Department of Economics
Discussion Paper 2002-10

The Dis-Integrating Canadian Labor Market: The Extent of the Market Then and Now

Patrick J. Coe and J. C. Herbert Emery
August 2002

Department of Economics
University of Calgary
Calgary, Alberta, Canada
T2N 1N4

The Dis-Integrating Canadian Labor Market: The Extent of the Market Then and Now*

Patrick J. Coe†
Department of Economics
University of Calgary

J.C. Herbert Emery
Department of Economics
University of Calgary

August 2002

Abstract

This paper presents an analysis of real wages for three occupations in 13 Canadian cities for the period 1901 to 1950 and 10 Canadian cities for the period 1971 to 2000 in order to determine the geographic extents of Canadian labor markets. Panel unit root tests and estimated half lives of shocks to relative real wages suggest that Canadian regional labor markets were more likely to have been integrated at the beginning of the twentieth century than at its end. Two institutional factors are offered as candidate explanations for this somewhat surprising result; the presence of an unemployment insurance scheme in the 1971 to 2000 sample and the increase in the extent of unionization during the twentieth century.

*We thank Marc Prud'homme of Statistics Canada for supplying us with some of the data used in this paper. This paper has benefited from the comments of Gregor Smith, Stuart Wilson, seminar participants at the Universities of Adelaide and Western Ontario and participants in the February 2000 Queen's Economic History Workshop, the World Congress of Cliometrics held at Montreal in July 2000, the Canadian Network for Economic History Conferences held at Stratford, Ontario in October 2000 and Montreal in April 2002 and the Canadian Economic Association Conference held in Montreal in June 2001.

†Corresponding author: Department of Economics, University of Calgary, 2500 University Drive NW, Calgary, AB, T2N 1N4, Canada. Voice: 1 403 220-8912. Email: pcoe@ucalgary.ca.

1 Introduction

The existence of income differentials across Canada's regions and provinces has been a persistent feature of the Canadian economy since at least 1890, (McInnis [19], A. Green [12]). Unemployment rates in labor markets east of Ottawa have typically exceeded those rates for labor markets in Ontario and west of Ontario. Further, the disparities in regional incomes and unemployment rates have been unaffected by dramatic changes in market forces and government policy over the last century. More often than not, the Canadian consensus as to the cause of the persistence in regional income disparities has been a dysfunctional Canadian labor market. Whether the cause of the dysfunction in the labor market is structural (for example, a mismatch of job demands in one region and the skills of the supply of workers available from another region), or policy related (for example government transfers discourage labor mobility), Canadian workers are viewed as not fully exploiting available arbitrage opportunities across regional labor markets. Consequently, to eliminate regional income and unemployment differentials in Canada, policy makers have focused on encouraging an expansion of the extents of Canada's regional labor markets, (D. Green [13]).

Needless to say, policy efforts aimed at extending the geographic margins of regional labor markets and improving the operations of labor markets through government established labor exchanges before 1930, or more recently, Employment Insurance reforms and the expanded investment in training for displaced workers, have not eliminated regional income and unemployment disparities. At this point there are two candidate explanations for this outcome. First, despite the best intentions and efforts of government, regional labor markets remain weakly integrated or non-integrated. Second, it is possible that regional labor markets in Canada are adequately integrated and the regional disparities are not arbitraged away because they represent equilibrium differentials rather than arbitrage opportunities. Our inability to distinguish between these two competing hypotheses at this point reflects that a direct test of the links between Canada's regional labor markets has not been provided.

Given the existence of regional income differentials since at least 1890, an important contribution towards an understanding of the reasons for the differentials would be to develop better information about the structure, evolution and operations of Canadian labor markets. That is the purpose of this paper. By examining trends in regional real wages and regional real wage growth rates for the periods $1900 - 1950$ and $1971 - 2000$, we seek to determine whether regional income and unemployment disparities reflect the fact that Canadian workers did not exploit arbitrage opportunities, or, whether the regional labor market disparities reflect equilibrium differentials. If the former is the better description, and non-integration of regional labor markets is the source of regional income disparities, then efforts of Canadian policy makers to date are well targeted. On the other hand, if the latter description is the better of the two, then more attention should be paid to long term factors in Canadian development as possible reasons for the regional labor market disparities.

This paper presents an analysis of Emery's and Levitt's [11] real wage series for three building trade occupations in 13 Canadian cities for the period 1900 to 1950 to determine the geographic extent of Canadian labor markets in the first half of the twentieth century. We also analyze the real wages of the same three occupations for 10 cities between 1971 and

2000 in order to determine the geographic extent of Canadian labor markets at the end of the twentieth century.

If the labor market is well integrated, then a shock that raises real wages in one location in the market relative to other locations (in the absence of compensating differentials etc.) will cause labor to move from the other locations to the one that experienced the positive shock. This will put downward pressure on real wages at the location in the market experiencing the shock and upward pressure on real wages at those locations that did not experience the shock. As a result, relative real wages across all locations in a market return to their original levels. In other words shocks that are specific to individual locations in a market have purely transitory effects on relative wages across locations. On the other hand, if two locations are not in the same market, then a shock that is to one of the locations does not induce migration from the other so real wages at that market remain permanently high relative to locations in other markets. That is location specific shocks have permanent effects.

We model real wages as being subject to two shocks, an aggregate (national) shock and an idiosyncratic (city specific) shock. To remove the aggregate shock from each real wage series we subtract the time-varying cross-sectional mean for that occupation. We then ask whether or not these demeaned series are best characterized by a unit root process or a stationary process. In the former case idiosyncratic shocks are permanent and are not arbitraged away. This would be inconsistent with Canada having a national labor market. However, in the latter case, consistent with Canada having a national labor market, idiosyncratic shocks are purely transitory. Our evidence from panel unit root tests suggests a reasonable degree of integration amongst Canada's regional labor markets during the first half of the twentieth century. However, our evidence suggests that by the end of the twentieth century this was no longer the case and we find very little evidence to suggest that Canada's regional labor markets are integrated from the $1971-2000$ sample. These results are supported by the estimated half lives of shocks to relative real wage series. We find the effects of these shocks to be more persistent in the $1971-2000$ sample than in the $1900-1950$ sample.

The remainder of the paper proceeds as follows. In section two we briefly discuss the context of our $1900-1950$ sample. In section three we discuss our measures of labor market integration. Section four introduces our data and section five discusses the results of applying the measures outlined in section three to that data. Section six offers some conclusions.

2 Early Canadian Labor Markets

Determining whether Canada's regional labor markets were integrated to a degree that Canada has had a national labor market is an important step towards understanding contemporary Canadian labor markets. In particular, the impact of government intervention and policies on Canadian labor markets can only be assessed accurately if we know the state of the labor markets prior to the policies or interventions being analyzed.

Inter-regional factor mobility and inter-regional trade in goods are unquestionable features of Canadian history that have been interpreted as evidence that Canada had a national economy and a national labor market before 1930. During the years 1896 to 1914 the Canadian prairies were settled, wheat was exported, and the Canadian economy grew rapidly.

Under the traditional Wheat Boom story for this period, prairie wheat exports "transformed the static and isolated regions (of Canada) into an integrated and expanding national economy." (Rowell-Sirois report [6, Book I, p93]). While the term "national economy" is vague, it included the notion of factor market integration:

> "The development of the west was a national achievement and the participation of all areas in a common effort fostered a new sense of nationhood. Sons and daughters of the Maritimes and Central Canada migrated to the plains and built up the west, thus forging innumerable links between older Canada and the new." (Rowell-Sirois [6, Book I, pp. 91-92])

Beyond the observed population and goods movements, there are other reasons to believe that Canada could have had a national labor market before 1930. Canada's rapid economic development before World War I coincided with what Williamson [29], [30] characterizes as an emergence of a global economy with convergence of real wages across countries. By 1890, Canada had a transcontinental railway to link the prairie region with the East. Good information about economic opportunities on the prairies was available. Struthers [27] describes in detail how the Federal government created and operated "labor exchanges" to aid the dissemination of information to enhance labor flows in Canada.

Norrie and Owram [20, p345] interpret movements of labor (and capital) over Canada's history as evidence that factor flows necessary for factor price equalization across regions were taking place. Emery and Levitt [11] find, however, that over the period 1900 to 1950 there was no evidence of convergence in real wages across 13 Canadian cities. But as Boyer and Hatton [5, p84] point out, there is no necessary link between migration and the extent of market integration; "Analyses of the pattern and extent of migration movements shed little light on the issue of integration. Markets could be perfectly integrated but exhibit little migration or they could exhibit high rates of migration but be poorly integrated."

A lack of labor market integration would not be unique to Canadian history. Boyer and Hatton [5, p84] find that in Victorian Britain, "considerable migration opportunities for arbitrage were not fully exploited." Similarly, Rosenbloom [24, p98] argues that the persistence of regional real wage differentials in the US after the Civil War suggest that "significant variations in the relative scarcity of labor persisted over more than three decades and that potential opportunities for arbitrage went unexploited." Allen [1, p125] finds that "despite massive migration both ways across the border with the United States, Canada preserved a distinctive wage structure." In contrast to Williamson's view of integrated international labor markets, Allen argues that the persistence of distinctive wage structures despite massive migrations makes it impossible to believe that labor markets were well integrated internationally.

3 Labor Market Integration: Concepts and Measures

An economist's notion of integration of geographically distinct markets is based upon the notion of the law of one price. In the absence of transportation costs, if buyers and sellers of a homogeneous good have complete information of the price of that good in the two markets, then in equilibrium the price for the good is the same in both markets (Stigler and

Sherwin [26]). If demand for the good rises in market A, then the price of the good will rise at A triggering additional supply into A from market B. Equilibrium is restored once the expansion of supply is large enough to restore the equality of the price in markets A and B. This concept of one price can be generalized such that if there are transportation costs, or local amenities or dis-amenities associated with a given location, then prices can differ in equilibrium, but by no more than the amount of transportation costs or "compensating differentials."

In applying this notion of market integration to labor market integration, Rosenbloom [24] characterizes a completely integrated labor market as one in which the workers are aware of employment opportunities at all locations in the market and through migration can offer their services to employers at any location in the market. If there are no site-specific amenities or dis-amenities, labor market equilibrium will have all workers of equal ability doing identical work receiving the same real wage. If workers are not indifferent to the location where they work, migration between locations will cease when real wages differ in equilibrium only to the extent that the individuals are indifferent between working in the two locations.

Labor market integration is most likely less than complete and determining the degree of labor market integration is primarily an empirical problem. Complete integration may be prevented by imperfect information about employment opportunities in distant locations; by institutional and financial constraints that impinge on a potential migrant's ability to act on information about employment opportunities in other places, and given that migrating is costly and potentially irreversible, uncertainty as to the persistence of favorable labor market conditions in other locations.

One approach for determining the geographic extents of markets has been to calculate the correlation coefficient of wage changes in two labor markets (Stigler and Sherwin). The higher the correlation coefficient, the more closely integrated two markets are assumed to be. Boyer and Hatton [5] point out that an important shortcoming of this approach is that one cannot distinguish between a strong tendency for instantaneous arbitrage (market integration) and common shocks to labor demand and supply at each location (spurious correlation).

An alternative approach is to search for trends over time in measures of wage dispersion (e.g. the coefficient of variation) across several markets. Diminishing dispersion of wage rates is interpreted as evidence of an increased degree of labor market integration. However, as with the correlation coefficient, this measure of dispersion approach has limitations for identifying labor market integration; an absence of a distinct trend in the measure of dispersion could reflect either well-integrated markets or very poorly integrated markets (Boyer and Hatton).

A popular recent approach to testing the law of one price in international goods markets is to use panel unit root tests to determine whether real exchange rates are mean reverting. See, for example, Oh[21] or Papell [22]. Under the null hypothesis that purchasing power parity (PPP) does not hold, real exchange rates can be described by unit root processes. This implies that shocks to the real exchange rate are permanent. Under the alternative hypothesis real exchange rates are stationary around a mean (or possibly around a deterministic trend).

Here shocks to the real exchange rate are purely transitory, and in the long-run a generalized version of PPP holds.

Another popular approach is to determine how long the effects of a shock to relative prices will persist. Here the half life of shocks measures the expected time until the effect of a shock to relative prices decays by 50%. The higher the half life, the longer deviations to purchasing power parity persist. We use both of these approaches to explore the extent of labor market integration in Canada during the first half of, and the last 30 years of, the twentieth century.

Suppose that the log of the real wage in city i can be described by the following stochastic process:

$$w_{i,t} = \alpha_i + \gamma_i \tau_t + \rho_i w_{i,t-1} + u_{i,t}, \qquad i = 1, \ldots, N, \quad t = 1, \ldots T, \tag{1}$$

where $w_{i,t}$ is the log of the real wage in city i at time t, τ_t is a linear time trend, ρ_i measures the persistence of the shocks, $u_{i,t}$, to the real wage process, N is the number of cities and T is the number of time periods. When $\rho_i = 1$ shocks to $w_{i,t}$ are permanent, in other words $w_{i,t}$ contains a unit root. In this case the half life of a shock to $w_{i,t}$ is undefined. On the other hand when $\rho_i = 0$ shocks to $w_{i,t}$ are transitory and the half life provides a measure of their persistence.

Note, in this context, a value of $\rho_i = 1$ does not necessarily imply that the labor market in city i is not integrated with other labor markets. The reason for this goes back to Hatton and Boyer's point about common shocks. Suppose that the shock to real wages in city i at time t is the sum of two orthogonal random components and that we can write $u_{i,t}$ as follows:

$$u_{i,t} = \theta_t + \varepsilon_{i,t}, \tag{2}$$

where θ_t represents an aggregate (nationwide) random shock and $\varepsilon_{i,t}$ represents an idiosyncratic (city specific) random shock, which is independently distributed across cities and has variance σ_i^2. In this case, the presence of permanent aggregate shocks and transitory idiosyncratic shocks will lead to a unit root in real wages. However, the fact that idiosyncratic shocks are purely transitory is consistent with labor market integration.

If the aggregate shock can be removed from each real wage series and the remaining time series is still characterized by a unit root process then this is inconsistent with labor market integration. In this case the idiosyncratic shocks are permanent, that is, they are not arbitraged by, for example, labor migration between cities. On the other hand, if the remaining time series is stationary then, consistent with an integrated labor market, the idiosyncratic shocks are purely transitory.

One way to remove the aggregate shock is to subtract the cross-sectional mean from each individual real wage series.[1] In this case equation (1) becomes:

$$\widetilde{w}_{i,t} = \widetilde{\alpha}_i + \widetilde{\gamma}_i \tau_t + \rho_i \widetilde{w}_{i,t-1} + \zeta_{i,t}, \qquad i = 1, \ldots N, \quad t = 1, \ldots T. \tag{3}$$

where $\widetilde{w}_{i,t} = w_{i,t} - N^{-1} \sum_{j=1}^{N} w_{j,t}$ is the demeaned real wage for city i at time t, $\widetilde{\alpha}_i = \alpha_i - N^{-1} \sum_{j=1}^{N} \alpha_j$, $\widetilde{\gamma}_i = \gamma_i - N^{-1} \sum_{j=1}^{N} \gamma_j$ and $\zeta_{i,t} = \widetilde{\varepsilon}_{i,t} + N^{-1} \sum_{j=1}^{N} \left(\rho_i - \rho_j\right) w_{j,t-1}$

[1] Note, that we are implicitly assuming that the impact of the (unobserved) common shock does not differ across the units of the panel.

where $\widetilde{\varepsilon}_{i,t} = \varepsilon_{i,t} - N^{-1} \sum_{j=1}^{N} \varepsilon_{j,t}$.

We employ the Fisher test of Madalla and Wu [18] to test the null hypothesis:

$$H_0 : \rho_i = 1 \text{ for all } i = 1, \ldots, N \tag{4}$$

against the alternative:

$$H_1 : \rho_i < 1 \text{ for } i = 1, \ldots N_1, \ \ \rho_i = 1 \text{ for } i = N_1 + 1, \ldots N. \tag{5}$$

The null hypothesis is that each time series in the panel is non-stationary, suggesting no labor market integration. However, the alternative is not that each time series within the panel is stationary, but rather that some fraction of the time series (N_1/N) are stationary.[2] An alternative test to the one that we employ which has the alternative hypothesis that each series in the panel is stationary is the one proposed by Levin and Lin [17]. However, by employing the less restrictive alternative hypothesis of equation (5), we are able to allow for the possibility that some subset of the locations we consider are integrated.[3] Therefore, rejection of the null hypothesis implies that there is some degree of labor market integration. If this is the case, then by examining the individual city statistics used to derive the panel

[2] Note for this test to be consistent under the alternative hypothesis we also require that $\lim_{N\to\infty} (N_1/N) = \lambda_1$, $0 < \lambda_1 \leq 1$.

[3] Note that the Levin and Lin test is also more restrictive in another way. As the statistic is derived using a pooled panel estimator and so imposes homogeneity on the ρ_i parameters and on the residual variance for each unit of the panel (the intercepts, α_i, are allowed to differ through the use of unit specific dummy variables). Madalla and Wu's [18] Monte Carlo studies also suggest that the Levin and Lin test has poorer small sample properities than the Fisher test.

statistics we are able to draw some inference regarding the extent of labor market integration.

The Fisher test tests the null hypothesis of equation (4) by combining the $p-$values from individual unit root tests. Under the null hypothesis that each series contains a unit root, the statistic

$$\lambda = -2 \sum_{i=1}^{N} \ln \pi_i \tag{6}$$

is distributed $\chi^2(2N)$, where π_i is the $p-$value for the test of $\rho_i = 1$ for $i = 1, 2, \ldots, N$ against the alternative that $\rho_i < 1$. The individual unit root test that we employ is the DF-GLS test of Elliot, Rothenberg and Stock [10].[4] Further details of this test can be found in the notes to table 2A.

Note, that while the demeaning process removes the aggregate shock from the time series for real wages it may introduce correlation among the error terms in the N equations described by (3). If this is the case then, under the null hypothesis, the distribution of the test statistics for $\rho_i = 1$ for $i = 1, 2, \ldots, N$ are non-standard. For this reason we use the bootstrap procedure of Madalla and Wu [18] to calculate the $p-$values from which we calculate the Fisher statistic. This bootstrap procedure captures the cross-section correlation that is present in the data. Further details of this procedure are contained in the appendix.

While unit root tests can provide evidence on whether or not shocks to individual locations are transitory they are silent on the how long the effects of these shocks will persist.

[4] Elliot, Rothenberg and Stock show how the DF-GLS test provides an improvment in power over the standard ADF tests in the presence of deterministic components such as a constant and a linear trend. We also experiment with the ADF test as the underlying unit root test. As with the results presented in this paper we find much less evidence of labor market integration in the $1971 - 2000$ sample than in the $1900 - 1950$ sample when using the ADF test. Full details of these results are available on request.

Therefore in order to obtain a measure of how quickly real wages return to equilibrium ratios following idiosyncratic shocks we also calculate the half-life of shocks to the de-meaned real wage series. The half-life of a shock to the demeaned real wage in city i is calculated as:

$$h_i = \left| \frac{\ln(0.5)}{\ln(\rho_i)} \right| \tag{7}$$

When deterministic components such as an intercept or time trend are included in an autoregressive model standard estimators of the autoregressive parameter contain downward bias. This is problematic in this context as downward bias in ρ_i translates into downward bias in h_i. This may lead us to conclude that idiosyncratic shocks are less persistent than they really are and that the Canadian labor market is functioning more efficiently than it really is. To avoid this potential pitfall we use a median-unbiased estimate for ρ_i obtained using the procedure of Andrews [2]. Further details of this procedure are contained in the notes to table 2A.

4 Real Wage Data

To test for labor market integration in Canada over the $1900 - 1950$ time period we use observations of real wages for 13 cities in Canada. Emery and Levitt [11] construct the real wage series with data from Department of Labor supplement to the Labor Gazette [9] on hours and wages. From this source they obtain nominal hourly wage rates for carpenters, bricklayers and builders' laborers for the period $1901 - 1950$.[5] The cities are: Victoria, Vancouver, Edmonton, Calgary, Regina, Winnipeg, Hamilton, Toronto, Ottawa, Montreal, Quebec City, Saint John and Halifax.[6] Emery and Levitt use price data from Coats [7], the expenditure weights from Bertram and Percy [4] and the Labor Gazette [8] to construct inter-urban price indexes that express the price level in city i at time t in terms of goods in the base city (Toronto) in the base year (1913). For a discussion of the construction of these real wage series and their potential limitations see Emery and Levitt.[7]

To test for labor market integration over the $1971 - 2000$ time period we use observations of real wages for 10 cities. Our nominal wage series are taken from the CANSIM databank. The cities are: Vancouver, Edmonton, Regina, Winnipeg, Toronto, Ottawa, Montreal, Saint John, Halifax and St. John's. We than convert these nominal wages series into real wages expressed in base city (Toronto), base year (1999) dollars using city price indices from the CANSIM databank and an inter-city price index for 1999 provided by Marc Prud'homme of Statistics Canada. Further details of the $1971 - 2000$ sample are contained in the appendix.

While nominal wages in the west of Canada were higher than in the east in the early

[5] Emery and Levitt also collect data for machinists in metal trades for the period $1901 - 1938$ and common labor in factories for the period $1911 - 1940$. Unfortunately, we are unable to obtain comprable data for these occupations for the 1971-2000 period. However, we do obtain similar results as for the three building trades for these two occupations over the sample from the first half of the twentieth century. These results are available from the authors on request.

[6] It could be argued that Hamilton is part of Toronto and therefore including it as a separate unit biases the results towards finding labor market integration. In fact, with Hamilton excluded from our sample we find that the data suggests a slightly higher degree of labor market integration over the period $1900 - 1950$ than the results presented in this paper. Full details available on request.

[7] For the years between 1900 and 1905 and between 1905 and 1909 we have used linear interpolation to obtain price index values. When undertaking the panel unit root tests and estimating the half lives of shocks we also restrict our analysis to data beginning in 1909 rather than 1900. Again, when doing this we obtain results similar to those presented in this paper (available on request).

twentieth century, it was well known that the cost of living was higher in the west, and the early conditions of life in the west made it a less desirable place to settle than the east. Table 1A shows the real wages of each city divided by the sample average for that year for selected years of our historical sample. Throughout the sample, and across occupations real wages were typically highest in British Columbia and Alberta and lowest in Quebec and the Maritimes. Table 1B shows that for the $1971-2000$ sample relative wages are typically highest in Toronto and Ottawa and, to a lesser extent, Vancouver.

5 Empirical Results

For the historical sample our real wage data spans the period 1900 to 1950. In our (panel) unit root tests we allow for up to 4 lagged dependent variables and so with the loss of one observation when we take first differences our sample period is $1905-1950$ and the sample size is $T=46$. When calculating the half life of shocks we estimate an AR(1) model on the levels of the relative wage series and therefore lose only one observation. As such our sample period is $1901-1950$ and $T=50$. With real wage data for 13 cities for these years, $N=13$.

For the contemporary sample our real wage data spans the period 1971 to 2000. Again, in our (panel) unit root tests we allow for up to 4 lagged dependent variables and lose one observation when differencing, so our sample period is $1976-2000$ and the sample size is $T=25$. When calculating the half life of shocks from an AR(1) model we lose one observation and so our sample period is $1972-2000$ and $T=29$. For our contemporary sample we have real wage data for 10 cities and so $N = 10$.[8]

Tables 2A to 2C contains the results of our unit root tests and estimates of the half-life of shocks to the de-meaned real wage series for each of our three occupations. This table contains the individual DF-GLS test statistics for each city. Each of these individual test statistics is accompanied by a bootstrapped $p-$value. We use these $p-$values to construct the Fisher panel unit root test. In each individual DF-GLS regression we follow Elliot, Rothenberg and Stock [10] and choose the lag order for each equation using the BIC.

The results in tables 2A to 2C show that for the $1900-1950$ sample the null hypothesis of equation (4) is overwhelmingly rejected. That is, we reject the null hypothesis of no labor market integration in Canada over this period. However, recently the interpretation of the results of panel unit root tests has been the subject of much research. See, for example, Karlsson and Löthgren [14] and Sarno and Taylor [25]. A common theme of many of these studies is what inference can be drawn about the time series properties of a panel when the null hypothesis is rejected. In particular, it is often stressed that a rejection of the null hypothesis, as stated by equation (4), does not imply that each time series in the panel is stationary. What a rejection of the null hypothesis does tell us is that at least one of the series in the panel is stationary. In other words, for at least one Canadian city over this

[8] It could be argued that the difference in our results across samples can be attributed to the historical sample being longer than the contemporary sample. That is, with a longer time span we are more likely to reject the null hypothesis when it is false. We also perform our analysis on sub-samples of 30 years of our historical data. Estimates (available on request) using the middle 30 years of our historical sample imply a similar degree of labor market integration as those from the whole $1900-1950$ sample. It could also be argued that our results differ as our two samples do not contain an identical set of cities. Again we repeat our analysis confining our attention to the nine cities that are common to both samples and find stronger evidence in favor of labor market integration in our $1900-1950$ sample than in our $1971-2000$ sample. These results are also available on request.

period shocks to real wages were purely transitory. However, this alone tells us very little about the extent of labor market integration in Canada in the first half of the twentieth century.

Karlsson and Löthgren suggest that in order to better understand the time series properties of panel data the researcher should look at both panel and individual unit root test statistics. In order to try to determine the extent of labor market integration we now focus our attention on the individual city DF-GLS test statistics and bootstrapped $p-$values from the de-meaned regressions. Recall that the absence of a unit root implies that idiosyncratic shocks are purely transitory and is therefore consistent with an integrated labor market in which shocks are arbitraged away.

These statistics are evidence of the Canadian labor market being integrated during the first half of the twentieth century, particularly when we use the real wage data for building laborers and bricklayers. In other words, it is for these occupations that we find the most evidence against the null hypothesis of a unit root across the individual city statistics. The statistics for builders' laborers reject the null at the 10% level for 9 of the 13 cities. The cities for which we do not reject the null hypothesis are Ottawa, Montreal, Quebec City and Saint John. For bricklayers we reject the null hypothesis in 8 of 13 instances. Again Ottawa and Montreal are among the group of cities for which we fail to reject the null hypothesis. Finally, for carpenters we only find 4 of 13 $p-$values less than 0.10, suggesting weaker evidence of labor market integration for this occupation.

In our contemporary sample we find much less evidence in favor of an integrated labor market. The Fisher test fails to reject the null hypothesis that each series in the panel contains a unit root for both the bricklayer and carpenter samples. In other words we fail to reject the null hypothesis of no labor market integration. This is supported by looking at the results of individual unit root tests. For bricklayers we find only one $p-$value less than 0.1 (Montreal) and for Carpenters we find just two such $p-$values (Winnipeg and Ottawa). Implying that for almost all the cities in our sample we cannot reject the null hypothesis of a unit root in the cross sectionally demeaned real wage series. Moving over to the sample on building laborers' real wages we do find a rejection of the null hypothesis of equation (4). However, again a look at the individual DF-GLS statistics reveals a rejection of the null hypothesis that the demeaned real wage in city i contains a unit root in only 3 (Ottawa, Montreal and St. John's) of the 10 cases. Thus, based on the evidence of our panel and individual unit root tests we conclude that Canadian labor markets are less likely to be integrated with one another now than they were during the first half of the twentieth century.

This conclusion is supported by looking at the estimated half lives of shocks to demeaned real wages. Recall these figures give us information about the persistence of shocks to relative real wages. All else equal, the greater the degree of labor market integration the quicker we would expect to see relative wages adjust to city specific shocks. Across our three occupations we find half lives that are mostly in the range of 1 to 4 years in our historical sample, with only 6 of 39 being in excess of 4 years. Also all of the half-lives estimated using data from $1900 - 1950$ are finite consistent with a value of ρ_i that is less than one.

On the other hand, in our contemporary sample, 14 of our 30 point estimates of the half life of a shock are equal to infinity. In other words the median unbiased estimate of ρ is unity, suggesting that idiosyncratic shocks are permanent. Of those that are finite, most half lives are also in the range of 1 to 4 years, and 3 of those 16 are greater than 4 years. Finally, nine of our cities are common to both time periods. Across these 9 cities and the 3 occupations we find that the estimate of the half-life of idiosyncratic shocks is lower in the historical sample in 19 of 27 cases.

It might appear odd that the Canadian labor market is less integrated at the end of the twentieth century than at the beginning. We might expect that with advances in communications and transportation technology labor markets would become more integrated as workers had better access to information concerning wages in other locations and cheaper and quicker means of getting to those locations. We suggest two institutional factors that might have reduced the amount of labor market integration. The first is the presence of an publicly administered unemployment insurance scheme and the changes to that scheme contained in the 1971 Unemployment Insurance Act that may have reduced the incentive for workers to migrate out of a location in response to a negative labor market shock. The second is the rise in the extent of unionization, particularly amongst the building trades that may have reduced the ability of workers to move across provincial borders to seek employment.

For much of our historical sample there was no state run unemployment insurance scheme. The 1940 Unemployment Insurance Act marked the beginning of publicly administered coverage for most workers.[9] Under this Act a person who had paid contributions for at least 180 days in the past two years and was available for work was eligible to receive benefits once a 10 day waiting period had been served. A single person could then receive benefits of between approximately 38 and 63 percent of their previous earnings. In the subsequent 30 years a number of relatively minor revisions to the scheme took place and then the 1971 Unemployment Insurance Act introduced substantial changes. This Act changed the eligibility requirement to 8 weeks of paid contributions within a qualifying period. This qualifying period was either the last 52 weeks or the period since the last benefit period began. In addition to making the qualification for benefits less demanding the 1971 raised the level of benefits. For example a single person received benefits equal to 66.7% of earnings in 1972.[10]

One might expect that as unemployment benefits become more readily available and more generous workers in regions experiencing negative idiosyncratic shocks will be less inclined to move away from those regions in order to look for work. As such labor markets might become less integrated. This maybe particularly relevant for the occupations that we analyze. If the demand for labor in the building industry is cyclical and still somewhat seasonal, and that cyclical and seasonal patterns vary across locations, then the presence of a fairly generous unemployment insurance scheme could well reduce the degree of labor market integration.

An alternative explanation for the decline in labor market integration is the rise in the extent of unionization, particularly among the building trades. Overall union density in

[9]Exclusions still existed, these included those working in agriculture, fishing, teaching, domestic service and a number of other occupations. See Kesselman [16] for more details on the 1940 and 1971 Acts.

[10]In 1979 this was lowered to 60%. See Kesselman, page 49.

Canada has increased from 14% in 1930 to 38% in 1985.[11] In the construction industry these figures are 25% in 1930 and over 50% in the mid 1980s.[12] Union wage gains come at the expense of free entry of labor into the unionized labor market. In many industries and occupations, unions have successfully institutionalized barriers to entry into the provincial labor market through provincial labor market policies. Beaulieu, Higginson and Gaisford . argue that interprovincial barriers to labor mobility are recognized as significant in the Canadian union. While the 1994 Agreement on Internal Trade (AIT) between the federal, provincial and territorial governments included provisions to reduce interprovincial barriers to labor mobility through requirements that jurisdictions recognize qualifications of workers from other jurisdictions and harmonize occupational standards, barriers to labor mobility persist. For example, if a province is experiencing high unemployment, under the AIT, a province can impede the in-migration of out of province trades people.

6 Conclusions

A necessary condition for markets to be integrated is that shocks which are specific to one location cannot lead to permanent changes in relative real wages across locations. Instead idiosyncratic shocks will have purely transitory effects on relative real wages. Once we remove the common shock to real wages by cross-sectionally demeaning our real wages series our panel and individual unit root tests are generally supportive of the alternative of stationarity

[11] See Riddell [23]. These figures are union membership as a percentage of non-agricultural workers.

[12] The first figure is the ratio of union membership (taken from the Historical Atlas of Canada [15]) to the number of paid workers with jobs (taken from the Historical Statistics of Canada [28]). The latter figure is taken from CANSIM series V810402.

and therefore consistent an integrated labor market for the period 1901 to 1950. Similar analysis for the period 1971 to 2000 is much less supportive of Canada's labor market being integrated. We also construct the half-life of shocks to relative wages in each sample period. We find that these shocks are more persistent in the 1971 to 2000 sample, again suggesting Canada's labor market is less well integrated at the beginning of the twenty-first century than in the first half of the twentieth century.

We offer two candidate explanations for these differences, the rise in the proportion of the workforce that is unionized and the presence of an unemployment insurance scheme during the period 1971 to 2000. An avenue for future research is further exploration of these channels.

References

[1] R.C. Allen (1994) “Real Incomes in the English Speaking World, 1879-1913,” in George Grantham and Mary MacKinnon eds. Labor Market Evolution.

[2] Donald Andrews (1993) “Exactly Median-Unbiased Estimation of First Order Autoregressive / Unit Root Models” Econometrica 61(1), 139-165.

[3] Beaulieu, Eugene, Jim Higginson and Jim Gaisford (2002) “Interprovincial Trade Barriers in Canada: How Far Have We Come? Where Should We Go?” Report Prepared for The Van Horne Institute, April 20, 2002

[4] Gordon Bertram and Michael B. Percy (1979) “Real Wage Trends in Canada 1900-26: Some Provisional Estimates,” Canadian Journal of Economics XII(2), 299-312.

[5] George Boyer and Timothy J. Hatton (1994) “Regional Labor Market Integration in England and Wales, 1850-1913,” in George Grantham and Mary MacKinnon eds. Labor Market Evolution.

[6] Canada, Royal Commission on Dominion Provincial Relations (1964) The Rowell-Sirois Report: An Abridgement of Book I of the Royal Commission Report on Dominion Provincial Relations, Donald V. Smiley ed. (Toronto: McClelland and Stewart).

[7] R.H. Coats (1915) The Rise of Prices and the Cost of Living in Canada, 1900-1914, Board of Inquiry into Cost of Living, Vol. II (Ottawa: King’s Printer).

[8] Department of Labor, Canada Labor Gazette.

[9] Department of Labor, Canada, Wages and Hours of Labor in Canada.

[10] Elliot, G., T.J. Rothenberg. and J.H. Stock, (1996) “Efficient Tests for an Autoregressive Unit Root”, Econometrica, 64, $813 - 836$.

[11] J.C. Herbert Emery and Clinton Levitt (2002) “Cost of Living, Real Wages and Real Incomes in Thirteen Canadian Cities, 1900-1950,” Canadian Journal of Economics, 35(1).

[12] Alan G. Green (1971) Regional Aspects of Canada’s Economic Growth (Toronto: University of Toronto Press).

[13] David A. Green (1994) “Bridging the Gap Between Labor Economics and Economic History: A Labor Economist’s Perspective,” in George Grantham and Mary MacKinnon eds. Labor Market Evolution.

[14] Sune Karlsson and Mickael Löthgren (2000) “On the Power and Interpretation of Panel Unit Root Tests,” Economics Letters, 66, 249-255.

[15] Donald Kerr and Deryck W. Holdsworth eds. (1990) "Historical Atlas of Canada: Volume III" (Toronto: University of Toronto Press).

[16] Jonathan R. Kesselman (1983) "Financing Canadian Unemployment Insurance" Canadian Tax Foundation, Canadian Tax Paper Number 73.

[17] A. Levin and C.F. Lin (1993) "Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties," mimeo, University of California, San Diego.

[18] G.S. Maddala and Shaowen Wu (1999) "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test," Oxford Bulletin of Economics and Statistics, Special Issue, 631-652.

[19] Marvin McInnis (1968) "The Trend of Regional Income Differentials in Canada," Canadian Journal of Economics 1(2), 440-470.

[20] Kenneth Norrie and Douglas Owram (1996) A History of the Canadian Economy Second Edition (Toronto: Harcourt Brace & Company).

[21] Oh, K.-Y. (1996) "Purchasing Power Parity and Unit Root Tests using Panel Data," Journal of International Money and Finance 15, 405-418.

[22] Papell, D.H. (1997) "Searching for Stationarity: Purchasing Power Parity under the Current Float," Journal of International Economics 43, 313-332.

[23] W. Craig Riddell (1993) "Unionization in Canada and the United States: A Tale of Two Countries" in David Card and Richard B. Freeman eds. "Small Differences That Matter: Labor Markets and Income Maintainance in Canada and the United States" (Chicago: University of Chicago Press).

[24] Joshua Rosenbloom (1990) "One Market or Many? Labor Market Integration in the Late Nineteenth Century United States," Journal of Economic History L(1), 85-107.

[25] Lucio Sarno and Mark P. Taylor (2000) "Deviations of Exchange Rates from Purchasing Power Parity: A Cautionary Note," mimeo, University of Oxford and Warwick University.

[26] George J. Stigler and Robert A. Sherwin (1985) "The Extent of the Market," Journal of Law and Economics 28, 555-585.

[27] James Struthers (1983) No Fault of Their Own: Unemployment and the Canadian Welfare State 1914-1941 (Toronto: University of Toronto Press).

[28] M.C. Urguhart ed. (1965) "Historical Statistics of Canada" (Toronto: Macmillan).

[29] Jeffrey G. Williamson (1995) "The Evolution of Global Labor Markets Since 1830: Background Evidence and Hypotheses," Explorations in Economic History 32(2), 141-196.

[30] Jeffrey G. Williamson (1996) "Globalization, Convergence and History," The Journal of Economic History 56(2), 277-306.

Table 1A: Ratios of Real Wages to Canadian Average for Selected Years 1900 -1950

	Building Laborers					Bricklayers					Carpenters				
	1900	1913	1926	1938	1950	1900	1913	1926	1938	1950	1900	1913	1926	1938	1950
Victoria	1.21	1.19	1.28	1.14	1.16	1.12	1.04	1.09	1.01	1.06	1.22	1.05	1.09	0.98	1.11
Vancouver	1.27	1.40	1.25	1.13	1.16	1.18	1.23	1.05	1.10	1.10	1.28	1.24	1.26	1.07	1.15
Edmonton	0.98	0.99	1.10	1.23	1.21	1.19	1.02	1.18	1.26	1.15	1.05	0.93	1.08	1.34	1.15
Calgary	0.91	1.05	0.98	1.15	1.02	0.84	1.07	1.08	1.19	1.12	0.99	1.20	1.24	1.12	1.08
Regina	0.74	0.72	0.96	0.89	1.02	0.99	0.91	1.08	1.10	1.06	0.69	0.78	1.11	0.98	1.03
Winnipeg	0.94	0.78	1.01	0.99	0.89	1.10	1.01	1.17	1.08	1.04	0.90	0.98	1.23	1.09	1.04
Hamilton	1.27	1.10	0.92	0.90	1.01	1.05	1.03	0.99	0.85	1.01	1.07	1.07	1.00	0.92	1.06
Toronto	1.32	0.99	1.13	0.93	1.03	1.00	0.92	0.97	0.97	1.09	1.10	1.08	1.06	1.14	1.15
Ottawa	0.97	1.01	1.09	1.07	0.84	0.98	0.95	0.97	0.90	0.87	1.02	0.86	0.95	1.11	0.85
Montreal	0.76	1.07	0.82	0.91	0.98	0.72	1.00	0.90	0.82	0.92	0.68	1.08	0.90	0.87	0.95
Quebec City	0.77	0.89	0.85	0.95	0.93	0.88	0.91	0.83	0.78	0.76	0.95	0.78	0.66	0.75	0.75
Saint John	0.94	0.84	0.85	0.86	0.78	0.89	0.99	0.87	0.93	0.96	0.97	0.96	0.68	0.74	0.81
Halifax	0.91	0.97	0.78	0.86	0.99	1.08	0.90	0.83	1.01	0.88	1.08	0.99	0.75	0.88	0.88

The real wage for city i at time t ($W_{i,t}$) is the nominal wages deflated by the urban price index. The base for the price index is Toronto in 1913. The relative real wage for city i at at time t is given by:

$$\widetilde{W}_{i,t} = \frac{W_{i,t}}{N^{-1}\sum_{j=1}^{N} W_{j,t}}.$$

Table 1B: Ratios of Real Wages to Canadian Average for Selected Years 1971 -2000

	Building Laborers				Bricklayers				Carpenters			
	1971	1981	1991	2000	1971	1981	1991	2000	1971	1981	1991	2000
Vancouver	1.47	1.16	1.20	1.17	1.12	0.93	0.91	0.94	1.38	1.30	1.27	1.22
Edmonton	1.14	0.98	0.96	0.93	0.87	0.83	0.89	0.80	1.00	1.03	0.94	1.04
Regina	0.99	0.99	0.96	0.93	0.74	0.84	0.83	0.81	0.77	0.87	0.86	0.80
Winnipeg	0.82	0.94	0.84	0.81	0.79	0.85	0.83	0.82	0.91	0.97	0.89	0.88
Toronto	1.31	1.37	1.44	1.46	1.57	1.41	1.43	1.49	1.50	1.35	1.36	1.39
Ottawa	1.04	1.11	1.17	1.24	1.29	1.24	1.29	1.35	1.15	1.17	1.22	1.24
Montreal	1.01	0.92	0.93	0.98	1.08	1.07	1.03	1.08	1.01	0.95	0.96	1.01
Saint Johns	0.72	0.79	0.70	0.75	0.85	0.87	0.87	0.88	0.78	0.77	0.82	0.74
Halifax	0.84	0.89	0.93	0.93	0.97	0.98	1.01	1.00	0.83	0.80	0.89	0.92
St John	0.63	0.85	0.88	0.82	0.72	0.98	0.90	0.83	0.64	0.78	0.79	0.76

See notes to table1A.

Table 2A: Unit Root Tests and Half Lives of Shocks: Building Laborers						
	1900 – 1950			1971 – 2000		
	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks
Victoria	−3.5329	0.0386	2.6745	−−	−−	−−
Vancouver	−3.5096	0.0202	2.6516	−0.9052	0.5567	∞
Edmonton	−4.2164	0.0018	1.6848	−1.6875	0.7564	1.1900
Calgary	−4.1150	0.0096	0.8383	−−	−−	−−
Regina	−2.9968	0.0643	2.8100	−3.6741	0.1804	1.0438
Winnipeg	−2.9568	0.0882	2.5100	−1.8055	0.1338	∞
Hamilton	−2.5758	0.0421	5.9300	−−	−−	−−
Toronto	−3.5465	0.0660	0.9954	−1.7512	0.6006	3.3924
Ottawa	−2.3193	0.1880	4.4005	−4.1872	0.0031	1.1496
Montreal	−2.5444	0.3626	3.9042	−1.9220	0.0301	5.1977
Quebec City	−3.2582	0.1285	1.9742	−−	−−	−−
Saint John	−2.9497	0.1491	1.7208	−2.4573	0.2596	∞
Halifax	−4.1971	0.0134	0.9303	−2.3799	0.2250	∞
St Johns	−−	−−	−−	−2.7621	0.0261	3.0015
Fisher Statistic	80.268			41.73		
$p-$value	(0.000)			(0.003)		

The underlying regression for the DF-GLS unit root tests is:

$$\Delta \widetilde{w}_{i,t}^{d} = \alpha_i \widetilde{w}_{i,t-1}^{d} + \sum_{j=1}^{p} \gamma_{i,j} \Delta \widetilde{w}_{i,t-j}^{d} + \varepsilon_{i,t},$$

where $\widetilde{w}_{i,t}^{d}$ is constructed by locally de-trending $\widetilde{w}_{i,t}$ according to:

$$\widetilde{w}_{i,t}^{d} = \widetilde{w}_{i,t} - \widehat{\beta}_0 - \widehat{\beta}_1 \tau_t$$

and $\widetilde{w}_{i,t}$ is the de-meaned natural logarithm of the real wage in city i at time t and τ is a linear time trend. The parameters $\widehat{\beta}_0$ and $\widehat{\beta}_1$ are obtained by regressing $\overline{w}$ on $\overline{z}$ where

$$\overline{w} = \left[\ \widetilde{w}_{i,1},\ \ (1-\overline{\alpha}L)\,\widetilde{w}_{i,2},\ \ \ldots,\ \ (1-\overline{\alpha}L)\,\widetilde{w}_{i,T}\ \right],$$
$$\overline{z} = \left[\ z_1,\ \ (1-\overline{\alpha}L)\,z_2,\ \ \ldots,\ \ (1-\overline{\alpha}L)\,z_T\ \right]$$

and $z_t = \left[\ 1\quad \tau_t\ \right]^{/}$, $\overline{\alpha} = 1 + \overline{c}/T$. Following Elliot, Rothenberg and Stock we set $\overline{c} = 13.5$.[1]

Under the null hypothesis each series in the panel contains a unit root, that is $\alpha_i = 0$ for all i. Under the alternative at least one of the time series in the panel is a stationary process, that is $|\alpha_i| < 0$ for $i = 1, \ldots N_1$ and $\alpha_i = 0$ for $i = N_1 + 1, \ldots N$. The Fisher statistic is calculated as

$$\lambda = -2 \sum_{i=1}^{N} \ln \pi_i$$

where π_i is the bootstrapped $p-$value for the DF-GLS statistic for city i. These $p-$values are constructed using a bootstrap procedure that allows for the possibility that the error terms, $\varepsilon_{i,t}$, are correlated across units (see appendix). Under the null hypothesis $\lambda \sim \chi^2(2)$.

The half-life of shocks are calculated using the procedure for exactly median unbiased estimates of an AR(1) parameter proposed by Andrews [2]. The median unbiased estimator of ρ calculated as

$$\widehat{\rho}_U = \begin{cases} 1 & \text{if } \widehat{\rho}_{LS} > m(1) \\ m^{-1}(\widehat{\rho}_{LS}) & \text{if } m(-1) < \widehat{\rho}_{LS} \leq m(1) \\ -1 & \text{if } \widehat{\rho}_{LS} \leq m(-1) \end{cases}$$

where $m(\cdot)$ is taken from table III of Andrews [2] and $\widehat{\rho}_{LS}$ is the least squares estimator of ρ from the following regression. The half-life of a shock is then calculated as $\widehat{h} = |\ln(0.5)/\ln(\widehat{\rho}_U)|$.

[1] This choice of $\overline{c}$ causes the power function of the DF-GLS test to be within 0.01 of the power envelope for $0.9 < \rho < 0.99$. This is the region in which the power problems of traditional ADF tests are most severe. Note when the linear trend is omitted from $\overline{z}$, $\overline{c} = 7.0$.

Table 2B: Unit Root Tests and Half Lives of Shocks: Bricklayers						
	1900 − 1950			1971 − 2000		
	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks
Victoria	−4.4958	0.0393	0.9670	−−	−−	−−
Vancouver	−2.7990	0.1033	3.9211	−2.0692	0.1578	∞
Edmonton	−3.8281	0.0524	1.1080	−1.7347	0.5299	∞
Calgary	−2.6668	0.2860	2.3198	−−	−−	−−
Regina	−4.4854	0.0073	0.9245	−2.4583	0.2311	3.6429
Winnipeg	−3.2689	0.1168	2.3096	−1.9456	0.5079	2.6989
Hamilton	−3.4364	0.0054	2.8287	−−	−−	−−
Toronto	−2.0294	0.0190	1.3088	−0.9279	0.5520	∞
Ottawa	−2.7430	0.2891	3.3402	−1.6899	0.7011	4.9993
Montreal	−2.2659	0.5004	3.2257	−2.8188	0.0585	1.5732
Quebec City	−3.4539	0.0283	1.6056	−−	−−	−−
Saint John	−4.5305	0.0164	0.8145	−3.2494	0.1873	0.6907
Halifax	−2.0200	0.4108	5.0182	−2.5710	0.2064	4.6997
St Johns	−−	−−	−−	−1.2363	0.7284	∞
Fisher Statistic	72.915			23.964		
$p-$value	(0.000)			(0.244)		

See notes to table 2A.

Table 2C: Unit Root Tests and Half Lives of Shocks: Carpenters

	1900 − 1950			1971 − 2000		
	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks	Individual DF-GLS Statistic	Bootstrapped $p-$ value	Half-life of shocks
Victoria	−3.0985	0.0556	2.2846	−−	−−	−−
Vancouver	−3.5235	0.0593	1.5816	−3.4188	0.1900	0.5304
Edmonton	−3.8470	0.0314	1.2245	−2.3084	0.2587	∞
Calgary	−2.7372	0.1152	2.8781	−−	−−	−−
Regina	−2.4092	0.2057	3.1371	−1.2714	0.1718	∞
Winnipeg	−0.3638	0.7493	2.1698	−2.2918	0.0389	∞
Hamilton	−2.3398	0.1859	6.5249	−−	−−	−−
Toronto	−3.8348	0.0095	1.1131	−0.7082	0.8546	∞
Ottawa	−2.5092	0.2132	3.2714	−1.7246	0.0714	3.5732
Montreal	−2.2756	0.2531	4.1564	−0.2166	0.7464	0.7174
Quebec City	−1.9652	0.5399	5.0279	−−	−−	−−
Saint John	−2.5108	0.2948	3.3836	−1.2709	0.7467	∞
Halifax	−0.9800	0.8092	3.9353	−2.2414	0.3414	∞
St Johns	−−	−−	−−	−2.5848	0.2720	1.5439
Fisher Statistic	49.030			23.964		
$p-$value	(0.004)			(0.122)		

See notes to table 2A.

Appendices

Bootstrap Procedure

A simple procedure to obtain the bootstrapped $p-$values needed for the Fisher test proposed by Madalla and Wu is presented below. Recall that the de-meaning process may induce cross-sectional correlation among the error terms from the individual DF-GLS regressions. Therefore, in our bootstrap procedure we generate artificial data under the null hypothesis for which the cross-sectional correlation mimics that seen in the data. Our $p-$values are then based on these artificial samples.

Step 1: Estimate the following equation for each city

$$\Delta\widetilde{w}_{i,t} = \alpha_i^0 \sum_{j=1}^{p} \gamma_{i,j}^0 \Delta\widetilde{w}_{i,t-j} + u_{i,t}^0. \tag{A1}$$

Note that this imposes the null hypothesis that the cross-sectionally demeaned real wage series contain a unit root. Save the parameter estimates $\widehat{\alpha}_i^0$ and $\widehat{\gamma}_{i,j}^0$ and the time series of residuals under the null hypothesis for each city, $u_{i,t}^0$. Here the superscript 0 denotes parameters (or residuals) under the null hypothesis.

Step 2: Create an artificial time series for each demeaned real wage series using:

$$\widetilde{w}_{i,t}^* = \widetilde{w}_{i,t-1}^* + v_{i,t}^* \tag{A2}$$

where

$$v_{i,t}^* = \sum_{j=1}^{p} \widehat{\gamma}_{i,j}^0 v_{i,t-j}^* + u_{i,t}^* \tag{A3}$$

where the $*$ superscript denote a bootstrap sample. Due to the cross-sectional correlation in residuals of equation (A1) we cannot re-sample directly from $u_{i,t}^0$. Instead we re-sample from $u_t^0 = \left[\begin{array}{cccc} u_{1,t}^0 & u_{2,t}^0 & \cdots & u_{N,t}^0 \end{array}\right]^{/}$ to get u_t^*. In other words we re-sample with the cross-section index fixed. We use sample data for the initial values of $\widetilde{w}_{i,t}$ and generate $3T$ observations for each unit of the panel, where T is the time dimension of the panel. We then discard the first $2T$ observations to minimize the influence of starting values.

Step 3: Using the bootstrap samples we calculate the DF-GLS statistic for each unit of the panel.

We repeat this procedure 10000 times and then using the bootstrap distributions of these test statistics calculate $p-$values for the test statistics derived from the sample data.

CANSIM Codes for 1971-2000 Sample

Below are the CANSIM codes for our $1971-2000$ sample. In each case the codes are ordered as follows: Vancouver, Edmonton, Regina, Winnipeg, Toronto, Ottawa, Montreal Saint John, Halifax, St. Johns. For the nominal wages of building laborers these codes are: D476125, D476109, D476061, D476045, D475917, D475901, D475885, D475837, D475805. For the nominal wages of bricklayers they are: D476131, D476115, D476067, D476051, D475917, D475901, D475885, D475837, D475821, D475805. For the nominal wages of carpenters they are: D476121, D476105, D476057, D476041, D475913, D475901, D475881, D475833, D475817, D475801.

We convert these series into 1999 Toronto dollars using city consumer price indices from the CANSIM databank and a spatial consumer price index for 1999 provided by Marc Prud'homme at Statistics Canada. The codes for the city CPI series are P218800, P218400, P218000, P217800, P217400, P217200, P217000, P216600, P216400, P216000. The 1999 spatial CPI numbers are: 105, 93, 92, 92, 108, 103, 95, 93, 99, 100.