Regional income disparities in Canada: exploring the geographical dimensions of an old debate

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ABSTRACT
The existing literature on convergence in Canada largely ignores the underlying geographical dimensions of regional disparities. By using income measures developed from census micro-data files to analyze patterns of convergence across census divisions, we show that regional disparities are increasingly clustered across the Canadian space-economy along (1) East–West and (2) urban–rural gradients. Rural census divisions in the Eastern provinces, in particular, are showing increased signs of distress in terms of differences in levels and growth rates of incomes with other regions in the country. Such findings have important policy implications which are briefly discussed.

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INTRODUCTION

Regional disparities have been a persistent feature of Canada’s economic landscape. In the midst of the Great Depression in the 1930s, growing concern over the erosion of the fiscal capacity of provinces led the federal government to establish a royal commission tasked with (1) taking stock of the socio-economic situation of provinces and the state of their public finances and (2) re-examining the shared role of federal and provincial governments in the distribution of tax sources and revenues. Upon publishing its final report in 1940, the federal government would, for the first time, officially recognize that economic imbalances across provinces were such that some were ‘unable to find the money to enable them to meet the needs of their citizens’ (Royal Commission on Dominion–Provincial Relations, 1940, p. 269). In order to counter such disparities, the commission offered a series of recommendations aimed at expanding the federal government’s economic powers. One of these was to provide so-called national adjustment grants to poorer provinces to allow them to offer public services at average Canadian levels. Thus was born the principle of equalization.

With the onset of the Second World War, the implementation of the proposed fiscal equalization programme would wait until 1957. That same year, another royal commission would produce
a report on Canada’s Economic Prospects. Known as the Gordon Commission, it went beyond the issue of differences in terms of provincial fiscal capacities and attempted to quantify regional economic disparities. Here, regional disparities were defined in terms of the difference between a province’s level of income (measured as personal income per capita) and that of the national average (or Ontario) as the yardstick of choice (Howland, 1957). By identifying and explicitly recognizing the existence of significant regional income differentials, the Gordon Commission called for the need to promote economic development in slow-growth provinces. Subsequent studies by Williamson (1965), McInnis (1968) and Green (1969) suggested that Canada had one of the highest degrees of regional imbalance among highly developed countries and that evidence of convergence over time (i.e., a decrease in the dispersion of income levels across provinces) was trivial at best.

It is only in the 1990s that empirical studies would show regional income disparities in the country had narrowed, starting in the late 1950s (Coulombe & Lee, 1995; Helliwell, 1996; Afxentiou & Serletis, 1998; Coulombe, 1999; Coulombe & Day, 1999; see also Coulombe, 2000; Coulombe & Tremblay, 2001; DeJuan & Tomljanovich 2005; James & Krieckaus, 2008). These studies also suggested that the convergence process began losing steam by the mid-1980s. After three decades of closing the gap, it seemed as though we had reached a steady-state equilibrium. But as Coulombe himself pointed out, even if regional disparities had decreased in Canada, they ‘[remained] a problem because of their size – about 50 percent higher than that of the disparities among US border states’ (Coulombe, 1999, p. 2). And as more recent evidence from the Organisation for Economic Co-operation and Development (OECD) (2014) shows, Canada continues to have one of the largest regional disparities in gross domestic product (GDP) per capita among member countries (third highest in 2010).

Canada is not alone here. According to the same OECD report, since the mid-1990s inter-regional income disparities increased in 20 out of the 33 countries considered. Such a trend inscribes itself within the context of growing concerns over the recent surge in income inequality writ large following the Great Recession and the Occupy Movement of 2011 (e.g., Stiglitz, 2012; Piketty, 2014; Atkinson, 2015).

In this paper, we revisit the debate on convergence in Canada with two objectives in mind. The first is to examine the evolution of income disparities at the provincial level in order to provide a more up-to-date assessment of the convergence hypothesis in Canada. The second is to explore the convergence process below the provincial scale (using census divisions (CDs) as the unit of analysis) in order to gain a better understanding of the underlying spatial dynamics of income disparities and of the factors that potentially give rise to them.

Existing studies of income disparities in Canada have focused almost exclusively on provincial-level differentials. This is so mainly because statistical, political and administrative convenience has dictated the use of provincial boundaries and data for policy purposes (Mansell & Copithorne, 1986; Ray, Lamarche, & MacLachlan, 2013). However, if analysis of provincial-level data is particularly useful in identifying long-term convergence trajectories, the trade-off is that studies at such a geographical scale can mask important underlying spatial patterns in regional disparities.

Alasia (2003) was one of the first to point this out. Using income data from tax returns over 1992–99, he showed that regional income disparities (with regions defined as CDs) had increased, especially over the latter half of the 1990s. Alasia’s decomposition analysis also suggested that this increase came from greater within-province differences rather than between-province differences. Specifically, his results showed a gradual shift from a provincial to an urban–rural divide. Though Alasia’s findings were important in drawing attention to the importance of space, they remained mainly descriptive and ignored the question about what factors may be behind such variations in regional incomes.

More recently, Desjardins (2011) revisits the notion of a growing urban–rural divide in Canada. Using modified Beale codes, he classifies CDs as either metropolitan or non-metropolitan regions
for 2006. Like Alasia (2003), Desjardins’ findings suggest that income disparities in Canada are more pronounced among urban and rural regions than between provinces. Given that his analysis is static, he goes on to argue that a more in-depth and longer-term perspective of the geographical dimensions of regional disparities in the country is necessary in order to understand better how regional development policies can play a role in addressing such disparities.

In this paper, we construct a unique geographically disaggregated dataset (across 287 CDs) using micro-data files from the 20% long-form census for 1996–2006. Drawing on exploratory spatial data analysis (ESDA) and spatial econometric methods, we show that the geographical concentration of regional income disparities increases over time. In particular, a growing East–West imbalance in levels and growth rates of incomes is emerging, with rural CDs in the Eastern provinces showing the most acute signs of distress. The identification of significant spatial effects across regional income measures also has important implications for the estimation of standard \( \beta \)-convergence models. Results from spatial regressions suggest that there is unconditional divergence in income growth from 1996 to 2006 and only weak evidence of conditional convergence after controlling for key economic and socio-demographic characteristics of regional economies.

By emphasizing the continuously shifting nature of regional disparities in Canada, our results show that standard approaches to the study of convergence at the provincial level miss out on important geographical patterns. Our findings also add a voice to the growing calls for renewed efforts at developing a ‘place-based’ policy framework where spatially aware regional development policies are balanced with other, more general, ‘place-neutral’ (or spatially blind) policies in areas such as education and training, health and social capital (Alasia, 2003; Bradford, 2005; Barca, McCann, & Rodríguez-Pose, 2012; Ray et al., 2013). As Polèse recently argues: ‘nothing really changes if all places adopt similar strategies’ (Polèse, 2013, p. 252). And if market forces alone cannot curb the new patterns of regional disparities observed, then we need to revisit our approach to development policies that can respond to today’s new challenges.

The paper is organized as follows. The next section begins by reviewing basic convergence concepts. The third section describes the data used for the analysis. The fourth section presents the results. The fifth section closes with a brief discussion of policy implications and future research directions.

**Setting the scene: a review of basic convergence concepts**

The term ‘convergence’ is generally used to describe the evolution of income disparities across countries or regions. Over the years, a number of different approaches to defining and measuring convergence have been suggested. The notion of \( \sigma \) (sigma)-convergence refers to situations where the cross-sectional dispersion of per-capita incomes declines over time. Since the classic papers by Kuznets (1955) and Williamson (1965), measures of the dispersion of a distribution such as the range, standard deviation and coefficient of variation have become a mainstay in studies of regional income disparities (e.g., Barro & Sala-i-Martin, 1991; Carlino & Mills, 1993; Fan & Casetti, 1994).

More contemporary methods of assessing the convergence hypothesis appeared in empirical studies of regional income disparities in the late 1980s and early 1990s. Growth regressions were among the new methods deployed. Initially developed by macroeconomists, the argument was that income levels in poorer countries would eventually ‘catch-up’ with those of richer countries as the former would experience faster growth rates than the latter (Abramowitz, 1986; Baumol, 1986). Such a ‘catch-up’ effect became known as \( \beta \) (beta)-convergence, the name derived from the estimation of a cross-sectional growth model typically specified as:

\[
\frac{1}{T} \ln \left( \frac{y_{it+T}}{y_{it}} \right) = \alpha + \beta \ln (y_{it}) + \epsilon_{it} \tag{1}
\]
where $y_{it}$ is per-capita income in region $i$ at time $t$; and $t$ and $T$ are respectively the initial and final years of the sample period (such that the left-hand-side of the equation is the average annual growth rate of income in region $i$); $\alpha$ is a constant term across regions; $\beta$ represents the speed of convergence of incomes; and $\varepsilon_{it}$ is the error term. A simple estimation of Equation (1) yielding a negative and significant $\beta$-coefficient is said to provide evidence of unconditional or absolute convergence since only a region’s initial level of income per capita is seen as contributing to the convergence of growth rates towards a steady-state equilibrium. In contrast, if convergence is observed only when equation (1) is augmented (or conditioned) by additional controls also thought to affect growth rates (for instance, by adding variables to reflect a region’s industrial structure, its demographic composition, human capital characteristics, etc.), then the process is said to be one of ‘conditional convergence’ (Barro & Sala-i-Martin, 1991; Sala-i-Martin, 1996).1

An alternative approach to convergence also emerged using time-series methods (e.g., Carlino & Mills, 1993; Bernard & Durlauf, 1996; Li & Papell, 1999; DeJuan & Tomljanovich, 2005). This latter approach is usually based on unit root tests for non-stationarity to confirm (or reject) the hypothesis of stochastic convergence in regional income differences over time.

As Rey and Montouri (1999) point out, the three approaches to convergence described above have led to conflicting results which to some extent reflect important differences between two principal schools of thought: neoclassical growth theory and endogenous growth theory. Past research also shows that each method has its limitations. For instance, time-series studies of convergence are typically very sensitive to the number of years included in the sample period. Quah (1993) also argues that empirical studies of $\beta$-convergence do not necessarily reflect the dynamics of regional convergence as they are plagued by Galton’s fallacy of regression towards the mean. Instead, he argues that Markov chain analysis should be used to develop models of the distribution dynamics in order to study the convergence hypothesis. Yet these too can be of limited value if they treat regional economies as independent cross-sectional observations and ignore the implications of spatial autocorrelation (SA) (Fingleton, 1999; Rey & Janikas, 2005). Given the shorter-time frame of the data available for regions in Canada (see below) and our focus on the underlying spatial dimensions of regional disparities, the analysis carried out in this paper relies on $\sigma$- and $\beta$-convergence measures.

**Regional data sources**

The paper draws on two main sources of data. First, in order to revisit and provide an up-to-date assessment of provincial-level convergence trends, we use personal income per capita data taken from Statistics Canada’s provincial economic accounts (CANSIM table 384–0013). These data are available for the period 1981–2010 and are deflated using provincial consumer price indices to ensure comparability over time (expressed in 2002 Canadian dollars).

Second, to examine income disparities at the regional (i.e., sub-provincial) level, we use micro-data files from the 20% long-form sample of the Canadian Census for 1996, 2001 and 2006.2 The 20% sample provides a number of advantages for studying income dynamics at the regional level. Of particular importance are its large sample size (e.g., over 6.2 million observations in 2006) and its level of detail on the socio-economic characteristics of respondents, including information on place of residence at the CD and census subdivision (CSD) levels.

This information is particularly important to build a set of variables for regions that is geographically consistent over time (Martin et al., 2002; Puderer, 2008). In Canada, CDs are relatively stable geographic units covering the entire country established by Statistics Canada to facilitate regional planning. Each CD comprises contiguous municipalities (i.e., CSDs) and is delineated according to provincial/territorial policies. There were a number of changes to CD boundaries between 1996 and 2006 and Nunavut’s designation as a territory in 1999 resulted in the reassignment of CSDs to that territory. To account for these changes, ArcMap was used...
to overlay the 2006 CD boundaries on top of the 2001 and 1996 micro-data files. Individual-level responses from the 20% sample were then re-aggregated to the 2006 boundaries for each census providing us with a consistent longitudinal and cross-sectional dataset containing a total of 287 CDs.

For each CD, we use two different measures of income: average employment earnings and average total income. Employment earnings reflect the wages (i.e., salaries) and self-employment income received by individuals whereas total income also includes dividends and other investment incomes, retirement pensions as well as government transfer payments (e.g., old age security, Canada and Quebec pension plans, employment insurance benefits, child benefits). Both income concepts are measured on a pre-tax basis and for each census income is reported for the prior calendar year.3 And since we are particularly interested in how differences in industrial structure may affect regional disparities, we focus on the incomes of effective labour force participants; these are individuals between the ages of 25 and 64 reporting a minimum total income of C$1000.

RESULTS AND DISCUSSION

Re-examining the evidence

At the provincial level

We begin the analysis by reviewing longer-term convergence trends at the provincial level. Figure 1 charts the trajectories of the standard deviation and coefficient of variation for real personal income per capita across provinces from 1981 to 2010. Both indicators provide clear evidence of \(\sigma\)-convergence from the early 1980s to the mid-1990s, a result in line with findings from previous studies.4 From the mid-1990s, however, the convergence process runs out of steam and appears to reach a steady-state equilibrium beyond which emerges a ‘see-saw’ pattern of alternating periods of divergence and convergence. This is consistent with recent studies by Capeluck (2014) and Brown and Macdonald (2015) who find the interprovincial convergence process to be ‘episodic’ rather than smooth with significant fluctuations in patterns of disparities across different time periods.

Table 1 provides further evidence of the convergence process. Here, growth-initial-level regressions, as specified by equation (1), of real per-capita personal income are estimated for the entire period (1981–2010) and then separately for the two sub-periods (1981–96 and 1996–2010) as per the patterns of convergence and non-convergence identified above. In the first specification (1981–2010), the coefficient estimate for the log of real per-capita personal income is negative and statistically significant, suggesting the presence of unconditional convergence. The speed of convergence, estimated at 1.9% per year over the entire sample period, is consistent with results from Coulombe and Lee (1995) and Coulombe and Day (1999). Re-estimating the model separately for each sub-period confirms the pattern observed in Figure 1. From 1981 to 1996, there is clear evidence of unconditional convergence: the speed at which the poorer provinces are ‘catching-up’ the richer ones is estimated to be 3.2%, on average, annually. However, from 1996 to 2010, the coefficient estimate for \(\beta\)-convergence is no longer statistically significant.

These results support Coulombe’s (1999) conclusion that the convergence of incomes at the provincial level had ceased by the mid-1990s (i.e., given existing institutional structures such as federal transfers and employment insurance). Yet several questions remain. Did this convergence process stop because we reached a steady-state equilibrium whereby remaining income disparities truly reflect differences in the industrial structure and socio-demographic characteristics of provincial economies? Or does the lack of convergence at the provincial level mask deeper or more pronounced disparities at a finer regional scale of analysis? If so, what do spatial patterns look like at this finer regional scale and how have they changed over time? The remainder of the paper sets out to answer these questions by examining the post-1996 period.
Table 2 presents summary statistics on the regional dimensions of income by census year and geographic scale (national, provincial and urban–rural regions). There are 287 time-consistent CDs from 1996 to 2006 and, overall, real average total income increased by almost 10%. Underneath this national trend, however, there is much variation in income growth rates across provinces and regions. Real average total income is highest – and increased most rapidly – in Alberta, the Territories, Ontario and British Columbia. The Prairie provinces of Saskatchewan and Manitoba have also experienced above-average growth in incomes, though their levels remained slightly below the national average. The Atlantic provinces and Quebec, in comparison, generally have lower average total incomes and slower growth rates.

The bottom half of Table 2 reveals two further geographical differences in recent patterns of income levels and growth across regions. First, average total incomes are higher (16%) and continue to grow more rapidly in highly urban compared with rural CDs (highly urban CDs are those with more than 50% of their population living in a census metropolitan area (CMA) based on the 2006 Census). This is consistent with the claim of Alasia (2003) and Desjardins (2011) that the geographical nature of regional disparities in Canada has changed since the 1990s, with emphasis on a growing urban–rural divide between regions both within and across
provinces. Second, the range of income values has increased over the period, pointing to much greater heterogeneity across CDs. Incomes at the regional level also show a tendency towards greater $\sigma$-divergence as the standard deviation and coefficient of variation increased by 38% and 25%, respectively, from 1996 to 2006.

Table 3 reports the $\beta$-convergence estimates from the growth regressions, as specified by equation (1), for average wages and salaries as well as average total income across CDs. In both cases, the $\beta$-coefficient estimate is positive and significant. This is an interesting finding. Whereas the provincial-level results reported in Table 1 simply indicate the absence of convergence post-1996, they mask a pattern of divergence at the regional level. In other words, income disparities between regions have grown from the mid-1990s to the mid-2000s. In the spatial $\beta$-convergence models estimated further below, we explore a number of potential drivers of such divergence by adding a series of variables reflecting regional differences in labour markets and industrial structure.

**More on the spatial dimensions of income disparities in Canada**

To explore the geographical dimensions of regional income disparities in greater detail, we begin by calculating the Moran's $I$ statistic using two different spatial weights matrices. The first is a simple Queen's contiguity weight matrix which defines a CD's neighbours as those CDs with shared borders or vertices. The second is a distance-based nearest-neighbour weight matrix where values of income in each CD are compared with those of its 10 ($k = 10$) nearest neighbours (i.e., the intuition is that spatial interactions beyond those nearest neighbours is assumed to be
Using two different spatial weights matrices for the analysis provides a way of checking the robustness of the results. Table 4 displays the values of Moran’s $I$ statistic for both weight matrices. Across the three census cycles, all values are positive and statistically significant (at the $p = .001$ level), a clear indication that regions with high (low) levels of income have a propensity to be clustered close to other high (low) income regions. Moreover, the values of the statistic suggest that the geographical concentration of incomes is highest in 2006.

While Moran’s $I$ is a useful summary measure of global SA, it does not allow us to identify local patterns of spatial association, i.e., whether or not there are clusters (hot or cold spots) of regional incomes around particular foci within the country that contribute more to the global SA observed above. Nor does Moran’s $I$ shed a light on the extent and evolution of spatial heterogeneity of regional incomes across the country. To explore these dynamics, we use information on the spatial covariances to calculate local indicators of spatial association (LISA) statistics for each CD (Anselin, 1995).

Figure 2(A) and 2(B) shows CDs with significant LISA values for total average income in 1996 and 2006. In each map, the LISAs are classified by type of SA: grey for high–high (HH) associations (i.e., CDs with high average total incomes surrounded by CDs with similarly high average total incomes), diagonal lines for low–low (i.e., CDs with low average total incomes surrounded by CDs with similarly low average total incomes), simple points for low–high and plaid patterns for high–low (HL) associations. Of particular interest are the HH (low–low, i.e., LL) CDs which suggest clustering of high (or low) levels of income. HL and LH CDs represent spatial outliers. CDs that do not exhibit statistically significant LISA values are left hollow. Several points are worth highlighting.

First, glancing at the maps, we see clearly that there are two dominant spatial regimes. On the one hand, there are clusters of high-income (HH) regions found mostly in Southern Ontario and in the Western parts of the country. On the other hand, we can also distinguish clusters of low-income (LL) regions concentrated in Manitoba/Saskatchewan, the Eastern parts of Quebec and throughout the Atlantic provinces.

Second, these two spatial regimes are persistent over time. In fact, there appears to be a pattern of increased spatial polarization with a higher relative incidence of both HH and LL regions. This is confirmed in the top two panels of Table 5, which reports LISA counts for both measures of regional income for 1996 and 2006. For average wages, the percentage of significant LISA values that fall either in the HH or LL category (i.e., hot or cold spots) increases from 86.9% in 1996 to 89.7% in 2006. For average total income, the increase is from 88.4% to 90.5%. The distribution between significant HH and LL associations also changes over time. Using average total incomes as an example, in 1996 the split between HH and LL associations was quite even (47% negligible). Using two different spatial weights matrices for the analysis provides a way of checking the robustness of the results.

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Table 3. Regression analysis of β-convergence of regional income measures, 1996–2006.

| Dependent variable: Δln (real income measure) | Average wages | Average total income |
|-----------------------------------------------|---------------|---------------------|
| ln Real income measure$_{t=1996}$              | .006**(.003)  | .011***(.003)       |
| Constant                                      | −.049(.027)   | −.110***(.030)      |
| $R^2$                                         | .017          | .051                |
| $F$                                           | 4.83**        | 16.0***             |
| Observations                                  | 287           | 287                 |

Notes: All income measures are reported in real Canadian dollar values (2002 = 100). Heteroskedasticity robust standard errors are shown in parentheses.

*p < .1; **p < .05; ***p < .01.
versus 53%). By 2006, 60% of significant associations fell into the LL category, with most of the increased clustering of these low–low regions (i.e., 89% of all LL regions) concentrated in Quebec (e.g., the côte Nord and Gaspésie regions) and the Atlantic provinces (e.g., New Brunswick’s Northeastern peninsula, Nova Scotia’s Bay of Fundy and South shore regions, and Newfoundland’s central and western regions). Changes in the spatial distribution of HH associations are marked by losses in the northern regions of Ontario and Quebec and rural regions of British Columbia, which are ultimately offset by a greater concentration of ‘richer’ regions in Alberta where incomes continued to be buoyed by the westward shift in manufacturing employment (Ray et al., 2013) and the growth of extractive industries (though the distribution of incomes within many of these ‘oil patch’ regions is increasingly uneven (e.g., Bolton and Breau, 2012; Breau, Kogler, & Bolton, 2014). The top/bottom 10 regions based on average total income for 1996 and 2006 are reported in Appendix A.

Third, within that East–West divide, another spatial pattern emerges between urban and rural regions. Whereas the HH associations are roughly split between urban and rural CDs, the distribution of LL clusters is much more lopsided: three-quarters of LL associations are in rural CDs. What is more, over time these low–low clusters are increasingly concentrated in rural regions in Quebec and the Atlantic provinces. In other words, the contrast between the fortunes of rural CDs in the Western provinces and those of their Eastern counterparts is growing.

Fourth, there are few ‘atypical’ regions (with LH or HL associations). Among the sea of LL associations in the Atlantic provinces, there are pockets of wealth (HL associations) found in the Halifax region in Nova Scotia, Kings county New Brunswick (just North of Saint John) and as of 2006 in Newfoundland’s Division No. 1 (the Avalon Peninsula). The Sherbrooke and Memphremagog regions part of Quebec’s ‘manufacturing croissant’ (Proulx, 2006; Polèse, 2009) are also high-income regions surrounded by low-income CDs, as are Divisions Nos 21 and 1 in Manitoba and Saskatchewan where mining, oil and gas are the primary industrial activities along with the agricultural sector.

In theory, if low-income regions were growing at a faster rate than high-income regions, the spatial inequality described above would have decreased over the 1996–2006 period. Yet as Figure 3 and the bottom panel of Table 5 suggest, the East–West cleavage in growth rates is even more pronounced than that of average total income levels. More than three-quarters of the HH associations in growth rates occurred in the Western regions of the country (including those in the Territories). In contrast, 93% of LL associations are located East of the Manitoba-Ontario boundary.
Figure 2. Local indicators of spatial association (LISA) maps of average total income levels across census divisions, 1996 and 2006.
Table 5. Local spatial autocorrelation for regional income measures.

|                | Average wages | Average total income |
|----------------|---------------|----------------------|
| 1996 Not significant | 111           | 115                  |
| High–high      | 78            | 71                   |
| Low–low        | 75            | 81                   |
| Low–high       | 10            | 7                    |
| High–low       | 13            | 13                   |
| 2006 Not significant | 122           | 117                  |
| High–high      | 66            | 64                   |
| Low–low        | 82            | 90                   |
| Low–high       | 8             | 6                    |
| High–low       | 9             | 10                   |
| Growth rates (1996 to 2006) | 161          | 171                  |
| Not significant | 57            | 48                   |
| High–high      | 58            | 55                   |
| Low–low        | 5             | 7                    |
| Low–high       | 6             | 6                    |

Notes: The counts of regions falling in each category based on a $k = 10$ nearest neighbour spatial weights matrix with 499 permutations are reported.

Figure 3. LISA map of average total income growth across census divisions, 1996–2006.
The results from the ESDA carried out above suggest there are highly persistent—even growing—spatial disparities among Canadian regions: high-income regions (CDs) surrounded by similarly high-income neighbours appear to benefit from their affluent environment whereas low-income regions surrounded by other low-income regions continue to lag behind. The characteristics of neighbouring regions thus play an important role in determining regional income trajectories (Lesage & Fischer, 2008). From an inferential perspective, the presence of such spatial spillovers raises a number of analytical complications for $\beta$-convergence models, not least of which is the basic assumption that observations in a sample are independent of each other.

Indeed, in Table 6 we re-estimate the $\beta$-convergence models specified in Equation (1) and report a series of diagnostics for spatial effects. Again, Moran’s $I$ values are substantive and statistically significant across both regional income measures, a clear indication that SA is an issue. If we ignore such spatial dependence, the $\beta$-convergence estimates from the standard ordinary least squares (OLS) models are thus inconsistent and biased.

To specify correctly the convergence models, we need more information on the nature of the spatial dependence present in the data. For this, we turn to the bottom two rows of Table 6 where the robust Lagrange multiplier (RLM) tests, as Anselin and Rey (1991) and Anselin, Bera, Florax, and Yoon (1996) have shown, can be used to help discriminate between spatial lag (LAG) and spatial error (ERR) autocorrelation, the two most common forms of SA. In this case, the robust tests suggest that the source of dependence is the spatial lag. The correct specification for the $\beta$-convergence models at the CD level can thus be expressed as:

$$\frac{1}{T} \ln \left( \frac{y_{it+T}}{y_{it}} \right) = \alpha + \beta \ln (y_{it}) + \rho W \ln \left( \frac{y_{it+T}}{y_{it}} \right) + \epsilon_{it} \tag{2}$$

where the parameters are the same as those defined in Equation (1) with the exception of the third term on the right-hand side of the equation where $\rho$ is the spatial autoregressive coefficient on the spatially lagged dependent variable ($W \ln \left( \frac{y_{it+T}}{y_{it}} \right)$). The latter can be interpreted as the spatially weighted average of income growth in neighbouring regions (based on a Queen’s contiguity matrix).

Table 7 presents three $\beta$-convergence spatial dependence models based on average total incomes. The spatial lag models are estimated by maximum likelihood and the values of the Akaike information criterion (AIC) suggest that all three models have a better fit than the unconditional models estimated earlier. The first model reproduces the results for the original unconditional model estimated in Table 3: the $\beta$-coefficient is positive and significant, implying divergence in regional average total incomes though the speed of divergence is about half of that of the a-spatial model estimate.
In model 2, we add a number of control variables to equation (2) in order to reflect factors that may also influence convergence trajectories across regions. The standard practice in the literature is to include controls for differences in regional industrial structures (Coulombe & Lee, 1995). We do so by adding variables for the percentage of the regional workforce employed in (1) manufacturing activities, (2) finance, insurance, real estate as well as professional and technical services, and (3) government services. The unemployment rate is also included as a proxy reflecting the overall strength of the regional labour market. Finally, much has been written recently on the relationship between growth and inequality (e.g., Perugini & Martino, 2008; Partridge & Weinstein, 2013; Piketty, 2014). The jury is still out as to whether and under what circumstances this relationship should be positive or negative; however, we examine the effect of income inequality levels on subsequent growth across Canadian regions by including the Gini coefficient to Equation (2).

All control variables are measured at their initial levels (t = 1996). While the results for the unconditional model indicated divergence, adding variables that reflect the structural characteristics of regional economies produces a negative, though not statistically significant, β-coefficient. Regions with higher initial levels of unemployment have slower subsequent growth rates, while regions with higher levels of employment in finance and related service sectors experience faster growth. No significant relationship was found between growth and manufacturing or government sectors, nor with the initial level of inequality.

Finally, further regional socio-demographic controls are added in model 3. As Coulombe and Tremblay (2001) have shown, historically human capital has played an important role in explaining per-capita income convergence patterns in Canada. To test this relationship, we include a variable for the percentage of the labour force with a bachelor’s degree or higher. We also include controls for the female participation rate, the percentage of the regional population that is of

### Table 7. Regression analysis of regional conditional β-convergence models with spatial dependence, 1996–2006.

| Dependent variable: Δln (real average total income) | Model 1 | Model 2 | Model 3 |
|---------------------------------------------------|---------|---------|---------|
| ln Real average total income (t=1996)             | .005** (.002) | −.004 (.003) | −.006* (.004) |
| Labour market controls (t=1996)                   |         |         |         |
| Unemployment rate                                 | −.027*** (.008) | −.025*** (.008) |
| % manufacturing                                  | −.007 (.007) | −.004 (.006) |
| % FIRE & TEC                                      | .041** (.019) | .045*** (.019) |
| % government                                      | .009 (.007) | .011 (.008) |
| Gini coefficient                                  | .026 (.034) | .049 (.039) |
| Socio-demographic controls (t=1996)               |         |         |         |
| % high education                                  | −.011 (.009) |
| FPR                                               | .058*** (.017) |
| % visible minority                                | −.008 (.006) |
| % young                                           | .002 (.004) |
| % senior                                          | −.014*** (.004) |
| Urban dummy                                       | −.001 (.001) |
| Spatial lag (ρ)                                   | .579*** (.060) | .473*** (.066) | .414*** (.067) |
| Constant                                          | −.051*** (.025) | .038 (.037) | .033 (.039) |
| AIC                                               | −2120.3 | −2147.6 | −2155.8 |
| Observations                                      | 284     | 284     | 284     |

Notes: The spatial lag model based on a Queen’s contiguity matrix. FIRE & TEC = employment in finance, insurance and real estate industries, as well as in high-tech industries. FPR = female participation rate. AIC = Akaike Information Criterion. Heteroskedasticity robust standard errors are shown in parentheses. *p < .1; **p < .05; ***p < .01.
visible minority status, young (<15 years of age) and senior (>64 years of age). An urban dummy variable is also included to reflect the urban–rural nature of regions (as defined in Table 2). A number of results stand out from model 3 estimates. First, based on the AIC this last spatial model provides the best fit of all models estimated. Second, when accounting for regional differences in both labour market and socio-demographic characteristics, there is weak evidence (i.e., significant only at the 0.1 level) of conditional convergence in regional average total incomes. Third, in contrast to earlier (provincial-level) studies, the empirical evidence on the impact of human capital and the level of urbanization across regions is mixed as none of these variables has a statistically significant coefficient estimate. Fourth, regions with higher female participation rates have experienced higher subsequent growth. And fifth, the demographic structure of regions matters as the coefficient estimate for the percentage of the population aged 64 and above is negative and significant. This latter finding, in particular, raises concerns with regards to the future trajectory of regional income disparities in Canada. Most of those rural CDs in Eastern Canada which are showing acute signs of distress in terms of differences in levels and growth rates of incomes are also among those whose population is oldest and ageing fastest (Statistics Canada, 2015; Saillant, 2016). Based on our model estimates, such demographic pressures are thus likely going to increase regional disparities (on a per-capita basis) moving forward.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This paper set out to explore the geographical dimensions of income disparities in Canada, a topic that has mostly been overlooked until now. To do so, we use the long-form sample of the census to construct a series of income measures over a set of 287 geographically consistent CDs. By applying ESDA methods to this dataset, we show that standard approaches focusing solely on $\sigma$- or $\beta$-convergence at the provincial level are missing out on important geographical patterns that change over time. Using global measures of SA, we show that regional income disparities are increasingly concentrated across the Canadian space-economy, with CDs with high (low) levels of income more and more clustered around CDs with similarly high (low) incomes.

Furthermore, analysis of LISA maps reveals that this clustering occurs along an East–West divide: high-income regions are typically concentrated in the Western parts of the country, whereas low-income regions are found mainly in Quebec and the Atlantic provinces. These latter regions are also characterized by slower growth, higher levels of unemployment, as well as older and faster-ageing populations. From 1996 to 2006, the dominant HH and LL spatial regimes seem to be consolidating their relative positions.

From an applied econometric perspective, the identification of significant spatial effects across regional income measures has important implications for the estimation of $\beta$-convergence models. Using a spatial lag modelling approach, we showed that there is growing divergence in regional incomes in the unconditional setting and only weak evidence of conditional convergence. These are important results in that they provide the first detailed account of the role of spatial effects in income convergence–divergence patterns across Canadian regions.

Looking forward, we will be developing a regional dataset with a longer time-series dimension going back to the long-form census of 1981. This will allow us to probe further changes in the distributional dynamics of the convergence hypothesis in Canada while also accounting for spatial dependence.

Moreover, as mentioned above, this paper focuses on the process of economic convergence for effective labour market participants. It is thus in relation to the incomes of these participants that we measured regional disparities. While critically important, this is only one aspect of the evolution of regional disparities in Canada. Regional levels of prosperity are affected by other variables, including differences in labour force participation as well in population age structures. Some of these, in turn, are influenced by the country’s policy and institutional setting. Indeed, one
of Coulombe’s (1999) main findings was that regional disparities in per capita output remained high because of the employment insurance programme as well as the availability of adequate public services in low-productivity regions made possible by the federal transfer system. He could have added that other transfers to persons beyond employment insurance payments play a critical role in the evolution of regional disparities, particularly with regards to total income.

In the coming decades, the evolution of transfers to individuals from both levels of governments will play an important role in overall incomes for slower-growing, faster-ageing populations. It must be recalled that while the ageing of the population will have a negative impact on growth across Canada as a whole, this impact will be most acutely felt in eastern provinces, whose populations are older and faster ageing (Saillant, 2016).13 Faster ageing in Atlantic Canada – and, to a lesser extent, Central Canada – will severely constrain provincial finances. As these provinces will also have lower shares of effective market participants, the evolution of transfers to individuals (in particular, federal transfers to seniors) will have a proportionately more important impact on total regional income than for western provinces. A less redistributive and interventionist Ottawa could thus exacerbate existing diverging trends in regional income disparities.

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NOTES

1. Note that there is a potential upward bias when estimating such models with short time series (Greene, 2003).
2. In 2011, the mandatory long-form census was replaced by a voluntary National Household Survey. We do not include this latest Census round in our analysis of convergence in order to maintain consistency and comparability over time.
3. Though a measure of after-tax income is available for the 2006 Census, it is not for earlier censuses.
4. Using longer time-series data, Coulombe and Day (1999) show that the dispersion of personal incomes per capita started to decline in Canada in the 1950s.
5. Graphically, this classification corresponds to the four quadrants of the Moran scatterplot: high–high (HH), low–low (LL), low–high (LH) and high–low (HL). For more information, see Haining (2003) and LeSage and Kelley Pace (2009).
6. A spatial regime can be defined as a form of spatial heterogeneity that implies structural differences across space (Anselin, 1988).
7. Since the actual coefficient estimates do not change from those reported in Table 3, we do not repeat the information here.
8. To estimate the spatial econometric models, three CD were dropped from the sample because they are islands (Îles-de-la Madeleine, Île-d’Orléans and Laval) which do not share common borders in the spatial weights matrix. One option would be to use the k-nearest neighbour weights...
matrix to get around this problem. However, Stata’s spatial regression tools are designed primarily to handle contiguity-based weights matrices (Pisati, 2001; Drukker, Peng, & Prucha, 2013).

9. Standard tests reveal that multicollinearity is not a concern among the independent variables.

10. The inclusion of these last five variables is inspired by the conceptual framework used in recent studies of metropolitan and regional income inequalities (Bolton & Breau, 2012; Wallace, Gauchat, & Fullerton, 2013; Peters, 2013).

11. We also estimated alternative specifications, in particular to try to gauge the effects of the urban population within regions. Results from these estimations were qualitatively similar to those reported in Table 7.

12. For instance, in a recent study where changes in unemployment rates across aggregate economic regions in Eastern Canada are decomposed into changes in labour force and employment growth, Dubé and Polèse (2014) find that some regions in Quebec and Atlantic Canada (i.e., predominantly urban areas) have been able to close the gap with Central Canadian regions. Our results suggest the same ‘catch-up’ effect in terms of incomes has yet to occur.

13. The literature examining the age-structure effects on regional economic growth is scarce in Canada and clearly warrants further investigation (e.g., Lindh & Malmberg, 1999; De la Croix, Lindh, & Malmberg, 2009). This is another area we will be investigating in future work.

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### APPENDIX A

**Table A1.** Top/bottom 10 regions, average total income, 1996 and 2006.

| 1996                      | 2006                      |
|---------------------------|---------------------------|
| **10 lowest values**      | **10 highest values**     |
| Division No. 19 (MB)      | Division No. 16 (AB)      |
| Division No. 3 (NF)       | Halton (ON)               |
| Kings (PEI)               | York (ON)                 |
| Division No. 6 (MB)       | Fort Smith (NWT)          |
| Division No. 4 (MB)       | Ottawa (ON)               |
| Kent (NB)                 | Durham (ON)               |
| Division No. 8 (NF)       | Lajemmerais (QC)          |
| Division No. 9 (NF)       | Division No. 6 (AB)       |
| Division No. 8 (MB)       | Essex (ON)                |
| Guysborough (NS)          | Division No. 18 (AB)      |

| 1996                      | 2006                      |
|---------------------------|---------------------------|
| **10 lowest values**      | **10 highest values**     |
| Division No. 19 (MB)      | Division No. 16 (AB)      |
| Division No. 9 (NF)       | Halton (ON)               |
| Division No. 8 (NF)       | Division No. 6 (AB)       |
| Division No. 3 (NF)       | Division No. 9 (AB)       |
| Kent (NB)                 | Fort Smith (NWT)          |
| Kings (PEI)               | Northern Rockies (BC)     |
| La Haute-Gaspésie (QC)    | York (ON)                 |
| Division No. 4 (NF)       | Ottawa (ON)               |
| Guysborough (NS)          | Baffin (NU)               |
| Les Basques (QC)          | Toronto (ON)              |

Notes: Census division name (and province).