

Convergence Across Canadian Provinces*

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Interest in convergence, that is to say whether poor countries or regions tend to grow faster than rich ones, is relatively recent. The underlying rationale of convergence however is not new, and in closed economies can be easily traced to the premise of diminishing returns to capital, whereas in open economies this premise is reinforced by the movement of capital and technology from rich countries to poor, and of labour from poor countries to rich. Myrdal's (1957) cumulative causation and Hirschman's (1958) agglomeration mechanisms and "growth poles" in which the "spread" or "trickle down" effects dominate the "backwash" or "polarisation" effects are earlier formulations or variations of the same growth process.

In this process, irrespective of the temporal sequential interchangeability of leaders and laggards, the growth rates of previously laggard entities are seen to surpass in time the growth rates of earlier leaders, until real per capita incomes disparities across regions or countries are eventually reduced. Due to labour mobility restrictions, crucial factors in this long run levelling process are movements of capital and technological transplants, manifested through replacements of outdated capital stocks in lagging countries by those embodying the most advanced technology (Abramovitz 1986). In the present universe of expanding knowledge and information, technological transfers are relatively easy but they do not alone guarantee increases in productivity unless accompanied by major investments in human skills, in organisation and management (Nelson and Wright 1994). Such major investments are viewed as prerequisites to successful restructuring, which in our context has broad economic and social dimensions.¹

Ultimately convergence is a homogenising process often induced by either intra- or inter-country social engineering policies. In the former, transfer payments and tax incentives constitute the primary regional equalisation policies, whereas in the latter global competition transforms the socioeconomic scenery through direct investment embodying new technology in advanced capital goods.² The contribution of competitive forces as convergence factors have been recognised by Gerschenkron (1952), Kuznets (1973) and Abramovitz (1986) in their corresponding analyses of late-industrialisation, of growth patterns, and interchangeability of industrial leadership over time. A multiplicity of social and political factors, under the name of "social capability", relating to characteristics of people, their attitudes toward cooperation,

competition, trust, respect for institutions, also partake in the convergence process whether identified as culture comprising the totality of inherited artifacts, technical processes and mental constructs (Ruttan 1988), or reflecting differences in human attitudes which essentially mirror different stages of economic development (Johnson 1963).³ Social capability retains a generality that prevents accurate quantification, and only rough approximations of its impact on convergence are given in empirical studies through gross estimates of education attainment, and government instability.⁴

Per capita income equalisation either within or among countries is rather unattainable if not totally unrealistic. Some degree of inequality must be taken for granted and the conditions responsible for such a state of affairs be sought in the broad spectrum of heterogeneity of regional or country socio-economic environments and in differences in economic policies. Such heterogeneity is not difficult to encounter when large sample sizes are examined or when the time coverage is extended over long periods of time.⁵ Despite reductions in cultural fragmentation caused by breakthroughs in mass communication media, our planet continues to be richly diversified. Variations of all sorts persist among countries and peoples, some more striking than others. These variations, however, tend to disappear within single countries, but not always and not necessarily entirely.

Canada, with its vast geographic area and its major linguistic division between English and French, is not without its regional resource diversities and not without certain minor cultural variability among its provinces.⁶ Despite these differences conscious efforts are made to gradually lessen, if not eliminate entirely, per capita regional income disparities, primarily through federal transfers, which finance social programs, health and education, and through integrative provincial government policies.

Which forces have and which have not contributed to provincial per capita income convergence is not covered in this study, which concentrates exclusively on whether convergence per se has taken place over the 1961-1991 period. Consequently the principal convergence factors cited in the literature, namely education and government instability, are not investigated. Some comments are nevertheless called for with respect to the separatist Quebec movement and its likely impact on convergence. Its exclusion, in addition to its alien nature to the focus of the study, is justified by the following: first, government instability is empirically treated as synonymous with revolution, which is definitely not representative of the Quebec case; second, separatism intensified at specific points in time and then, after unsuccessful Quebec sovereignty referenda, it gradually dissipated over the long period covered in this study with its economic consequences roughly spread equally among provinces

without affecting the convergence process⁷; third, no significant ideological bend can be discerned in Quebec or in the rest of the country that can be regarded as strengthening or retarding the convergence process⁸; and fourth, federal transfers to Quebec that might assist Quebec to catch up with Ontario could not be excessively generous because:

- Quebec is not a poor province, and
- any semblance of generosity would be highly resented by poor Canadian provinces and strongly opposed by the rich provinces, and would thus end up being more of a divisive instead of a concerted unifying force.

Another angle of Quebec's place in the Canadian federation is elaborated further within the recent neoclassical anti-government climate in which government failures are regarded as more serious than market failures and government spending is commonly suspect and constantly scrutinised. Transfers, notwithstanding their honourable intentions, do not escape from these fashionable criticisms which proceed to suggest that they create dependencies in poorer provinces that prevent market forces from narrowing provincial per capita income disparities. Such transfer dependency, especially in the form of unemployment insurance is seen by Courchene (1981) to impede labour mobility, to perpetuate existing market imperfections and to result in equilibrium differentials. The issue of transfers and of unemployment disparities have been extensively researched in the context of regional economics, albeit with inconclusive results, as shown in the survey of Mansell and Copithorne (1986). What is often missing in this literature is the equalisation importance of exhaustive federal expenditure. In a study aimed at partially filling this gap, Afxentiou and Serletis (1999) investigated the provincial equalisation impact of government expenditure and tested for convergence, in the sense of finding out whether in line with government policy of bringing per capita income levels across Canada closer together in a growth sustainable environment poorer provinces benefit more from federal spending in real per capita terms than rich provinces. Their conclusion was that overall Quebec did marginally better than the other rich provinces when exhaustive expenditures were considered, and probably better than the poor provinces if the latter's low per capita incomes are taken into account; Quebec was also found to be marginally ahead of the other rich provinces with respect to transfers, but, as in the case of exhaustive expenditure, transfers appear to benefit more the poor than the rich provinces in line with convergence expectations.⁹

Our work belongs to a family of studies which approached the subject of income convergence in Canada from different perspectives, using different methodologies and covering different time periods. A selective sample of such studies include those of Williamson (1965), Chernick (1966), McInnis (1968), Green (1971) and more recently those by Coulombe and Lee (1995), Lee and Coulombe (1995), Helliwell (1996) and Lee (1996). Our objective is to test for real per capita income convergence across Canada, and not to proceed from these findings to the identification of the growth factors in each province. Our tests will serve primarily one purpose, namely to see whether there are discernible convergence trends across the country

that by themselves suggest that Canada is moving toward economic homogeneity, and secondarily to judge from these findings whether regional equalisation policies in the form of transfers have contributed to this homogenisation process. In accordance with our stated objective, the next section deals with data and methodological issues related to the statistical tests carried out. In the third section the empirical findings from the statistical tests are presented and analysed, while in the fourth section the conclusions of the paper are summarised.

Data and Methodology

The data used in this study are extracted from Statistics Canada, Provincial Accounts publications for the period 1966 to 1991 and from publications of the Conference Board of Canada for 1961 to 1965. In all tests the data are expressed in real per capita GDP terms.

Three kinds of convergence tests, involving all ten Canadian provinces (the Yukon and the Northwestern Territories are excluded because of their non-provincial status and sparse population) are carried out. The first test entails a weak criterion and according to the spirit of Barro and Sala I Martin (1990: 11) convergence applies if a poor province "tends to grow faster than a rich one, so that - other things equal - the poor one tends to catch up with the rich one in terms of the level of per capita income or product."¹⁰ From this conceptual scheme Barro and Sala I Martin (1992) using cross sectional data and regressing the average growth rate of per capita income on the initial level of per capita income arrive at the following formulation

$$G_I = \alpha + \beta Y_{I0} + U_I \quad (1)$$

where \bar{g} stands, in our case, for the average growth rate of income per capita in province I and y_{i0} for the logarithm of income per capita in province I at the beginning of the sample period.

A second convergence formulation, being a variant of the first one, appears in the shape of the following regression equation: ¹¹

$$G_I = \alpha + \beta(Y_{\text{ONTARIO}} - Y_I) + \epsilon_I \quad (2)$$

where g_i stands for the growth rate of per capita income in province I, and $(y_{\text{Ontario}} - y_i)$ is the logarithmic difference in per capita income levels between the province of Ontario and province I. In this expression the province of Ontario, which is the industrial heartland and

economic powerhouse of Canada, appears as the gravitational force toward which the other nine provinces tend to converge. In both convergence cases, a significant negative β indicates that provinces which start out with low levels of per capita income as such or in relation to per capita income levels in Ontario tend to grow faster, thus bringing about convergence in levels. For an application of these approaches see Baumol (1986) and Dowrick and Nguyen (1989).

The third set of convergence tests employs Johansen's (1988) cointegration approach that is based on the maximum likelihood methodology. The superior statistical nature of this approach derives from the fact that it fully captures the underlying time series properties of the data, provides estimates of all the cointegrating relations among a given set of variables, offers test statistics for the number of cointegrating vectors, and allows direct hypothesis tests on the elements of the cointegrating vectors - see, for example, Johansen and Juselius (1992). The steps in this procedure consist of testing the data for unit roots using augmented Dickey-Fuller (ADF) type regressions - see Dickey and Fuller (1981) - followed by a cointegration analysis that shows the existence or not of long run equilibrium relationships between the relevant variables. Fundamentally this multivariate approach to the estimation of the number of linearly independent cointegrating vectors for a vector autoregressive process, x_t , of order k involves:

- regressing Δx_t on $\Delta x_{t-1}, \dots, \Delta x_{t-k+1}$,
- regressing x_{t-k} on the same set of regressors, and
- performing a canonical correlation analysis of the residuals of these two regressions.

See Serletis and Krichel (1992) for an application of Johansen's approach in investigating the degree of shared output trends among European countries.

As stated in the previous section, earlier researchers employed statistical tests that differ from ours. At the core of these tests is some measure of dispersion around a mean. Williamson (1965) in his large study that examines a number of countries from 1926-1960 uses a weighted coefficient of variation which measures the dispersion of the regional (provincial) per capita levels relative to the national average with each regional (provincial) deviation weighted by its share in the national population. Unweighted coefficients of variations were used by Chernick (1966) with respect to per capita personal income and earned income for the period 1926-1964, and by Green (1971) who analysed regional disparities in gross value added per capita (as a proxy for income) for the period 1890-1956. McInnis (1968) covered five regions (Quebec, Ontario, British Columbia, the prairie provinces, and the Maritime provinces) for the period 1926-1962 using three measures of dispersion, namely the mean deviation from the Canadian average income level, the relative mean deviation and the relative root-mean-

squared deviation, both of the last two weighted by regional population. An unweighted standard deviation of income levels among provinces was used by Helliwell (1996) for the period 1960-1990 and for 1926-1990.

A certain degree of statistical affinity to our study is detected in Coulombe and Lee (1995) and Lee and Coulombe (1995) that cover the period 1961 to 1991 with the former dealing with convergence of different income concepts, and the latter analysing productivity convergence. The main analytical difference between these two studies and ours is that in these studies, which rely on pooled cross-sectional data, convergence is examined in terms of dispersions around the national mean, whereas in our work convergence is measured by the success of poorer provinces catching up with the Canadian economic leader-province of Ontario. Even though both studies as well as part of our study draw their intellectual origin from Barro and Sala i Martin (1992), the different way they view convergence puts them in different analytical camps. As for the Lee (1996) study that covers the period 1968-1992, it is an extension of productivity convergence as it emerges from a Cobb-Douglas production function which includes the stock of human capital, the private stock of physical capital, the public stock of public capital and raw labour, that are considered to be the sources of productivity differentials across Canada.

Two points must be stressed before the presentation of results. First, convergence refers to a process of catching up with the per capita income of the leader that is brought about by market forces. Consequently, convergence of per capita personal or disposable incomes which incorporates government interferences that mask the true market forces does violate the true spirit of convergence. Taxes, expenditure and transfers being corrective measures for unsatisfactory convergence, once introduced they become institutionalised and by their relative temporal stability they obscure the economic forces on which real convergence depends. Second, coefficients of variation which elevate the importance of the mean may be misleading as measurements of convergence. This may be seen in the case where the standard deviation remains constant over two chronically contiguous periods, thus suggesting no convergence or divergence, when in actuality the leader-province moved over time farther from the national mean income without affecting the coefficient of dispersion due to minor offsetting movements toward the new mean by the rest of the provinces. In such a case, instead of a failure in catching up with the leader, the constancy of the coefficient points misleadingly to a no change in provincial disparities.

Empirical Results

Average real per capita income growth rates are presented in Table 1 for the entire 1961-1991 period and for the sub-periods 1961-1971, 1971-1981, and 1981-1991 for each of the 10 Canadian provinces. For the long term purposes of convergence, the relevant statistic is the growth rate performance over the whole period 1961-1991, with the record of the three subperiods providing evidence of consistency in closing the per capita income gap between rich and poor provinces. Considering Alberta, British Columbia, Ontario and Quebec as the rich provinces, it is shown that by and large their overall per capita growth rates were lower than those of the poor (rest) provinces. The borderline exception is Alberta's growth record which is superior to that of the other rich provinces and approaches that of the poor provinces, but this aberration is uniquely attributable to its good fortunes from the oil industry particularly during 1971-1981; when the oil prices collapsed in the 1980s Alberta's negative per capita growth rate came to partially offset the growth of the previous ten years. Taking, however, the overall growth picture into account, Table 1 provides evidence of convergence across the provinces.

For a more rigorous convergence test we estimated equation (1) as proposed by Barro and Sala I Martin (1992). Regressing the average growth rate of per capita income in province I , \bar{g}_I , on the logarithm of the level of per capita income in that province at the beginning of the sample period, y_{10} , we obtained the following results (with t-statistics in parentheses)

$$\bar{G}_I = -0.0001 - 0.0118 Y_{10}, \quad N = 10, \quad R^2 = .855$$

$$(-.03) \quad (-6.8)$$

TABLE 1 Properties of Real per Capita GDP Growth Rates

Province	Sample period			
	1961-1971	1971-1981	1981-1991	1961-1991
Alberta	3.6	6.8	-1.3	3.1
British Columbia	3.3	4.1	0.8	2.7
Manitoba	4.2	3.5	1.4	2.8
New Brunswick	4.1	3.4	4.2	3.5
Newfoundland	5.3	3.6	2.9	3.8
Nova Scotia	3.4	1.4	4.0	3.2
Ontario	3.8	2.5	1.5	2.6
P.E.I.	3.5	4.7	3.5	3.5
Quebec	4.0	3.1	1.3	2.8
Saskatchewan	4.5	6.1	-0.1	3.0

Note: 1. Moments (in percentage) were computed from log-differences of real per Capita GDP.

From the negative and highly significant y_{i0} one deduces the operation of convergence forces across the country. From the small magnitude of the coefficient it can be further inferred that the convergence process is as expected a slow one, in line with Marshall (1920: 6) who observed "... the maxim that 'Nature does not willingly make a jump' ... is especially applicable to economic developments."

When we turn to disaggregated tests, we observe that the weak convergence trend obtained in model (1) for the entire country is further weakened and loses its statistical significance when applied to each province in model (2). As shown in Table 2, in model (2) in which Ontario is used as the centre of convergence, four of the poor provinces, namely, New Brunswick, Nova Scotia, Prince Edward Island (P.E.I.), and Saskatchewan emerge with a negative, but non-significant $\hat{\beta}$, suggesting that the air of convergence was barely blowing them in the direction of Ontario. For the rest of the provinces we found no statistical evidence of convergence in the levels of their real per capita incomes.

Tests in logged real per capita GDP, with trend and without trend, overwhelmingly failed to reject the null hypothesis of a unit root as shown by Table 3, in each of the 10 Canadian provinces. Proceeding to cointegration tests, which are designed to determine whether long run equilibrium relations exist among variables, we jointly model logged real per capita provincial GDP using Johansen's (1988) maximum likelihood extension of the Engle and Granger (1987) approach - see Serletis (1994) for an application. Johansen's maximum likelihood approach to the estimation of the number of linearly independent cointegrating vectors for a vector autoregressive process, X_t , of order k involves the three steps cited in the previous section.

TABLE 2 Comparison of (Convergence) Regressions Across Canadian Provinces

Province	α	$T(\alpha)$	β	$T(\beta)$	R^2
Alberta	.031	2.45	.003	0.06	.000
British Columbia	.018	1.61	.131	1.03	.036
Manitoba	-.012	-0.36	.168	1.25	.053
New Brunswick	.083	1.34	-.069	-0.78	.021
Newfoundland	-.002	-0.03	.059	0.85	.025
Nova Scotia	.101	1.83	-.140	-1.26	.053
P.E.I.	.060	0.90	-.033	-0.37	.004
Quebec	-.041	-1.41	.328	2.44	.176
Saskatchewan	.045	1.49	-.060	-0.52	.009

Note: 1. The following regression was run, $G_i = \alpha + \beta(Y_{\text{ONTARIO}} - Y_i) + \epsilon_i$
 2. Sample period, annual data: 1961-1991. The dependent variable is the growth rate of real per capita GDP. The independent variable is the logarithmic difference in real per capita GDP between a province and Ontario.

TABLE 3 Augmented Dickey-Fuller Unit Root Tests in Logged Real Per Capita GDP

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Province	Without Trend		With Trend	
	DF	ADF	DF	ADF
Alberta	-1.845	-1.773	-0.022	-0.242
British Columbia	-1.992	-1.434	-1.238	-0.989
Manitoba	-2.876	-3.279*	-1.028	-0.856
New Brunswick	-0.893	-0.817	-3.516	-1.994
Newfoundland	-1.810	-3.313*	-2.260	-2.142
Nova Scotia	-0.701	-0.761	-3.078	-2.466
Ontario	-2.492	-1.491	-1.744	-2.141
P.E.I.	-0.724	-0.665	-3.690*	-1.624
Quebec	-2.749	-1.840	-0.994	-1.046
Saskatchewan	-2.387	-1.726	-1.540	-0.258

Note: 1. The following regression was run:

$$\Delta \text{LOGZ}_t = \alpha_0 + \alpha_1 T + \alpha_2 \text{LOGZ}_{t-1} + \sum_{i=1}^k \beta_i \Delta \text{LOGZ}_{t-i} + \epsilon_t$$

2. Sample period, annual data: 1961-1991. Results are reported for an ADF statistic of order 4. The 95% critical values for the DF and ADF test statistics are -2.962 and -2.979, respectively, for the "without trend" version of the test; and -3.567 and -3.594 for the "with trend" version of the test.

TABLE 4 Maximum Likelihood Tests of The Cointegration Rank: Western Provinces

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Province	λ_1	Null hypothesis	Test statistic		Critical values			
			λ_{max}	Trace	λ_{max}		Trace	
					95%	90%	95%	90%
Alberta	.80	$r=0$ [$r=1$]	16.01	34.22	27.07	24.73	47.21	43.95
B.C.	.42	$r \leq 1$ [$r=2$]	12.82	18.20	20.97	18.60	29.68	26.79
Sask.	.25	$r \leq 2$ [$r=3$]	4.59	5.38	14.07	12.07	15.41	13.33
Manitoba	.14	$r \leq 3$ [$r=4$]	.80	.80	3.76	2.69	3.76	2.69

Note: 1. Moments (in percentage) were computed from log-differences of real per capita GDP. λ_1 denotes eigenvalues.

TABLE 5 Maximum Likelihood Tests of the Cointegration Rank: Atlantic Provinces

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Province	λ_1	Null hypothesis	Test statistic		Critical values			
			λ_{max}	Trace	λ_{max}		Trace	
					95%	90%	95%	90%
N.B.	.87	$r=0$ [$r=1$]	16.29	37.81	27.07	24.73	47.21	43.95
N.F.	.74	$r \leq 1$ [$r=2$]	13.24	21.51	20.97	18.60	29.68	26.79
N.S.	.36	$r \leq 2$ [$r=3$]	5.47	8.27	14.07	12.07	15.41	13.33
P.E.I.	.19	$r \leq 3$ [$r=4$]	2.80	2.80	3.76	2.67	3.76	2.67

Note: 1. Moments (in percentage) were computed from log-differences of real per capita GDP. λ_1 denotes eigenvalues.

We use vector autoregressions of order 2 and employ two test statistics to test for the number of cointegrating vectors: the trace and maximum eigenvalue (λ_{max}) test statistics. In these tests the provinces were divided into three groups; the first two groups (Western and Atlantic provinces - see Tables 4 and 5) are based on the criterion of geographic proximity, and the third group consists of the rich provinces (see Table 6). In the first two groups the lack of cointegrating relationships suggests the absence of common trends determining the long term equilibrium conditions of real per capita income. Only in the case of the rich provinces (Table 6) we detect two equilibrium relationships. From the point of economic interdependence these findings indicate that there is not much of it, and what interdependence exists is perhaps restricted to the two most populous Canadian provinces, which are not only rich but also are geographically next to each other.¹²

TABLE 6 Maximum Likelihood Tests of the Cointegration Rank: Rich Provinces

Province	λ_1	Null hypothesis	Test statistic		Critical values			
			λ_{max}	Trace	λ_{max}		Trace	
					95%	90%	95%	90%
Ontario	.92	$r=0$ [$r=1$]	34.21*	74.45*	27.07	24.73	47.21	43.95
Quebec	.60	$r \leq 1$ [$r=2$]	29.00*	40.24*	20.97	18.60	29.68	26.79
Alberta	.41	$r \leq 2$ [$r=3$]	7.66	11.24	14.07	12.07	15.41	13.33
B.C.	.03	$r \leq 3$ [$r=4$]	3.58	3.58	3.76	2.67	3.76	2.67

Note: 1. Moments (in percentage) were computed from log-differences of real per capita GDP. λ_1 denotes eigenvalues.

Despite differences in statistical methodology and time coverage, there is some value in comparing our results with those of other researchers. The value of comparability declines for periods not coinciding with our coverage. Thus the agreement of no convergence based on our

statistically highly demanding approaches with those of Williamson (1965), Chernick (1966) should be considered with caution, though it may represent certain ingrained provincial natural resource rigidities that are difficult to break even in the long run. Similar caution should be exercised in interpreting the lack of convergence in per capita gross value added found by Green (1971), as well as the findings of McInnis (1968) regarding both the approximate constancy in the regional variability of income levels and the remarkable stability of the relative per capita income positions of the individual regions.

As for the conflict between our results and those claiming convergence of some form, it is an issue for future research to resolve. This relates particularly to the work of Coulombe and Lee (1995), who found that different per capita concepts converge at different speeds toward the national average, because of some statistical affinity it has with our approach. This also applies to Lee and Coulombe (1995) and Lee (1996), who examined productivity per capita convergence, examined and found it to converge more rapidly than income per capita, due to the close connection between productivity and income. From our point of view the comparability of Helliwell (1996) and that of Courchene (1981) with us lies in the common inferential conclusion that the various regional developmental policies and transfers introduced after 1960 had neither sped nor slowed down the overall convergence process.

Conclusions

In addition to its strictly economic relevance to resource allocation and growth, convergence has important public finance implications for Canada where the federal government employing a system of equalisation payments ensures that provincial governments have sufficient funds to provide essential public services of reasonable quality to all citizens. Without denigrating the importance of these public finance implications, they are peripheral to the essence of per capita income convergence across the provinces that constitutes the subject of this paper.

Geographically large countries like Canada are characterised by significant regional economic differences which have their origins mainly in substantial natural resource disparities and to a lesser extent in cumulative processes that give the industrial pioneers a comparative dynamic advantage which once attained is difficult to change over time. Real per capita income inequalities across the Canadian provinces seem to depend more on natural resource endowment differences and can be explained by location theory rather than follow the dynamics of convergence as indicated by the classical theory of diminishing returns to capital and the consequential mobility of capital from rich provinces to poor and of movements of labour in the opposite direction from poor to rich provinces.

When convergence was tested for the period from 1961 to 1991 in its crudest form as a process whereby the growth rates of real per capita income in poor provinces exceed those in rich provinces some evidence of it was found. However, the differences in growth rates were rather small, pointing out that convergence is at best a very slow process. This finding was substantiated by an across-provinces test where the convergence coefficient, though statistically significant, assumed a very small value. When more statistically rigorous disaggregate tests, based on the experience of each province, were carried out, the convergence significance disappeared. No evidence was found that the real per capita income levels of Canadian provinces were converging toward that of Ontario, nor did the statistical properties of data and the use of Johansen-type tests show convergence to be associated with geographic proximity of provinces. In summary our critical finding is that Canada is not an economically homogeneous country. For how long the prevailing economic heterogeneity among provinces will continue in the future is impossible to predict. We may nevertheless intuitively state that the generous transfer programs and regional equalisation policies do not appear to have at best succeeded in attaining their goals, and at worst they may even have impeded the natural process of convergence among Canadian provinces.

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