using the notions of unit roots and cointegration. In these models, convergence in per capita income requires that permanent shocks to the national economy are associated with permanent shocks to regional economies. If some component of regional per capita income deviations is due to permanent regional-specific shocks, such as localized technology shocks, convergence may not be achieved. Thus, this definition of convergence requires that a non-zero mean stationary stochastic process characterizing deviation in a region's per capita income relative to per capita income in the nation.

[5] argues that both time-series and cross-sectional tests are necessary for detecting convergence. Furthermore, they stress that two conditions must be met for convergence to hold: (i) shocks to relative regional per capita income should be temporary (stochastic convergence), and (ii) regions having per capita incomes initially above their compensating differential should exhibit slower growth than those regions having per capita incomes initially below their compensating differential (cross-sectional convergence).

Cross-sectional (i.e., [8]; [7]), time-series [15], and a pooled time/series cross-section ([21]; and [4]) approaches were followed to examine the convergence in per capita incomes across regions and nations. Previous research reports mixed results. [22] uses annual data for 72 countries over the period from 1950-1990 and finds no convergence overall, but a homogeneous group of countries. [17] and [16] find cross-sectional conditional convergence among a group of countries after controlling for savings rates, population growth rates, and educational attainment. [18] find that US states, Japanese and Western European regions converged at a speed of 2% across states/regions within countries. Other studies find no convergence among regions in Italy [11], UK [13], and Greece [2].

III. Convergent or Divergent Behaviour?

Annual data for US (Canadian) per capita personal income are available from the Economagic site from 1929 to 2003 (the Statistics Canada[1] for 10 provinces and 2 territories from 1951 to 1990). Ideally, regional per capita personal incomes should be deflated using regional price deflators for data to be comparable across regions. Since the regional price indexes are not available, this is not possible, and the national US (Canadian) consumer price index with the base year at 1967 (1992) is used instead.

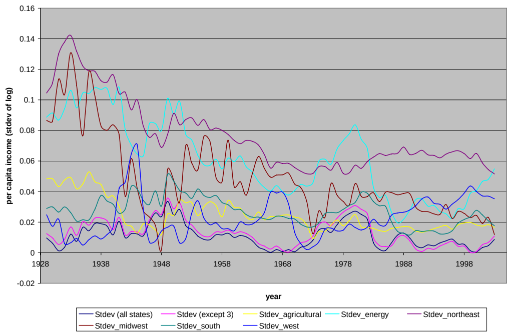
σ-convergence is perhaps the simplest and most widely used test for convergence. Fig. 2 uses a standard cross-sectional measure of dispersion, the (un)weighted standard deviation of log per capita personal income, to show the trajectory of the dispersion in regional per capita personal income over time. Panel A uses the unweighted cross-sectional standard deviation of the logarithm of per capita income and the graph shows that the disparity in per capita income levels across all states has not changed over 1929-2003 period. However, the unweighted cross-sectional standard deviation of the logarithm of per capita income across Midwest, Northeast, and Energy producing states does show a pattern of convergence. Panel B uses weighted cross-sectional standard deviation of the logarithm of per capita income and the graph reinforces our initial finding that the disparity in US per capita income levels across all states has not changed over 1929-2003 period. Once, we account for differences in population levels across states, we also find that the pattern of convergence across Midwest, Northeast, and Energy producing states disappears as well. Panel C uses the unweighted cross-sectional standard deviation of the logarithm of Canadian per capita income and the graph shows that the disparity in per capita income levels across all states has diminished over 1951-1990 period, with the exception of the period between 1976 and 1990 when it either stayed on the

[1] We used Canadian Economic Observer and Cansim database for this particular variable.

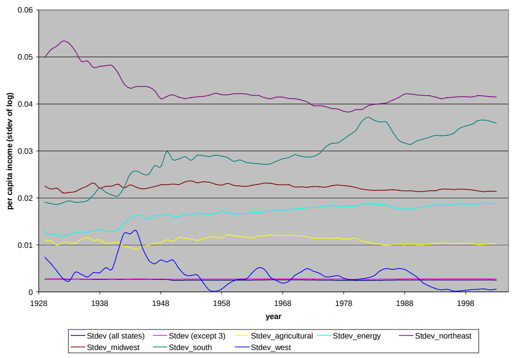
same level or rose significantly[2]. The dispersion in relative regional Canadian per capita incomes fell dramatically between 1954 and 1976, declining to 0.18 in 1976. After 1976 it rose slowly but steadily to 0.21 in 1982, although it declined to 0.17 in 1990.

To find out how the dispersion index of regional per capita income has evolved over time, one can either find the change rate of the standard dispersion of per capita income over time using the regression of a logarithm of the (un)weighted standard deviation of the per capita income on a linear time trend or test for the stationarity of the dispersion series of

A. The trajectory of unweighted cross-sectional standard deviation of real US income per capita over 1929-2003 period



B. The trajectory of weighted cross-sectional standard deviation of real US income per capita over 1929-2003 period



C. The trajectory of unweighted cross-sectional standard deviation of real Canadian income per capita over 1951-1990 period

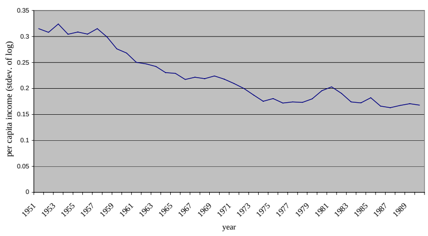


Fig. 2 income dispersion across us states and Canadian provinces

regional per capita income. The second approach accounts for the presence of breaks and structural shocks which cannot be established a priori. Table 1 presents results of log-linear dispersion regressions. Panel A (B) describes US (Canadian) results for regressions with the unweighted and weighted cross-sectional dispersion series used as dependent variables. Using unweighted cross-sectional dispersion series as a dependent variable, we find that all states except for Alaska, Hawaii, and DC are converging at a statistically significant rate of 4.10%. We also find that the dispersion in per capita personal income across energy producing (Midwest) states declines at a rate of 1.65% (1.71%), whereas it increases at 5.04% (5.17%) across northeast (west) states. Using weighted cross-sectional dispersion series as a dependent variable, we find that agricultural, midwest, northeast, and west states are converging at a statistically significant rate of 0.51%, 0.16%, 0.60%, and 7.86% respectively. We also find that the dispersion in per capita personal income across energy producing (south) states increases at a rate of 0.13% (0.55%). The results of log-linear regression model with the unweighted Canadian cross-sectional dispersion series as the dependent variable show that the dispersion in per capita income falls across all and across Atlantic provinces at approximately the same rate of 1.8%, whereas it falls across energy producing provinces (British Columbia, Saskatchewan, and Alberta) at a rate of 2.12%.

To account for the possibility of inherent structural breaks (shocks) in the dispersion index time series, we also present unit root test results for per capita US (Canadian) dispersion measure results in Panels A (B). Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS)[3] univariate unit root test results are presented. All tests are run with an included drift term and an appropriate lag length selected by minimizing the Scwartz information criterion (SIC). PP tests are superior to ADF tests (the former allows disturbances to be serially correlated and heteroscedastic), but the disadvantage of the latter procedures lies in their inability to distinguish between the unit root and near unit root processes. For this reason, we give preference to the KPSS test results because the KPSS test allow for heterogeneous/homogeneous innovations and for all ARMA processes, and satisfies PP regularity assumptions. KPSS test results show that the null of level stationarity is rejected for all unweighted dispersion series, except the series across all states, all states except for Alaska, Hawaii, and DC, agricultural, energy producing, and south states where shocks to the US per capita regional unweighted cross-sectional dispersion series are temporary in nature. Testing the US per capita regional weighted cross-sectional dispersion series for the presence of unit roots, we find that only dispersion series across all states, and all states except the three noted above are stationary. Results in Panel B of Table 2 show that

[2]One possible explanation for this divergence found in the literature is the plunge in oil prices during the early 1980s. Due to the fact that the data of oil prices are available only for the 1980-1990 period, we are unable to check whether the plunge oil prices is a possible reason for exhibited divergence.

[3]KPSS test is better able to differentiate between long and short memory processes. The alternative hypothesis in KPSS test is that the series are integrated with an integration parameter being one or less than one.

TABLE I
CONVERGENCE RATE US AND CANADIAN ESTIMATES FROM LOG-LINEAR TREND REGRESSIONS RUN ON DISPERSION INDEX TIME-SERIES

Panel A. US convergence rate estimates						
Log(sigma)	*Intercept*	*T-statistic*	*Slope*	*T-statistic*	*Adj* R^2	*DW*
Unweighted						
All States	-4.7244	-14.4070	-0.0206	-1.2415	0.0157	0.5807
All Except Three	-4.4089	-11.3290	-0.0410	-2.0839	0.0895	0.6688
Agricultural	-4.0341	-62.4716	-0.0021	-0.6464	-0.0174	0.9201
Energy	-2.9186	-24.4554	-0.0165	-2.7297	0.1595	0.2342
Midwest	-3.2091	-33.4370	-0.0171	-3.5221	0.2512	1.1742
South	-3.7062	-32.7479	-0.0102	-1.7733	0.0593	0.2152
Northeast	-4.8957	-19.8739	0.0504	4.0481	0.3116	0.2510
West	-4.7682	-32.0848	0.0517	6.8831	0.5770	0.6657
Log(sigma)	*Intercept*	*T-statistic*	*Slope*	*T-statistic*	*Adj* R^2	*DW*
Weighted						
All States	-5.9938	-1213.7870	0.0004	1.6588	0.0490	0.1067
All Except Three	-5.8995	-1252.5660	0.0004	1.8805	0.0694	0.1073
Agricultural	-4.4554	-387.0493	-0.0051	-8.7129	0.6878	0.2032
Energy	-4.0245	-682.9732	0.0013	4.4201	0.3528	0.3040
Midwest	-3.7950	-912.6282	-0.0016	-7.4017	0.6127	0.3490
South	-3.5018	-179.4127	0.0055	5.5639	0.4684	0.1576
Northeast	-3.2420	-276.6708	-0.0060	-10.1422	0.7497	0.2018
West	-5.0065	-22.2132	-0.0786	-6.8977	0.5781	0.2508
Panel B. Canadian convergence rate estimates						
Log(sigma)	*Intercept*	*T-statistic*	*Slope*	*T-statistic*	*Adj* R^2	*DW*
Unweighted						
All Provinces	-1.1685	-51.3868	-0.0183	-18.2191	0.8946	0.3526
Atlantic	0.0001	0.1327	-0.0184	-4.0737	0.2662	1.9210
Energy	0.0000	-0.0211	-0.0212	-3.1242	0.0915	2.4353

unweighted Canadian cross-sectional dispersion series are non-stationary and, thus, the null hypothesis of no convergence cannot be rejected.

We also test for unconditional (for the US and Canadian sample) and conditional (for the Canadian sample only) β-convergence using cross-sectional and cross-sectional time series approaches**.** In [1], which focuses on cross-sectional convergence, a negative β-coefficient is shown to imply β-convergence in the equation of the following form:

$$log\,Y_{it} - log\,Y_{i0} = \alpha + \beta Y_{i0} + \varepsilon \qquad (1)$$

over the period from 0 to T, where Y is per capita personal income and subscript i denotes regions. In cross-sectional US tests, we use per capita personal income (un)adjusted for the cost of living differences across US states. Per capita income convergence may be a gradual process because of sustained differences in hours of work and especially unemployment. Regional differences in unemployment rates affect regional differences in housing affordability and imply differences in living standards of workers across North America. Other studies account for the costs of living by considering housing costs (i.e., [10]) and observed prices of goods and services (i.e., [20]). We also adjust for the differences in housing costs across US states. This means that instead of using relative regional per capita income, we use relative regional per capita income adjusted for differences in housing costs because housing costs account for the biggest share of one's monthly expenses in North America[4]. The adjustment is done by subtracting the vector of logarithmic equivalents of the variable X from the vector of logarithmic relative per capita incomes. The vector of Xs is calculated as follows:

TABLE II
US AND CANADIAN UNIT ROOT TEST RESULTS FOR PER CAPITA INCOME DISPERSION MEASURES

Panel A. Sigma (weighted and unweighted) unit root tests based on CPI-deflated US data over 1969-2003				
	Statistic	ADF	PP	KPSS
Unweighted				
All States	Test stat	-2.9107	-1.6991	0.2385
	Prob	0.0548*	0.4227	Stat
l Except Thr	Test stat	-2.1924	-1.8585	0.2985
	Prob	0.2127	0.3471	Stat
Agricultural	Test stat	-3.5088	-3.5257	0.1535
	Prob	0.0138**	0.0132**	Stat
Energy	Test stat	-1.1364	-1.5643	0.2862
	Prob	0.6898	0.4895	Stat
Northeast	Test stat	-1.4016	-1.4504	0.3914
	Prob	0.5700	0.5461	Nonstat*
Midwest	Test stat	-2.0102	-2.8915	0.5810
	Prob	0.2812	0.0568*	Nonstat**
South	Test stat	-2.1295	-1.7144	0.1865
	Prob	0.2350	0.4152	Stat
Northeast	Test stat	-1.8076	-1.2269	0.4347
	Prob	0.3700	0.6513	Nonstat*
West	Test stat	-1.1086	-1.3260	0.6086
	Prob	0.7010	0.6061	Nonstat**
Weighted				
All States	Test stat	-2.2261	-1.7679	0.1873
	Prob	0.2013	0.3894	Stat
l Except Thr	Test stat	-2.1497	-1.7456	0.2028
	Prob	0.2276	0.4001	Stat
Agricultural	Test stat	-2.0752	-2.0533	0.5588
	Prob	0.2554	0.2639	Nonstat**
Energy	Test stat	-2.0762	-2.1916	0.3799
	Prob	0.2550	0.2128	Nonstat*
Northeast	Test stat	-1.3705	-1.2649	0.3859
	Prob	0.5845	0.6343	Nonstat*
Midwest	Test stat	-1.7044	-1.8084	0.6093
	Prob	0.4201	0.3703	Nonstat**
South	Test stat	-2.0958	-1.6772	0.4250
	Prob	0.2475	0.4334	Nonstat*
Northeast	Test stat	-1.0909	-0.6343	0.5721
	Prob	0.7076	0.8497	Nonstat**
West	Test stat	-1.8363	-1.1314	0.4425
	Prob	0.3571	0.6918	Nonstat*
Panel B. Sigma (unweighted) unit root tests based on CPI-deflated Canadian data over 1951-1990				
	Statistic	ADF	PP	KPSS
Unweighted				
All Province:	Test stat	-1.4825	-1.5025	0.7075
	Prob	0.5318	0.5218	Nonstat**
Atlantic	Test stat	-3.7696	-3.7955	0.6947
	Prob	0.0066***	0.0062***	Nonstat**
Energy	Test stat	-2.5591	-2.6111	0.5664
	Prob	0.1100	0.0994*	Nonstat**

This table reports results of univariate unit root tests. The null hypothesis for the ADF and PP tests is nonstationarity, whereas the null hypothesis for the KPSS test is stationarity. Initially 12 lags of the tested variables are included, but the final test statistics are based on the optimal lag length selected by minimizing SIC. The significance of results is established using the tabulated critical values for these tests. ***, **, and * stand for the significance of results at the 1%, 5%, and 10% significance levels respectively.

$$X_t = [(p_t / \bar{p}_t) - 1] * 0.3571 + 1 \ ,$$

Where pt bar is the average cross-sectional sales price across the US states. The annual US regional sales prices are available from the Economagic site only starting 1963. To make results for adjusted and unadjusted for costs of living comparable, we use the sample period from 1969 to 2003 to estimate β-convergence across US states.

Panel A (B) of Table 3 shows the results of simple cross-sectional tests estimated using US unadjusted (adjusted) for costs of living differences per capita incomes for the overall time period, and for each 4-year and 6-year period.

[4] A 2001 study by the centre of housing research at Harvard University finds that over 14 million US households spend more than half of their income on housing [3]. [3] also report that affordability problems intensified over the years for all classes of households pointing to increasing income inequality within the Canadian society. The proportion of households that spend more than 30-50% of before-tax income on shelter is used as an affordability measure. Using the census Canada PUMF statistics for households, authors find that for about 21.4% of households with earned income below LICO, the percentage with severe affordability problems increased from the 1991 estimate of 23.8% to the 1996 estimate of 26%. For low income households, the percentage with severe affordability problems increased from 60.3% (1991) to 68.2% (1996). Assuming that 23% of the total population face severe housing affordability problems and using the above statistics, we calculate the average proportion of household income paid on housing to be 35.71% (0.23*68.2%+0.77*26%).

The results reported in Panels A and B are mostly consistent and indicate that there is evidence of β-convergence across US states, except over the 1979-1989 time period when slope coefficients are either insignificant or insignificantly positive. Using adjusted per capita incomes, we find higher β-estimates and lower estimates for logarithms of real per capita incomes. This means that unadjusted for costs of living estimates are biased downward. For example, the rate of convergence across US states over the 1969-2003 period reported in Panel A is only 1.02% compared to the rate reported in Panel B of 1.83%. Thus, after taking regional differences in housing costs into account, the distribution of income gets compressed because richer (poor) provinces tend to have highest (lowest) housing costs. Panel C of Table 3 shows the results of simple cross-sectional tests estimated using Canadian unadjusted for costs of living differences per capita incomes for the overall time period, and for each decade. All of the β-coefficients are negative and support our hypothesis of β-convergence for the overall period of 1951-1990 and all sub-periods. However, the coefficients for 1976-1990 and 1971-1980 periods are not statistically significant and the null hypothesis of no β-convergence during these periods cannot be rejected at the 5% level. In unreported results and in support of the β-test results, we find correlation coefficients among the growth rate of per capita Canadian income and the log of initial per capita income over different time periods to be negative[5].

TABLE III

US AND CANADIAN UNIT ROOT TEST RESULTS FOR PER CAPITA INCOME DISPERSION MEASURES

Panel A. Unconditional convergence test results for real per capita US income over 1969-2003

Time Period	*Intercept*	*log(Y_0)*	*β*	*Adj R^2*	*DW*	*F*
1969-2003	-0.02210	-0.2932	0.01021	0.298	1.9811	20.9506
	(-1.8469)	(-4.5772)				
1969-1973	-0.01770	-0.24230	0.06937	0.2702	2.0744	18.3985
	(-1.6761)	(-4.2893)				
1974-1978	-0.0037	-0.0781	0.02033	0.092	1.4452	5.7601
	(-0.7829)	(-2.4000)				
1979-1983	-0.0014	-0.0072	0.00181	-0.0213	1.3967	0.0176
	(-0.1846)	(-0.1326)				
1984-1988	0.0047	0.1392	0.03747	0.0813	2.0567	5.1613
	(0.5196)	(2.2718)				
1989-1993	-0.0086	-0.1644	0.04490	0.5421	2.1082	56.6388
	(-2.2635)	(-7.5259)				
1994-1998	0.0024	0.0672	0.01739	0.2142	2.4887	13.8095
	(0.9329)	(3.7161)				
1999-2003	-0.0038	-0.0814	0.02123	0.1249	2.1789	7.71
	(-0.8200)	(-2.7767)				
1969-1975	-0.0181	-0.2589	0.04994	0.4151	2.142	34.3535
	(-2.1919)	(-5.8612)				
1976-1982	-0.0005	0.0093	0.00156	-0.021	2.2678	0.0315
	(-0.0747)	(0.1775)				
1983-1989	0.0018	0.0872	0.01521	0.0126	2.0516	1.5996
	(0.1717)	(1.2648)				
1990-1996	-0.0065	-0.1206	0.02142	0.3026	1.9665	21.3934
	(-1.5064)	(-4.6253)				
1997-2003	-0.0022	-0.0409	0.00696	0.004	2.1724	1.1887
	(-0.4020)	(-1.0903)				

Panel B. Unconditional convergence test results for real per capita US income adjusted for the cost of living differences over 1969-2003

Time Period	*Intercept*	*log(Y0)*	*β*	*Adj R2*	*DW*	*F*
1969-2003	-0.02570	-0.4625	0.01826	0.3602	2.3537	27.4655
	(-1.7553)	(-5.2408)				
1969-1973	-0.01810	-0.24500	0.07026	0.2113	2.0455	13.5881
	(-1.6402)	(-3.6862)				
1974-1978	-0.0033	-0.1392	0.03747	0.1931	1.9417	12.248
	(-0.6205)	(-3.4997)				
1979-1983	-0.0019	0.0239	0.00605	-0.0178	1.2743	0.1758
	(-0.2740)	(0.4193)				
1984-1988	0.0023	0.0361	0.00919	-0.0148	2.2138	0.313
	(0.2668)	(0.5594)				
1989-1993	-0.0126	-0.1775	0.04885	0.3736	2.0534	29.0364
	(-2.6500)	(-5.3885)				
1994-1998	0.0025	0.0659	0.01704	0.1407	2.5092	8.7063
	(0.9557)	(2.9506)				
1999-2003	0.0001	-0.106	0.02801	0.0872	2.2413	5.4886
	(0.0217)	(-2.3428)				
1969-1975	-0.0165	-0.248	0.04750	0.3396	2.2158	25.1692
	(-2.0097)	(-5.0169)				
1976-1982	0.0006	0.0325	0.00551	-0.0152	2.2111	0.2974
	(0.0799)	(0.5453)				
1983-1989	-0.0003	-0.0755	0.01308	-0.0024	2.0794	0.8863
	(-0.0248)	(-0.9415)				
1990-1996	-0.0105	-0.1709	0.03124	0.284	1.8934	19.6438
	(-1.9843)	(-4.4321)				
1997-2003	0.0013	-0.0405	0.00689	-0.0109	2.3291	0.4929
	(0.1888)	(-0.7021)				

Panel C. Unconditional convergence test results for real per capita Canadian income over 1951-1990

Time Period	*Intercept*	*log(Y_0)*	*β*	*Adj R^2*	*DW*	*F*
1951-1990	-0.0722	-0.6027	0.0237	0.7138	2.4132	25.9460
	-1.7704	-5.0937				
1976-1990	-0.0198	-0.1606	0.0125	-0.0074	2.1791	0.9264
	-0.5764	-0.9625				
1951-1960	-0.0222	-0.1985	0.0246	0.2531	2.3859	4.3892
	-0.6780	-2.0950				
1961-1970	-0.0165	-0.1377	0.0165	0.4941	1.9394	10.7658
	-1.3530	-3.2811				
1971-1980	-0.0174	-0.1221	0.0145	0.0329	1.0160	1.3402
	-0.6379	-1.1577				
1981-1990	-0.0276	-0.2818	0.0368	0.2440	2.0751	4.2274
	-0.8893	-2.0561				

A (B) reports estimates of β convergence rates for real per capita US income adjusted for costs of living over 1969-2003. Panel C reports estimates of β convergence rates for real per capita Canadian income unadjusted for costs of living over 1951-1990 period.

The hypothesis of conditional β-measures is examined for the Canadian sample of per capita incomes[6]. Conditional convergence occurs when the income of each province is moving towards its own steady state level. To strengthen σ and β-convergence results conditional convergence is tested to support our hypothesis of the same steady-state personal per capita incomes across all provinces. A test for conditional convergence must include additional information to explain the difference between the average income level across provinces and the individual province steady-state income level. Some researchers argue that omitted variables that capture steady-state differences across provinces may have biased the estimation of β. That means that each province may be approaching its own steady state level.

Following this approach regressions augmented for educational attainment are run. It is argued that per capita income should grow more rapidly in provinces with greater human capital. The first column of Table 4 confirms our σ and β-convergence results obtained earlier in that the speed of unconditional convergence across the 1976-1990 period is only 0.64%. The second column of Table 4 shows the results

TABLE IV

CONDITIONAL CONVERGENCE TEST RESULTS FOR THE CANADIAN REAL PER CAPITA INCOME OVER 1976-1990 PERIOD

	(i)	(ii)	(iii)
Intercept	1.3613	2.2694	1.06
	-2.3089	-1.7434	-7.7388
Log (Y0)	-0.2203	-0.3875	-0.0637
	(-1.9032)	(-1.5936)	(-2.1616)
Log (post-secondary education)			0.1558
			-12.095
log (university degrees)		0.8072	
		-0.7876	
Adjusted R-square	0.226	0.187	0.9596

This table reports results of conditional cross-sectional tests of the growth rate in per capita personal income on the initial level of per capita income and on a proxy for educational attainment. The table reports real per capita Canadian income unadjusted for costs of living over 1976-1990 period.

5 However, the value for the 1971-1980 period is the lowest. This implies that the poor provinces are growing faster than the rich provinces. Results are available upon request.

6 [23] notes that no empirical research in Canada has considered effects of human capital on macro convergence in Canada. And the neoclassical growth model considers only two inputs: labour and capital.

for the augmented equation, where human capital is measured by the proportion of labour force with university degrees.[7] They indicate that conditional β-convergence is more rapid (at 1.26%) and less significant statistically, though the sign of the augmenting variable is as expected. The explanatory power of the equation is even poorer than before.

In the third column of Table 4 the results of the second augmented regression are presented, where the proportion of the labour force with a post-secondary education is used as a proxy for human capital. The β-coefficient in this regression is very low (0.17%). The coefficient of human capital variable is positive as expected and highly statistically significant. However, the explanatory power of this third regression is considerably better than that of the other two.

Simple cross-sectional tests will not be very reliable because of the relatively few degrees of freedom. Therefore, the conceptually superior methodology of [21] is followed. The idea is to use other additional information coming from the evolution of relative growth patterns within the entire study period in a pooled cross-section / time-series approach. Thus, we split our US adjusted and unadjusted for costs of living samples into 5 (7) sub-periods, each of 7 (5) years in duration. The Canadian unadjusted for costs of living sample is divided into 4 (8) sub-periods, each of 10 (5) years in duration. The number of observations equals the number of states (provinces) times the number of sub-periods.

In order to eliminate the time trend effect, each region's growth rate relative to the national average is regressed on the initial level of provincial income relative to the national average for each time period. The following equation is used:

$$\frac{1}{T}\ln((Y_{i,t+T}/\bar{Y}_{t+T})/(Y_{it}/\bar{Y}_t)) = A - \left(\left(\frac{1-\exp(-\beta\times T)}{T}\right)\times\ln\left(\frac{Y_{it}}{\bar{Y}_t}\right)\right) + u_{it}, \qquad (2)$$

where i=1,...,T; t are stock variables (dated 1969 for the period 1969-1975 period) and $\overline{Y_t}$ refers to the national average income;

Regression (2) is non-linear, which can be transformed into linear form by simple manipulations[8]. In both cases convergence will imply that the poorer province should grow at a faster rate than the richer one. β-coefficients corresponding to regression (2) are presented in Table 5 for all samples.

Positive β-coefficients obtained in a pooled cross-section time-series approach (obtained after the transformation to the linear regression) provide evidence of β-convergence. The results obtained using US unadjusted for costs of living real per capita incomes indicate that the rate of convergence across US states is between 1.29% and 1.50% annually. Those obtained using US adjusted for costs of living real per capita incomes indicate that the rate is higher, between 1.81% and 2.04% annually. Results reported in Panel C of Table 5 show that the rate of convergence across Canadian provinces is between 2.15% and 2.24% annually. Overall, the results indicate that regions have converged in the β-sense, meaning that the poor regions are catching up to the rich ones. The t-statistics reported in Table 5 are surprisingly high. Therefore the null hypothesis of no β-convergence can be rejected. The results of the pooled cross-section time series are slightly different as compared with the results of the simple cross-sectional tests, but the former tests are considered more reliable.

While the cross-sectional evidence supports the convergence hypothesis, it is possible that relative regional per capita incomes are separate random walks. [6] argue that the cross-sectional convergence tests examine only the two end-points in the sample for each region. It might be possible that the time series on relative per capita incomes is non-stationary, so that the appearance of convergence at the two end-points is random. Therefore, the time-series test for convergence is useful in examining the dynamic path of relative provincial per capita personal income.

TABLE V
POOLED CROSS-SECTION TIME SERIES CONVERGENCE IN THE US AND CANADIAN PER CAPITA PERSONAL INCOME TEST RESULTS

Time Period	*Intercept*	*log(Y0)*	*β*	*Adj R2*	*DW*	*F*
Panel A. Unconditional pooled cross-section time series convergence test results for real per capita US income over 1969-2003						
T-t=7	-0.00006	-0.01232	0.01289	0.05637	2.045789	15.27701
	(-0.132208)	(-3.908582)				
T-t=5	-0.00007	-0.01449	0.01504	0.04770	1.874425	17.77987
	(-0.144243)	(-4.216618)				
Panel B. Unconditional pooled cross-section time series convergence test results for real per capita US income adjusted for the cost of living differences over 1969-2003						
Time Period	*Intercept*	*log(Y0)*	*β*	*Adj R2*	*DW*	*F*
T-t=7	0.00025	-0.01696	0.01806	0.07488	2.183021	20.34522
	(0.537256)	(-4.510568)				
T-t=5	0.00016	-0.01939	0.02039	0.06447	2.043877	24.08546
	(0.321276)	(-4.907694)				
Panel C. Unconditional pooled cross-section time series convergence test results for real per capita Canadian income over 1951-1990						
Time Period	*Intercept*	*log(Y_0)*	*β*	*Adj R^2*	*DW*	*F*
T-t=10	0.0001	-0.0184	0.0215	0.2662	1.9210	16.5953
	0.1327	-4.0737				
T-t=5	0.0000	-0.0212	0.0224	0.0915	2.4353	9.7605
	-0.0211	-3.1242				

Pooled cross-section / time-series test results are presented in this Table. Our US adjusted and unadjusted for costs of living samples are divided into 5 (7) sub-periods, each of 7 (5) years in duration. The Canadian unadjusted for costs of living sample is divided into 4 (8) sub-periods, each of 10 (5) years in duration. The number of observations equals the number of states (provinces) times the number of sub-periods.

[7] The source of the data: Statistics Canada. "Labour force estimate by education level, age, sex, Canada/Province, annual average" on Labour force Historical review. [CD-ROM]. 71 F0004 XCB. Ottawa: Statistics Canada, 1998. We have chosen to use measures of educational attainment out of labour force, because of the data unavailability of these measures out of the population for the entire 1976-1990 sample period.

[8] The assumption here is that the "comparison between the growth rates of any two provinces during the same sub-period provides the same information as does a comparison between the growth rates of the same provinces during two sub-periods" [21].

Let us consider the time-series properties of the per capita personal income across US states (Canadian provinces) relative to the per capita personal income in the nation. We use the logarithm of annual data on relative per capita personal income over the 1969-2003 period for the US data and over the 1951-2003 period for the Canadian data. To check the stochastic convergence hypothesis, we use univariate ADF, PP, and KPSS tests. Tests for a unit root are often criticized on the grounds that a permanent component may be present in a time-series, but this component may not be responsible for a large proportion of the total variation in the series. As noted previously, KPSS results are given preference over ADF and PP test results.

The null hypothesis of level stationarity based on results presented in Panel A (for unadjusted for costs of living real relative per capita incomes) of Table 6 fails to be rejected for Florida, Idaho, Lousiana, Nebraska, New Mexico, New York, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Texas, Washington, West Virginia, Wisconsin, Wyoming. For the rest of the US states, the null is rejected, meaning that shocks to real relative per capita incomes in these states are permanent. Panel B of Table 6 shows that shocks to real relative per capita incomes in Alberta, Saskatchewan, and Yukon are temporary, whereas real relative per capita incomes in the rest of Canada are separate random walks that approach their own steady state. That is, once shocked, relative provincial per capita personal incomes do not return to a deterministic trend. The results presented in Table 7 for adjusted for costs of living real US relative per capita incomes are generally consistent with those in Table 6 (Panel A). State per capita relative personal incomes in Florida, Louisiana, New Mexico, New York, North Dakota, Oklahoma, Rhode Island, Texas, Washington, and West Virginia are also stationarity. Additionally, state per capita relative personal income series in Colorado, Illinois, Indiana, Iowa, Kansas, Maryland, Michigan, and Ohio are also stationary.

IV. CONCLUSION

In this study we show that the divergence in personal regional per capita income across US states (Canadian provinces) has diminished over time. Overall, results suggest that the gap in regional real per capita incomes has narrowed and that the absolute regional level of the real income has increased, but incomes have not equalized across regions. The US σ-convergence results are mixed. Plotting the unweighted by population share cross-sectional standard deviation of real per capita income versus time, we see that the disparity in per capita income has declined over the overall time period (1929-2003), but not over the 1979-1989 period. No changes in dispersion of per capita income are observed for the trajectory of weighted by population share cross-sectional standard deviation of real per capita US income. The results of simple cross-sectional and pooled cross-section time-series tests are consistent and show that US states are converging at a rate between 1.3% and 2.04% annually. We also adjust US real

TABLE VI
PERSISTENCE IN RELATIVE US AND CANADIAN PER CAPITA INCOME
Panel A. Unit root tests for the CPI-deflated per capita income (1969-2003)

	Statistic	ADF	PP	KPSS
Alabama	Test stat	-2.6441	-2.4229	0.7210
	Prob	0.0943*	0.1432	Nonstat**
Alaska	Test stat	-1.5120	-0.9903	0.5020
	Prob	0.5152	0.7456	Nonstat**
Arizona	Test stat	-0.5709	-0.7978	0.6572
	Prob	0.8642	0.8070	Nonstat**
Arkansas	Test stat	-3.7912	-3.7720	0.3644
	Prob	0.0068***	0.0072***	Nonstat*
California	Test stat	-1.0488	-0.9184	0.5792
	Prob	0.7238	0.7701	Nonstat**
Colorado	Test stat	-2.0347	-2.2657	0.3584
	Prob	0.2713	0.1884	Nonstat*
Connecticut	Test stat	-0.3438	-0.6732	0.5707
	Prob	0.9077	0.8403	Nonstat**
Delaware	Test stat	-2.4243	-2.0718	0.4036
	Prob	0.1436	0.2567	Nonstat*
District of Columbi	Test stat	-0.4105	-0.6762	0.6526
	Prob	0.8962	0.8395	Nonstat**
Florida	Test stat	-1.9844	-2.3996	0.1292
	Prob	0.2919	0.1493	Stat
Georgia	Test stat	-0.5392	-1.2399	0.6394
	Prob	0.8696	0.6455	Nonstat**
Hawaii	Test stat	-1.5268	-0.8027	0.5933
	Prob	0.5071	0.8056	Nonstat**
Idaho	Test stat	-1.9576	-1.4700	0.3264
	Prob	0.3030	0.5364	Stat
Illinois	Test stat	-1.3612	-1.4812	0.4401
	Prob	0.5894	0.5309	Nonstat*
Indiana	Test stat	-1.3433	-1.9330	0.3537
	Prob	0.5975	0.3139	Nonstat*
Iowa	Test stat	-2.0034	-1.8921	0.4669
	Prob	0.2841	0.3319	Nonstat**
Kansas	Test stat	-1.9035	-1.9528	0.4256
	Prob	0.3267	0.3053	Nonstat*
Kentucky	Test stat	-1.9786	-2.0344	0.4002
	Prob	0.2944	0.2715	Nonstat*
Lousiana	Test stat	-3.0210	-2.1202	0.0949
	Prob	0.0433*	0.2384	Stat
Maine	Test stat	-0.5861	-0.9310	0.5718
	Prob	0.8605	0.7659	Nonstat**
Maryland	Test stat	-2.9183	-1.5482	0.4614
	Prob	0.058*	0.4975	Nonstat*
Missouri	Test stat	-2.7915	-2.7334	0.4290
	Prob	0.0704*	0.0789*	Nonstat*
Montana	Test stat	-1.0594	-1.2039	0.5386
	Prob	0.7202	0.6613	Nonstat**
Nebraska	Test stat	-3.5809	-3.6759	0.1830
	Prob	0.0116**	0.0091***	Stat
Nevada	Test stat	-2.1719	-0.6064	0.7111
	Prob	0.2211	0.8562	Nonstat**
New Hampshire	Test stat	-0.5859	-0.8488	0.5523
	Prob	0.8609	0.7920	Nonstat**
New Jersey	Test stat	-0.2677	-0.4760	0.5834
	Prob	0.9196	0.8839	Nonstat**
New Mexico	Test stat	-2.1457	-2.2382	0.2543
	Prob	0.2291	0.1972	Stat
New York	Test stat	-2.1533	-1.7498	0.2326
	Prob	0.2265	0.3981	Stat
North Carolina	Test stat	-1.3847	-1.5168	0.6163
	Prob	0.5777	0.5132	Nonstat**
North Dakota	Test stat	-2.7601	-2.7601	0.3163
	Prob	0.0747*	0.0747*	Stat
Ohio	Test stat	-1.8708	-1.8708	0.6956
	Prob	0.3415	0.3415	Nonstat**
Oklahoma	Test stat	-1.7338	-1.5222	0.3085
	Prob	0.4019	0.5105	Stat
Oregon	Test stat	-1.5378	-1.4160	0.3293
	Prob	0.5024	0.5629	Stat
Pennsylvania	Test stat	-2.0412	-1.9597	0.2255
	Prob	0.2687	0.3024	Stat
Rhode Island	Test stat	-1.7338	-1.5394	0.3098
	Prob	0.4056	0.5019	Stat
South Carolina	Test stat	-1.9505	-1.9456	0.6647
	Prob	0.3063	0.3084	Nonstat**
South Dakota	Test stat	-2.4744	-2.9825	0.1606
	Prob	0.1306	0.0467**	Stat
Tennessee	Test stat	-1.5934	-1.7283	0.6514
	Prob	0.4746	0.4085	Nonstat**
Texas	Test stat	-3.1686	-2.0259	0.0991
	Prob	0.0317**	0.2749	Stat
Utah	Test stat	-1.7590	-1.2797	0.3857
	Prob	0.3934	0.6276	Nonstat*
Vermont	Test stat	0.4307	-0.0374	0.5548
	Prob	0.9814	0.9484	Nonstat**
Virginia	Test stat	-2.1283	-2.0230	0.5825
	Prob	0.2353	0.2761	Nonstat**
Washington	Test stat	-2.8127	-2.2508	0.1052
	Prob	0.0674*	0.1931	Stat
West Virginia	Test stat	-2.1026	-2.2924	0.2184
	Prob	0.2450	0.1801	Stat
Wisconsin	Test stat	-1.1036	-1.4726	0.2369
	Prob	0.7030	0.5351	Stat
Wyoming	Test stat	-1.7574	-1.6530	0.2584
	Prob	0.3942	0.4453	Stat

Panel B. Unit root tests on Canadian provincial per capita income (1951-1990)

	Statistic	ADF	PP	KPSS
Alberta	Test stat	-1.9205	-2.4320	0.1790
	Prob	0.3197	0.1399	Stat
BC	Test stat	-0.8508	-0.6217	0.6593
	Prob	0.7927	0.8541	Nonstat**
Manitoba	Test stat	-2.4183	-2.2595	0.7456
	Prob	0.1435	0.1897	Nonstat***
New Brunswick	Test stat	-0.4588	-0.1826	0.7366
	Prob	0.8885	0.9323	Nonstat**
Newfoundland	Test stat	-1.6114	-2.0886	0.7670
	Prob	0.4673	0.2501	Nonstat***
Nova Scotia	Test stat	-1.9815	-2.0439	0.6932
	Prob	0.2935	0.2677	Nonstat**
Ontario	Test stat	-1.1212	-1.2045	0.5550
	Prob	0.6975	0.6629	Nonstat**
Prince Edward Island	Test stat	-0.4849	-1.2963	0.7417
	Prob	0.8832	0.6217	Nonstat***
Quebec	Test stat	-2.1771	-2.2145	0.6930
	Prob	0.2175	0.2046	Nonstat**
Saskatchewan	Test stat	-4.1859	-4.0743	0.1489
	Prob	0.0021***	0.0029***	Stat
Yukon and NW territories	Test stat	-1.9477	-2.2741	0.1573
	Prob	0.3079	0.1851	Stat

This table reports results of univariate unit root tests. The null hypothesis for the ADF and PP tests is nonstationarity, whereas the null hypothesis for the KPSS test is stationarity. Initially 12 lags of the tested variables are included, but the final test statistics are based on the optimal lag length selected by minimizing SIC. The significance of results is established using the tabulated critical values for these tests. ***, **, and * stand for the significance of results at the 1%, 5%, and 10% significance levels respectively.

personal per capita incomes for costs of living using housing costs and find slightly higher convergence rates than those calculated using unadjusted for costs of living real per capita incomes. Using unit root tests, we find that 10 US state real per capita un(adjusted) for costs of living personal income series (Florida, Louisiana, New Mexico, New York, North Dakota, Oklahoma, Rhode Island, Texas, Washington, and West Virginia) are stationary and, thus, these states are also stochastically converging. Additionally, we find that state un(adjusted) real per capita income series for 7 (8) US states are stationary including Idaho, Nebraska, Oregon, Pennsylvania, South Dakota, Wisconsin, and Wyoming (Colorado, Illinois, Indiana, Iowa, Kansas, Maryland, Michigan, and Ohio). The rest 26 states face permanent shocks to their per capita incomes due to state- or region-specific influences (i.e., variation in productivity levels, differences in resource endowments, climate, preferences, etc).

Canadian convergence tests appear to have converged in both the σ and β senses during the entire study period. However, the σ- and β-measures both suggest that the 1976-1990 sample period is different from the much of the rest of the examined period of 1951-1990. The pace of both σ and β-convergence is considerably slower during the 1976-1990 period than it is earlier and the augmented regression results support the possibility that differences in province's steady-state income levels may explain some of the slowdown. The results of the pooled cross-section time-series indicate that the poorer provinces are catching up to the richer ones at a rate of between 2.15% and 2.37% annually. Testing for stochastic convergence, we find that most provinces, except Alberta, Saskatchewan, and the Yukon and Northwest Territories, face region - specific shocks that have highly persistent effects.

ACKNOWLEDGMENT

Shiller thanks the University of New Brunswick for financial support, Ying Wu for research assistance.

TABLE VII
PERSISTENCE IN RELATIVE US PER CAPITA INCOME ADJUSTED FOR THE COST OF LIVING DIFFERENCES, 1969-2003

Panel A. Unit root tests for the CPI-deflated per capita income (1969-2003) (adjusted for the cost of living)

	Statistic	ADF	PP	KPSS
Alabama	Test stat	-1.3935	-1.3767	0.6370
	Prob	0.5739	0.5820	Nonstat**
Alaska	Test stat	-0.3982	-0.5766	0.5627
	Prob	0.8985	0.8629	Nonstat**
Arizona	Test stat	-1.2658	-1.2658	0.3988
	Prob	0.6339	0.6339	Nonstat*
Arkansas	Test stat	-2.7491	-3.0129	0.6782
	Prob	0.0765*	0.0437**	Nonstat**
California	Test stat	-1.3151	-1.3151	0.7474
	Prob	0.6112	0.6112	Nonstat***
Colorado	Test stat	-2.9674	-2.1681	0.2008
	Prob	0.0486**	0.2210	Stat
Connecticut	Test stat	-1.8562	-1.3663	0.6172
	Prob	0.3480	0.5870	Nonstat**
Delaware	Test stat	-1.6570	-1.5728	0.7812
	Prob	0.4434	0.4852	Nonstat***
District of Columbia	Test stat	-1.1022	-1.1022	0.4567
	Prob	0.7036	0.7036	Nonstat*
Florida	Test stat	-1.3109	-1.7159	0.2360
	Prob	0.6131	0.4145	Stat
Georgia	Test stat	-0.6911	-0.8493	0.5963
	Prob	0.8358	0.7918	Nonstat**
Hawaii	Test stat	-0.5484	-0.7330	0.5880
	Prob	0.8691	0.8249	Nonstat**
Idaho	Test stat	-1.7054	-1.3005	0.4511
	Prob	0.4148	0.6180	Nonstat*
Illinois	Test stat	-2.8200	-2.2976	0.1435
	Prob	0.0664**	0.1785	Stat
Indiana	Test stat	-2.6103	-2.4812	0.1621
	Prob	0.1011	0.1287	Stat
Iowa	Test stat	-2.7387	-3.3161	0.3324
	Prob	0.0787*	0.0219**	Stat
Kansas	Test stat	-4.0461	-3.3106	0.1743
	Prob	0.0036***	0.0222**	Stat
Kentucky	Test stat	-1.3640	-1.1656	0.6409
	Prob	0.5880	0.6777	Nonstat**
Lousiana	Test stat	-2.5488	-1.8722	0.2418
	Prob	0.1137	0.3408	Stat
Maine	Test stat	-2.5872	-2.3785	0.3844
	Prob	0.1057	0.1551	Nonstat*
Maryland	Test stat	-2.2872	-2.2835	0.2066
	Prob	0.1817	0.1828	Stat
Massachusetts	Test stat	-0.6196	-0.6299	0.5751
	Prob	0.8532	0.8507	Nonstat**
Michigan	Test stat	-3.4328	-3.1168	0.1225
	Prob	0.0168**	0.0347**	Stat
Minnesota	Test stat	-0.6612	-0.1596	0.7436
	Prob	0.8432	0.9344	Nonstat***
Mississippi	Test stat	-1.4609	-1.4587	0.6480
	Prob	0.5409	0.5420	Nonstat**
Missouri	Test stat	-2.0019	-1.8413	0.4191
	Prob	0.2846	0.3550	Nonstat*
Montana	Test stat	-1.0220	-1.0220	0.6188
	Prob	0.7341	0.7341	Nonstat**
Nebraska	Test stat	-2.6372	-2.4937	0.5165
	Prob	0.0956*	0.1258	Nonstat**
Nevada	Test stat	-0.5427	-0.7234	0.7073
	Prob	0.8703	0.8274	Nonstat**
New Hampshire	Test stat	-1.0489	-1.1298	0.4618
	Prob	0.7242	0.6925	Nonstat*
New Jersey	Test stat	-2.4462	-1.6563	0.6061
	Prob	0.1375	0.4437	Nonstat**
New Mexico	Test stat	-2.7661	-2.2569	0.1497
	Prob	0.0741*	0.1912	Stat
New York	Test stat	-3.3003	-2.9525	0.3160
	Prob	0.0230**	0.0499**	Stat
North Carolina	Test stat	-0.9162	-1.0303	0.5859
	Prob	0.7708	0.7311	Nonstat**
North Dakota	Test stat	-3.1914	-3.2135	0.1778
	Prob	0.0293**	0.0278**	Stat
Ohio	Test stat	-2.1279	-2.9784	0.0908
	Prob	0.2363	0.0471**	Stat
Oklahoma	Test stat	-1.2603	-1.5360	0.2394
	Prob	0.6364	0.5036	Stat
Oregon	Test stat	-0.7765	-1.0617	0.4957
	Prob	0.8130	0.7193	Nonstat**
Pennsylvania	Test stat	-1.6729	-1.6729	0.4206
	Prob	0.4355	0.4355	Nonstat*
Rhode Island	Test stat	-2.9262	-2.9539	0.2228
	Prob	0.0528*	0.0497**	Stat
South Carolina	Test stat	-0.9625	-0.9712	0.6138
	Prob	0.7553	0.7523	Nonstat**
South Dakota	Test stat	0.6070	-2.5513	0.5262
	Prob	0.9867	0.1129	Nonstat**
Tennessee	Test stat	-0.9380	-0.9708	0.6383
	Prob	0.7636	0.7524	Nonstat**
Texas	Test stat	-2.0531	-1.8044	0.2505
	Prob	0.2640	0.3721	Stat
Utah	Test stat	-1.8050	-1.1327	0.5617
	Prob	0.3717	0.6913	Nonstat**
Vermont	Test stat	-2.2271	-1.5943	0.4117
	Prob	0.2010	0.4745	Nonstat*
Virginia	Test stat	-1.2585	-1.1075	0.5527
	Prob	0.6368	0.7015	Nonstat**
Washington	Test stat	-3.7566	-3.7566	0.2304
	Prob	0.0074***	0.0074***	Stat
West Virginia	Test stat	-2.8188	-3.0432	0.0674
	Prob	0.0689*	0.0409**	Stat
Wisconsin	Test stat	-2.4203	-1.8159	0.4404
	Prob	0.1441	0.3668	Nonstat*
Wyoming	Test stat	-1.5304	-1.3483	0.3688
	Prob	0.5060	0.5955	Nonstat*

REFERENCES

[1] C. Sherwood-Call, “The 1980s divergence in state per capita incomes: what does it tell us?,” Federal Reserve Bank of San Francisco, 1994
[2] C. Siriopoulos and D. Asteriou, (1998), Testing for Convergence Across the Greek Regions," *Regional Studies, Taylor and Francis Journals,* vol. 32 (6), pp. 537-546.
[3] E. Moore. and A. Skaburskis, “Canada’s increasing housing affordability burdens,” *Housing Studies,* vol.19, 2004, pp. 395-413.
[4] F.C Lee and S. Coulombe, “Regional productivity convergence in Canada,” *Canadian Journal of Regional Science,* vol.18, 1995, pp. 39-56.
[5] G. A. Carlino and L. Mills, “Are U.S. regional incomes converging? A time-series analysis,” *Journal of Monetary Economics,* vol. 32, 1993, pp. 335-346.
[6] G. A. Carlino and L. Mills, “Testing neoclassical convergence in regional incomes and earnings,” *Regional Science and Urban Economics,* vol. 26, 1996, pp. 416-418.
[7] J. Helliwell, “Convergence and migration among provinces,” Policy and Economic Analysis Program Study, 94-2, University of Toronto, 1994.
[8] J. Helliwell and A. Chung, “Are bigger countries better off?,” *in R. Boadway, T. Courchene and D. Purvis (eds.), Economic dimension of constitutional change,* Kingston, 1991, John Deutsch Institute
[9] J. H. L. Dewhurst, “Convergence and divergence in regional household incomes per head in the United Kingdom: 1984 - 93,” *Applied economics,* vol.30, 1995, pp. 31-35.
[10] J. Persson, “Convergence in per capita income and migration across the Swedish counties: 1906-1990,” Institute for International Economic Studies, Stockholm University, 1994.
[11] J. Sachs and A. Warner, “Economic reform and the process of global integration,” *Brookings papers on economic activity,* vol.1, 1995, pp. 1-118.
[12] L. Mauro, and E. Podrecca**,** “The case of Italian regions: Convergence or dualism,” *Economics Notes,* vol.3, 1994, pp. 447–468.
[13] M. Chatterji, and J. H. Ll. Dewhurst, (1996), Convergence Clubs and Relative Economic Performance in Great Britain: 1977--1991, *Regional Studies*, *Taylor and Francis Journals*, vol. 30 (1), pp 31-39. Available: http://ideas.repec.org/a/taf/regstd/v30y1996i1p31-39.html
[14] M. Gunderson, “Regional productivity and income convergence in Canada under increasing economic integration,” Working paper at the Centre for Industrial Relations., University of Toronto, 2006.
[15] M. Lefebvre, “Les provinces canadiennes et la convergence : une évaluation empirique,” Working paper 94-10, Bank of Canada, 1994.
[16] N.G. Mankiw, D. Romer, and D. N. Weil, “A contribution to the empirics of economic growth,” *Quarterly Journal of Economics,* vol.106, 1992, pp. 407-37.
[17] R. Barro, “Economic growth in a cross-section of countries,” *Quarterly Journal of Economics,* vol. 105, 1991, pp. 407-443.
[18] R.J. Barro and X. Sala-i-Martin, “Convergence across states and regions,” *Brookings papers on economic activity,* vol.1, 1991, pp. 107-182.
[19] R.J. Barro and X. Sala-i-Martin, “Convergence”, *Journal of Political Economy,* vol.100, 1992, pp. 223-51.
[20] R. Summers and A. Heston, 1993, *The Penn World Table,*
[21] S. Coloumbe and F. Lee, “Convergence across Canadian provinces: 1961-1991,” *Canadian Journal of Economics,* vol.10, 1995, pp. 886-898.
[22] W. J. Baumol, “Productivity growth, convergence and welfare: what the long-run data shows,” *American Economic Review,* vol. 76 (5), 1986, pp. 1072-1085.
[23] F. Lee, “Convergence in Canada”, *Canadian Journal of Economics,* vol. 29, 1996, pp. 331-336.

Ilona Shiller (Ph.D. in finance (Manitoba, 2006), MBA (Kiev, 1998), MA (Manitoba, 1999), BA (Kiev, 1993) is an Associate Professor at the University of New Brunswick