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## New perspectives on Canadian national and regional income inequality

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We examine regional differences in household income inequality employing the Theil entropy measures, which are decomposable into a between-regions element and an element representing inequality within each of five major geographical regions in Canada from 1991-1997. A bootstrapping technique is applied in order to draw statistical inferences from our findings. We do not find significant between-region differences in the overall degree of inequality; it appears that the observed rise in inequality over this period is due to factors operating within regions. We also find that the regions of Canada have experienced differential trends in inequality, a pattern that is masked when analyzing trends at the national level. Given the regional differences in the dynamics of income inequality, we also attempt to explain this apparent volatility in income inequality as a function of production shocks, but the estimates are imprecise.

À partir des mesures d'entropie Theil, nous examinons les différences régionales pour les revenus familiaux. Nous les décomposons en un élément inter-régional et un autre intra-régional (les cinq grandes régions du Canada) au cours de notre intervalle de 1991-1997. À fin d'effectuer l'inférence statistique de nos résultats, nous appliquons une technique de «bootstrapping». Nous ne trouvons pas de différences significatives pour le degré d'inégalité entre les régions, et donc il semble que la hausse que nous observons pour le degré d'inégalité globale au cours de cette période est due à des facteurs qui s'opèrent parmi les régions. Nous trouvons également que les régions du Canada ont eu des tendances d'inégalité différenciées – une structure qui est masquée lorsque l'on analyse seulement les tendances au niveau national. Étant donné les différences régionales dans le cadre dynamique, nous essayons d'expliquer cette volatilité apparente comme une fonction de chocs à la production, mais les valeurs estimées demeurent imprécises.

Regional disparities in income have been an important issue for economic policy in Canada since at least the Second World War. Many economic studies have sought to measure regional disparities. Some—such as Sharpe & Zyblock (1998), Rashid (1998), Countryman (1999), Finnie (2002), and Dhawan-Biswal (2002)—have a regional basis and measure inequality for the entire distribution of income among individuals or households. Using various statistical instruments, they measure and compare income inequality within Canadian provinces.

Many studies have investigated regional inequality in countries other than Canada, again using a variety of techniques. Overall, there has been a convergence toward use of the Theil index; its decomposability property enables comparisons between regions and within regions. Beblo & Knaus (2001) examine income inequality using aggregate measures for the founding countries of the European monetary union. Applying the Theil index, they derive a measure for Europe as a whole by exploiting information from two data sets: the European Commu-

nity Household Panel and the Luxembourg Income Study. The additive decomposability property of the Theil index allows those authors to determine each country's contribution to overall income inequality as well as that of each demographic group. They also measure the impact of government transfers on this inequality measure. Duro & Esteban (1998) use factor decomposition of cross-country income inequality, across 23 OECD countries. Goerlich & Mas (2001) examine inequality among fifty provinces and seventeen regions of Spain using household budget survey data. Schwarze (1996) treats the question of how reunification changed income inequality in Germany. Massive public transfers from west to east narrowed the east-west income gap, offset the rise in income inequality from private sources, and lessened overall inequality in the western states of Germany. Terrasi (1999) measures patterns in convergence and divergence across Italian regions in the context of the current policy debate on regional convergence in that country.

We observe similar analyses in regions of the world outside of North America and Europe. For example, Ferreira (2000) provides analysis of the interstate income distribution to demonstrate growth and convergence in Brazil. Bourguignon, Ferreira, & Menendez (2007) shed light on the observed inequality in Brazil by decomposing earnings inequality into a component due to unequal labour market opportunities and a residual term. Using the Theil index, Fan & Sun (2008) and Liu (2006) investigate rural and regional inequality in China. They measure the changes and level of regional inequality in China due to recent government efforts toward inequality reduction and reforms. In a multi-country study involving Indonesia, Akita (2003) employs a variation of the Theil decomposition method. This paper considers a three-level, hierarchical structure of region-province-district, and decomposes overall regional inequality, as measured by Theil indices based on district-level mean incomes, into three components: the between-region, between-province,

and within-province components. Akita & Alisjahbana (2002) employ the Theil index to address regional income inequality in Indonesia and the impact of the economic crisis on it.

Globally, the development of primary micro data sets has provided an opportunity for researchers to not only conduct empirical analysis of inequality, but also to conduct more cross-country and regional analysis. However, all the studies cited above—while they use state of the art techniques in inequality measurement—fail to assess the statistical significance of the observed changes in inequality. Mills & Zandvakili (1997) demonstrate that even when large sample sizes are used, statistical significance cannot be assumed.

This study seeks to extend the scope of the literature on inter-regional income disparities in Canada by measuring household income inequality between as well as within the broad regional economies of Canada. In addition we will conduct tests of statistical significance to gauge the strength of our findings. To our knowledge, this work is among a limited number of Canadian studies involving a decomposition of overall income inequality into those two elements on a regional basis. In a previous paper (Gray et al, 2004), we analyzed the impact of structural factors such as education, age, and marital status on income inequality at the provincial level. The unit of analysis in that paper was the province rather than the broad geographical region, and thus the level of aggregation is higher in this current paper.

One objective of this paper is to examine how sensitive the results are to this change in the level of aggregation – an issue called the ‘Modifiable Areal Unit Problem’ in the discipline of Geography. The primary goal, however, is to examine any differentiated patterns of income dispersion over the period from 1991 to 1997, including any possible differences in the trends for household income inequality over time among regions of Canada. Of particular interest in the Canadian context is whether the so-called “have not” re-

gions—the targeted beneficiaries of fiscal transfers via the ‘equalization’ program executed by the federal government—tend to have a higher or lower degree of income inequality within their economies than the so-called “have” regions, which contribute to those fiscal transfers.<sup>1</sup> These policies are based solely on income inequality between provinces. While it is beyond the scope of this paper to assess the impact of these policies on regional patterns of income inequality, we conduct some preliminary analysis of how macroeconomic shocks to regional economies could potentially influence income inequality in the spirit of Sharpe & Zyblock (1998). Those authors exploit regional variation in order to model the empirical relationship between income inequality and macroeconomic variables, but they include different indications in their equations and base their analysis on the Gini coefficient.

#### Methodology and Data Set

In the income inequality literature, there is not a sole criterion for selecting an appropriate inequality measure, but some desirable properties should be satisfied. For our purpose, we utilize the property of decomposability, according to which the value for the total inequality in the distribution of income of a population can be broken down into a weighted average of the inequality within sub-groups of the population and the inequality between these sub-groups, as described in Shorrocks (1980). We limit our choices to measures that satisfy certain axioms that are satisfied by the Generalized Entropy family of measures, as described in Cowell & Kuga (1981).<sup>2</sup> The Theil (1967) entropy measures that we employ are special cases of that family of measures that allow for decomposition of the overall household income inequality into an element attributable to differentials between sub-groups and an element within them.

The property of decomposability is important within this regional context, as one can compare the magnitudes of the disparities in household income

across regions (reflected in mean values) to the income inequality among individuals or households within regions (reflected in dispersion measures). We use the following Theil measure and its decomposition:

Theil 1:

$$(1) \quad T1 = - \sum_{i=1}^N w_i s_i \log(ns_i)$$

Between-Theil 1:

$$(2) \quad BT1 = \sum_{j=1}^{\omega} s_j^* \log\left(\frac{ns_j^*}{n_j}\right)$$

Within-Theil 1:

$$(3) \quad WT1 = \sum_{j=1}^{\omega} s_j^* T1_j$$

where

$y_i$  income of sampled household,  
 $N_j$  number of sampled households in group  $j$ ,

$$N = \sum_j N_j$$

$w_i$  = population weight for household  $i$  (one observation represents  $w_i$  households from the total population of households,

$w_i^j$  population weight for  $i$ th household in group  $j$ ,

$n_j$  sum of population weights for  $j$ th group (i.e. total population of households in  $j$ th group),

$$n_j = \sum_{i=1}^{N_j} w_i^j$$

$n$  total number of households in the statistical population

$$n = \sum_{j=1}^{\omega} n_j$$

$s_i$  Income share (unweighted) of household  $i$

$$s_i = y_i / \sum_{i=1}^N y_i$$

$s_j^j$  income share of the  $j$ th group

$$s_j^j = \sum_{i=1}^{N_j} y_i^j$$

$s_j^*$  weighted income share of group  $j$

$$s_j^* = \sum_{i=1}^{N_j} w_i^j s_i^j$$

$T1_j$  Theil 1 for the  $j$ th group.

The form of the welfare function is changed as we choose a different measure within this family.

The bootstrapping procedure employed in Mills and Zandvakili (1997) is used to conduct statistical inference for cross-sectional comparisons of point estimates derived from two sep-

arate income distributions, such as income inequality that exists between two regions. This procedure is absent in the studies in the Canadian literature cited above. This method generates the standard errors and probability intervals necessary for hypothesis testing for the Theil measures. Note that tail probability values for hypothesis tests can be calculated directly from the bootstrap distribution in the same manner as probability intervals, and can be used to compare different values of an inequality measure, such as for different points in time or discrepancies across different subgroups, which are regions in our case.

The data are drawn from Statistics Canada's Survey of Consumer Finances HIFE file (Household, Income, Finance, and Equipment) for economic families for the years 1991-1997. The interval of 1991-1997 was chosen in order to analyze trends in income inequality over the recovery phase of the business cycle. This data set was discontinued after 1997. In addition to comparing the endpoints of this interval, we also examine the annual evolutions in income inequality over this interval. There is a separate file for each year containing approximately 35,000 observations; each data set is strictly cross-sectional in structure. The specified survey weights for each year are employed throughout the empirical analysis. The income variable refers to total annual income for the household unit. Over the entire interval, the weighted average of income was approximately \$44,000 annually in nominal terms.

As in Sharpe & Zybblock (1998), the household is chosen as the unit of analysis because it may be more relevant from a social welfare perspective. Household members can pool their financial resources and benefit from economies of scale in consumption. They are also in a better position to diversify their income sources.

Empirical studies such as Sharpe & Zybblock (1998) and Beach, Finnie &

Gray (2005) that employ Canadian data on a regional basis frequently aggregate the data from the provincial level to the regional level, as some of the provinces have very small economies. Although this procedure involves the loss of degrees of freedom, the larger sample sizes for each region make inferences more robust. We have recoded the provincial data in order to define the following regional groups. Region one consists of the Atlantic provinces: Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick. Regions two and three are Quebec and Ontario, respectively. Region four consists of the Prairie provinces: Manitoba, Saskatchewan, and Alberta. Region five is British Columbia. Below, we examine how sensitive our results are to this aggregation procedure by comparing them to the calculations derived from the provincially based analysis presented in Gray et al (2004).

At a later stage in this paper, two-way decompositions are calculated along the dimensions of educational attainment crossed with region and immigrant status crossed with region.<sup>3</sup> Decompositions of overall income inequality by educational attainment of the household head are based on the following four groups: below a high school diploma, high school diploma, some post-secondary certificate, and a university degree or higher. Decompositions by immigration status are based on three groups, where first group consists of households whose head is a native Canadian. The second and third groups are households whose head immigrated to Canada before 1981 and after 1981, respectively.

### Empirical Results

We present the values for the Theil 1 statistic from 1991 to 1997.<sup>4</sup> The results for the overall household income inequality for all of Canada are presented in the column [1] of Table 1. Note that the figure for the overall level of inequality in column [1] is the sum of the figures for the within component and

the between components in columns [2] and [3]. In this paper, the level of the Theil measure is of less interest than changes observed over time periods or cross-sectional comparisons, and thus our analysis focuses on estimates of those quantities. It has followed an apparent trend over this period.

We tested the significance of the change in inequality from one year to the next as well as over longer time intervals, as shown in each column of Table 2; these display year-to-year changes in the values of the Theil 1 statistic for each of the 21 pairs of years over the interval of 1991-1997. Note that changes over consecutive years are examined as well as changes over longer intervals. Presenting all of this information involves a lot of empirical detail, but it can reveal patterns and events that are missed when only changes over selected intervals are shown. In addition, comparisons based on selected intervals are quite sensitive to the choice of the endpoints. For instance, a significant change over two consecutive years might be reversed for the next year, indicating no trend when measured over the two-year interval. Conversely, a significant change over a four-year period can accumulate even if the changes over consecutive years are insignificant. All in all, our presentation constitutes a complete empirical portrait of the changes in inequality that occurred over this period.

For each set of years that appear in Table 2, the upper value in each pair of rows indicates the value of the Theil 1 statistic in the later year minus its value in the prior year; a positive (negative) figure indicates a rise (fall) in inequality. The lower figure represents the significance of a one-tailed test of the null hypothesis of no difference in the values between the two years or intervals. When considering longer time horizons, the rise in inequality becomes more pronounced.

**Table 1:** Decompositions of income inequality by region, region-education and region-immigration status using Theil 1 measure

Year	Overall	Between Region	Within Region	Regions of Canada					Region-Education		Region-Immigration	
				Atlantic provinces	Québec	Ontario	Prairie provinces	British Columbia	Between Region	Within Region	Between Region	Within Region
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
1991	0.231	0.004	0.227	0.208	0.243	0.220	0.227	0.227	0.024	0.207	0.006	0.225
	0.003	0.001	0.003	0.004	0.006	0.005	0.004	0.007	0.001	0.002	0.001	0.003
1992	0.237	0.003	0.233	0.214	0.242	0.228	0.248	0.226	0.026	0.211	0.006	0.230
	0.003	0.000	0.003	0.001	0.006	0.005	0.006	0.006	0.001	0.002	0.001	0.003
1993	0.236	0.004	0.232	0.224	0.231	0.228	0.250	0.228	0.028	0.208	0.006	0.230
	0.003	0.001	0.003	0.004	0.005	0.005	0.005	0.008	0.002	0.003	0.001	0.003
1994	0.237	0.003	0.233	0.222	0.229	0.231	0.240	0.243	0.025	0.211	0.006	0.231
	0.003	0.001	0.003	0.005	0.005	0.005	0.005	0.009	0.001	0.003	0.001	0.003
1995	0.238	0.004	0.233	0.230	0.242	0.228	0.228	0.242	0.028	0.210	0.006	0.232
	0.002	0.000	0.002	0.004	0.005	0.004	0.004	0.006	0.001	0.002	0.001	0.002
1996	0.241	0.004	0.237	0.227	0.250	0.235	0.223	0.241	0.026	0.215	0.006	0.235
	0.003	0.000	0.002	0.005	0.006	0.004	0.004	0.007	0.001	0.002	0.001	0.003
1997	0.258	0.005	0.253	0.226	0.258	0.256	0.240	0.261	0.028	0.230	0.007	0.251
	0.003	0.001	0.003	0.005	0.007	0.004	0.005	0.006	0.001	0.002	0.001	0.003

Notes: The top line reported for each year corresponds to the Theil measure. The bottom line gives the bootstrap standard errors.

Although we observe a rising trend in overall income inequality in Canada over this period, our findings suggest very little inequality exists in household income between regions per se. Our decompositions of overall inequality by region into between-region and a weighted average of within-region inequality, as shown in columns [2] (for the “between” measure) and [3] (for the “within” measure) of Table 1, suggest that almost all of the observed income inequality - approximately 98% - occurs within regions. Between-region inequality is minimal and statistically insignificant. Although it is hardly surprising that the ‘within’ component dwarfs the ‘between’ one, as an application of the law of averages as we aggregate across regions would lead one to expect, the minuteness of between-region inequality is unanticipated given that it is the foundation of Canada’s regional development policies. We also find the changes in the between-region inequality over time to be generally insignificant, as shown in column [2] of Table 2 (reading down).

The evolution of the weighted average of within-region inequality (aggregated over all 5 regions) over time is shown in column [3] of Table 2. Year-over-year changes are found to be significant for the following pairs of years based on the Theil 1 measure of inequality: 1991-1992, 1991-1995, 1991-

1996 and 1991-1997; 1992-1997; 1993-1997, 1994-1997; 1995-1996 and 1995-1997 and 1996-1997. Given the magnitude and the significance of the trend of widening within-region inequality, which is the primary source of the trend towards rising overall inequality in Canada, it is instructive to examine whether all five regions portray the same trend, and so we turn to the regional breakdown.

The values for the levels of region-specific income inequality (i.e. the within measure) for each region are provided in columns [4] through [8] of Table 1. We do not observe any consistent pattern among the five regions. For instance, in 1991, inequality in Quebec was significantly higher than elsewhere, while it was the lowest in Atlantic Canada. The Prairie provinces and British Columbia had mid-range values. In 1997, the highest degree of inequality was found in British Columbia, with Ontario and Quebec having slightly lower values, while the lowest was still found in the Atlantic provinces.

Turning from levels to trends over the time period, it appears as though Quebec and British Columbia show declining income inequality in the initial years and rising inequality in the later years (columns [5] and [8] of Table 1). Atlantic Canada displays a relatively steady pattern of rising inequality, while the value for Ontario rises at

the beginning and at the end of the period of 1991-1997. For the Prairie provinces, the values of the within-group inequality measure show the least marked intertemporal pattern. These findings suggest that the five regional groups are subject to differential dynamics within their income distributions.

The changes over time in the within-region income inequality measures mentioned just above have been tested for statistical significance, as shown in Table 2. We find that the observed increases between 1991 and 1997, which are the end-points of the interval, are significant for all regions. In Atlantic Canada, the increase in inequality observed between 1991 and every year up to 1995 is significant, whereas in Quebec the significant rises occur between 1994 and 1996 after insignificant decreases in inequality were observed in the prior years. Thus when comparing the year 1993 (after a slight drop in inequality was registered) with 1995, 1996 and 1997, the increases in inequality are significant. For the case of Ontario, the period of rising inequality is concentrated at or near 1997; specifically, the rise in inequality is significant for the following year-to-year comparisons: 1991-1994, 1996, 1997; 1992-1997, 1993-1997; 1994-1997, 1995-1997 and 1996-1997. The Prairie provinces show a sharp increase in 1992 followed by a declining trend, although



**Table 2:** Differences in Theil 1 - comparison across years

Year	Theil 1 [1]	Between [2]	Within [3]	Atlantic [4]	Quebec [5]	Ontario [6]	Prairie [7]	BC [8]
91-92	0.006	-0.001	0.007	0.007	-0.001	0.008	0.021	-0.00
	0.088	0.909	0.049	0.122	0.552	0.133	0.002	0.57
-93	0.005	0.000	0.005	0.016	-0.011	0.008	0.022	0.00
	0.095	0.450	0.091	0.003	0.920	0.122	0.001	0.49
-94	0.006	-0.001	0.006	0.014	-0.014	0.011	0.013	0.02
	0.083	0.882	0.053	0.01	0.956	0.036	0.025	0.08
-95	0.007	0.000	0.007	0.023	-0.001	0.009	0.000	0.02
	0.029	0.575	0.027	0.000	0.536	0.087	0.456	0.04
-96	0.010	0.000	0.010	0.019	0.008	0.015	-0.004	0.01
	0.001	0.467	0.001	0.000	0.169	0.009	0.748	0.07
-97	0.027	0.001	0.026	0.019	0.016	0.036	0.012	0.03
	0.000	0.185	0.000	0.001	0.048	0.000	0.019	0.00
92-93	0.000	0.001	-0.001	0.01	-0.010	0.000	0.001	0.00
	0.497	0.057	0.622	0.051	0.886	0.471	0.408	0.44
-94	0.000	0.000	0.000	0.008	-0.013	0.003	-0.018	0.02
	0.486	0.427	0.508	0.106	0.952	0.281	0.849	0.07
-95	0.001	0.001	0.000	0.016	0.001	0.001	-0.021	0.02
	0.371	0.074	0.459	0.003	0.481	0.467	0.998	0.03
-96	0.005	0.001	0.004	0.013	0.009	0.007	-0.025	0.02
	0.109	0.064	0.151	0.020	0.136	0.135	1.000	0.06
-97	0.021	0.002	0.019	0.012	0.017	0.028	-0.008	0.04
	0.000	0.010	0.000	0.027	0.037	0.000	0.865	0.00
93-94	0.000	-0.001	0.001	-0.002	-0.003	0.003	-0.009	0.02
	0.484	0.901	0.402	0.627	0.639	0.341	0.916	0.11
-95	0.001	0.000	0.002	0.006	0.011	0.000	-0.022	0.01
	0.381	0.609	0.362	0.147	0.064	0.495	1.000	0.07
-96	0.005	0.000	0.005	0.003	0.019	0.006	-0.027	0.01
	0.108	0.524	0.105	0.327	0.007	0.191	1.000	0.11
-97	0.021	0.001	0.021	0.002	0.027	0.028	-0.010	0.03
	0.000	0.229	0.000	0.354	0.001	0.000	0.909	0.00
94-95	0.001	0.001	0.000	0.008	0.013	-0.003	-0.013	-0.00
	0.358	0.132	0.448	0.084	0.025	0.724	0.971	0.53
-96	0.005	0.001	0.004	0.005	0.022	0.003	-0.017	-0.00
	0.100	0.112	0.142	0.220	0.001	0.311	0.992	0.56
-97	0.021	0.002	0.02	0.004	0.030	0.025	-0.001	0.02
	0.000	0.021	0.000	0.247	0.000	0.000	0.511	0.07
95-96	0.004	0.000	0.003	-0.003	0.008	0.006	-0.005	-0.00
	0.133	0.400	0.135	0.690	0.112	0.150	0.766	0.55
-97	0.020	0.001	0.019	-0.004	0.016	0.027	0.012	0.02
	0.000	0.126	0.000	0.755	0.023	0.000	0.025	0.01
96-97	0.016	0.001	0.016	-0.001	0.008	0.021	0.017	0.02
	0.000	0.173	0.000	0.527	0.178	0.000	0.001	0.02

Notes: The top line reported for each year corresponds to the Theil measure. The bottom line gives the probability value. At the two-tailed 10 (5) % level of significance, the null hypothesis is rejected if the p-value > 0.95 (0.975) or if the p-value < 0.05 (0.025)

an increase in inequality was still significant when comparing 1991 to 1997. Finally, the region of British Columbia displays stable inequality over the first 5 years, as the observed rise between 1993 and 1994 is insignificant, followed by a sharp increase in 1997 that is significant compared to any other year.

These region-specific results suggest that it can be misleading to evaluate overall earnings inequality, or trends in inequality, and then applying

the findings to the country as whole. Whereas inequality for the entire Canadian population displayed a fairly steady upward trend over the interval 1991-1997, the evolution varied substantially among regions. Over certain intervals, most of which were relatively brief, inequality actually fell in all five of these regions. The fact that regional economies have differing sectoral compositions, and thus experience positive and negative economic shocks to their labor markets at vary-

ing times, probably contributes to that result. We explore this issue in more depth below. Other factors that are known to affect income equality, such as institutions like the minimum wage and union density and the composition of family structure, are more time invariant, and are thus less likely to generate differing dynamics (at least over the shorter term) of income inequality across regions. A similar argument applies to an oft-cited factor that is thought to contribute to widening wage and income inequality, namely 'skill-biased technological change.'

These empirical findings are qualitatively similar to those in Gray et al (2004), which is based on a lower level of aggregation, specifically the provincial level. As one would expect, the between-group component increases slightly when the level of aggregation is raised. In comparing the calculations of the Theil 1 index listed in Table 1, column [2], the corresponding figures for the provincial level are slightly larger.<sup>5</sup>

A more interesting discrepancy between the provincial and the regional analysis is displayed in Table 3. In the top panel, the within-province estimates for the three Atlantic provinces are compared with the corresponding estimate for the Atlantic region (column [4]). For each calendar year, the first row gives the value of the Theil statistic, and the corresponding bootstrapped standard errors appear in the row below. In the bottom panel, the within-province estimates for the three Prairie provinces are compared with the corresponding estimate for the entire Prairies region (column [8]). In both instances visual inspection suggests that the levels of income inequality are of fairly similar magnitude, but that the dynamics of income inequality were different even in neighboring provinces that are part of the same aggregated region. For instance, despite the fact that the economies of all four Atlantic provinces are relatively natural resource intensive, and thus might have experienced similar production shocks, their labour markets did not exhibit the same dynamics for income inequality. New-

Table 3: Theil Statistic values: comparison across two levels of aggregation

Year	Newfoundland /PEI [1]	Nova Scotia [2]	New Brunswick [3]	Atlantic region [4]
1991	0.201 (0.006)	0.208 (0.006)	0.213 (0.008)	0.208 (0.006)
1992	0.222 (0.008)	0.210 (0.007)	0.213 (0.006)	0.214 (0.007)
1993	0.217 (0.006)	0.233 (0.008)	0.218 (0.006)	0.224 (0.008)
1994	0.211 (0.007)	0.234 (0.008)	0.215 (0.007)	0.222 (0.007)
1995	0.218 (0.007)	0.237 (0.007)	0.232 (0.008)	0.230 (0.007)
1996	0.209 (0.012)	0.228 (0.007)	0.229 (0.007)	0.227 (0.008)
1997	0.213 (0.008)	0.227 (0.008)	0.235 (0.008)	0.226 (0.007)
	Manitoba [5]	Saskatchewan [6]	Alberta [7]	Prairie region [8]
1991	0.222 (0.008)	0.243 (0.006)	0.220 (0.006)	0.227 (0.007)
1992	0.242 (0.012)	0.235 (0.007)	0.248 (0.008)	0.248 (0.007)
1993	0.251 (0.011)	0.235 (0.009)	0.246 (0.007)	0.250 (0.008)
1994	0.236 (0.010)	0.229 (0.007)	0.242 (0.008)	0.240 (0.009)
1995	0.216 (0.006)	0.228 (0.008)	0.228 (0.006)	0.228 (0.007)
1996	0.217 (0.007)	0.250 (0.010)	0.216 (0.006)	0.223 (0.007)
1997	0.238 (0.007)	0.242 (0.007)	0.237 (0.007)	0.240 (0.006)

Note: Standard errors shown in parentheses.

foundland and PEI show no obvious trend. Nova Scotia exhibits a rising trend from 1991-1995 followed by a dip, and New Brunswick exhibits stable inequality from 1991-1994 followed by a persistent rise in inequality. The dynamics for Manitoba, Saskatchewan, and Alberta also diverge over the period. These differences are masked when the smaller provinces are aggregated into regions.

This result suggests that ideally it would be useful, if it were possible, to partition the economies of larger provinces such as Quebec, Ontario, and British Columbia into much less aggregated regional units in order to measure trends and dynamics of income inequality and potentially link them to more localized labour market characteristics and shocks. The research challenge is to obtain data measuring both income inequality and production indices on a compatible regional basis. In

light of the apparent differing dynamics of income inequality across regions that are described above, we conduct a more formal statistical analysis for the presence of differential time trends.

#### Transitory economic shocks

In this section we estimate any potential time trends, and then search for empirical patterns within the unexplained variation, which reflects in part transitory influences on income inequality. To this end we include indicators for macroeconomic shocks to regional economies. Taking a similar approach to Sharpe & Zybblock (1998), we pool observations by the five major geographical regions over time, and we specify specific intercepts and time trends for each region in linear equations.<sup>6</sup> The transitory shocks that generate different cycles for regional economies, such as the boom/bust na-

ture of the energy and primary materials sectors and the somewhat less volatile manufacturing sectors, are only partially reflected in the unemployment rate variable. In order to capture shocks of that nature, we include the first-difference indicators of the growth rate of real GDP and the growth rates for production in the manufacturing and the primary sectors at the level of each regional economy. The coefficients are thus identified from both between and within variation.

As mentioned above, all observations are pooled into a data set containing 5 regions, 7 years of data, and 35 observations. A binary variable is included for each region, with Ontario serving as the omitted category. A time trend is included that is interacted with the set of regional indicators, with Ontario again serving as the omitted category. Although we do have sufficient degrees of freedom in order to generate estimates, many of them are imprecise due in part to the low number of observations. The time interval is not long enough to estimate an autocorrelation parameter for each region, and thus we employ the ordinary least squares technique. Ideally one could estimate equations that include lagged values for these indicators for shocks, but again there are insufficient time periods.

The regression results are presented in table 4. The overall explanatory power of the equations is fairly high, as the unadjusted coefficient of determination is approximately 0.7. Both of the specifications contain a statistically significant upward trend in income inequality for Ontario (the omitted category). Because the interaction terms are insignificant with the exception of the Prairie provinces, the results indicate that most regions experienced a trend toward rising inequality over this period. As far as the levels of inequality are concerned, the Prairies and Quebec experienced somewhat higher levels than did Ontario over the interval. The specification whose results appear in column [1] includes the growth rate in real GDP for the entire regional economy, but the point estimate is insignificant.

**Table 4:** Trend estimates for income inequality

Exogenous variable	Equation 1		Equation 2	
	Estimated Coefficient	(prob. value)	Estimated coefficient	(prob. value)
	[1]	[2]	[3]	[4]
Constant	0.216	(0.00)	0.215	(0.00)
Time	0.004	(0.03)	0.004	(0.03)
Atlantic Region	-0.006	(0.55)	-0.006	(0.54)
Quebec Region	0.017	(0.10)	0.017	(0.10)
Prairie Region	0.026	(0.01)	0.030	(0.01)
British Columbia	0.001	(0.96)	0.003	(0.79)
Time*Atlantic	-0.001	(0.64)	-0.001	(0.63)
Time*Quebec	-0.002	(0.47)	-0.001	(0.51)
Time*Prairies	-0.006	(0.02)	-0.006	(0.01)
Time*British Columbia	0.001	(0.60)	0.001	(0.62)
% change real GDP	0.0004	(0.64)		
% change real manufacturing			0.0003	(0.47)
% change primary sector			-0.0004	(0.36)
R-squared	0.56		0.56	
F-statistic	5.34		4.92	
Mean dependent vbl.	0.234		0.234	
s.e. of the regression	0.008		0.008	

Moving over to column [3], the growth rate in GDP is replaced by the growth rates in primary sector and manufacturing production. These coefficients are estimated imprecisely, but there might exist a negative association between shocks in primary sector production and the level of inequality.

### Societal Structures

We reported above that when the overall degree of household income inequality is decomposed into an element attributable to disparities in average household incomes between regions and an element attributable to a weighted average of household income inequality within these five regions, the “between element” is quite small in relative terms. Given the lack of explanatory power for the regional factors in affecting overall income inequality, we briefly analyze the impact of other readily observable attributes. Societal factors such as educational attainment, labour market experience, age, household composition, and immigration status are thought to affect income inequality, although in a more persistent fashion than regional production shocks. In addition to the regional dimension, we include the effects of the educational attainment of

the family head as well as his/her immigrant status in our calculations of the decomposition of inequality. The importance of these variables in the Canadian context have been addressed in the other narrowly focused papers, such as Bar-Or, Burbidge, Magee and Robb (1995), Coulombe and Tremblay (2001) for the effect of education, and Schaafsma and Sweetman (2001) for the effect of immigrant status.

The Theil statistic allows for a joint, two-way decomposition of the impact of education crossed with region or immigrant status crossed with region. The decomposition of overall inequality by region-education and region-immigration status is provided in columns [9] through [12] of Table 1, while the tests for significance in differences observed over time are provided in Table 5. As far as the levels of inequality are concerned, the relevant comparisons are between columns [2] and [9] in Table 1 and columns [2] and [11] in Table 1. The first comparison shows that the inclusion of the factor of educational attainment raises the between-group component by approximately six fold, suggesting that it contributes substantially to the level of inequality between groups. On the other hand, for the second compari-

son, immigrant status, like the case of regional location, contributes very little to accounting for observed income inequality, as it adds little to the ‘between’ unit component beyond the impact of region.

For both of these two-way decompositions, most of the observed inequality is still within-groups. We calculate that approximately 12-13 % of total income inequality is between groups for the criteria of region crossed with education, but less than 3 % for region crossed with immigration. Consistent with almost all of the literature on income inequality, the most widely used and observable attributes contained in micro data sets for earnings and incomes, such as educational attainment, marital status, gender, age, and immigrant status fail to explain the major proportion of income inequality. Addressing the changes observed over the interval 1991-1997, the between-group inequality based on region crossed with education had a slightly rising trend, while the between-group inequality for region crossed with immigration status has been generally stable. Within-group inequality for both types of decompositions has had a rising trend, as shown in Table 1. We have tested the statistical significance of these changes. Between-group changes over time based on region and immigration status are generally not significant, with an exception occurring over 1995-1997 (column [4] of Table 5). Between-group changes for region crossed with education are somewhat significant, however, and education significantly contributes to the changes in between-group inequality for 1991-1993, 1995, 1997 and 1993-1994 (column [2] of Table 5). This implies that the gap in average incomes between the education-regional groups grew somewhat over the interval. “Within-group” changes are far greater, however, and the changes are more significant (column [3] of Table 5). Similar patterns are observed based on region crossed with immigration status (column [5] of Table 5).

**Table 5:** Comparison across years by region, education and immigration status

	Overall [1]	By region crossed with education		By region crossed with immigration status	
		Between [2]	Within [3]	Between [4]	Within [5]
91-92	0.006	0.002	0.004	0.000	0.005
	0.073	0.161	0.132	0.4	0.082
-93	0.005	0.004	0.001	0.000	0.005
	0.087	0.011	0.365	0.381	0.088
-94	0.006	0.001	0.004	0.000	0.006
	0.066	0.255	0.109	0.491	0.080
-95	0.007	0.004	0.003	0.000	0.007
	0.026	0.007	0.163	0.615	0.016
-96	0.010	0.002	0.008	0.000	0.010
	0.002	0.076	0.008	0.287	0.005
-97	0.027	0.004	0.023	0.001	0.025
	0.000	0.019	0.000	0.082	0.000
92-93	0.000	0.002	-0.003	0.000	0.000
	0.523	0.130	0.751	0.496	0.499
-94	0.000	-0.001	0.001	0.000	0.000
	0.519	0.653	0.438	0.605	0.474
-95	0.001	0.002	-0.001	0.000	0.002
	0.386	0.112	0.599	0.744	0.318
-96	0.005	0.001	0.004	0.000	0.005
	0.092	0.408	0.096	0.379	0.111
-97	0.021	0.002	0.019	0.001	0.020
	0.000	0.149	0.000	0.124	0.000
93-94	0.000	-0.003	0.003	0.000	0.000
	0.501	0.951	0.201	0.596	0.458
-95	0.001	0.000	0.002	0.000	0.002
	0.367	0.554	0.32	0.716	0.309
-96	0.005	-0.002	0.007	0.000	0.005
	0.102	0.832	0.022	0.414	0.114
-97	0.021	0.000	0.022	0.001	0.020
	0.000	0.585	0.000	0.147	0.000
94-95	0.001	0.003	-0.002	0.000	0.001
	0.363	0.061	0.703	0.627	0.333
-96	0.005	0.001	0.003	0.000	0.004
	0.112	0.241	0.161	0.312	0.112
-97	0.021	0.003	0.018	0.001	0.020
	0.000	0.074	0.000	0.099	0.000
95-96	0.004	-0.002	0.005	0.001	0.003
	0.135	0.837	0.033	0.168	0.201
-97	0.020	0.000	0.020	0.002	0.018
	0.000	0.520	0.000	0.026	0.000
96-97	0.016	0.001	0.015	0.001	0.016
	0.000	0.217	0.000	0.170	0.000

Notes: The top line reported for each year corresponds to the Theil measure. The bottom line gives the probability value. At the one-tailed 10 (5) % level of significance, the null hypothesis is rejected if the p-value > 0.90 (0.95) or if the p-value < 0.10 (0.90).

## Conclusions

Our results indicate the existence of a low between-region household income inequality, which is deemed to be statistically insignificant. On the other hand, there are significant differences in income inequality within the five major economic regions. More importantly, not only does income in-

equality within these regions vary, but so do the trends over time in within-region inequality. The trend of increasing inequality that is discerned for all of Canada over this period is not uniformly shared among these regions. As far as the factors that may affect income inequality are concerned, we find no empirical relationship between the rate of growth in real GDP in regional economies and income inequal-

ity, nor do we discern any significant association with production shocks to the manufacturing or the primary sectors of the regional economies.

Our empirical findings suggest that evaluations and discussions of regional economic policy—which has repercussions for other federations of states such as the European Union—should take account of the level of income inequality within regions relative to the level between them. We observe between-region inequality to be a very small and statistically insignificant proportion of total inequality, which is somewhat surprising given that regional income disparities have been central to Canada's policies surrounding fiscal federalism for decades. By administrative design of the tax cum subsidy apparatus of the equalization program, it can only affect the between-region component of income inequality. Given a broad policy objective of reducing inequality, it might be worthwhile to consider a refocusing from a reduction in regional disparities in income toward less categorical redistributive measures, such as those aimed at individuals with certain socio-economic or educational backgrounds or those at the periphery of the labour market.

It is further observed that regions have differing dynamics and trends in income inequality over time. This implies that any national policy designed to address inequality might well have different impacts in regional economies. It is beyond the scope of this paper, however, to estimate the impact that the redistributive policies have had on either the levels in income inequality across regions or (what would constitute a formidable research challenge) on their underlying dynamics.

A third result is that some of the readily observable attributes that are associated with societal structures do have a statistically significant and fairly strong impact on the distribution of household income. For instance, the level of educational attainment does explain the between-group component to some extent, thus contributing to income inequality between regions, whereas that does not apply



to immigrant status. In contrast, our analysis of transitory or cyclical factors – production shocks to the regional economies in this case – did not generate statistically significant correlations.

Finally, we provided a comparison of statistical calculations that were generated by two levels of regional aggregation – provincial and regional. This exercise generated the mechanical effect that the between-region component is higher at a lower level (i.e. the provincial) of aggregation. More importantly, it reveals that the provincial economies within the more aggregated regional groups exhibited different dynamics. This result militates toward basing analysis on lower levels of aggregation, provided that data are available and that weighting schemes are implemented. Subsequent research should be aimed at modeling the changes in observed inequality by region as a function of measurable shocks to macroeconomic variables such as production shocks at fairly disaggregated regions. Longer intervals might be required in order to specify equations with lag structures that can be estimated precisely.

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<sup>1</sup> The 'have' provinces have traditionally been Ontario (although not since 2009), Alberta, and British Columbia. All of the remaining provinces have traditionally been of 'have-not' status, with the Atlantic provinces receiving the most on a per-capita basis. The stated goal of the equalization program is to ensure that the health, education, and welfare programs are of fairly uniform quality across provinces. There are other federal programs and agencies that have a regional redistributive dimension, such as the unemployment insurance regime (labeled *Employment Insurance*) and regional economic development agencies.

<sup>2</sup> These are mean independence, symmetry, the Pigou-Dalton principle of transfer, the principle of population, and decomposability.

<sup>3</sup> In a previous paper (Gray et al. 2003) that is based on the same data set but does not have a regional dimension, we carry out decompositions by gender, age of head, and marital status.

<sup>4</sup> Please note, in order to gauge sensitivity, we measured inequality based on Theil 1 and Theil 2. While the values for the latter measure are more sensitive to the tails of the income distribution, most of the patterns and trends that we discern are not sensitive to this choice of inequality measure. In the interests of brevity, we only present values obtained from the Theil 1 measure.

<sup>5</sup> The figures calculated from the provincial disaggregation scheme are: 1991, 0.005 compared to 0.004; 1992, 0.004 compared to 0.003; 1993, 0.005 compared to 0.004; 1994, 0.004 compared to 0.003; 1995, 0.005 compared to 0.004; 1996, 0.004 compared to 0.004; 1997, 0.005 compared to 0.005)

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<sup>6</sup> The dependent variable for their regression equation is the Gini coefficient, and their indicator for macroeconomic conditions is the unemployment rate. By including the level of the unemployment, they are capturing both structural unemployment, which is often very persistent, and cyclical unemployment.