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The Role of the Interprovincial Transfers in the $\beta-$Convergence Process. Further Empirical Evidence for Canada[1]

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Abstract

Based on the approach of Timljonavich and Vogelsang (2002), I present empirical evidence of the role of the federal transfers on the β-convergence process in Canadian provinces. Using information on personal income for the period 1926-1999, the principal conclusion is that the interprovincial transfers were not determinant or decisive to the attainment of deterministic convergence in the Canadian provinces. Their role have been to accelerate the convergence process, particularly in poorer provinces.

Keywords: β-Convergence, Regional per capita Income, Trend Functions, Serial Correlation, I(0) and I(1) Process.

JEL Classification: C22, O40, R00.

Résumé

Fondée sur l'approche de Timljonavich and Vogelsang (2002), je présente l'évidence empirique du rôle des transferts fédéraux dans le processus entraînant la convergence β pour les provinces canadiennes. Utilisant l'information sur le revenu personnel pour la période de 1926 à 1999, la principale conclusion qui en ressort est que les transferts inter-provinciaux ne se sont pas avérés déterminants ou décisifs dans l'atteinte d'une convergence déterministique pour les provinces canadiennes. Leur rôle a plutôt été d'accélérer le processus de convergence, en particulier pour les provinces moins nanties.

Mots-clés: Convergence β, revenu régional par habitant, tendance, corrélation sériale, processus I(0) et I(1).

Code JEL: C22, O40, R00.

1 Introduction

Convergence is a key feature of the neo-classical growth framework. We say that there is absolute convergence when the economies converge to the same level of per capita output in a steady state. On the other hand, there is conditional β-convergence when the economies converge to different steady states. For a more complete survey about other notions of convergence and growth models, see De La Fuente (1995, 1998).

In empirical terms, conditional β-convergence has been strongly supported across a broad group of developed and underdeveloped countries in the post World War II period, see Baumol (1986) as well as Barro (1991, 1997). In another case, absolute β-convergence has been supported by regional studies; basically because most of the variables used in cross-country empirical studies to account for different steady states can reasonably be assumed to be constant across regions of the same countries. Such is the case of Barro and Sala-I-Martin (1995), Carlino and Mills (1993) using US data sets; Cashin (1995) using data for Australian states; Hofer and Wörgötter (1997) using information for Austrian regions; and Coulombe (1999, 2000), Coulombe and Day (1999), Coulombe and Lee (1995), Coulombe and Tremblay (2001) using data for Canadian provinces. Lefebvre (1994) has also contributed to the evidence in favor of convergence using time series tools in analyzing the deviations of income between provinces. See also Dolado et al. (1994) and Shioji (1996) for evidence about regional convergence in Spain and Japan, respectively[3].

In other papers, an issue of important discussion is the date since convergence is observed. For example, for Abramovitz (1988), the convergence in developed countries is only observed for the period after the World War II. In another example, Coulombe and Lee (1993) argue that convergence is not clear for the period 1926-1939; while Helliwell (1994) supported the idea that the convergence rate between 1920 and 1960 is not different than the convergence rate observed between 1960 and 1990. Furthermore, in the case of Canada, Coulombe and Lee (1998) found that the null hypothesis of no convergence before 1950 cannot be rejected. However, a regular convergence is observed, according to them, after 1950.

In most of the papers mentioned above, the authors argued that the empirical evidence suggests that poorer regions present higher rates of con-

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[3] On the other hand, other studies have found opposite evidence for absolute convergence as in the case of Brown, Coulson and Engle (1990) for US using time series methods. See also the citations mentioned in Coulombe (2000). Some critical issues about convergence have been addressed by Quah (1993).

vergence compared to the richer regions, which in theoretical terms is the same conclusion as the neoclassical model of growth. The basic equation proposed in those studies is

$$\Delta y_{it} = x_i - \beta y_{it} + \epsilon_{it} \tag{1}$$

where $y_{it} = ln(Y_{it}/Y_t)$ denotes the logarithm of the income per capita in country (or region) i in period t (Y_{it}) normalized by the sample mean of the same variable (Y_t) and $\Delta y_{it} = y_{it} - y_{it-1}$ is approximately equal to the growth rate of per capita income in country i, measured in deviations from the average growth rate in the sample. In (1), the term x_i summarizes the "fundamental" determinants of growth in country i and it is constant over time and distributed across countries with zero mean and variance σ_x^2.[4]

Following Carlino and Mills (1993), convergence is said to exist if stochastic convergence and β-convergence are verified. The former type means that shocks only have a temporary effect. Using regional US data, they find no evidence of stochastic convergence without including a break in the trend of the series. Doing that, they show that three of eight US regions display stochastic convergence, indicating that at least part of the US is converging. The latter type means that poorer provinces are on average catching up to the national average. Finally, they add that the bulk of the US convergence took place before World War II.

In a related research, Loewy and Papell (1996) have extended these findings by testing for a unit root allowing for an unknown break date. They find evidence in support of stochastic convergence in seven out of eight US regions, but they ignore the β-convergence tests needed to make complete statements on US regional convergence.

Recently, Tomljanovich and Vogelsang (2002) contribute to this debate expanding the findings of Carlino and Mills (1993) and Loewy and Papell (1996). Their approach consists of using the new econometric tools suggested by Vogelsang (1997, 1998) and Bunzel (1998), which allow the researcher to estimate and perform inference on the parameters related to the trend function of the series. What is important about these kind of econometric tools is the fact that these statistics are robust to the presence of a unit root in the noise function of the time series. In fact, when the noise component is I(0), inference related to the slope (β) may be obtained from the estimate

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[4] Among the most important "fundamentals" proposed in the literature, we can mention the inclusion of human capital in the basic Solow model proposed by Mankiw, Romer and Weil (1992). Another example is Coulombe (2000) where the urbanization rate is introduced to extend the basic neo-classical growth model using Canadian information.

of the coefficient on the trend in the autoregressive representation of a time series y_t. However, when the noise function is I(1), this estimate is not associated to the slope (β) given that the true coefficient becomes zero and information about the slope has to be obtained from the estimate of the coefficient on the intercept in the autoregressive representation of y_t.

This paper presents further empirical evidence about the existence of β-convergence in Canadian provinces. Two data sets are used in the estimations where the only difference between them is the inclusion or exclusion of the federal transfers. The estimates of the intercept and the slope of the trend function from both data sets sugegst the existence of deterministic convergence, using unknown and known break dates. When estimates from both data sets are compared, we observe that the role of the federal transfers has been to accelerate the speed of the convergence, in particular in the poor Canadian provinces.

The rest of the paper is organized as follows. Section 2 presents a brief review of the relationship between federal transfers and the issue of β-convergence in the Canadian literature. Section 3 deals with the framework and the results from the analysis of stochastic convergence. In section 4, the models and the approach to obtain estimates of the trend function are presented. Section 5 presents empirical evidence for the estimates of the coefficients of the trend function and implications on deterministic convergence. Section 6 briefly concludes.

2 Brief Review of the Literature of the Federal Transfers and β-Convergence

An important issue in the research of convergence for Canadian provinces has been the argument that federal transfers helped the redistribution of income among regions, see among others, Coulombe (2000), Coulombe and Day (1999). In fact, these amounts have been designed to reduce fiscal disparities among provinces and as Kaufman et al (2003) precise: "[they are] intended to assure that lower income provinces have access to sufficient resources to provide reasonably comparable levels of public services at reasonably comparable levels of taxation" (p.4). These authors also argue that the reforms to the equalizing income system in the 1990s may have had important beneficial effects by promoting labor migration and regional convergence. A similar argument was also formulated by Coulombe and Day

(1999).[5]

As Coulombe (2000) noted, there is a difference between regional output and regional income and "this fact confirms that governments transfers payments do play an important role in redistributing personal income across regions" (p. 159). However, some years before, Coulombe (1994) argued that "convergence across provinces is a fundamental economic phenomenon. It is more than the mere direct consequence of the interregional redistribution that Ottawa has operated on a large scale since 1950s" (p.12).

In an analysis by sub-samples, Coulombe and Lee (1998) found that the transfers (and taxes) seem to have contributed in an important way to the phenomenon of convergence (p. 16). In this same analysis, they found high estimates for the periods 1927-1948 and lower estimates for the periods 1949-1977 and 1977-1994. Then, they consider that the bulk of the convergence occurred in the period before the World War II. Furthermore, as they argue, the inference based on the t-statistics is difficult because there is a period of many changes and these coefficients are also small in magnitude. In fact, using a critical value of 5% (hypothesis of one side) the null hypothesis of absence of convergence cannot be rejected. This hypothesis is only rejected at 10%. In this sense, the evidence is not robust as Coulombe (1999) argues. Coulombe and Lee (1995, 1998) also found that the rhythm of convergence is slower for the income measures excluding the interprovincial transfers in comparison with the measures that include this component. From this, they concluded that the transfers have contributed to the convergence of income per-capita in Canadian provinces for the period after 1949. At this respect, Coulombe (1994) argues that the "convergence occurred faster between 1961 and 1991 for income measures that include the effect of transfers and income tax than for income measures that omit transfers" (p. 12).

3 The Models and The Statistics

3.1 Stochastic Convergence

Let y_t denotes the logarithm of the ratio of per-capita income of a region to average income (across regions) of the entire country. In this section, we test for the presence of a unit root in y_t. The existence of a unit root means that the time series is not stationary, implying that there is not stochastic convergence. To perform this analysis, we use unit root statistics

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[5] The importance of the transfers is know in some research as the birth of the *welfare state*, see Coulombe (1994). Note that the federal transfers are calculated based on benchmark estimates of revenues capacity and they are not based on actual revenues.

recently proposed by Perron and Rodríguez (2003). They extended the GLS detrending approach suggested by Elliott, Rothenberg and Stock (1996), Ng and Perron (2001) to the context of structural change. The models considered are either a break in the slope or a break in both the intercept and the slope of the trend function of y_t.

Following the notation of Perron and Rodríguez (2003), the statistic ADF^{GLS} is constructed using the following equation[6]

$$\Delta \tilde{y}_t = b_0 \tilde{y}_{t-1} + \sum_{j=1}^{k} b_j \Delta \tilde{y}_{t-j} + e_{tk} \tag{2}$$

with $\tilde{y}_t = y_t - \hat{\psi}^{GLS} z_t$ and the set of coefficients $\hat{\psi}^{GLS}$ minimizes

$$S(\psi, \bar{\alpha}) = \sum_{t=1}^{T} [y_t^{\bar{\alpha}} - \psi' z_t^{\bar{\alpha}}]^2 \tag{3}$$

where $y_t^{\bar{\alpha}} = [y_1, (1 - \bar{\alpha} L) y_t]$, $z_t^{\bar{\alpha}} = [z_{1,}(1 - \bar{\alpha} L) z_t]$, for $t = 2, ..., T$; and $\overline{\alpha} = 1 + \overline{c}/T$ representing a value under the alternative hypothesis. Finally, $z_t = \{1,\ t, 1(t \geq T_B)(t - T_B)\}$ or $z_t = \{1,\ 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$ represent the deterministic components included in the detrending regression. Using simulations, Perron and Rodríguez (2003) selected $\overline{c} = -22.5$ as the "optimal" non centrality parameter[7] and hence this value is used in the subsequent empirical applications. Notice that in expression (2), a lag has to be selected to eliminate possible correlation in residuals.

3.2 β-Convergence

As before, let y_t denote the natural logarithm of the ratio of per-capita income of that region to average income (across regions) of the entire country. In a time series framework, β-convergence requires that regions with initial incomes above average should grow slower than the rest of the country while regions below average should grow faster than the rest of the country. It is equivalent to require that in regions where y_t is initially positive, the growth rate of y_t should be negative and the converse also has to be true.

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[6] Other unit root tests as the so called M-tests originally suggested by Stock (1999) and further analyzed by Perron and Ng (1995) were also considered. To save space, only framework and results for the ADF statistic are included. Other results are available upon request.

[7] This parameter is chosen such that the power envelope attains 50.0% of the asymptotic power.

According to the requirements mentioned above, β-convergence can be analyzed estimating the parameters of the deterministic trend function of y_t. Hence, suppose that y_t is modeled as

$$y_t = \mu + \beta t + u_t \tag{4}$$

where u_t is a mean zero random process that is serially correlated, β represents the average growth of y_t over time and μ represents the initial level of y_t. Therefore, in the context of β-convergence, if $\mu > 0$ then $\beta < 0$ and if $\mu < 0$ then $\beta > 0$. Hence, the evidence on β-convergence can be obtained from estimates of the trend function of y_t.

However, the inference on estimates of μ and β is not straightforward because u_t is serially correlated and may be an integrated process of order one, denoted as I(1). For example, in their study, Carlino and Mills (1993) modeled u_t as an $AR(2)$ process. Unfortunately, as argued by Tomljanovich and Vogelsang (2002), there are some pitfalls to writing y_t in this form. One inconvenience is the fact that parameters associated to the trend function in the autoregressive representation of y_t are nonlinear functions of μ, β and the structure of the correlation. On other hand, using an $AR(2)$ representation may not be a good approximation of the true structure of the correlation in u_t. Furthermore, when u_t is an I(0) or an I(1) process, it will have different implications about the interpretation of the trend parameters in the autoregressive representation of y_t. More precisely, if u_t is an I(0) process, then inference about β can be obtained from the estimate of the slope. But if u_t is an $I(1)$ process, this coefficient is zero and the inference has to be found from the estimate of the intercept in the autoregressive representation of y_t.

In this note, I follow the approach proposed by Tomljanovich and Vogelsang (2002) which involves direct estimates of μ and β based on simple regressions. Their approach is based on a class of statistics proposed by Vogelsang (1997, 1998) and Bunzel (1998), which are robust to the case where u_t is either an I(0) or I(1) process. In what follows similar notation is used as in Tomljanovich and Vogelsang (2002). The method consists of estimating two OLS regressions. The first regression is given by

$$y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + u_t \tag{5}$$

where $DU_{1t} = 1$ if $t \preccurlyeq T_B$ or 0 otherwise, $DU_{2t} = 1$ if $t > T_B$ or 0 otherwise, $DT_{1t} = t$ if $t \preccurlyeq T_B$ or 0 otherwise and $DT_{2t} = t - T_B$ if $t > T_B$ and 0 otherwise. In this case, T_B is the date of a shift in the parameters of the trend function of y_t. This point is considered as unknown but it can be estimated from the data. Estimates where $\mu_i > 0$ or $\mu_i < 0$ indicate whether relative per-capita income is above or below average at times 1 and T_B, respectively. The parameters β_1 and β_2 are growth rates before and after the break, respectively.

The second regression, named the z_t regression, is given by

$$z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t \tag{6}$$

where $z_t = \sum_{j=1}^{t} y_j,\ SDT_{it} = \sum_{j=1}^{t} DT_{ij},\ S_t = \sum_{j=1}^{t} u_j$, for $i = 1, 2$ and DT_{it} was defined before. Hence, this regression is obtained calculating partial sums of y_t.

In terms of notation, let t_y and t_z denote the t-statistics for testing the null hypothesis that the individual parameters in the y_t and z_t regressions are zero. For the y_t regression, the appropriate modified t-statistic is simply $T^{-1/2}t_y$, where T is the sample size. On another side, for the z_t regression, the appropriate modified t-statistic is defined as $t - PS_T = T^{-1/2}t_z \exp(-bJ_T)$, where b is a constant (to be calculated) and J_T is T^{-1} multiplied by the Wald statistic for testing $c_2 = c_3 = ... = c_9 = 0$ in the following OLS regression

$$y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + \sum_{i=2}^{9} c_i t^i + u_t. \tag{7}$$

Note that the J_T-statistic is the unit root statistic proposed by Park and Choi (1988) and Park (1990) and it can be computed as

$$\frac{RSS_Y - RSS_J}{RSS_J} \tag{8}$$

where RSS_Y is the residuals sum of squares from regression (5), and RSS_J is the residual sum of squares from regression (7). Given a significance level for the test, the constant b can be chosen so that the critical values of the $t-PS_T$ statistics are the same whether u_t is I(0) or I(1). In consequence, the J_T modification results in t-statistics from the z_t regression that are robust to I(1) errors. Note that if $b = 0$, the distribution of $t - PS_T$ is different when u_t is I(0) compared to when u_t is I(1) given that in this situation the J_T modification has no effect. Hence, the use of $b = 0$ is recommended if the errors are known to be $I(0)$ and we are certain that the I(0) asymptotic distribution is more accurate.

As Tomljanovich and Vogelsang (2002) mention, the J_T modification is not needed in the y_t regression since $T^{-1/2}t_y$ statistics have well-defined asymptotic distribution when u_t is I(1) and when u_t is I(0), the statistic $T^{-1/2}t_y$ converges to zero. Therefore, $T^{-1/2}t_y$ is a conservative test when the errors are I(0).

Asymptotic distributions for the $T^{-1/2}t_y$ and $t-PS_T$ statistics are non-standard and depend on the break date used in the regressions. In particular, the critical values depend on whether the break date is assumed to be known or unknown. In the last case, the break date has to be estimated from the data to avoid criticism of data mining (see Christiano, 1992). Selection method affects also the limiting distribution. Here, the same method used in Tomljanovich and Vogelsang (2002) is followed, which consists of taking a trimming from the sample, which is $(0.1T, 0.90T)$, with T as the sample size. By doing that, break dates near the start and end points of the sample are not considered. Then, for each regression, it is calculated T^{-1} multiplied by the Wald statistic in order to test the joint hypothesis that $\mu_1 = \mu_2$ and $\beta_1 = \beta_2$. In other words, the null hypothesis is that there is no break in the trend function of the time series y_t. Critical values are taken from Vogelsang (1997) and they are reported at the end of each tables.

4 Empirical Results

Annual data of per-capita personal income from 1926-1999 for the ten Canadian provinces is used[8]. The ten provinces are Alberta, British Columbia, Manitoba, Saskatchewan, New Brunswick, Nova Scotia, Newfoundland, Prince Edward Island (hereafter PEI), Ontario and Quebec.

In all cases, I use the logarithms of the ratio of per-capita income for individual provinces to the unweighted provincial average. Two data sets are used in the estimations. The only difference between both data sets is the inclusion or exclusion of the interprovincial transfers. The comparison between estimates from both data sets will indicate the importance or relevance of the interprovincial transfers for the deterministic convergence processes.

Table 1 presents the results obtained from the application of the ADF^{GLS} statistics. Lag length is selected using BIC and the break point is selected minimizing the value of the statistic as suggested by Zivot and Andrews (1992)[9]. Finite critical values tabulated by Perron and Rodríguez (2003)

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[8] This is the same data set used in Coulombe (2000). It corresponds to CANSIM label series D11701-D11710.

[9] Other criteria as the new $MAIC$ (see Ng and Perron, 2001) were also applied. Overall, similar results were found although evidence is weaker with $MAIC$. It is consistent with

are used. In a first moment, we use the more general model analyzed in Perron and Rodríguez (2003), that is, assuming a break both in the intercept and the slope of the trend function. When the null hypothesis of a unit root is not rejected, we use the model where only a break is allowed in the slope of the trend function. In other words, we are assuming that a loss of power may exist when the more general model is used. The model where only a break in the intercept is allowed is also performed[10]. Using this model, the results suggest that we can reject the null hypothesis of a unit root for the provinces of Ontario and Quebec. In all other cases, the more general model is sufficient to reject the null hypothesis of a unit root. However, we can not reject the null hypothesis for the province of British Columbia. Using the simpler model (break only in the intercept), we strongly reject the null hypothesis. But the visual analysis suggests the presence of a time trend or a broken trend in the series. Hence, the more convenient model seems to be the more general model. Even when a no reject of the null hypothesis is observed using this model, the estimated value is very close to the 10.0% finite critical value. Furthermore, using asymptotic critical value at 5.0% the reject is clear. Therefore, we consider that this province present evidence to reject the null hypothesis of a unit root.

The next step consists to calculate the test statistics described in the last section[11]. Tables 2, 3 and 4 include the results obtained using the $t - PS_T$ without J_T correction, the $t - PS_T$ with J_T correction, and the $T^{-1/2}t_y$, respectively. In each table, results are presented for both data sets discussed above and they are calculated considering an unknown break date in the regressions. Table 2 shows the estimated break point for each province. It is clear that most of break points are detected around 1935, 1940 and 1945[12].

There are few differences in the estimated break point when interprovincial transfers are or not included in the estimations. Such is the case of New Brunswick where 1937 is the break date selected using data excluding transfers. The other case is Newfoundland where data set excluding transfers selects 1953 as the break point. Notice that this date is very close to

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size and power simulations performed by Perron and Rodríguez (2003). Other methods to select the break point were also tried. Overall, the results were similar to those obtained using the minimum of the statistic.

[10] In this case, critical values for the case where there is no structural change have to be used. The explanation is given by the fact that a break in the intercept belongs to the class of *"slowly evolving regressors"*. See the condition B of Elliott, Rothenberg and Stock (1996). See also Perron and Rodríguez (2003) for some details about this issue.

[11] Estimations were performed using the Gauss code supplied by Tim Vogelsang.

[12] The only exception is Newfoundland because this province entered in Canada in 1949.

the enter date of Newfoundland in Canada (1949). This issue is interesting in the measure that the presence of transfers in this province seems to be affected by the location of the structural change both for intercept and the growth rate of the personal income.

The selected break points in Tables 2 to 4, are different than those dates selected by the unit root statistic (Table 1) which used the method infimum to select the break point. As it is well known, the break date selected by this method is not a consistent estimator of the true date. For further details, see Vogelsang and Perron (1998).

Table 2 also presents estimates of μ and β before and after the break date. According to these results, most of the provinces or regions satisfy the conditions for deterministic convergence. Regarding the existence or not of deterministic convergence, both data sets present a similar answer which is the fact that deterministic convergence has been attained. Furthermore, the results seem to indicate that the bulk of the convergence process occurred in the period after the selected break point.

Unfortunately, the results obtained in Table 2 need to be considered with caution, because they are obtained assuming I(0) disturbances in the residuals. In Table 3, similar results are presented, but they have been corrected for the possibility that a unit root is present in the errors of the process. In this case, deterministic convergence is found in Manitoba, New Brunswick, Newfoundland, and PEI. The more obvious conclusion from Table 3 is that there is important empirical evidence for deterministic convergence in the poorer provinces. This fact is in line with theoretical expectations and with some other results in the empirical literature for Canada such as Coulombe (2000).

Table 4 presents the results using the statistic $T^{-1/2}t_y$, which is also robust to the presence of unit root disturbances. The results suggest a similar conclusion as reached from the results of Table 3. However, unlike Table 3, there are some cases where this statistic is able to find evidence for convergence, as in the case of British Columbia. On another hand, Ontario is converging and not in equilibrium as we found before (see Table 3). Another difference is that Manitoba and Saskatchewan are in equilibrium. Note that before it was not possible to give an answer for these two provinces. The statistics confirms that Quebec and Nova Scotia are in equilibrium after the break date.

An important result appearing in Table 4, and not so clearly in Tables 2 and 3, is that estimates of μ_1 are statistically different from zero for most of the provinces considered. This means that the initial per capita income of these territories were not the same in 1926. Therefore, the question as to whether income convergence has occurred is relevant for most of these provinces, i.e. these provinces were not in equilibrium in 1926. The only exception are Ontario, Quebec and Saskatchewan.

Table 5 presents a summary of all results of Tables 2 to 4. In this table, a (large) C denotes point estimates consistent with β-convergence, that is, $\mu_1 > 0$ and $\beta < 0$, or $\mu < 0$ and $\beta > 0$. In this case we consider that *both* estimates are statistically significant at least at the 10.0% level. A (small) c denotes point estimates consistent with β-convergence but *only with one* coefficient statistically significant at least at the 10.0% level. The D and (small) d denote estimates consistent with divergence, where D signifies that *both* coefficients are statistically significant and d signifies that *only one* coefficient is statistically significant at least at 10.0% level. An E denotes point estimates that are small in magnitude and not statistically different from zero. Such point estimates suggest that β-convergence has already occurred. It is exactly the same notation as used in Tomljanovich and Vogelsang (2002). Note however, that the criteria used to identify a coefficient as "small" in magnitude is not clear. Observing the results found in Tomljanovich and Vogelsang (2002), it seems that they are assuming that a coefficient is small in magnitude if it is not larger than around $|0.12|$. In the present case, I am considering as small magnitude a coefficient not larger than $|0.20|$. Finally, a (small) u means that no conclusion is possible to be advanced about the province using all information in Tables 2 to 4. This situation is characterized when coefficients are not significant but they are not small in magnitude to be considered as an equilibrium situation (E).

In Table 5, for each sub-sample, there are columns (1) and (2) related to the inclusion or exclusion of the federal transfers, respectively. What we observe is that there are not great differences between both columns. Some exceptions are the following. Observing the pre-break sample, Newfoundland presents clear deterministic convergence when the data set includes transfers. However, notice that this results should not be a surprise given that the break point selected using both data sets is different. In fact, the break point in column (2) is 1953 which left a very small sample to think that it is possible to find clear deterministic convergence in this period. Another interesting case is Alberta, where the evidence for deterministic convergence is stronger in column (1). Similar comments are applied for Newfoundland using the $t-PS_T$ with I(1) errors and the $T^{-1/2}t_y$. There are no differences in the final results in all other provinces.

It is well know that statistics calculated with unknown break point have lower power. This means that using a known break date may increase the power in a such way that stronger evidence in favor of convergence, if there exists, may be obtained. In this sense, and following other papers (see Carlino and Mills, 1999; Tomljanovich and Vogelsang, 2002), I perform the same set of results fixing the break date at 1946. For Newfoundland the break date is fixed at 1972, the same date selected in Table 2. Tables 6 to 8 present the results for the $t - PS_T$ without the J_T correction, $t - PS_T$ with the J_T correction, and the $T^{-1/2}t_y$ statistics, respectively. Table 9 presents a summary of these results in a similar way as Table 5.

Overall, Table 6 indicates similar results as found in Table 2. However, an interesting observation is that for the pre-break sample, the evidence in favor of weak or strong deterministic convergence is more clear in Table 6 than in Table 2. The results are, however, almost the same when the post-break sample is analyzed. Tables 7 and 8 present a similar behavior. The higher power observed in the first sample is not related exactly with the fact that the break date is fixed. More than that, the higher power in this sub-sample seems to be originated for the fact that the sub-sample has more observations than before and naturally power is higher.

As for Table 5, using Table 9, it is possible to compare the influence of the transfers regarding the answer of the existence of convergence. Again, when the $t - PS_T$ without the J_T correction is used, more differences are observed between the results with both data sets. In fact, stronger evidence of convergence is observed using data with transfers for British Columbia, Alberta, New Brunswick, PEI and Ontario. In the other sub-sample the evidence in favor of the presence of transfers is observed only for Alberta and Nova Scotia. When the $t - PS_T$ statistic with the J_T correction is used, the differences decrease and it is observed some evidence in favor of the presence of federal transfers in the case of Newfoundland. Using the third statistic, similar conclusion is reached for British Columbia and Newfoundland.

The overall conclusion from Tables 5 and 9 is that the presence of transfers does not change in a significant way the existence or not of deterministic convergence. There is some partial evidence in favor of the effect of transfers in the convergence process when the statistic $t - PS_T$ with I(0) errors assumed is used and where the break point is known. However, these results are not robust to the presence of very persistent errors as may be the case of our time series. Unfortunately in these cases, the results show that inter-provincial transfers are not determinants to the attainment of deterministic convergence.

As we observed before, the estimates of the intercept in the pre-break sample show that at the origin (1926), the provinces had different initial levels of output and consequently, the convergence was a relevant issue at this moment. Apparently, the policy makers understood this situation and after some years the so named *welfare state* was impulsed. The overall conclusion mentioned before is discouraging from this perspective because the evidence suggests some questions about the beneficial effects of the interprovincial transfers. But not all news are unfortunate. Even when the results indicate that the interprovincial transfers seem to have played no significant role in the existence or not of the deterministic convergence, the fortunate news is that these transfers have contributed in a significant way in the speed to reach the convergence. In fact, a detailed observation of the estimates in Tables 2-4 or 6-8 offers some issues about the particular role of the interprovincial transfers. For example, consider the estimates presented in Table 6. Observing both sub samples, almost in all cases, the estimate of the slope is higher (in absolute value) when the data set including transfers is used in comparison to the situation when data set excluding federal transfers is used. It is more clear in the second sample, where furthermore, we observe that the coefficient related to the intercept is lower (in absolute value) using data set including transfers. Notice that we are only analyzing those coefficients that are statistically significant. Some estimates are not statistically significant and consequently in statistical terms, they are not different from zero. The results are less clear when we move to Tables 3-4 or Tables 7-8 because they are based on more conservative statistics. What is new is that Tables 3 and 7 show that this phenomenon of higher speeds towards convergence is relevant in the provinces of New Brunswick, Newfoundland and PEI, forming the region of Maritimes, known as the poorest region of Canada.

Therefore, the estimated coefficients allow us to recognize a particular role of the interprovincial transfer in the convergence process. This role consists in increasing the speed to which personal income in Canadian provinces is converging to the national average, particularly in provinces as Newfoundland, New Brunswick and PEI. The overall conclusion is that the interprovincial transfers were not determinant or decisive to the attainment of deterministic convergence in the Canadian provinces. More than that, the interprovincial transfers have had the role to accelerate the convergence process in poorer Canadian provinces.

5 Conclusions

This study presents further empirical evidence about the notion of β-convergence for the ten Canadian provinces using annual personal income data covering the period 1926-1999. While the issue of convergence has been analyzed especially using cross-sectional data or panel data (see the references of the introduction), I use a time-series methodology with statistics recently proposed by Vogelsang (1997, 1998) and Bunzel (1998) which are robust to the presence of I(0) or I(1) disturbances.

The estimated coefficients allow us to recognize a particular role of the interprovincial transfers in the convergence process. This role consists to increase the speed at which personal income in Canadian provinces is converging to the national average, particularly in poorer provinces such as Newfoundland, New Brunswick and PEI. The overall conclusion is that the interprovincial transfers were not determinant or decisive to the attainment of deterministic convergence in the Canadian provinces. More than that, the interprovincial transfers have had the role to accelerate the convergence process in poorer Canadian provinces.

A possible extension to this study is a recursive estimation of the statistics $t - PS_T$ and $t^{-1/2}t_y$. In this way, an analysis of the time when convergence is occurring could be interesting and informative. At the same time, a different set of critical values are necessary because the break date is changing in recursive estimation. This is the issue of a future research.

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Table 1. ADF^{GLS} Results choosing the break date minimizing the statistics*

Province or Region	$t_{\widehat{\alpha}}$	k	$\widehat{T}_B$	$\widehat{\alpha}$	Deterministic Components
British Columbia	-3.945	0	1936	0.646	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Alberta	-4.392^b	0	1936	0.582	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Manitoba	-6.564^a	0	1945	0.259	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Saskatshewan	-5.238^a	0	1937	0.453	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
New Brunswick	-5.755^a	0	1933	0.371	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Newfounland	-4.329^d	0	1956	0.454	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Nova Scotia	-5.002^b	0	1933	0.488	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Prince Edward Island	-7.461^a	0	1940	0.119	$z_t = \{1, 1(t \geq T_B), t, 1(t \geq T_B)(t - T_B)\}$
Ontario	-1.860^d	0	1972	0.758	$z_t = \{1, 1(t \geq T_B)\}$
Quebec	-2.460^b	0	1928	0.843	$z_t = \{1, 1(t \geq T_B)\}$

* a, b,c and d denote significance levels at the $1.0\%, 2.5\%, 5.0\%$, and 10.0%, respectively. Using the equation (2), $\widehat{\alpha} = 1 + \widehat{b}_0$.

Table 2. Empirical results using the z_t regression and $t - PS_t$ statistics
without J_T correction; Unknown break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers					Data without Govern		
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{T}_B$	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$
	(t-stat)	(t-stat)	(t-stat)	(t-stat)		(t-stat)	(t-stat)	(t-st
British Columbia	0.257	2.752	0.402**	-0.459**	1933	0.225	3.032	0.37
	(0.897)	(0.409)	(16.032)	(-6.290)		(0.802)	(0.462)	(15.1
Alberta	0.357	-6.034	0.158**	0.024	1936	0.348	-5.728	0.151
	(1.311)	(-1.242)	(3.844)	(0.189)		(1.286)	(-1.182)	(3.61
Manitoba	0.109**	-0.403	0.138**	-0.307**	1945	0.087**	-0.286	0.14
	(2.880)	(-1.001)	(8.270)	(-5.072)		(3.610)	(-1.157)	(11.9
Saskatshewan	0.040	-6.465**	-0.021	-0.068	1938	0.086	-8.547**	-0.0
	(0.174)	(-1.806)	(-0.442)	(-0.460)		(0.344)	(-2.207)	(-0.8
New Brunswick	-0.385**	2.660	-0.278**	0.284**	1933	-0.344**	1.753	-0.27
	(-2.600)	(0.769)	(-21.523)	(7.563)		(-2.863)	(0.881)	(-12.6
Newfounland	-0.576**	1.182**	-0.340**	1.040**	1979	-0.486*	-2.515	-0.44
	(-47.405)	(12.840)	(-9.842)	(2.904)		(-1.589)	(-0.236)	(-20.0
Nova Scotia	-0.364*	5.564	-0.095**	0.058*	1933	-0.367	6.375	-0.07
	(-1.545)	(1.012)	(-4.622)	(0.964)		(-1.290)	(0.958)	(-2.9
Prince Edward Island	-0.514**	0.356	-0.570**	0.889**	1940	-0.497**	0.849	-0.62
	(-6.33)	(0.352)	(-29.541)	(14.021)		(-5.796)	(0.729)	(-27.1
Ontario	0.165	2.939	0.355**	-0.280**	1933	0.147	3.381	0.36
	(0.438)	(0.335)	(10.845)	(-2.935)		(0.319)	(0.281)	(11.0
Quebec	-0.123	1.789	-0.096**	0.244**	1936	-0.101	1.746	-0.07
	(-0.664)	(0.543)	(-3.450)	(2.858)		(-0.472)	(0.456)	(-2.3
10.0% critical value	±1.570	±1.330	±1.140	±0.936		±1.570	±1.330	±1.1
5.0% critical value	±2.190	±1.760	±1.500	±1.270		±2.190	±1.760	±1.

Table 3. Empirical results using the z_t regression and $t-PS_t$ statistics
with J_T correction; Unknown break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers				Data withou	
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}_1$
	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-s
	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-s
British Columbia	0.257	2.752	0.402	-0.459	0.225	3.03
	(0.282)	(0.012)	(0.158)	(-0.215)	(0.252)	(0.01
	(0.335)	(0.034)	(0.528)	(-0.553)	(0.299)	(0.03
Alberta	0.357	-6.034	0.158	0.024	0.348	-5.72
	(0.286)	(-0.012)	(0.009)	(0.002)	(0.250)	(-0.00
	(0.359)	(-0.047)	(0.042)	(0.008)	(0.319)	(-0.03
Manitoba	0.109**	-0.403	0.138**	-0.307**	0.087**	-0.28
	(2.229)	(-0.457)	(2.964)	(-2.369)	(3.210)	(-0.80
	(2.316)	(-0.576)	(3.874)	(-2.956)	(3.267)	(-0.89
Saskatshewan	0.040	-6.465	-0.021	-0.068	0.086	-8.54
	(0.105)	(-0.388)	(-0.059)	(-0.106)	(0.228)	(-0.63
	(0.113)	(-0.611)	(0.100)	(-0.160)	(0.243)	(-0.91
New Brunswick	-0.385*	2.660	-0.278**	0.284**	-0.344	1.75
	(-1.765)	(0.234)	(-4.525)	(2.419)	(-1.082)	(0.04
	(-1.867)	(0.332)	(-6.799)	(3.329)	(-1.252)	(0.10
Newfounland	-0.576**	1.182*	-0.340*	1.040	-0.486	-2.51
	(-23.429)	(1.491)	(-0.564)	(0.369)	(-0.492)	(-0.00
	(-26.032)	(2.813)	(-1.179)	(0.658)	(-0.587)	(-0.01
10.0% critical value	±1.570	±1.330	±1.140	±0.936	±1.570	±1.3
5.0% critical value	±2.190	±1.760	±1.500	±1.270	±2.190	±1.7

Table 3 (continues). Empirical results using the z_t regression and $t-PS_t$ statistics without J_T correction; Unknown break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers				Data with	
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	
	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t
	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10%
Nova Scotia	-0.364	5.564	-0.095	0.058	-0.367	6.
	(-0.909)	(0.200)	(-0.554)	(0.205)	(-0.606)	(0.
	(-0.989)	(0.323)	(0.964)	(0.316)	(-0.678)	(0.
Prince Edward Island	-0.514**	0.356	-0.570**	0.889**	-0.497**	0.
	(-4.994)	(0.129)	(-7.954)	(5.374)	(-4.600)	(0.
	(-5.245)	(0.174)	(-11.203)	(7.030)	(-4.761)	(0.
Ontario	0.165	2.939	0.355	-0.280	0.147	3.
	(0.154)	(0.014)	(0.165)	(-0.138)	(0.094)	(0.
	(0.180)	(0.035)	(0.493)	(-0.325)	(0.112)	(0.
Quebec	-0.123	1.789	-0.096	0.244	-0.101	1.
	(-0.146)	(0.005)	(-0.008)	(0.034)	(-0.071)	(0.
	(-0.183)	(0.021)	(-0.039)	(0.117)	(-0.094)	(0.
10.0% critical value	±1.570	±1.330	±1.140	±0.936	±1.570	±1.
5.0% critical value	±2.190	±1.760	±1.500	±1.270	±2.190	±1.

Table 4. Empirical results using the y_t regression and $T^{-1/2}t_y$; Unknown break point

Regression: $y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + u_t$

	Data with Government Transfers				Data without Government Transf			
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	
	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-
British Columbia	0.260^{**}	2.687	0.405^{**}	-0.473^{**}	0.234^{**}	2.738	0.383^{**}	-0.
	(1.141)	(0.596)	(5.572)	(-2.507)	(1.019)	(0.601)	(5.178)	(-1
Alberta	0.276^{*}	-3.898	0.131	0.072	0.278^{*}	-3.891	0.121	0.
	(0.863)	(-0.827)	(1.041)	(0.209)	(0.847)	(-0.804)	(0.985)	(0.
Manitoba	0.106^{**}	-0.366	0.130	-0.269	0.084^{*}	-0.245	0.140	-0
	(0.945)	(-0.389)	(1.943)	(-1.271)	(0.751)	(-0.275)	(2.010)	(-1
Saskatshewan	-0.023	-4.985	-0.053	0.006	0.014	-6.896	-0.079	0.
	(-0.039)	(-0.667)	(-0.207)	(0.008)	(0.021)	(-0.821)	(-0.266)	(0.
New Brunswick	-0.362^{**}	1.902	-0.275^{**}	0.286^{*}	-0.325^{**}	1.297	-0.273^{**}	0.
	(-1.989)	(0.528)	(-4.377)	(1.893)	(-1.913)	(0.562)	(-3.803)	(1.
Newfounland	-0.573^{**}	1.143^{**}	-0.317^{**}	0.827	-0.519^{**}	-0.900	-0.452^{**}	0.
	(-8.689)	(3.180)	(-3.813)	(1.192)	(-2.488)	(-0.144)	(-7.501)	(1.
Nova Scotia	-0.307^{**}	3.623	-0.082	0.034	-0.297^{**}	3.964	-0.059	-0
	(-1.481)	(0.882)	(-1.236)	(0.196)	(-1.271)	(0.856)	(-0.784)	(-0
Prince Edward Island	-0.512^{**}	0.330	-0.561^{**}	0.843^{**}	-0.469^{**}	0.304	-0.603^{**}	0.7
	(-2.592)	(0.152)	(-5.849)	(3.035)	(-2.190)	(0.129)	(-5.753)	(2.
Ontario	0.156	3.265	0.354^{**}	-0.284	0.139	3.750	0.364^{**}	-0
	(0.618)	(0.652)	(4.389)	(-1.354)	(0.505)	(0.611)	(4.506)	(-1
Quebec	-0.118	1.681	-0.087	0.203	-0.100	1.727	-0.070	0.
	(-0.600)	(0.579)	(-1.117)	(0.964)	(-0.477)	(0.559)	(-0.842)	(0.
10.0% critical value	±0.671	±1.470	±2.370	±1.480	±0.671	±1.470	±2.370	±1
5.0% critical value	±0.875	±2.000	±3.000	±2.010	±0.875	±2.000	±3.000	±

Table 5. Summary of Empirical Results

Province	$t - PS_T$				$t - PS_T$				$T^{-1/2}t_y$			
	I(0) Errors assumed				I(1) Errors assumed				Robust to I(1) Errors			
	Pre-Break		Post Break		Pre-Break		Post Break		Pre-Break		Post Brea	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
British Columbia	u	u	C	C	u	u	u	u	d	d	C	C
Alberta	u	u	d	D	u	u	E	E	c	c	E	E
Manitoba	c	c	C	C	c	c	C	C	c	c	E	E
Saskatchewan	c	c	E	E	u	u	E	E	u	u	u	u
New Brunswick	c	c	C	C	c	u	C	u	c	c	C	c
Newfounland	C	c	C	C	C	u	c	u	C	d	c	C
Nova Scotia	c	u	C	d	u	u	E	E	c	c	E	E
Prince Edward Island	c	c	C	C	c	c	C	C	c	c	C	C
Ontario	u	u	C	C	u	u	u	u	u	u	c	c
Quebec	u	u	C	C	u	u	u	u	u	u	E	E

C denotes point estimates consistent with β-convergence that are statistically significant at least at the 10.0% level; d denotes point estimates consistent with β-convergence with *only one* estimate statistically significant at least at the 10.0% level; D denotes point estimates consistent with divergence that are statistically significant at least at the 10.0% level; d denotes point estimates consistent with divergence with *only one* estimate statistically significant at least at the 10.0% level; E denotes point estimates very small in magnitude and statistically insignificant which suggests that β -convergence has occurred (Equilibrium growth). A (small) u means that no conclusion is possible to be advanced about the province using all information in Tables 2-4. This situation is characterized when coefficients are not significant but they are not small in magnitude to be considered as an equilibrium situation (E).

Table 6. Empirical results using the z_t regression and $t - PS_t$ statistics
without J_T correction; Known break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers				Data without Government Trans		
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$
	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)
British Columbia	0.415^{**}	-0.444^{*}	0.359^{**}	-0.516^{**}	0.388^{**}	-0.353	0.346^{**}
	(6.090)	(-0.639)	(10.871)	(-4.228)	(5.562)	(-0.495)	(9.979)
Alberta	0.084^{*}	-0.293	0.200^{**}	-0.108	0.083	-0.226	0.202^{**}
	(0.826)	(-0.282)	(4.057)	(-0.592)	(0.756)	(-0.200)	(3.687)
Manitoba	0.103^{**}	-0.316^{**}	0.137^{**}	-0.304^{**}	0.087^{**}	-0.286^{**}	0.144^{**}
	(3.329)	(-0.998)	(9.093)	(-5.483)	(3.610)	(-1.157)	(11.990)
Saskatshewan	-0.363^{**}	0.736	0.004	-0.162	-0.431^{**}	0.663	-0.008
	(-1.622)	(0.322)	(0.035)	(-0.405)	(-1.543)	(0.232)	(-0.056)
New Brunswick	-0.296^{**}	0.357^{**}	-0.248^{**}	0.308^{**}	-0.273^{**}	0.320	-0.269^{**}
	(-8.423)	(0.993)	(-14.551)	(4.898)	(-5.325)	(0.612)	(-10.557)
Newfounland	-0.589^{**}	1.328^{**}	-0.318^{**}	0.530^{**}	-0.550^{**}	0.908^{**}	-0.403^{**}
	(-23.178)	(5.547)	(-8.825)	(2.011)	(-23.735)	(4.147)	(-11.668)
Nova Scotia	-0.174^{**}	0.791^{*}	-0.111^{**}	0.136^{**}	-0.146^{**}	0.756^{**}	-0.103^{**}
	(-3.481)	(1.548)	(-4.564)	(1.516)	(-2.463)	(1.248)	(-3.512)
Prince Edward Island	-0.489^{**}	-0.086	-0.521^{**}	0.903^{**}	-0.435^{**}	-0.272^{*}	-0.589^{**}
	(-10.546)	(-0.181)	(-23.185)	(10.885)	(-10.895)	(-0.665)	(-29.613)
Ontario	0.318^{**}	-0.046	0.336^{**}	-0.337^{**}	0.311^{**}	0.047	0.354^{**}
	(-3.560)	(-0.050)	(7.758)	(-2.111)	(3.626)	(0.054)	(8.296)
Quebec	0.010	-0.589^{*}	-0.057^{**}	0.194^{**}	0.036	-0.680^{*}	-0.036
	(0.130)	(-0.760)	(-1.546)	(1.426)	(0.431)	(-0.796)	(-0.870)
10.0% critical value	±0.854	±0.683	±1.030	±0.908	±0.850	±0.683	±1.030
5.0% critical value	±1.120	±0.883	±1.350	±1.200	±1.120	±0.883	±1.350

Table 7. Empirical results using the z_t regression and $t - PS_t$ statistics
with J_T correction; Known break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers				Data withou	
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}_1$
	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-s
	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-s
British Columbia	0.415	-0.444	0.359	-0.516	0.388^{*}	-0.35
	(0.489)	(-0.000)	(0.000)	(-0.003)	(0.600)	(-0.00
	(0.713)	(-0.003)	(0.006)	(-0.021)	(0.837)	(-0.00
Alberta	0.084	-0.293	0.200	-0.108	0.083	-0.22
	(0.130)	(-0.001)	(0.002)	(-0.003)	(0.115)	(-0.00
	(0.172)	(-0.005)	(0.017)	(-0.012)	(0.152)	(-0.00
Manitoba	0.103^{**}	-0.316^{*}	0.137^{**}	-0.304^{**}	0.087^{**}	-0.286
	(2.738)	(-0.549)	(4.154)	(-3.093)	(3.210)	(-0.80
	(2.819)	(-0.655)	(5.097)	(-3.631)	(3.267)	(-0.89
Saskatshewan	-0.363	0.736	0.004	-0.162	-0.431	0.66
	(-0.530)	(0.011)	(0.000)	(-0.015)	(-0.448)	(0.00
	(-0.626)	(0.029)	(0.001)	(-0.038)	(-0.539)	(0.01
New Brunswick	-0.296^{**}	0.357	-0.248^{**}	0.308^{*}	-0.273^{**}	0.32
	(-4.412)	(0.138)	(-1.093)	(0.738)	(-1.611)	(0.01
	(-4.860)	(0.247)	(-2.148)	(1.255)	(-1.926)	(0.04
Newfounland	-0.589^{**}	1.328	-0.318	0.530	-0.550^{**}	0.90
	(-6.322)	(0.105)	(-0.049)	(0.045)	(-7.523)	(0.12
	(-7.677)	(0.338)	(-0.189)	(0.130)	(-8.933)	(0.34
10.0% critical value	±0.850	±0.683	±1.030	±0.908	±0.850	±0.6
5.0% critical value	±1.120	±0.883	±1.350	±1.200	±1.120	±0.8

Table 7 (continues). Empirical results using the z_t regression and $t - PS_t$ statistics with J_T correction; Known break point
Regression: $z_t = \mu_1 DT_{1t} + \beta_1 SDT_{1t} + \mu_2 DT_{2t} + \beta_2 SDT_{2t} + S_t$

	Data with Government Transfers				Data with	
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}$
	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t-stat)	(5% t
	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10% t-stat)	(10%
Nova Scotia	-0.174**	0.791	-0.111	0.136	-0.146	0.7
	(-1.111)	(0.047)	(-0.047)	(0.054)	(-0.624)	(0.0
	(-1.318)	(0.132)	(-0.156)	(0.137)	(-0.766)	(0.0
Prince Edward Island	-0.489**	-0.086	-0.521**	0.903**	-0.435**	-0.
	(-8.597)	(-0.097)	(-10.232)	(5.986)	(-9.263)	(-0.
	(-8.864)	(-0.117)	(-12.667)	(7.078)	(-9.491)	(-0.
Ontario	0.318	-0.046	0.336	-0.337	0.311	0.0
	(0.109)	(-0.000)	(0.000)	(-0.000)	(0.169)	(0.0
	(0.184)	(-0.000)	(0.000)	(-0.001)	(0.268)	(0.0
Quebec	0.010	-0.589	-0.057	0.194	0.036	-0.0
	(0.004)	(-0.000)	(-0.000)	(0.000)	(0.016)	(-0.0
	(0.007)	(-0.001)	(-0.000)	(0.001)	(0.026)	(-0.0
10.0% critical value	±0.854	±0.683	±1.030	±0.908	±0.854	±0.
5.0% critical value	±1.120	±0.883	±1.350	±1.200	±1.120	±0.

Table 8. Empirical results using the y_t regression and $T^{-1/2}t_y$; Known break point

Regression: $y_t = \mu_1 DU_{1t} + \beta_1 DT_{1t} + \mu_2 DU_{2t} + \beta_2 DT_{2t} + u_t$

	Data with Government Transfers				Data without Government Transf			
Province	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	$\widehat{\beta}_2$	$\widehat{\mu}_1$	$\widehat{\beta}_1$	$\widehat{\mu}_2$	
	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-
British Columbia	0.410**	-0.397	0.355**	-0.504*	0.382**	-0.282	0.341**	-0
	(2.553)	(-0.310)	(3.591)	(-1.580)	(2.347)	(-0.217)	(3.373)	(-1
Alberta	0.087	-0.297	0.198	-0.102	0.090	-0.283	0.204	0.
	(0.341)	(-0.146)	(1.256)	(-0.200)	(0.341)	(-0.134)	(1.243)	(0.
Manitoba	0.101**	-0.292	0.130*	-0.272	0.084**	-0.245	0.140*	-0
	(0.951)	(-0.345)	(1.993)	(-1.291)	(0.751)	(-0.275)	(2.010)	(-1
Saskatshewan	-0.357**	0.794	-0.005	-0.136	-0.433**	0.800	-0.022	-0
	(-0.610)	(0.159)	(-0.013)	(-0.117)	(-0.600)	(0.139)	(-0.049)	(-0
New Brunswick	-0.298**	0.358	-0.247**	0.311	-0.271**	0.269	-0.269**	0.
	(-2.616)	(0.394)	(-3.519)	(1.376)	(-2.006)	(0.250)	(-3.205)	(0.
Newfounland	-0.583**	1.249	-0.308**	0.497	-0.544**	0.828**	-0.392**	0.
	(-6.612)	(2.026)	(-3.726)	(0.961)	(-5.937)	(1.292)	(-4.469)	(0.
Nova Scotia	-0.182**	0.872*	-0.112	0.135	-0.152**	0.826*	-0.106	0.
	(-1.380)	(0.832)	(-1.387)	(0.519)	(-1.029)	(0.700)	(-1.147)	(0.
Prince Edward Island	-0.493**	-0.028	-0.513**	0.852**	-0.430**	-0.366	-0.577**	0.8
	(-2.827)	(-0.020)	(-4.779)	(2.461)	(-2.312)	(-0.247)	(-4.993)	(2.
Ontario	0.306**	0.118	0.322**	-0.296	0.299**	0.217	0.344**	-0
	(1.690)	(0.082)	(2.895)	(-0.825)	(1.660)	(0.151)	(3.073)	(-0
Quebec	-0.001	-0.452	-0.059	0.186	0.022	-0.503	-0.042	0.
	(-0.007)	(-0.354)	(-0.602)	(0.584)	(0.129)	(-0.371)	(-0.399)	(0.
10.0% critical value	±0.389	±0.676	±1.820	±1.560	±0.389	±0.676	±1.820	±1
5.0% critical value	±0.504	±0.887	±2.390	±2.040	±0.504	±0.887	±2.390	±2

Table 9. Summary of Empirical Results

Province	$t-PS_T$				$t-PS_T$				$T^{-1/2}t_y$			
	I(0) Errors assumed				I(1) Errors assumed				Robust to I(1) Errors			
	Pre-Break		Post Break		Pre-Break		Post Break		Pre-Break		Post Brea	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2
British Columbia	C	c	C	C	c	c	u	u	c	c	C	c
Alberta	c	u	c	d	u	u	E	E	u	u	E	E
Manitoba	C	C	C	C	C	C	C	C	c	c	c	c
Saskatchewan	c	c	E	E	u	u	E	E	c	c	E	E
New Brunswick	C	c	C	C	c	c	C	u	c	c	c	c
Newfounland	C	C	C	C	c	c	u	u	c	C	c	c
Nova Scotia	C	C	C	c	u	u	E	E	C	C	E	E
Prince Edward Island	d	D	C	C	c	c	C	C	c	c	C	C
Ontario	c	d	C	C	u	u	u	u	c	c	c	c
Quebec	c	c	C	C	u	u	E	E	u	u	E	E

C denotes point estimates consistent with β-convergence that are statistically significant at least at the 10.0% level; d denotes point estimates consistent with β-convergence with *only one* estimate statistically significant at least at the 10.0% level; D denotes point estimates consistent with divergence that are statistically significant at least at the 10.0% level; d denotes point estimates consistent with divergence with *only one* estimate statistically significant at least at the 10.0% level; E denotes point estimates very small in magnitude and statistically insignificant which suggests that β -convergence has occurred (Equilibrium growth). . A (small) u means that no conclusion is possible to be advanced about the province using all information in Tables 6-8. This situation is characterized when coefficients are not significant but they are not small in magnitude to be considered as an equilibrium situation (E).