(2014) 44, 125–152

The Review of Regional Studies

The Official Journal of the Southern Regional Science Association

Explaining Canadian Regional Wage Differentials*

Ian G. Cahill[a] and Michael P. Gager[b]

[a]*Cahill Software, Alberta, Canada*
[b]*Treasury Board Secretariat, Government of Canada*

Abstract: We explore the potential of a human capital model augmented with controls for industry and occupation in explaining Canadian regional wage differentials. We place our approach in a broader theoretical context by first reviewing the literature on potential explanations for regional wage differences and also on the related issues of migration, population growth, industrial location, and agglomeration economies. We then estimate an econometric model using subprovincial wage data from the Statistics Canada Labour Force Survey. A striking finding is that subprovincial wage differences, including the urban-rural divide, can be explained by our model, but that the differences between broad regions defined by provincial boundaries cannot.

Keywords: regional, wage differentials
JEL Codes: R12, R11, J31

1. INTRODUCTION

The aim of our paper is to determine the extent to which Canadian regional wage differentials can be explained by differences between regions in the distribution of human capital and industrial structure. By exploiting microdata not previously available to researchers and including the hourly wages of individuals at the subprovincial level, we estimate a fairly standard econometric model predicting the logarithm of wages as a function of human capital variables, occupation, and industry. Such an investigation is particularly important for Canada, which is a vast country with significant and persistent geographic differences in wages (see Statistics Canada, 2014a). The importance of these wage differences and related income disparity, both across provinces and across subprovincial regions, are reflected in policy concerns about impediments to mobility and trade (see Helliwell and Verdier, 2001; Red Seal, 2012).

Our study differs from most previous Canadian empirical work on wages by exploiting a micro dataset that contains subprovincial wage information. Our econometric model of wage determination is based on a human capital model that has been used in earlier studies (Dickie and Gerking, 1998; Hunt and Mueller, 2002) but that did not have access to subprovincial wage information. Motivation for investigating intraprovincial wage differentials stems from the relative geographic and economic importance of provinces as well as from the significant

* The authors thank the anonymous referees for helpful comments. The views expressed in this paper are solely those of the authors, and do not necessarily represent the views or policy of the Government of Canada.

This work was done while both authors worked for the Treasury Board Secretariat, Government of Canada. *Corresponding Author:* I. G. Cahill E-mail: cahill@magma.ca

ISSN 1553-0892, 0048-749X (online)
www.srsa.org/rrs

responsibilities of provincial governments under the Canadian constitution. For example, Ontario alone, with about 11 percent of Canada's total land and freshwater area (Natural Resources Canada, 2005) accounted for about 37 percent of Canada's gross domestic product in 2013 (Statistics Canada, 2014b). Provincial governments exercise power over potential policy levers, such as transportation infrastructure spending, that may affect the relative economic advantages of subprovincial regions (Justice Canada, 2014).

We have used the additional subprovincial wage information to determine the explanatory power of our model, based on human capital and industrial structure, in explaining Canadian regional wage differentials. We conduct our analysis at both a broad regional level, defined by provincial boundaries with smaller provinces grouped, as well as at the subprovincial level, which includes differences between cities within regions as well as an investigation into possible agglomeration economies favoring larger cities and leading to an urban-rural divide in wages. Such an empirical specification has been incorporated into a solid theoretical context by Dickie and Gerking (1998), which we take as a point of departure. Because regional wage differentials and related issues have been studied extensively, we incorporate a literature review section into our paper, developing the connection of our work to the work of Dickie and Gerking and others.

The remainder of the paper consists of the literature review followed by sections on our data, econometric specification, results, and conclusions. The literature review in Section 2 covers some of the key literature on regional wages as well the related issues of migration, population growth, and industrial location. The contribution of our paper is placed in the context of this literature. The confidential micro-data source provided by Statistics Canada based on the agency's Labour Force Survey is described in Section 3. These data provide the subprovincial hourly wage data that distinguishes our study from earlier Canadian studies on wage differentials. The urban geographic units chosen for the analysis are the Statistics Canada geographic divisions of the Census, also used in the Labour Force Survey, and definitions of these are provided. Specifications of econometric models are provided in Section 4. Our empirical work includes sensitivity analysis conducted by estimating several versions of our basic econometric model. The results of estimating the models, in both tables and graphs, are presented in Section 5. We finish with conclusions and suggestions for further research in Section 6.

2. LITERATURE REVIEW

2.1 Amenities and relocation costs

Since Canadian wage differences among regions have been very persistent over time, theories that demonstrate equilibrium situations including such differences are of interest. An early development in this area is Roback (1982) who considered location specific amenities entering both the utility function of workers and the cost function of firms. Workers maximize utility by choosing quantities of a composite commodity and residential land constrained by the sum of wage income plus location-invariant non-labor income. The indirect utility function includes the wage and rental rates and the level of an amenity that depends on location. Firms minimize costs subject to a production function including land, labor, and the same amenity. The spatial variation in amenities leads to equilibrium differences in wages and rents even with costlessly mobile workers.

In a theoretical model applied to a country like Canada, assuming the absence of relocation and transportation costs is an obvious shortcoming. A significant extension of the Roback model was provided by Dickie and Gerking (1998). In their model, regions are endowed with differing amounts of land and produce different products, supporting the introduction of interregional trade, including transportation costs. Migrating workers now incur relocation costs so that differences in utility between regions may arise. An increase in relocation costs leads to increased and persistent wage differences.

Since their theoretical model posits homogeneous labor, in their empirical work Dickie and Gerking (1998) use econometric methods to control for observed differences between workers. They use the Statistics Canada Labour Market Activity Survey (LMAS), a two year panel micro dataset that suppresses subprovincial wage information. In their empirical model, the logarithm of hourly wages is explained by human capital variables, industry dummies, and provincial dummies. Their stated goal is to test whether wage differences between provinces are "illusory" and due simply to differing relative endowments of labor market characteristics that each earn a common rate of return in all provinces. Empirical tests reject the "illusion hypothesis," finding significant interprovincial differences in wages even after controlling for variations in labor market characteristics.

Dickie and Gerking (1998) find support for the plausibility of relocation costs as a significant driver of interprovincial wage differentials through tests of interprovincial wage dispersion for various demographic groups that are expected to have different relocation costs based on family responsibilities, regional ties, costs of acquiring information about opportunities elsewhere, and returns to migration. The results are generally as expected. For example, wage dispersion is found to increase with age, suggesting there are relatively higher mobility costs and attachment to location and reduced market opportunities for older workers.

2.2 Agglomeration economies

The possibility that geographic concentration of population and firms could increase productivity in some ways has been studied extensively in the literature. In a recent review, Heuermann, Halfdanarson, and Südekum (2010) (henceforth HHS) identify two major strands in the literature. Many studies have been concerned with what HHS term the Urban Wage Premium (UWP) that might arise when the density of economic activity in cities has a genuine influence on workers' productivity. For reasons that this might occur, they refer to a review of literature on agglomeration economies by Rosenthal and Strange (2004), particularly mentioning knowledge spillovers, sharing of specialized inputs, a constant market for skills useful in the production of goods and services, and better matching of those skills with the needs of employers. The second strand of the literature identified by HHS deals with localized Human Capital Externalities (HCE) and focuses on the influence that the aggregate level of human capital might have on individual wages. This includes the learning mechanisms expected to contribute to the UWP, with less educated workers learning informally from highly educated workers, as well as a tendency for physical capital investment decisions to be made on the basis of aggregate human capital.

Glaeser and Maré (2001) examine wages in the U.S. with an emphasis on the issue of an urban wage premium that may be due to agglomeration economies. On the supply side of the labor market, their theoretical model assumes wages are measured in efficiency units and may vary across locations. The price level may also vary, but with free mobility the real wage per efficiency unit must be constant across locations. On the demand side, total factor productivity may vary across regions, potentially leading to an UWP. A less formal discussion by Glaeser and Maré (2001) suggests possible reasons for an UWP, and covers both types of issues noted by HHS. To apply a theory based on efficiency units of labor, Glaeser and Maré concentrate their empirical work on controlling for skill differences in order to measure real productivity differences between dense urban areas and other areas. Without controls for skills, their model suggests that, even after controlling for local prices, there may be a relationship (termed an "ability bias") between wages and population. A simple test regressing nominal wages against the logarithm of population for 49 U.S. metropolitan areas showed a significant positive relationship, but dividing wages by a local cost of living removed this relationship. They take this as evidence that the wage premium is due to productivity increases from agglomeration and not due to ability bias. Using an integrated U.S panel micro dataset (PSID, CPS, and NLSY), Glaeser and Maré (2001) estimate regressions of the logarithm of wages against human capital variables and dummy variables indicating residence in a large city (more than 0.5 million) and in a lesser metropolitan area. Their estimated wage premium for large cities is from 4.5 percent (PSID data) to 11 percent (NLSY data).

Further work using the NLSY was carried out by Yankow (2006), taking the Glaeser and Maré (2001) work as a point of departure. Using a similar empirical approach, he finds a wage premium of about 6 percent for cities[1] then focusses on a thorough examination of wage growth, both within and between jobs. Analyzing annual wage growth, he finds symmetry between the wage changes due to moving into and out of cities (a 6 percent increase versus 7 percent decline, respectively). Analysing between job growth, Yankow (2006) finds that it is not larger in cities, as might be expected from an urban coordination theory (included in the first strand of literature noted by HHS but notes that job changes are more frequent in cities, so that a cumulative effect is possible. In conclusion, he suggests that overall the results support both learning externalities (the second strand noted by HHS) and urban coordination as mechanisms for a UWP.

The notion that population concentrations may affect firms is treated in a very different way by Polèse and Shearmur (2004), who study Canadian industrial location patterns over time. They present three idealized location models that illustrate how the relative concentration of an industry may depend on population size, considered separately for central areas and for peripheral areas. Using Canadian Census data for 1971 and 1996 they find a reasonable correspondence with their ideal models and a very striking stability of the curves over 25 years.

2.3 Effects of agglomeration and amenities on population growth and migration

While studies in the preceding section are concerned with the agglomeration effects on production functions, the idea that agglomeration may simultaneously play a role in household utility functions, along with other amenities that may enter both functions, is an important theme in the literature. When agglomeration effects enter utility functions, they may affect household labour supply decisions, including migration. The studies that we review in this section address these supply-side issues empirically by studying population growth and migration rather than wages. Although the objective of our paper is to understand how regional wage differentials are determined, we note below that understanding the determinants of population growth and

[1] To explain his low estimate compared to Glaeser and Maré (2001), Yankow (2006) points out that he defines the "non-urban" control sample as those areas with less than 250,000 population, which would include small Metropolitan Statistical Areas (MSA), whereas Glaeser and Maré (2001) use only non-MSA areas as the control sample.

migration may offer insights concerning agglomeration and amenities that would be difficult to obtain from only studying wages.

Using Canadian Census data, Partridge, Olfert, and Alasia (2007) conduct a study of population growth related to agglomeration and amenities. Their theoretical model draws inspiration from Roback (1982), considering both the household and firm optimization problems. In their view, population density, distance to the nearest urban center, and distance to a major metropolitan center enter both the indirect utility function of households and the cost function of firms. They suggest that the marginal effect of population density is ambiguous in both cases, with advantages from agglomeration potentially overcome by diseconomies of congestion at high density levels. The authors note that effects of agglomeration on income and wages are ambiguous. Agglomeration economies can have a positive effect on income and wages through increased productivity while attractive urban amenities can have an offsetting negative effect through increased labor supply. This difficulty with the study of wages is presented as an advantage of examining population growth. Indeed, we would argue that the studies of these phenomena are quite complementary. The authors conclude that metropolitan areas with population greater than 500,000 are engines of growth and Rural and Small Town (RST) communities benefit from proximity to major centers.

Also using Canadian Census data, Ferguson et al. (2007) examine the effects of local amenities, economic factors (including employment rate and income), and agglomeration economies on population growth. In rural areas, they find that economic variables are most important, while in urban areas, economic and amenity variables have similar importance. Agglomeration variables are the most influential for the youngest cohort. They note that natural amenities such as weather and the presence of forests and water do not have a strong effect, a result at variance with previous findings from U.S. data. To explain the weather-related aspect, they suggest that the U.S. findings are due to widespread Sunbelt migration, while Canadians have always lived in their "Deep South" along the U.S. border.

Chen and Rosenthal (2008), studying migration patterns in the U.S., also adopt an empirical approach that is compatible with the view that agglomeration and other amenities affect firms and households. Rather than apply a list of specific local amenities in their empirical work, they develop indices of the quality of life and the quality of the business environment based on estimates of local average wages and house rents adjusted for worker and house quality. The between-decades effect of average local changes in the indices on changes in the local worker population shares is estimated. The results show that areas with improving business environments attract skilled workers, while an improving quality of life index attracts retirees. Individual relocations and the corresponding changes in the indexes are also examined. They find that young, highly educated households are attracted to higher quality business environments, especially "power couples" with both partners highly educated, an effect attributed to the need to solve co-location problems.

2.4 Border effects on trade

While Dickie and Gerking (1998) focus on relocation costs that may impede mobility of workers and perpetuate differences in utility and wages, another mechanism for wage adjustment within a country might be intranational trade. According to Samuelson's (1948) factor price equalization theorem, trade could be a substitute for factor mobility, so any restrictions on trade between Canadian provinces (border effects) might impede wage adjustments. In this subsection, we note two studies dealing with the effects of intranational borders on trade within a federal state. Helliwell and Verdier (2001) fit a gravity model to trade data from 1991 to 1996 among Canadian provinces and between each province and 30 U.S. states with strong trading links. Including dummies to capture a preference for intraprovincial trade, they find that border effects may be substantial for the Atlantic provinces with lesser effects for Manitoba and Saskatchewan. Studying the effect of state borders in the U.S., Millimet and Osang (2007) also estimate a gravity model in a variety of specifications. Results were mixed, with large and significant border effects for some specifications, but reduced effects with controls for past levels of trade and migration.

2.5 Empirical studies on other issues

The range of issues appearing in the literature that might have some impact on regional wage differentials is quite large, and to finish our review we briefly note three studies devoted to other relevant issues. In a human capital model that controls for skill mix, Hunt and Mueller (2002) focus on returns to skills in U.S. states and Canadian provinces. Their most striking finding is that, although mean wages are similar in the U.S. and Canada, returns to skills are higher in the U.S. Another potentially relevant issue is the importance of subnational transfers, which could affect welfare and therefore migration and wage differentials in a federal state. Using data on interprovincial migration from 1982 to 2004, Bakhshi et al. (2009) analyze the effect of equalization payments in Canada and conclude that marginal changes have little effect. Finally, a study on import competition reminds us that any issue affecting wages asymmetrically across regions could play some role in explaining regional differentials. Using Canadian 2001 Census data and synthetic establishments from the 1999 Annual Survey of Manufactures, Breau and Rigby (2010) examine the effect of import competition on wages, concluding that the least educated workers are affected most by import penetration from low-income countries, with the strongest effect in Quebec and the Prairies.

2.6 Contribution of the current study

Using Dickie and Gerking (1998) as a point of departure, we attempt to answer questions that could not be addressed by these authors due to restrictions on the data they had available. We also consider further questions suggested by the literature we have reviewed, particularly on the possible impact of agglomeration on wage differentials. The approach taken in our empirical model relates to some of the theory and empirical findings reviewed.

Like Dickie and Gerking (1998), we ask whether regional wage differences in Canada are "illusory" and reflect primarily differences in worker characteristics. We extend their analysis by examining intraprovincial wage differences, using a human capital model similar to theirs and controlling for a variety of worker characteristics. We would expect the importance of relocation costs, a key feature in the Dickie and Gerking (1998) theoretical model, to play a smaller role within provinces so that the illusion hypothesis may not be rejected at this level. We augment the basic human capital model by adding controls for industry and occupation (Dickie and Gerking (1998) include industry controls). A supplementary question concerns the relative importance of these control variables, so we conduct sensitivity analyses to answer these questions.

Following Glaeser and Maré (2001) and Yankow (2007), we ask if there is an urban wage premium due to agglomeration in Canada. Although these authors both found strong evidence for such a premium in the U.S., even after carefully controlling for worker characteristics, the results of Hunt and Mueller (2002) indicate that, at least in the area of returns to skills, Canada is quite distinct, and it would be unwise to assume similarity. The Glaeser and Maré (2001) theoretical model does not highlight amenities, but this issue could be important if, as Partridge, Olfert, and Alasia (2007) suggest, the positive agglomeration effect on wages is offset by the negative effect of attractive urban amenities. The relative strengths of the agglomeration versus urban amenities effects might well differ between the two countries.

Several issues raised in our literature review relate primarily to the specification of our empirical model, particularly the choice of control variables. For example, the findings of Ferguson et al. (2007) that agglomeration effects vary by age cohort indicates that good controls for age are important. Since the results of Chen and Rosenthal (2008) suggest that the attractiveness of a good business environment may depend on colocation problems of couples, marital status may be an important control. The findings of Polèse and Shearmur (2004) showing how the attractiveness of locations varies by industry suggest that industry controls should be included. The work of Helliwell and Verdier (2001) and Millimet and Osang (2007) on border effects suggest the importance of including regions based on provincial boundaries in our model. The importance of controls for education is reinforced by the Hunt and Mueller (2002) separation of returns to skills from skills distribution in a human capital model, and also by the Breau and Rigby (2010) findings on import competition. On the other hand, the findings of Bakhshi et al. (2009) suggest that specific attention to equalization payments is unnecessary.

To summarize, our study focusses on determining the degree to which a human capital model augmented with occupation and industry controls can explain wage differentials. Our access to subprovincial data allows us to extend previous work to study differentials between cities and between urban and rural areas.

3. DATA

3.1 The Survey

The data used in this study come from the Statistics Canada Labour Force Survey (LFS) confidential microdata file made accessible through the Federal Research Data Centre (FRDC).[2] The survey collects information on the wages of employed workers. The detailed geographic location information combined with many socio-economic variables permits an analysis of the effects of region on wages while controlling for other factors.

The LFS is a monthly survey of about 54,000 households. A rotating panel sample design is used, with each household remaining in the survey for six months. However, information necessary to track individuals through each monthly rotation is not available in the file provided to researchers so that panel estimation methods cannot be applied. Also, each monthly file contains an unknown number of individuals who were present in the previous month.

The LFS uses a complex design based on stratification and clustering. Since the Public Use Microdata File released by Statistics Canada suppresses all information concerning the design with the exception of survey weights, analyses have rarely taken the design into account. The confidential microdata provided by the FRDC include design information, which we make use of in our analysis to obtain variance estimates (see Section 4.2).

[2] The Federal Research Data Centre is supported by Statistics Canada and permits access to confidential survey data solely for research purposes through a secure network accessed from computers on Statistics Canada premises. Individuals using the data must obtain security clearance and be sworn in as a Statistics Canada employee, as concerns the Statistics Act, which includes penalties for violating confidentiality.

3.2 Pooled Data

In seeking to analyze hourly wages that are approximately representative of a particular year, while at the same time avoiding the use of duplicate records, we choose two months, April and October, in each year. The six-month gap ensures that the monthly samples will be disjoint, and the distance from the beginning and end of the year should tend to make the pooled sample representative of the year. As noted in the previous section, these are not panel data.

We are concerned primarily with market-determined wages of employees. The sample is therefore restricted to employed paid workers, excluding self-employed and workers in federal public administration.[3]

The confidential LFS data is updated on an annual basis, and the years available to us during our period of access for this study were 2002-2007. We pooled each of the periods 2002-2004 and 2005-2007 separately to produce manageable size data sets. Since results from the two periods proved to be very similar, figures show only the later period, with both periods in the tables.

3.3 Geographic divisions

3.3.1 Urban geographic units

The urban geographic units chosen for the analysis are the Statistics Canada geographic divisions of the Census. A census metropolitan area (CMA) or a census agglomeration (CA) is formed by one or more adjacent municipalities centered on a large urban area (known as the urban core). A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the urban core. A CA must have an urban core population of at least 10,000 (Statistics Canada, 2007).

3.3.2 Broad Regions and CMAs

Based on provincial boundaries,[4] we define 6 disjoint broad regions comprising all of Canada: British Columbia, Alberta, the Prairie Provinces (Saskatchewan-Manitoba), Ontario plus Gatineau, Quebec excluding Gatineau, and the Atlantic Provinces.

We focus particularly on CMAs within the regions because of their importance, our interest in agglomeration economies (they differ widely in size), and the likelihood that highly urban areas will have a different distribution of occupations and human capital than smaller cities and rural areas. This choice will determine if the wage differences between major cities within a region, and between cities and their encompassing broad regions, are "illusory" in the sense defined by Dickie and Gerking (1998). In order to have a reasonably balanced distribution of CMAs by region, we initially chose the largest 20 out of 27 CMAs by population. Then to ensure more representation from the Atlantic provinces, the CMAs of Oshawa and Windsor were replaced with Moncton and Saint John. Our CMAs are Victoria, Vancouver, Calgary, Edmonton, Regina, Saskatoon, Winnipeg, Toronto, Ottawa-Gatineau (considered together), Hamilton, London, Kitchener-Waterloo, St. Catherine's-Niagara, Montreal, Quebec City, Sherbrooke, Moncton, Saint John, Halifax, and St. John's. Notice that, because we split Gatineau from

---

[3] Rates of pay for almost all of the federal public administration are uniform across Canada.

[4] The only deviation from provincial boundaries concerns Gatineau, which is in the province of Quebec but contiguous with Ottawa so that the two cities constitute one urban area. Since Ottawa is the larger, for our analysis we consider both cites as part of Ontario and remove Gatineau from the Quebec region.

Quebec and added it to Ontario, each CMA is encompassed by a particular broad region. Ottawa-Gatineau is the only CMA that spans provincial boundaries, and apart from our treatment of this CMA, a broad region is a province or collection of provinces.

3.3.3 The Urban-Rural Divide

As noted in our literature review, some researchers such as Glaeser and Maré (2001) and Yankow (2006) have developed theories leading us to expect wages to be greater in large cities, even after controlling for other factors. For this type of analysis, all of the CMAs and CAs in Canada are considered to be Urban, while the remaining areas are considered Rural.

4. THE EMPIRICAL MODEL

4.1 Wage Equations

As noted in our literature review, the model determining hourly wages is very similar to that used by Dickie and Gerking (1998). The logarithm of hourly wages is regressed against worker and job characteristics, including human capital variables such as education and job tenure, 47 National Occupation Classification (NOC) groupings, and 10 North American Industry Classification System (NAICS) groupings. In our model, we also add dummy variables representing regions of Canada. In order to evaluate the importance of control variables, we conduct a sensitivity analysis by adding sets of the explanatory variables to the most basic model. The model including regional dummies only can be described as

$$\ln(w_i) = \boldsymbol{z_i}\boldsymbol{\gamma} + u_i \tag{1}$$

where w_i is the average hourly wage of individual *i*, $\boldsymbol{z_i} = (1, z_{i2}, \cdots, z_{iR})$ is a vector including a constant term and dummy variables representing the *R* regions $r_1, \cdots, r_R$ using region r_1 as a reference (the omitted dummy), $\boldsymbol{\gamma}$ is the column vector of variable coefficients to be estimated and u_i are the independent and identically distributed error terms. We will usually refer to Equation (1) as the *Raw model*, since the estimated coefficients from this model will be used to represent wage differentials without any controls. With a vector of *K* control variables $\boldsymbol{x_i} = (x_{i1}, \cdots, x_{iK})$ included, the model becomes

$$\ln(w_i) = \boldsymbol{z_i}\boldsymbol{\mu} + \boldsymbol{x_i}\boldsymbol{\beta} + v_i \tag{2}$$

where $\boldsymbol{\mu}$ is a new vector of coefficients of $\boldsymbol{z_i}$, $\boldsymbol{\beta}$ is the vector of control variable coefficients, and $\boldsymbol{v_i}$ are the error terms. We are most interested in the coefficients of the regional dummies since these represent the effect of living in a particular region r_j relative to the base region r_1. Elements of the vector $\boldsymbol{x_i}$ are control variables that capture personal and job characteristics.

4.2 Estimation of parameters

The model is estimated by Weighted Least Squares (WLS) using the survey weights provided with the LFS microdata. This estimator is given by

$$\widehat{\boldsymbol{\beta}}_{\boldsymbol{wgt}} = (\boldsymbol{X}'\boldsymbol{\Omega}\boldsymbol{X})^{-1}\boldsymbol{X}'\boldsymbol{\Omega}\boldsymbol{X} \tag{3}$$

where $\boldsymbol{X}$ is a matrix with the *i*th row equal to observation $\boldsymbol{x_i}$ and $\boldsymbol{\Omega}$ is a diagonal matrix of survey weights. Because this is a descriptive study, we are taking the view that the parameter of interest is the vector of coefficients that would be obtained by applying OLS to the entire finite population (i.e. all of Canada), which exists whether or not the finite population is generated by

Equation (1) or Equation (2). For a discussion of the advantages of using the weighted estimator, see Carrington, Eltinge, and McCue (2000).

The complex sample design affects the estimation of the variance-covariance matrix $\boldsymbol{V}(\widehat{\boldsymbol{\beta}}_{wgt})$ of the regression. Particularly, if clustering were ignored, the variances would tend to be understated due to the correlation between error terms within clusters. We use linearization estimators as described in Carrington et al. (2000) to account for the LFS survey sampling methods. These methods forego potential efficiency gains of applying Generalized Least Squares and concentrate on developing unbiased estimates of $\boldsymbol{V}(\widehat{\boldsymbol{\beta}}_{wgt})$. Interest in accounting for complex survey design in the estimation of variances has increased among economists recently, and major econometric packages have implemented routines to deal with survey design. We use PROC SURVEYREG in the SAS statistical software to estimate parameters. All reported t statistics and F statistics in our study account for stratification and clustering of the LFS.

There are some econometric issues when estimating the parameters of a model given by Equation (2). We include education dummies in the vector $\boldsymbol{x_i}$, and a potential concern is that these may be endogenous variables (Bazen, 2011). Since our study uses education simply as a control variable, potential bias in the coefficients should be less of a problem than in a study focusing on returns to education. We do not have access to the instrumental variables (parent's education) suggested by Bazen (2011) as a remedy. Wooldridge (2010) discusses simultaneous equations models with hours and wages simultaneously determined. He notes instrumental variable methods that can be used in this case. We are not focusing on labor supply (hours) and we note that, in his example 9.6, the variable hours is dropped from the equation explaining log wages because it is insignificant. A very general problem is unobserved characteristics that affect wages. When panel data are available, the use of fixed or random effects methods may be useful (see Wooldridge, 2010). As we note in Section 3.2 above, our data do not permit these methods. Nevertheless, as we note below in Section 5.4, our findings are such that they do not depend on an assumption that all characteristics have been controlled for.

5. RESULTS

5.1 Estimates of wage differentials for regions and CMAS

5.1.1 Groups of variables

As shown in the previous section, the econometric model is based on a vector of explanatory variables divided into a set of regional dummies and a set of variables controlling for worker characteristics.[5] In order to conduct a sensitivity analysis, we group the variables so that we can determine relative importance. Figure 1 shows the wage differentials resulting from adding a sequence of three groups of explanatory variables, each of which define a model since the functional form of the specification is the same: *Raw model* (Regional dummies), Human Capital (Plus experience, education, and socio-economic characteristics), *Full* (Plus occupation categories and broad industry categories)

The *Raw model* is based on regional dummy variables for each of the 6 broad regions and each of the 20 CMAs. The "Ontario plus Gatineau" broad regional dummy is omitted so that the base region effectively becomes Ontario, excluding those who live in a CMA that we have included and who live in Ontario. In calculating wage differentials, the coefficients of CMAs are

[5] Since we are pooling 3-year periods, year dummies are included in all models.

added to those of their encompassing region to obtain the effect on wages of living in these CMAs, compared to the base region. Broad region differentials represent the effect of living in a particular broad region excluding any encompassed CMAs (among the 20 represented by dummies) compared to the base.[6]

The Human Capital model adds education, age, and job tenure. This group also includes other personal demographic characteristics (gender and marital status) and job characteristics (firm size, union status, and indicators of full-time employment, seasonal work, contract work, casual work, and public sector employment).

The *Full model* adds controls for occupation and industry. For occupation we use 47 categories that are groupings of occupations from Statistics Canada's occupational classification for 2001, called the National Occupational Classification for Statistics 2001 (NOC-S 2001) to distinguish it from the National Occupational Classification (NOC) put out by the Department of Human Resources and Social Development Canada.[7] These are the same categories that appear on the Public Use Microdata File (PUMF). A listing of the descriptions is provided in the appendix. For industrial sector controls, we use 10 broad groupings of the North American Industry Classification System (NAICS) 2002-Canada. Descriptions are in the Appendix.

Based on the logarithmic form of the wage equation, we take the exponential of the estimated coefficients.[8] This produces estimates of the ratio of hourly wages in each region to the reference group, Ontario (excluding workers in the six Ontario CMAs), which we express as percentages.

5.1.2 Graphical results for the 2005-2007 period

We first present results in graphical form for the 2005-2007 period (results for 2002-2004 are similar) so that the salient features can be more easily grasped. One of the most striking observations from Figure 1 is that the estimated wage differentials of CMAs are lowered relative to their broad region (which excludes these CMAs) as we move from the *Raw model* to the *Full model* including all explanatory variables. The same results, not shown in Figure 1, were observed for the earlier 2002-2004 period and are available in Table 1.

All the CMAs have a wage unadjusted for control factors that is higher than that of the region in which they are situated. In all cases except for Edmonton, the absolute difference is reduced when we take account of the control factors.

In contrast to this tendency for control factors to explain the differences between CMAs within a region, Figure 1 shows that large interregional wage differences remain after controlling for job and worker characteristics. Control variables lower the relative position of Ontario while at the same time accentuating the wage advantage of the western provinces. This is consistent with a view of Ontario as an industrial and financial center of Canada with high-skilled manufacturing and financial sector jobs.

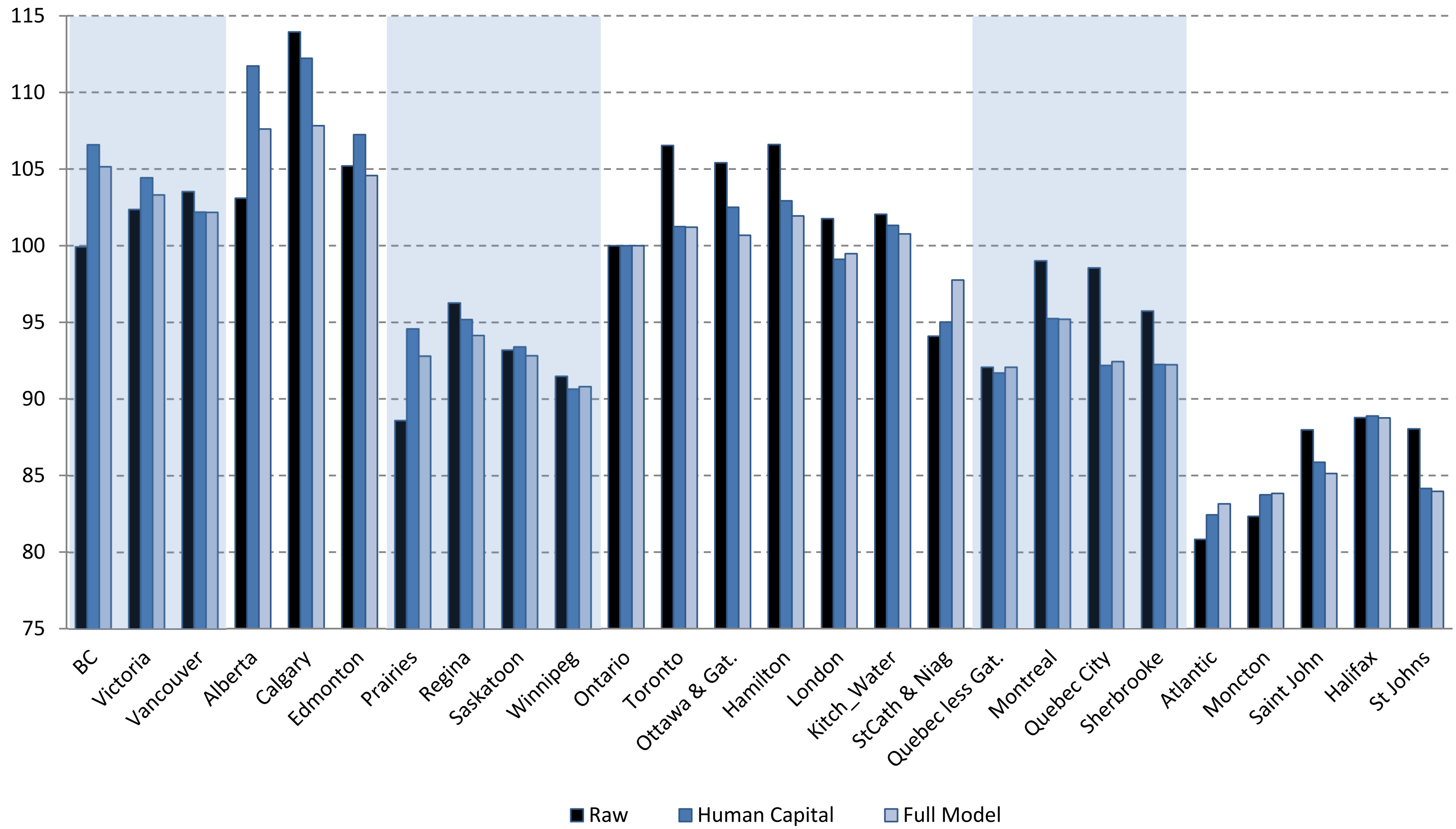
---

[6] This procedure is equivalent to using 26 disjoint regions that comprise all of Canada (removing the CMAs from their encompassing region) and estimating a model with the dummy representing “Ontario minus all encompassed CMAs” removed, except that in this case we would not add CMA coefficients to their encompassing region.

[7] The two classifications differ only in the aggregation structure of the classification.

[8] Details and rationale are in the appendix.

Figure 1: Regional wage relativities 2005-2007 for 26 regions, Index (Ontario=100)



Source: Statistics Canada LFS

5.1.3 Regression coefficient estimates and statistics for regions and CMAs

This section presents the estimated coefficients of the vector x_i of explanatory variables that lie behind Figure 1 presented in the previous section. Although Figure 1 shows results only for the later of the two-year periods that we use (2005-2007), we present results in Table 1 for the *Raw* and *Full models* separately for each period so that stability across periods can be checked.

Dummies indicating broad regions are included along with dummies indicating a particular CMA. This means that, for the broad regions, the coefficients (multiplied by 100) approximate the percentage difference of wages in the region above those of the omitted region (Ontario), always excluding the 20 CMAs we consider. For the individual CMAs, the coefficients approximate the percentage difference of wages in the CMA above those of its encompassing region, excluding any of the other CMAs we consider.

As we can see in Table 1, the results for the two periods are mostly similar. Notable differences are that, compared to 2005-2007, the *Raw model* shows a lower premium for Calgary, and higher premiums for Regina and Moncton.

Our thesis that the *Full model* leads to convergence of the wages of CMAs to their encompassing region is supported. In the *Raw model* almost all the coefficients are significant at any conventional level. As expected, when controls are added for the *Full model*, *Pr* values greatly increase so that 11 out of 20 CMAs remain significant at the 5 percent level and only 9 out of 20 at the 1 percent level. Since we use approximately 300 thousand observations, we can discern relatively small variations in wages from the mean of the broad region, so for about half the CMAs using the *Full model* we can reject the hypothesis of zero difference. Nevertheless we can be confident that differences are small. Taking the case of Toronto as an example, a 5 percent wage premium in the *Raw model* is reduced to 1.2 percent in the *Full model*, but still we can reject equality even at the 1 percent level. The standard error tells us, however, that we have a 95 percent confidence interval of ± 0.8 percentage points about the estimate.[9]

In contrast, coefficients of the broad regions remain relatively large and are significant at conventional levels as we move from the *Raw* to the *Full model*. *Pr* values remain small.

The controls include human capital variables and characteristics (see Table 2 below), occupation, and broad industry categories. Details of the occupation and industry groupings are given in the appendix.

[9] Notice that an approach based on H_0 representing equality leads here to a situation where having the power (observations) to reject H_0 may appear not to support our thesis, whereas using fewer observations would. Our preferred approach to hypothesis testing is presented in section 5.4.

Table 1: Wage premium for CMAs, Regression results

	2002-04 Raw Model			*2002-04 Full Model*			*2005-07 Raw Model*			*2005-07 Full Model*		
	Value	SE	Pr > | *t* |	Value	SE	Pr > | *t* |	Value	SE	Pr > | *t* |	Value	SE	Pr > | *t* |
Intercept	2.795	0.005	<.0001	1.924	0.007	<.0001	2.885	0.005	<.0001	2.037	0.008	<.0001
Victoria	0.003	0.017	0.868	-0.019	0.008	0.0151	0.024	0.015	0.1036	-0.018	0.006	0.0033
Vancouver	0.036	0.012	0.0018	-0.017	0.005	0.0017	0.035	0.011	0.0011	-0.029	0.005	<.0001
Calgary	0.064	0.016	<.0001	0.004	0.008	0.5718	0.100	0.013	<.0001	0.002	0.006	0.7457
Edmonton	0.043	0.013	0.0013	-0.019	0.006	0.0020	0.020	0.014	0.1512	-0.029	0.007	<.0001
Regina	0.114	0.019	<.0001	0.027	0.007	0.0001	0.083	0.015	<.0001	0.014	0.006	0.0266
Saskatoon	0.035	0.014	0.0103	0.002	0.006	0.7318	0.051	0.015	0.0007	0.000	0.006	0.9655
Winnipeg	0.049	0.012	<.0001	-0.013	0.006	0.0210	0.032	0.011	0.0045	-0.022	0.006	0.0002
Toronto	0.050	0.009	<.0001	0.015	0.004	0.0010	0.063	0.009	<.0001	0.012	0.004	0.007
OttawaGat	0.061	0.014	<.0001	0.018	0.006	0.0024	0.053	0.017	0.0019	0.007	0.007	0.3407
Hamilton	0.055	0.018	0.0028	0.028	0.009	0.0022	0.064	0.018	0.0003	0.019	0.008	0.0174
London	0.023	0.013	0.0802	-0.007	0.006	0.2020	0.017	0.015	0.2569	-0.005	0.006	0.406
Kitch_Water	0.006	0.012	0.6218	0.010	0.006	0.0879	0.020	0.013	0.1161	0.008	0.006	0.2121
StCath_Niag	-0.066	0.013	<.0001	-0.024	0.006	<.0001	-0.061	0.013	<.0001	-0.023	0.006	<.0001
Montreal	0.087	0.010	<.0001	0.040	0.005	<.0001	0.073	0.010	<.0001	0.033	0.005	<.0001
Quebec_cma	0.091	0.017	<.0001	0.019	0.006	0.0029	0.068	0.017	<.0001	0.004	0.006	0.5327
Sherbrooke	0.040	0.015	0.0085	-0.015	0.007	0.0235	0.039	0.015	0.0083	0.002	0.006	0.7831
Moncton	0.063	0.022	0.0039	0.042	0.008	<.0001	0.018	0.022	0.4094	0.008	0.008	0.3302
SaintJohn	0.076	0.018	<.0001	0.035	0.008	<.0001	0.085	0.021	<.0001	0.023	0.008	0.0035
Halifax	0.095	0.014	<.0001	0.066	0.006	<.0001	0.094	0.013	<.0001	0.065	0.006	<.0001
StJohns	0.084	0.019	<.0001	0.016	0.009	0.0645	0.085	0.014	<.0001	0.010	0.007	0.1832
BC	0.028	0.011	0.0086	0.069	0.005	<.0001	-0.001	0.009	0.936	0.050	0.004	<.0001
Alberta	-0.039	0.010	<.0001	0.012	0.005	0.0154	0.030	0.009	0.0008	0.073	0.005	<.0001
Man_Sask	-0.147	0.007	<.0001	-0.101	0.004	<.0001	-0.121	0.008	<.0001	-0.075	0.004	<.0001
Quebec_xncr	-0.090	0.007	<.0001	-0.079	0.004	<.0001	-0.083	0.007	<.0001	-0.083	0.003	<.0001
Atlantic	-0.227	0.007	<.0001	-0.201	0.003	<.0001	-0.213	0.007	<.0001	-0.185	0.003	<.0001
Yearlag1	-0.024	0.003	<.0001	-0.021	0.002	<.0001	-0.036	0.003	<.0001	-0.035	0.002	<.0001
Yearlag2	-0.043	0.004	<.0001	-0.042	0.002	<.0001	-0.065	0.003	<.0001	-0.061	0.002	<.0001
R^2	0.0215			0.6112			0.0232			0.5925		
Observations = 290820, Strata = 197, Clusters = 4519							Observations = 303225, Strata = 158, Clusters = 4553					

*Note: This is a complete list of variables for the *Raw Model*. Controls are omitted from other specifications (see Appendix for 2005-2007 full results).

Table 2: Explanatory variables, Human capital and characteristics*

Variable	Description
Gender	Indicates male gender
Age	5-year intervals (15-24 grouped)
Marital Status	Single, married/common law, widow, divorced/separated
Education	7 categories
Full-time	Indicates 30+ hours
Tenure	Years in current job: 5 categories up to 20 years+
Permanent-Temp	Permanent, seasonal, contract-temp, casual
Establishment Size	Number of employees at workplace, 4 categories
Union Status	Member or covered by collective agreement?
Public Sector	Provincial, municipal or other government employee

*See Table 4A in the appendix for more details

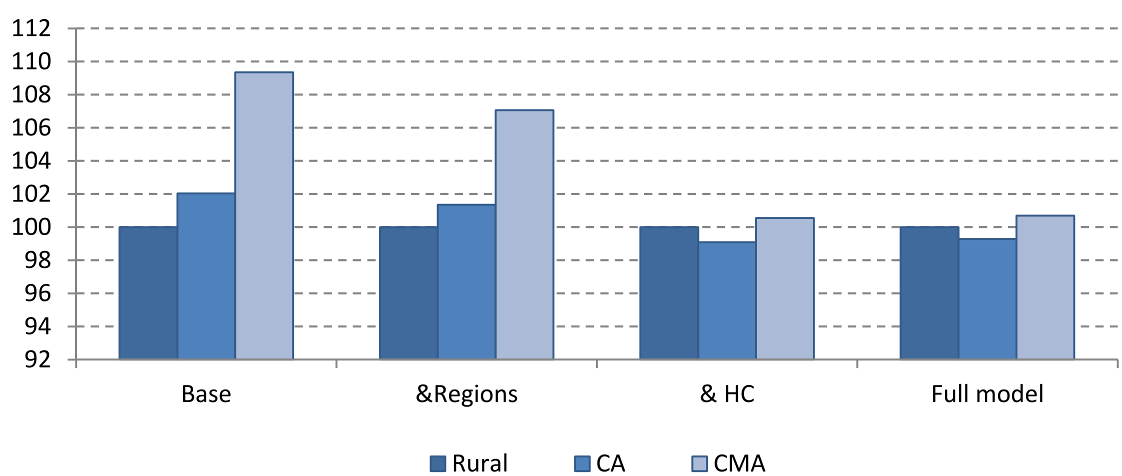
5.2 The urban-rural divide

5.2.1 Graphical results for the 2005-2007 period

In order to test whether there is an "urban-rural" divide in Canadian wages after controlling for other factors, we specified the wage equations including dummy variables indicating whether a worker lives in a CMA or Census Agglomeration (CA). The two indicators were included in a succession of five estimated wage equations where the dependent variable is the logarithm of hourly wages. The Base model has no additional independent variables.[10] This model is augmented by adding dummy variables representing the six major regions (Ontario omitted), then further augmented cumulatively by adding variables controlling for human capital, occupation, and finally industry to reach the *Full model*.

Considering the CMA and CA dummies, we refer to their complement, which is the omitted category, subsumed into the constant term of the regression, as "rural" Canada, although this term comprises towns of fewer than 10,000 people as well as truly rural areas.

Figure 2: Urban-rural divide in 2005-2007, Successive wage equations (Index: Rural=100)



Source: Statistics Canada LFS

[10] There are no regional dummies, which were included in the *Raw model* described in Section 5.1.1.

Figure 2 shows the results of estimating the parameters of the models (the effects of occupation and industry are combined). The wage differentials are presented as an index with the omitted category "Rural" equal to 100. In the base model with no controls, we see that living in a CA or CMA boosts wages by about 2 percent or 9 percent respectively, relative to the Rural category. While controlling for the six major regions reduces this slightly, adding human capital controls reduces the effects to less than 1 percent, and the effects remain tiny when controls for the 47 occupations (*+NOC47*) and ten industry controls (*+NAIC10*) are added.[11] Further details on the model parameter estimates and regression statistics are provided in the next section.

These results suggest that the difference in wages between metropolitan areas and the rest of Canada, and between urban and rural Canada, is primarily a result of the distribution of skills and other characteristics that we have included in our model. Certainly it is not surprising that these factors should play a large role in explaining the difference. However, based on the literature discussed in Section 2.2, a reasonable hypothesis might have been that some difference in productivity associated with the density of population would remain. According to our results, this does not appear to be the case.

5.2.2 Regression coefficient estimates and statistics, urban-rural model

The urban-rural divide regression results are presented in Table 3 below. For the most recent period, the estimate for the premium of living in a CMA drops from about 9 percent to 0.7 percent with the addition of control variables. For CAs the drop is from about 2 percent to -0.7 percent. The *Pr* values show that at the 5 percent level we can reject the null hypothesis that the effect of residence in a CMA on wages is zero after all controls are included. However, this is because of our large sample of about 300,000 workers, which permits us to detect the very small effect. The estimated standard errors indicate that, with 95 percent confidence, the premium for living in a CMA is about 0.7 percent ± 0.4 percent. It appears that our control variables explain most of the urban-rural divide.

Results for the 2002-2004 period are similar, although the estimate of the CMA premium with controls is not quite as low.

5.3 Adjusting for relative prices

As in the Glaeser and Maré (2001) study, we would like to examine wages adjusted for relative prices, but we face similar data limitations to those authors. Since published data on interregional price differences are scarce in Canada, we can only produce suggestive results for a few cities, and with a price index that is not ideal. We use the Statistics Canada Intercity Price Index for all items, available for eleven cities (see Figure 3). The index weights items based on average expenditures, but since the weights do not vary according to regional expenditure patterns, it cannot be considered a cost of living index.

Separately for our *Raw model* and for our *Full model* that includes all controls, we divide each mean wage estimate by the corresponding price index. Taking the resulting price-adjusted mean wage estimates as a percentage of that estimated for Toronto, we get a relativity index. Figure 4 shows the results.

[11] As will be seen in Table 3 of Section 4.4.1 below, these very small effects are often statistically significant because of our very large sample size.

Table 3: Urban-rural divide, Regression results*

		2002-2004			2005-2007		
		Value	*S.E.*	*Pr > |t|*	*Value*	*S.E.*	*Pr > |t|*
BASE	ica**	0.025	0.008	0.0009	0.020	0.007	0.0039
	icma**	0.094	0.005	<.0001	0.089	0.005	<.0001
	R^2	0.008					
+REGIONS	ica	0.013	0.007	0.0524	0.013	0.006	0.0379
	icma	0.070	0.005	<.0001	0.068	0.004	<.0001
	R^2	0.021					
+HC	ica	-0.005	0.004	0.2395	-0.009	0.004	0.0226
	icma	0.013	0.003	<.0001	0.005	0.003	0.0516
	R^2	0.483					
+NOC47	ica	-0.003	0.003	0.3701	-0.009	0.003	0.0036
	icma	0.013	0.002	<.0001	0.003	0.002	0.1304
	R^2	0.605					
+NAIC10	ica	-0.001	0.003	0.7978	-0.007	0.003	0.0188
	icma	0.016	0.002	<.0001	0.007	0.002	0.0013
	R^2	0.611					
		Observations = 290820, Strata = 197, Clusters = 4519			Observation = 303225, Strata = 158, Clusters = 4553		

*Note: Results for other independent variables have been omitted.
**Parameters ica and icma refer to the coefficients of dummies for CA or CMA respectively

Moving to price-adjusted wages alone tends to reduce interregional differences, but considerable differences remain between the cities of different regions, whether or not controls are added. A very tentative conclusion might be that amenities (an issue not considered in the Glaeser and Maré (2001) model which predicted constant real wages) might play a role in some cases: Vancouver (high amenities) loses relative to Edmonton (low amenities) and Toronto (high urban amenities) loses relative to other cities.

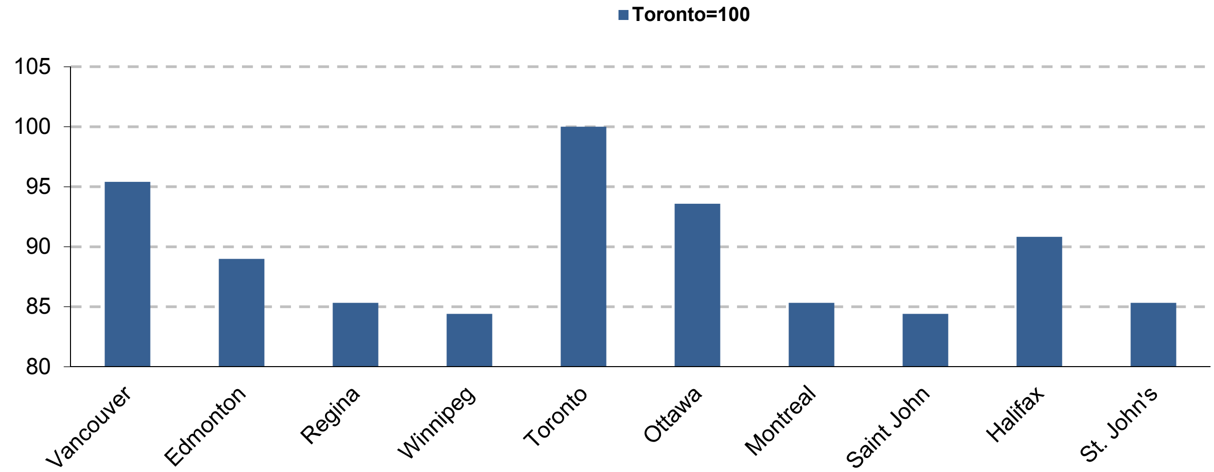
Unfortunately, due to the lack of availability of comparable price data for other cities and smaller towns, we cannot test whether our main finding that wage differences within broad regions are well explained by our human capital model applies with price adjustment.

5.4 Hypothesis tests

In Section 5.1 we observed that adding control variables in the wage model leads to the convergence of CMA wages to those of the encompassing region. Our goal is to conduct statistical tests of the hypothesis that these results are simply due to chance, arising from sampling variation.

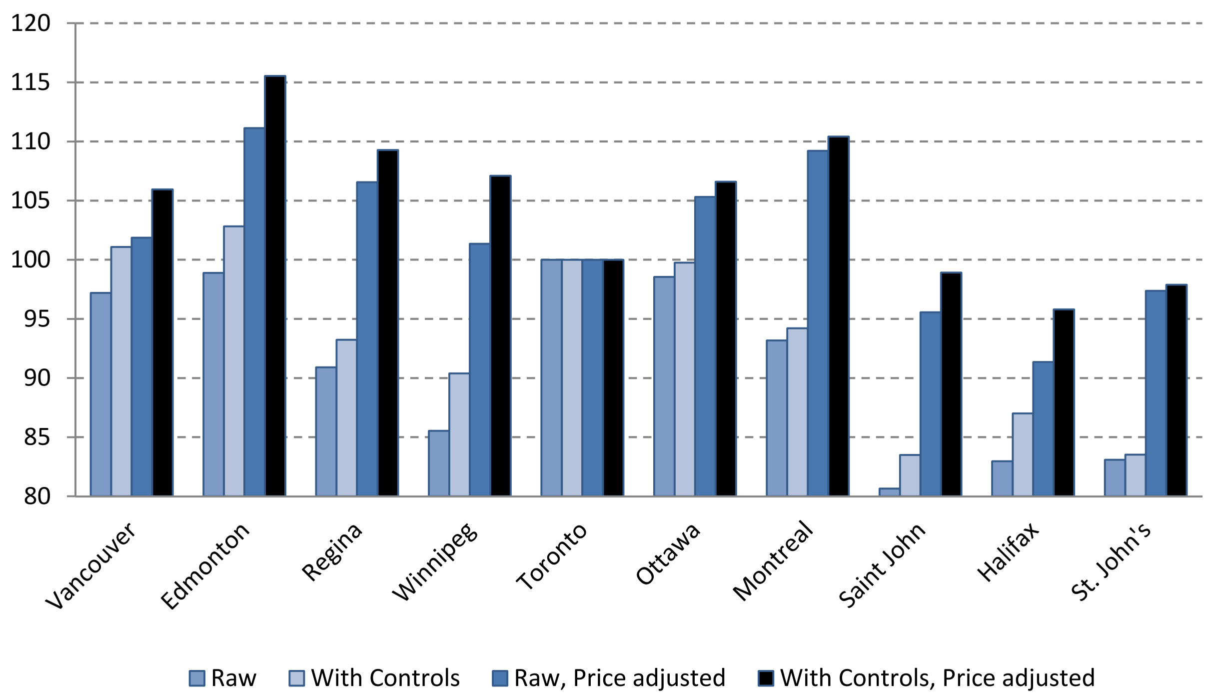
To capture the notion of convergence to encompassing regions in a simple way, we consider the Euclidean norm of the vector of coefficient estimates for the CMA dummy

Figure 3: The Intercity Price Indexes (IPI), 2005-07



Source: Statistics Canada LFS and Intercity Price Indexes

Figure 4: Price-adjusted wages, the effect of controlling for characteristics 2005-2007



Source: Statistics Canada LFS and Intercity Price Indexes

variables, each of which approximates the percentage difference of the expected hourly wage in the CMA from that of its region. This is carried out for Canada overall, and also for each region separately. Finally we consider each CMA separately with simple tests of the equality of coefficients.

These are all cross-model tests, since we are comparing coefficient estimates from the *Raw model*, with regions as explanatory variables, with those from a *Full model* including human capital and other controls. This adds some complexity to the procedures. We use the Wald statistic[12] (denoted as *W*) to test simple and joint hypotheses. To test the urban-rural hypotheses, we conduct simple tests of the equality of the CA and CMA dummy variable coefficients across the *Raw* and *Full models*. In addition, we conduct a joint test of equality across models.

As noted earlier, the estimate of the variance-covariance matrix is calculated using a linearization estimator (Carrington et. al., 2000) that accounts for clusters and strata. It is often referred to as the cluster-adjusted sandwich estimator. The statistic W/j is distributed as $F(j, k)$ where k is equal to the number of clusters minus the number of strata. Clogg, Petkova, and Haritou (1995) show how to implement tests across two models estimated on the same sample while taking into account the covariance between the estimators that are being compared. The tests are implemented using the "suest" (seemingly unrelated estimation) procedure developed and documented by Weesie (1999) for STATA statistical software.[13]

The results of tests that the norms of the estimated coefficient vectors are equal across the *Raw* and *Full models* are reported in Table 4. In the most recent period, the hypothesis that the sum of squares is equal across models can be rejected at any conventional level of significance in all regions except British Columbia (B.C.). In the period 2002-2004, the test results for B.C. are similar, and the hypothesis of equality in Alberta can be rejected at the 5 percent level, but not quite at the 1 percent level. Although for the case of B.C. we cannot reject the hypothesis that the distance of the CMA wage relativity vector from that of the encompassing region is equal across models, this is because the *Full model* results for CMAs are similar but of opposite sign to those of the Raw model. The addition of control variables leads to a slight estimated "urban gap" with the CMAs having lower wages than the rest of the province. This would be consistent with premiums for work in remote areas of B.C. for some occupations, but to be sure further research and analysis is necessary.

Table 4: Cross-model tests comparing the norm of the CMA coefficient vector

	2002-2004				2005-2007			
	$\|\|\gamma_R\|\|$ ×100	$\|\|\gamma_F\|\|$ ×100	*F***	Pr > *F*	$\|\|\gamma_R\|\|$ ×100	$\|\|\gamma_F\|\|$ ×100	*F****	Pr > *F*
Canada	28.51	11.75	110.82	<.0001	27.04	9.95	121.25	<.0001
BC	3.63	2.54	0.12	0.732	4.28	3.37	0.08	0.7775
Alberta	7.69	1.97	5.75	0.017	10.21	2.87	13.67	0.0002
Prairies	12.83	2.96	33.58	<.0001	10.25	2.60	16.32	0.0001
Ontario	11.93	4.53	51.80	<.0001	12.37	3.40	57.89	<.0001
Quebec	13.25	4.71	38.40	<.0001	10.69	3.37	27.24	<.0001
Atlantic	16.07	8.74	24.79	<.0001	15.37	7.05	33.80	<.0001

*γ_R refers to the *Raw model*, γ_F to the *Full model*,** Distributed as F(1, 4322), ***Distributed as F(1, 4395)

[12] See Cameron and Trivedi (2009, p. 409).

[13] We used the STATA *suest* procedure for the cross-model tests comparing the *Raw* and *Full models* and the SAS *surveyreg* procedure to estimate the full complement of models. We verified that STATA, using the *svyset* and *svy*: regress commands, produces exactly the same parameter and standard error estimates as SAS surveyreg.

Table 5: Cross-model tests of equality of coefficients

	2002-2004			2005-2007		
Individual CMAs	$(\gamma_R - \gamma_F)$* ×100	F**	Pr > F	$(\gamma_R - \gamma_F)$* ×100	F***	Pr > F
Victoria	2.20	3.63	0.0567	4.17	13.71	0.0002
Vancouver	5.28	42.71	<.0001	6.41	64.75	<.0001
Calgary	5.95	39.27	<.0001	9.81	105.37	<.0001
Edmonton	6.20	43.96	<.0001	4.88	24.79	<.0001
Regina	8.69	35.40	<.0001	6.87	40.25	<.0001
Saskatoon	3.26	10.90	0.0010	5.04	20.93	<.0001
Winnipeg	6.13	53.08	<.0001	5.38	52.25	<.0001
Toronto	3.51	39.25	<.0001	5.13	72.54	<.0001
OttawaGat	4.31	17.65	<.0001	4.59	18.54	<.0001
Hamilton	2.73	5.14	0.0234	4.48	14.96	0.0001
London	3.04	9.40	0.0022	2.27	4.05	0.0442
Kitch_Water	-0.36	0.10	0.7477	1.27	2.12	0.1454
StCath_Niag	-4.24	18.34	<.0001	-3.83	15.77	0.0001
Montreal	4.69	46.99	<.0001	3.93	30.65	<.0001
Quebec_cma	7.26	29.17	<.0001	6.41	22.77	<.0001
Sherbrooke	5.55	19.73	<.0001	3.73	9.66	0.0019
Moncton	2.05	1.44	0.2308	1.03	0.37	0.5408
SaintJohn	4.07	10.36	0.0013	6.13	15.76	0.0001
Halifax	2.90	9.49	0.0021	2.85	11.27	0.0008
StJohns	6.82	30.02	<.0001	7.57	49.89	<.0001
CA & CMA Dummies	$(\gamma_B - \gamma_F)$* *×100*			$(\gamma_B - \gamma_F)$* *×100*		
ica	2.61	24.05	<.0001	2.74	30.08	<.0001
icma	7.80	367.76	<.0001	8.24	456.96	<.0001
Joint test	—	189.01	<.0001	—	235.62	<.0001

*γ_R, γ_B, and γ_F refer to the *Raw*, *Base*, and *Full models* respectively, **Distributed as F(j, 4322), ***Distributed as F(j, 4395) where j =1 for the simple tests and j = 2 for the joint test.

The results of tests of the equality of individual CMA coefficients across models are reported in the top set of rows in Table 5. Our thesis is that the coefficients will usually be lower in the *Full model* than in the *Raw model*, since the human capital factors, occupation, and industry explain the higher wages in CMAs. For the most recent period this story fits the evidence in terms of the expected sign of the difference in every case except St. Catherines-Niagara. This CMA is unusual, as we already saw in Table 1 where the wage without controlling for characteristics is estimated to be about 6 percent lower than that for Ontario outside of its six largest cities. For this period the Wald test shows that we can reject the equality of coefficients for most cities. The notable exceptions are Kitchener-Waterloo and Moncton.

The results are similar for the period 2002-2004, except that equality cannot quite be rejected at the 5 percent level for Victoria. While the Kitchener-Waterloo coefficient does not have the expected sign, it is very close to zero.

The results of the urban-rural cross-model tests are shown in the bottom set of rows of Table 5. In this case we compare a Base model, having the CMA and CA dummies as explanatory variables indicators, with a *Full model* including the human capital, occupation and industry variables. We test the simple hypothesis that CMA dummy coefficients are equal across models and also the equivalent for CA dummy coefficients. In addition, we test the joint hypothesis that both CMA and CA dummy coefficients are equal across models. In all cases we can reject the Null hypothesis at any conventional level of significance.

As a final note, we return to the possibility of unobserved characteristics noted in section 4.2. Although our data do not permit panel methods, we claim that, because our conclusions are concerned with the effect of observed characteristics, concerns about unobserved characteristics should be less than in a case, such as that of Glaeser and Maré (2001), where the finding of agglomeration effects rests on seeing a residual effect after controlling for characteristics.

6. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

We find that, when we consider broad regions of Canada, based on provincial boundaries, intraregional differences in wages are largely "illusory" in the sense defined by Dickie and Gerking (1998). Using an empirical model specification similar to Dickie and Gerking, we find that these wage differences can be explained by a human capital model augmented by occupation and industry controls representing differences in industrial structure.[14] Notably, we find that the wages across the six largest urban centers and the rest of Ontario are similar when controlling for these factors, in spite of considerable differences in size. We also find that in Canada an urban-rural divide in wages (urban defined as within a CMA or CA) within the broad regions is illusory in the same sense, a result contrasting with the findings of Glaeser and Maré (2001) and Yankow (2006) for the U.S.

Although we have not detected an agglomeration wage premium in Canada, we do not interpret this as meaning that there are no agglomeration effects. Studying population growth in Canada, Partridge, Olfert, and Alasia (2007) and Ferguson et al. (2007) detect some positive effects of aggregation. In the first study, as noted in our literature review, Partridge et al. (2007) point out that, while at some high population density congestion may decrease both productivity and welfare, wages are an ambiguous indicator of welfare in this context because, while a positive effect of aggregation on productivity would tend to increase wages, a positive effect of aggregation on welfare would tend to depress wages. How might these offsetting effects play out differently in Canada and the U.S. so that our results could be reconciled with those of Glaeser and Maré (2001) and Yankow (2006)? One possibility might be that Canadian cities are less affected by negative congestion effects on welfare or more by positive effects of agglomeration. While further research would be necessary, some plausibility to this notion might stem from The Economist Intelligence Unit (2014) Liveability ranking that lists three of Canada's major cities among the top six. Another possibility stems from noting that neither the Glaeser and Maré (2001) nor Yankow (2006) models control for broad regions. Since urban concentration would vary by region, some confounding of effects might occur.

Although our augmented human capital model can explain wage differences within the broad regions based on provincial borders, like Dickie and Gerking (1998) we reject the hypothesis that wage differences between these regions are illusory. Dickie and Gerking propose relocation costs as an important factor, and these costs would impede adjustment from initial

[14] Although they include industry but not occupation in their specification, our sensitivity analysis showed that the human capital model is the primary driver of our results.

conditions. Partridge, Olfert, and Alasia (2007) point out the well documented persistence of U.S. migration flows, including outflows from the northern Frostbelt to the amenity-rich Sunbelt after WWII, showing that imbalances could persist for decades. The Ferguson et al. (2007) study on Canada does not reveal an analogous situation with respect to amenities, however. In our literature review, we suggested that the intranational border effects detected by Helliwell and Verdier (2001) and Millimet and Osang (2007) impeding trade provide another mechanism to slow adjustment. Impediments to the interprovincial movement of labor and goods are a Canadian policy concern, and our results for broad regions are not at variance with this. The Red Seal Program (Red Seal, 2012) is intended to increase interprovincial mobility of labor, and the Trade, Investment, and Labour Mobility Agreement (TILMA) between British Columbia and Alberta address both labour and goods mobility. TILMA was expanded in 2010 to include Saskatchewan (Canada's New West Partnership, 2010). Although the correspondence of broad regions with provinces does not rule out border effects slowing adjustment, further work would be necessary to establish this.

While we have focused primarily on assessing the explanatory power of the augmented human capital model, and fundamental causes of differences between broad regions are beyond the scope of our study, in our section on price-adjusted wages we did note some tentative support for the notion that natural and urban amenities play a role in some cases.

REFERENCES

Bakhshi, Samira, Mohammad Shakeri, M. Rose Olfert, Mark D. Partridge, and Simon Weseen. (2009) "Do Local Residents Value Federal Transfers? Evidence from Interprovincial Migration in Canada," *Public Finance Review*, 37, 235-268.

Bazen Stephen . (2011) *Econometric Methods for Labour Economics*. Oxford University Press.

Breau, Sébastien and David L. Rigby. (2010) "International Trade and Wage Inequality in Canada," *Journal of Economic Geography*, 10, 55-86.

Cameron, A. Colin. and Pravin K. Trivedi. (2009) *Microeconometrics using Stata.* Stata Press: College Station, TX.

Canada's New West Partnership. (2010) Available at: http://www.newwestpartnershiptrade.ca/the_agreement.asp

Carrington, William J., John L. Eltinge, and Kristin McCue. (2000) *An Economist's Primer on Survey Samples*. Washington D.C.: Center for Economic Studies, U.S. Bureau of the Census.

Chen, Yong and Stuart S. Rosenthal. (2008) "Local Amenities and Life-Cycle Migration: Do People Move for Jobs or Fun?," *Journal of Urban Economics*, 64, 519–537.

Clogg, Clifford C., Eva Petkova, and Adamantios Haritou. (1995) "Statistical Methods for Comparing Regression Coefficients between Models," *American Journal of Sociology*, 100, 1271–1293.

Dickie, M. and Shelbie Gerking. (1998) "Interregional Wage Disparities, Relocation Costs, and Labor Mobility in Canada," *Journal of Regional Science*, 38, 61–87.

Ferguson, Mark, Kumar Ali, M. Rose Olfert and Mark Partridge. (2007) "Voting with Their Feet: Jobs versus Amenities," *Growth and Change*, 38, 77–110.

Glaeser, Edward L. and David C. Maré. (2001) "Cities and Skills," *Journal of Labor Economics*, 19, 316–342.

Helliwell, John F. and Geneviève Verdier. (2001) "Measuring Internal Trade Distances: A New Method Applied to Estimate Provincial Border Effects in Canada," *Canadian Journal of Economics*, 34, 1024–1041.

Heuermann, Daniel, Benedikt Halfdanarson, and Jens Süedekum. (2010) "Human Capital Externalities and the Urban Wage Premium: Two Literatures and their Interrelations," *Urban Studies*, 47, 749–767.

Hunt, Gary L. and Richard E. Mueller. (2002) "A Methodology for Estimating Returns to Skills for Canadian Provinces and U.S. States," *Journal of Regional Science*, 42, 127–143.

Justice Canada. (2014) "Constitution Acts, 1867 to 1982," Available at: http://laws-lois.justice.gc.ca/eng/Const/Index.html

Millimet, Daniel L. and Thomas Osang. (2007) "Do State Borders Matter for U.S. Intranational Trade? The Role of History and Internal Migration," *Canadian Journal of Economics*, 40, 93-126.

Natural Resources Canada. (2005) "Land and Freshwater Area, by Province and Territory." Available at: http://data.gc.ca/data/dataset/e37f0fd5-ab31-4ada-8d46-2c20f2a61b24

Partridge, Mark, M. Rose Olfert, and Alessandro Alasia. (2007) "Canadian Cities as Regional Engines of Growth: Agglomeration and Amenities," *Canadian Journal of Economics*, 40, 39–68.

Polèse, Mario and Richard Shearmur. (2004) "Is Distance Really Dead? Comparing Industrial Location Patterns over Time in Canada," *International Regional Science Review*, 27, 431–457.

Red Seal. (2012) Available at: http://www.red-seal.ca/c.4nt.2nt@-eng.jsp?cid=7&lang=eng

Roback, Jennifer. (1982) "Wages, Rents, and the Quality of Life," *Journal of Political Economy*, 90, 1257-1278.

Rosenthal, Stuart S. and William C. Strange. (2004) "Evidence on the Nature and Sources of Agglomeration Economies," in J. Vernon Henderson and Jacques-Francois Thisse (eds.), *Handbook of Regional and Urban Economics,* vol. 4: Cities and Geography. Elsevier-North Holland: Amsterdam, pp. 2119-2171.

Samuelson, Paul. A. (1948) "International Trade and the Equalisation of Factor Prices," *Economic Journal*, 58, 163–184.

Statistics Canada. (2014a) "CANSIM Table 282-0070." Available at: http://www5.statcan.gc.ca/cansim/

Statistics Canada. (2014b) "CANSIM Table 384-0038." Available at: http://www5.statcan.gc.ca/cansim/

Statistics Canada. (2007) 2006 Census Dictionary, Census Metropolitan Area (CMA) and Census Agglomeration (CA)." Available at: http://www12.statcan.ca/english/census06/reference/dictionary/geo009.cfm

The Economist Intelligence Unit. (2014) "A Summary of the Liveability Ranking and Overview." Available at: http://www.eiu.com/

Yankow, Jeffrey J. (2006) "Why Do Cities Pay More? An Empirical Examination of Some Competing Theories of the Urban Wage Premium," *Journal of Urban Economics*, 60, 139–161.

Weesie, Jeroen. (1999) "sg121: Seemingly Unrelated Estimation and the Cluster-Adjusted Sandwich Estimator," *Stata Technical Bulletin*, 52, 34–47.

Wooldridge, Jeffrey M. (2010) *Econometric Analysis of Cross Section and Panel Data*, 2nd ed. MIT Press: Cambridge, Massachusetts.

APPENDIX

Calculating the impact estimates

We consider the difference in predicted wages w_1 of an individual living in the base region and the wages w_j that this same individual would receive if they were to live in region j.

From the estimated equation of a model described by Equation (2) we would have

$$\text{Ln}(\hat{w}_j) - \ln(\hat{w}_1) \approx \widehat{\ln}(w_j) - \widehat{\ln}(w_1) = \left\{\hat{\mu}_j \cdot 1 + \sum_{r \neq j} z_r \hat{\mu}_r + \sum_s x_s \hat{\beta}_s\right\} - \left\{\hat{\mu}_j \cdot 0 + \sum_{r \neq j} z_r \hat{\mu}_r + \sum_s x_s \hat{\beta}_s\right\} = \hat{\mu}_j \tag{4}$$

$\Rightarrow$

$$\exp\left(\ln(\hat{w}_j) - \ln(\hat{w}_1)\right) = \exp\left(\ln(\hat{w}_j/\hat{w}_1)\right) = \hat{w}_j/\hat{w}_1 \approx \exp(\hat{\mu}_j) \tag{5}$$

where $\hat{\mu}_j$ is the coefficient of the dummy indicating residence in region j. The approximation occurs because of the nonlinearity of the logarithmic function. This approximation is used in all of the figures that display wage differentials (the graphs show ratios rather than log differences). In cases where dummies for living in a broad region and a particular CMA within that region are both included, we use the sum of the coefficients.

Occupation and industry groupings

Occupation

The occupational groupings are the 47 groups of NOC-S codes provided with the Statistics Canada LFS Public Use Microdata File (PUMF). The descriptions are provided below in Table A1.

Industry

Very broad industry categories were created by grouping the North American Industrial Classifications (NAIC) into 10 categories as follows: Agriculture, Primary, Utilities, Construction, Manufacturing, Trade, and Service (4 groups as in Table A2).

Table A1: Occupational groupings

1	Senior Management Occupations
2	Specialist Managers
3	Managers in Retail Trade, Food and Accommodation Services
4	Other Managers N.E.C.
5	Professional Occupations in Business and Finance
6	Finance and Insurance Administrative Occupations
7	Secretaries
8	Administrative and Regulatory Occupations
9	Clerical Supervisors
10	Clerical Occupations
11	Professional Occupations in Natural and Applied Sciences
12	Technical Occupations Related to Natural and Applied Sciences
13	Professional Occupations in Health
14	Nurse Supervisors and Registered Nurses
15	Technical and Related Occupations in Health
16	Assisting Occupations in Support of Health Services
17	Judges, Lawyers, Psychologists, Social Workers, Ministers of Religion, and Policy and Program Officers
18	Teachers and Professors
19	Paralegals, Social Services Workers and Occupations in Education and Religion, N.E.C.
20	Professional Occupations in Art and Culture
21	Technical Occupations in Art, Culture, Recreation and Sport
22	Sales and Service Supervisors
23	Wholesale, Technical, Insurance, Real Estate Sales Specialists, and Retail, Wholesale and Grain Buyers
24	Retail Salespersons and Sales Clerks
25	Cashiers
26	Chefs and Cooks
27	Occupations in Food and Beverage Service
28	Occupations in Protective Services
29	Occupations in Travel and Accommodation Including Attendants in Recreation and Sport
30	Childcare and Home Support Workers
31	Sales & Service Occupations N.E.C.
32	Contractors and Supervisors in Trades and Transportation
33	Construction Trades
34	Stationary Engineers, Power Station Operators and Electrical Trades and Telecommunications Occupations
35	Machinists, Metal Forming, Shaping and Erecting Occupations
36	Mechanics
37	Other Trades N.E.C.
38	Heavy Equipment and Crane Operators Including Drillers
39	Transportation Equipment Operators and Related Workers, Excl. Labourers
40	Trades Helpers, Construction, and Transportation Labourers and Related Occupations
41	Occupations Unique to Agriculture Excluding Labourers
42	Occupations Unique to Forestry Operations, Mining, Oil and Gas Extraction, and Fishing, Excluding Labourers
43	Primary Production Labourers
44	Supervisors in Manufacturing
45	Machine Operators in Manufacturing
46	Assemblers in Manufacturing
47	Labourers in Processing, Manufacturing and Utilities

Table A2: Service industry groupings

1	Finance, Insurance, Real Estate and Leasing; Professional, Scientific and Technical Services; and Management, Administrative and Other Support
2	Educational Services; Health Care and Social Assistance; and Information, Culture and Recreation
3	Accommodation and Food Services
4	Other Services

Table A3: Wage premium for CMAs: *Full* regression results 2005-2007

	Value	SE	Pr >| *t* |		Value	SE	Pr >| *t* |
Intercept	2.037	0.008	<.0001	occ37	0.204	0.009	<.0001
victoria	-0.018	0.006	0.0033	occ38	0.295	0.008	<.0001
vancouver	-0.029	0.005	<.0001	occ39	0.210	0.005	<.0001
calgary	0.002	0.006	0.7457	occ40	0.145	0.006	<.0001
edmonton	-0.029	0.007	<.0001	occ41	0.191	0.017	<.0001
regina	0.014	0.006	0.0266	occ42	0.287	0.011	<.0001
saskatoon	0.000	0.006	0.9655	occ43	0.153	0.011	<.0001
winnipeg	-0.022	0.006	0.0002	occ44	0.310	0.010	<.0001
toronto	0.012	0.004	0.007	occ45	0.100	0.006	<.0001
ottawa_gat	0.007	0.007	0.3407	occ46	0.114	0.008	<.0001
hamilton	0.019	0.008	0.0174	occ47	0.023	0.008	0.002
london	-0.005	0.006	0.406	agric	-0.165	0.016	<.0001
kitch_water	0.008	0.006	0.2121	prim	0.149	0.007	<.0001
stcath_niag	-0.023	0.006	<.0001	util	0.134	0.009	<.0001
montreal	0.033	0.005	<.0001	const	0.073	0.005	<.0001
quebec_cma	0.004	0.006	0.5327	trade	-0.065	0.004	<.0001
sherbrooke	0.002	0.006	0.7831	serv1	-0.010	0.004	0.012
moncton	0.008	0.008	0.3302	serv2	-0.027	0.004	<.0001
saintjohn	0.023	0.008	0.0035	serv3	-0.124	0.005	<.0001
halifax	0.065	0.006	<.0001	serv4	-0.071	0.006	<.0001
stjohns	0.010	0.007	0.1832	male	0.113	0.002	<.0001
Bc	0.050	0.004	<.0001	age25_29	0.140	0.003	<.0001
alberta	0.073	0.005	<.0001	age30_34	0.201	0.004	<.0001
man_sask	-0.075	0.004	<.0001	age35_39	0.220	0.004	<.0001
que_xncr	-0.083	0.003	<.0001	age40_44	0.219	0.003	<.0001
Atln	-0.185	0.003	<.0001	age45_49	0.228	0.004	<.0001
occ1	0.785	0.017	<.0001	age50_54	0.220	0.004	<.0001
occ2	0.736	0.008	<.0001	age55_59	0.200	0.004	<.0001
occ3	0.399	0.008	<.0001	age60_64	0.183	0.005	<.0001
occ4	0.674	0.007	<.0001	age65_69	0.075	0.011	<.0001
occ5	0.589	0.008	<.0001	married	0.019	0.002	<.0001
occ6	0.318	0.008	<.0001	widowed	-0.016	0.009	0.0733
occ7	0.221	0.006	<.0001	divorced	-0.003	0.005	0.5544
occ8	0.335	0.006	<.0001	somehigh	0.039	0.005	<.0001

	Value	SE	Pr >| t |		Value	SE	Pr >| t |
occ9	0.294	0.008	<.0001	highschl	0.094	0.005	<.0001
occ10	0.175	0.004	<.0001	somepost	0.107	0.006	<.0001
occ11	0.625	0.006	<.0001	diploma	0.141	0.005	<.0001
occ12	0.413	0.006	<.0001	ba	0.187	0.006	<.0001
occ13	0.655	0.013	<.0001	masters	0.227	0.007	<.0001
occ14	0.607	0.006	<.0001	fulltime	0.075	0.002	<.0001
occ15	0.460	0.007	<.0001	ten6_11m	0.003	0.003	0.369
occ16	0.197	0.006	<.0001	ten1_5y	0.057	0.003	<.0001
occ17	0.528	0.008	<.0001	ten6_10y	0.131	0.003	<.0001
occ18	0.541	0.006	<.0001	ten11_20y	0.179	0.003	<.0001
occ19	0.294	0.007	<.0001	ten_20plus	0.226	0.004	<.0001
occ20	0.488	0.012	<.0001	seasonal	-0.078	0.005	<.0001
occ21	0.306	0.009	<.0001	contract	-0.055	0.004	<.0001
occ22	0.131	0.006	<.0001	casual	-0.059	0.004	<.0001
occ23	0.356	0.007	<.0001	covered	0.106	0.002	<.0001
occ24	0.030	0.005	<.0001	size20_99	0.060	0.002	<.0001
occ25	-0.032	0.004	<.0001	sz100_500	0.105	0.003	<.0001
occ26	0.052	0.006	<.0001	Sizegt500	0.161	0.003	<.0001
occ27	0.138	0.007	<.0001	provpub	0.078	0.007	<.0001
occ28	0.146	0.008	<.0001	localpub	0.101	0.006	<.0001
occ29	0.116	0.009	<.0001	othrpub	0.070	0.007	<.0001
occ30	0.099	0.008	<.0001	yearlag1	-0.035	0.002	<.0001
occ32	0.411	0.009	<.0001	yearlag2	-0.061	0.002	<.0001
occ33	0.304	0.007	<.0001				
occ34	0.353	0.007	<.0001				
occ35	0.314	0.006	<.0001				
R^2 0.5925							

Table A4: Control variable name guide

Variable Mnemonic	Description
Occupation	**omit *occ31***
occ1-occ47	Occupational groupings as listed in Table A1
Industry	**omit Manufacturing**
agric	Agriculture (industry grouping)
prim	Primary (Forestry, Fishing, Mining, Oil and Gas)
util	Utilities
const	Construction
trade	Trade
serv1-serv4	Service industry groupings as listed in Table A2
Gender	**omit female**
male	Indicator for male gender
Age	**omit *age15_24***
age25_29- age65_69	Age categories (year intervals including the boundaries)
Marital Status	**omit *Single***
married	Married or common-law
widowed	Widowed
divorced	Separated/divorced
Education	**omit < *grade 11***
somehigh	Grade 11 to 13
highschl	Graduated from high school
somepost	Some post secondary
diploma	Post secondary certificate of diploma
ba	University: bachelors degree
masters	University: graduate degree
Full-time/Part-time	**omit *Part-time***
fulltime	Full-time (30+ hours) at the main or only job
Job Tenure	**omit *ten1_5m***
ten6_11m	Job tenure 6-10 months, currently employed only,
ten1_5y- ten_20plus	Job tenure categories (year intervals including the boundaries)
Permanent-Temp	**omit *permanent***
seasonal	Not permanent, seasonal
contract	Not permanent, Temporary, term or contract (incl temp. help agency)
casual	Not permanent, Casual or other
Union Status	**omit *not_covered***
covered	Union member or Not member but covered by collective agreement
Establishment Size	**omit < *20 workers***
size20_99- Sizegt500	Number of employees at workplace, intervals including the boundaries
Public Sector	**omit *private sector* (*federal public admin* is excluded from the sample)**
provpub	Provincial and Territorial Public Administration
localpub	Local, Municipal & Regional Public Administration and Aboriginal, Inter & Other Extra-Territorial Public Admin
othrpub	All other public employees (includes education and health)
Survey Year	**omit *2007***
yearlag1	2006
yearlag2	2005