Geographic Spillovers of Booms:
The Effects of Canada's Resource Boom on Canada-US Differences in Wages *

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Abstract

Since 2000, the US and Canadian labour markets have evolved very differently. US real average wages have either stagnated or declined while Canadian average wages increased by almost 10% for males and 15% for females. We investigate the role of the Canadian resource boom in explaining this difference. We construct a model of wage setting that allows for spillover effects of a resource boom on wages in non-resource intensive locations and formulate an empirical specification based on that model. The core idea in the model is that workers in other places can bargain higher wages in places with strong links to resource areas because the value of their outside options increases during a resource boom. We find that wages do rise in areas with more long distance commuting but not with more permanent out-migration to resource intensive provinces. Overall, we conclude that because of wage spillovers, the resource boom can account for a substantial portion of the differences in wage movements between Canada and the US. Thus, long-distance commuting can integrate regions in an economy in a way that spreads the benefits and costs of a boom across the economy.

Key Words: Wages, Resource Boom, Inequality

JEL Class.: J30

Introduction

Since 2000, the Canadian and US labour markets have diverged substantially. The post-2000 period has seen stagnation or decline in wages in the US, with the real average hourly wage for prime age workers falling by 2 to 3 percent for males and being generally flat for females between the early 2000's and 2015. In contrast, in Canada, the real hourly wage rose by nearly 10% for males and 15% for females over the same period. Most strikingly, US wages declined substantially in the years just after the 2008 recession while Canadian wage series show only a short break in their upward trend at that point. Similarly, employment rates did not fall as much in Canada as the US. The term "Great" really did not apply to the 2008 recession in Canada. The two countries also followed different paths for wage inequality in this period. The log 90-10 wage differential rose by over 10% for both men and women in the US while in Canada, that differential was essentially flat, especially after 2003. Thus, the real wage growth in Canada was shared across the distribution in Canada while wages at the bottom of the US distribution, in particular, were falling.

In this paper, we seek to understand why Canada and the US have followed such different wage paths since about 2000. We argue that a substantial part of the difference can be explained by the impact of the resource boom that started in about 2003 for the Canadian economy. For anyone living in Canada during this period, such a claim might not seem surprising. The resource boom held a salient place in discussions about the economy and also in policy making in this period. But to an empirical economist who has worked with shift-share type decompositions, such a statement might seem unlikely to be true. This is the case because the extractive resource sector (mining plus oil and gas) makes up only 1.5% of employment in Canada in this period. This is triple the proportion for the US and reflects some substantial growth during the period, but working with such small proportions, it is not possible to generate substantial changes in the average wage for the economy as a whole. Since the standard "between" component in a shift-share composition is obtained by multiplying the change in the proportion of workers in a sector by the wage premium paid in that sector, the implied component must necessarily be very small. Our core idea, following on Beaudry et al. (2012), is that changes in the size and wages in a salient sector can have far-reaching spill-over effects through bargaining. When a high paying sector such as extractive resources expands or starts paying other wages, the outside option for workers in other jobs improves. In bargaining with their employers, they can point to the improved employment conditions in the resource sector and credibly threaten to quit to get a resource sector job unless their current employer increases their wages.[1] Importantly, this threat can

[1]In an article about the industrial heartland of the US, the Globe and Mail tells the story of Cathy McClure who lost a good paying job in a forklift factory at the time of the 2008 recession. Recently, the firm

be used by workers across the economy at the same time, resulting in the wage effects of the resource boom being substantially multiplied. In essence, there is no longer a clean separation of the between and within components of the shift-share decomposition and so the standard between component does not provide an accurate picture of the full extent of the boom. Indeed, in Beaudry et al. (2012)'s work with US cities, the spillover effect on the average wage in a local economy of shifts toward a higher paying sectoral composition is about 3 times the standard between effect on its own.

What makes the resource boom a plausible source of these wage spillovers (apart from its salience in general discussion and policy circles) is the movement of wages in the three provinces with the highest concentration of their employment in the extractive resource industries - Alberta, Saskatchewan, and New Brunswick. The average wage in those provinces rises sharply through the mid-2000s and then grows somwehat more slowly after the recession - a pattern matching the oil price series. Fortin and Lemieux (2015) and Green and Sand (2015) both argue that regional data patterns for Canada fit well with the idea of the resource price boom driving regional differences across Canada. We replicate some of those results in the second section of this paper. Both Fortin and Lemieux (2015) and Marchand (2015) present evidence that the oil boom had impacts in other sectors of the Alberta economy. Working with a specification similar to ours, Fortin and Lemieux (2015) show that wage spillovers to other sectors from the resource sector can account for over half the difference in wage growth between oil rich Alberta and more industrial Ontario in this period. Our work complements theirs in looking beyond the borders of the extractive resource intensive provinces to ask whether the resource boom had even broader effects.

At the heart of our approach is a rich administrative data set. We use the universe of Canadian individual tax filers between 2000 and 2015. Importantly for our purposes, we have information from their main tax form (the T1) including the address from which they filed their taxes as well as their job specific tax forms (T4's) on which is recorded the province of location of the firm for which they worked on that job. Using this, we can identify what we call long distance commuters to the extractive resource provinces: workers who file their taxes in a non resource intensive province but worked their main job in a resource intensive province. Working at the level of Statistics Canada economic regions (which are roughly the size of CMA's), we examine the wage changes of what we call residents (workers who do not migrate or commute to other provinces to work) in local labour markets in the non-resource provinces to see whether those changes were different in locations with more commuting

returned to operation and offered her an entry level position at $15 per hour. Rather than moving to that job, she negotiated a wage increase at her current employer. Thus, the introduction of a good paying job would have benefited both whoever actually took the job and, through a bargaining effect, Cathy McClure Slater (2016) to resource provinces. In other words, we investigate whether increases in the value of the commuting option led to increases in wages for non-commuters. There could be wage effects on the residents because of simple supply effects and/or the type of bargaining effects mentioned earlier. We estimate some specifications in which we control for employment rate changes - thus eliminating the supply effects channel.

Estimation of these spillover type effects faces two main identification challenges. The first is that commuting may be correlated with unobserved productivity shocks to local wages. For example, if commuting to resource intensive provinces increased the most in areas that were falling into a local recession then there would be a built-in negative bias to the estimated effects of commuting on wages. We set about addressing these concerns by first constructing a model of wage setting with multiple sectors and two regions (one with a resource boom and the other without). The model follows Beaudry et al. (2012) and Beaudry et al. (2014) and, like them, we use the theory to establish the form of our estimating equations, the content of the error term (and, from it, the nature of the endogeneity problems), and candidates for instrumental variables. We construct Bartk-style instrumental variables which rely on a combination of migration links across regions in 2000 and changes in average wages in the resource provinces driven by oil sector changes. We show that over-identifying restrictions specified by the model and related to the instruments are not rejected in this data.

The second identification challenge stems from potential selection of migrants and commuters. If, for example, lower ability workers take up the commuting option because they are the ones who do not have stable employment at the time of the resource boom then we could see an increase in average wages in our local non-resource economies just because of a change in the composition of workers. We address this in some specifications in which we restrict our sample to individuals who are present in non-resource province communities throughout our data period from 2000 to 2012. That group of non-movers is very likely highly selected but since it is the same set of people throughout, any changes in their wages will not stem from composition shifts.

Our estimates indicate that there were substantial spill-overs to wages in non-resource provinces from the resource boom. In Cape Breton - an economic region on Canada's east coast that was one of the largest senders of commuters to the oil patch - we estimate that the increase in the value of the option of commuting to a resource intensive province increased real wages by as much as 13% during the resource boom. On the other hand, Toronto - which had a very low rate of commuting to resource provinces - had almost no wage spill-over effect. Taken together, we show that these spill-overs can account for a substantial portion of the increase in mean wages in the Maritime provinces in our time period, with less in other provinces. Adding this to a more standard decomposition of wage movements that includes the direct effect of the resource boom in the resource intensive provinces, we find that the boom can explain a substantial portion of the difference between Canada's wage pattern and that of the US after 2000.

We see these results as potentially interesting for several reasons. First, many of the explanations for movements in US wages in recent decades have centred on the impact of technology and, to a lesser extent, trade (e.g.,Acemoglu and Autor (2010), Autor and Dorn (2010)). Several authors have argued that technological change impacts should show up in a similar form in the labour market outcomes in all developed economies and that, in fact, cross-country comparisons provide a means of identifying technological change effects (e.g., Antonczyk et al. (2010)). This is not necessarily the case in models of technological adoption in which the taking up of new technologies is related to an economy's relative factor supplies. Nonetheless, it seems surprising that two such similar economies would have experienced such different labour markets if the main driving force is technological change. Understanding the extent to which another force (a resource boom) drove Canadian outcomes is helpful when trying to understand what cross-country comparisons are actually telling us. In that regard, our resource boom effects have interesting parallels with the arguments in Charles et al. (2016) that the housing boom in the US masked problems related to the decline in the manufacturing sector until the collapse of that boom with the 2008 recession. In Canada, the resource boom appeared to play a similar role but with different timing since resource prices did not suffer a persistent drop at the time of the recession. They have dropped in the last two years, potentially pointing to difficulties in the years ahead for Canada.

Second, our results reveal regional interactions beyond simple migration that provide new insights into how regional economies are connected. Indeed, in our model, the fact that the wage gains of permanent migration are offset by house price increases implies that permanent migration should have no effect on wages in the locations from which the migrants emigrated. Since long distance commuting does not have house price effects of this type, it is predicted to have more substantial spill-over effects. We find both that permanent emigration has no effects on local wages and that increases in the value of commuting does. The fact that changes in outside options that do not directly affect productivity in the sending community alter wages in other sectors fits with recent findings pointing toward rents as important components of wages (Green (2015)). For example, in findings that firm specific effects are important components of wages in matched firm-worker data (e.g., Card et al. (2013)), our results indicate that one potential determinant of a high paying firm is whether it is located in a city with strong links to other high paying regions.

Finally, these resuls are useful for understanding the nature of the impact of the resource boom on the Canadian economy as a whole. We find that the resource boom had effects across a wide part of the economy, including geographically distant regions. That implies wage benefits for workers but also has the potential to reduce employment in those other regions. In essence, firms in the non-resource regions face increased wage costs without the associated increase in demand enjoyed by firms in the resource areas. Thus, the wage spillovers have the potential to have generated a version of Dutch disease in parts of the Canadian labour market.

Plausible given sectoral patterns. Fortin and Lemieux, Marchand. But what about beyond border? we use special data to look at effects on other labour markets through migration and long distance commuting links. Rene uses pattern to look at labour supply.

We believe this is a useful undertaking for several reasons.

We view it as interesting to try to separate out the resource boom effects for several reasons. First, because it will allow us to understand whether the resource boom had wider spread benefits than are typically measured. Second, because any such wage spread has potential implications for the costs of labour in parts of the country that did not receive the direct benefit of increasing demand for the resource sector but might have had to deal with wage increases. This could imply Dutch disease effects in the form of relative declines in employment in those areas. Third, understanding the extent of spillovers in wages from a resource boom provides insight into how labour markets operate and the inter-connectedness of regional labour markets in a country.

1 Data and Core Patterns

We begin our investigation with a comparison of movements in the wage structure in Canada and the US in the last 20 years. Our focus is on the cross-country comparison. Fortin and Lemieux(2015) provide much more detail on the evolution of the Canadian wage structure at the provincial level and Green and Sand(2015) do the same at the national level for Canada for recent decades.

The Canadian data for our exercise comes from the Labour Force Survey (LFS), which is Canada's monthly representative survey for collecting labour market data. The LFS has included data on wages since 1997 and so we make that our starting point. We have data through 2015. We restrict our attention to workers who are aged 25 to 54 and are not full time or part time students in the month in order to avoid issues related to schooling and retirement. Our goal is to get series that are as close as possible to movements in the price of labour, avoiding potential composition related movements. We use the hourly wage, which is reported directly for hourly wage earners and computed for other workers. We deflate the series to 2000 dollars using the national CPI. For the US, we use the Outgoing Rotation Group sample from the Current Population Survey (CPS) for the same years. We use the same age restrictions as for the Canadian data and, again, work with real hourly wages. Further details on the data construction are given in Appendix A.

Figure 1 contains mean log hourly wage series for Canadian and US men in the left panel and Canadian and US women in the right panel. In all the figures that follow, we normalize series to 0 in 1997 in order to avoid discussions of direct exchange rate effects on wage levels. For men, the US series shows an increase of about 8% between 1997 and 2002 but a general decline after that point, with a substantial drop at the time of the 2008 recession. The Canadian series mimics the up and down pattern of its US counterpart until about 2004 (though with more muted movements) but moves in an almost completely opposite pattern thereafter. Notably, the 2008 recession generates a stall in the overall upward pattern rather than a sizeable drop, as in the US case. For women, the picture shares the broad feature that the two countries have similar patterns up to about 2003 or 2004 (with the Canadian series being more muted) but part company thereafter. For female wages, the US series is generally flat after 2003 but the Canadian series shows strong and nearly continual growth after that point.

In figure 2, we plot the differences between the logs of the 90th and the 10th percentiles for each gender and country. In the male figure, the US 90-10 differential shows a strong upward trend, with the increases in the years just after the 2008 recession being particularly large. In contrast, for Canada, after an initial decline and rebound, the differential is quite stable. Similarly, for females, the US series shows increases in the 90-10 differential after 2004 that is not matched in the Canadian data. Underlying these patterns are quite different movements in the tails of the distribution in the two countries. In figure 3, we plot the log of the 10th percentile. For males, the pattern is very reminiscent of the mean wage plot in figure 1. For US males, the 10th percentile declines by 10% bewtween 2003 and 2013 while the Canadian series first increases and then is flat over the same period. In the female series, also, the Canadian pattern is one of increase while the matching US pattern is either decline or stagnation. The 90th percentiles for the two countries, in contrast, look much more similar, with similar long term increases in both (albeit with different timing). But this represents quite different patterns relative to the rest of the distribution. For the US, the 90th percentile is either increasing or flat while the mean and the 10th percentiles are declining - hence the strong increase in inequality in the period. For Canada, the various parts of the distribution move up together, with increases typically beginning around 2004.

The substantial differences between the two countries after 2004 seem striking to us. The two countries are similar in many regards - in the broad forms of their labour markets and

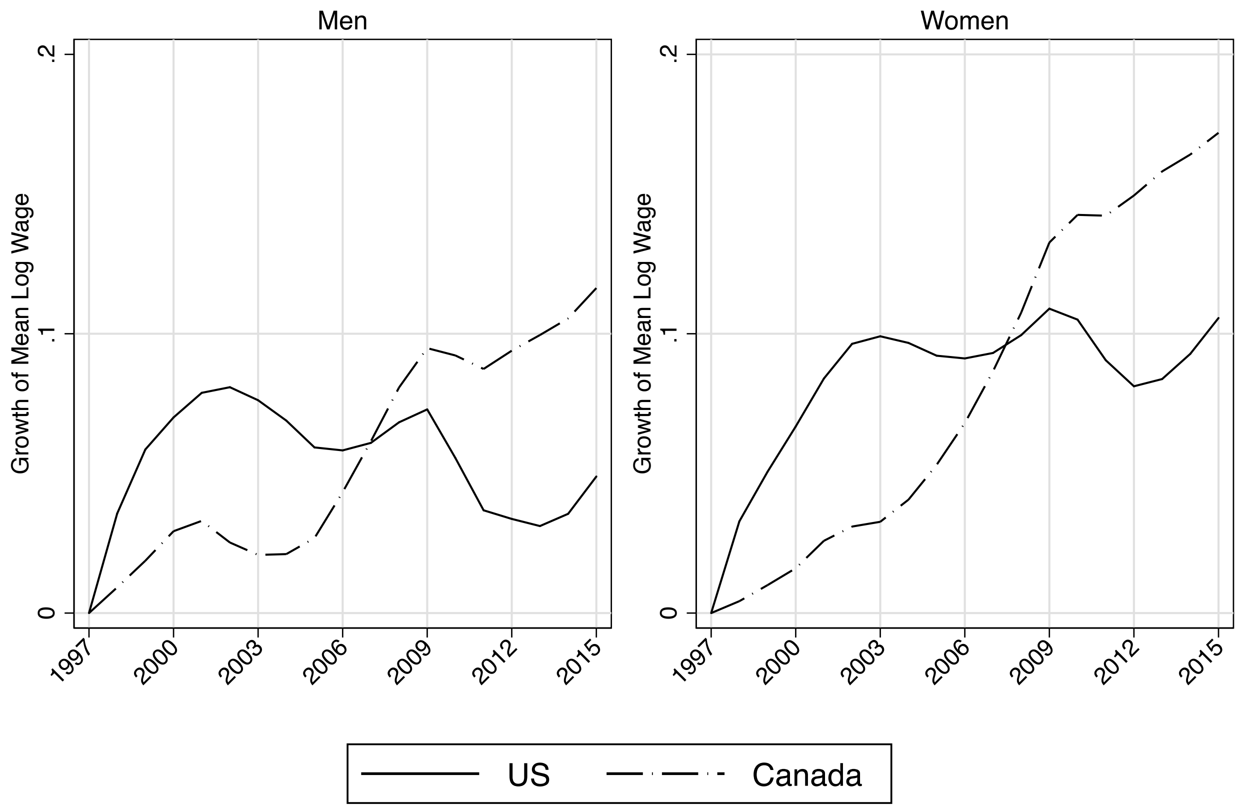

Figure 1: Real Mean Log Hourly Wages, Canada and the US, 1997-2015

labour market regulations, in their industrial structure, and in being substantial immigrant receiving nations. Most importantly, many authors have argued that technological change has been a key driver of movements in the US wage structure in recent decades and one would expect the same technological adjustments to be important in Canada. So, why have the wage patterns in the two neighbours diverged?

Both Green and Sand(2015) and Fortin and Lemieux(2015) argue that shifts in Canada's wage structure in the last 20 years have an important regional dimension. In particular, they argue that the resource boom that began in the mid-2000's had a discernible impact on wages in the three provinces with the greatest concentration in what Fortin and Lemieux (2015) call the Extractive Resource (ER) sector: Alberta, Saskatchewan, and Newfoundland.[2] To illustrate this, in fig 5, we plot mean log wages for the three ER intensive provinces along with

[2]In our sample, Alberta, Saskatchewan, and Newfoundland have 8%, 4.9%, and 4.1% in the ER sector (defined as the combination of the mining and oil and gas industries), respectively. The province with the next highest ER sector employment is New Brunswick at 1.4%. Between 1997 and 2008, Alberta, Saskatchewan and Newfoundland together accounted for 96% of Canada's production of crude oil (Morissette et al(2014).

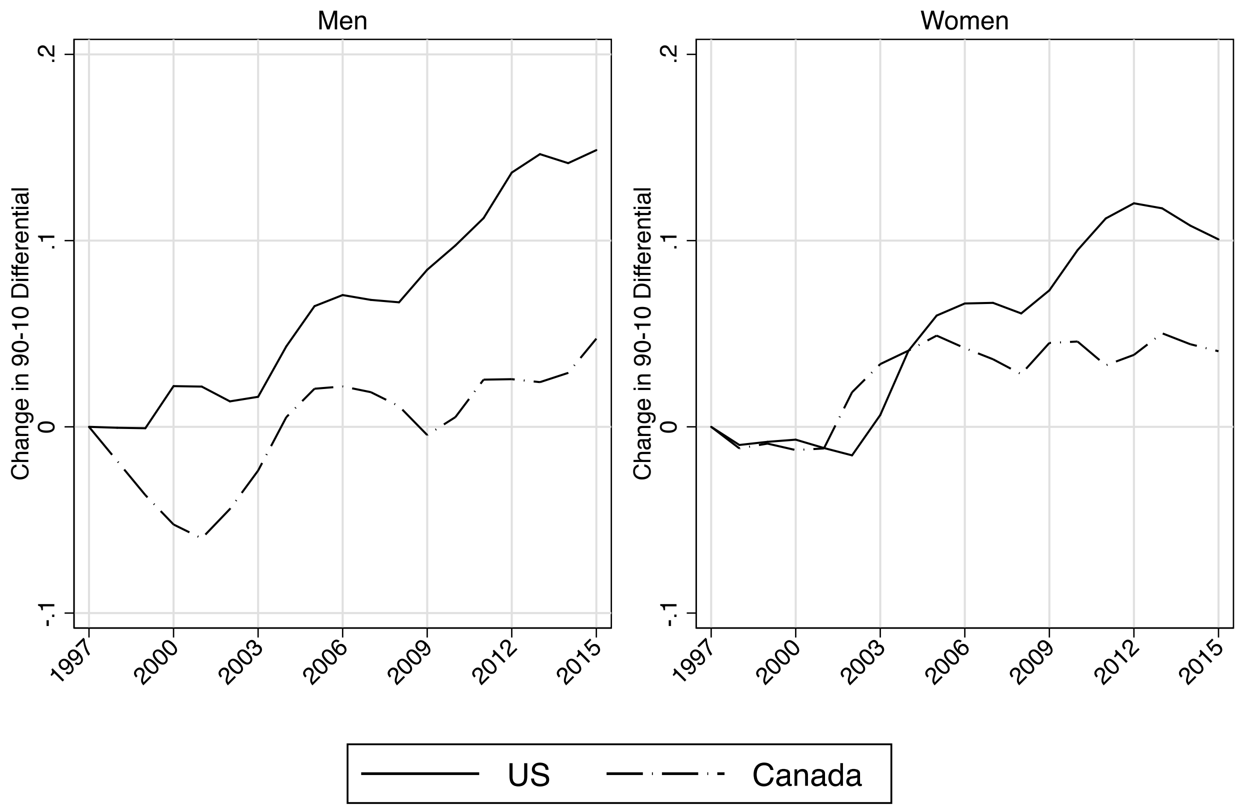

Figure 2: Log 90-10 Hourly Wage Differentials, Canada and the US, 1997-2015

those for Ontario and for the Maritime Provinces (PEI, Nova Scotia and New Brunswick. For both men and women, the mean log wage in the ER intensive provinces increase by about 0.3 log points across our sample period, compared to wage gains of under 0.1 log points for men and about 0.1 log points for women in Ontario (the most populous province). The experience of the Maritime provinces lies between the two. That the larger wage growth in the ER intensive provinces might be related to resource prices is supported by plots of the movement in the crude oil price (the annual average of the West Texas Intermediate price) and the mean log wage in the ER intensive provinces in figure 6. Both the wage series and the oil price series show a period of gradual growth before 2003 followed by substantial growth between about 2003 and 2009, and then a period of more gradual growth or stagnation after 2009. The timing of the inflection points in wages and oil prices are not exactly the same - the wage series lag the oil price series by one or two years - but the general patterns are strikingly similar. The idea that the wage movements could be related to the resource price boom is also supported by the fact that the wage increases in the ER intensive provinces are much stronger among high school or less educated workers and those with some post-secondary

Figure 3: Log 10th Percentile of the Hourly Wage Distribution, Canada and the US, 1997-2015

education (including trades workers) than among those with a university education. Both high school or less educated males and males with some post-secondary education experience real wage increases of over 0.3 log points in the ER intensive provinces in our sample period compared to increases of less than half that for males with a BA or more. We show figures for different education groups in the Appendix.

But, could labour market effects of the resource boom account for the differences in movements in the national wage structures in the two countries? In Canada, the ER sector makes up 1.5% of employment compared to 0.55% in the US. Alberta's 8% of workers in the ER sector compares with 2.2% in the sector in Texas.[3] Thus, the resource sector is more salient in Canada. Nonetheless, one might doubt that one sector could cause such large changes in the average wage, even within ER provinces. After all, the ER sectors make up only 8% of Albertan employment and less in the other two ER provinces. In fact,

[3]Wyoming is the only state with an ER employment share above Alberta's at 12.1% but Wyoming makes up only 0.18% of US employment compared to Alberta's 11% of total Canadian employment.

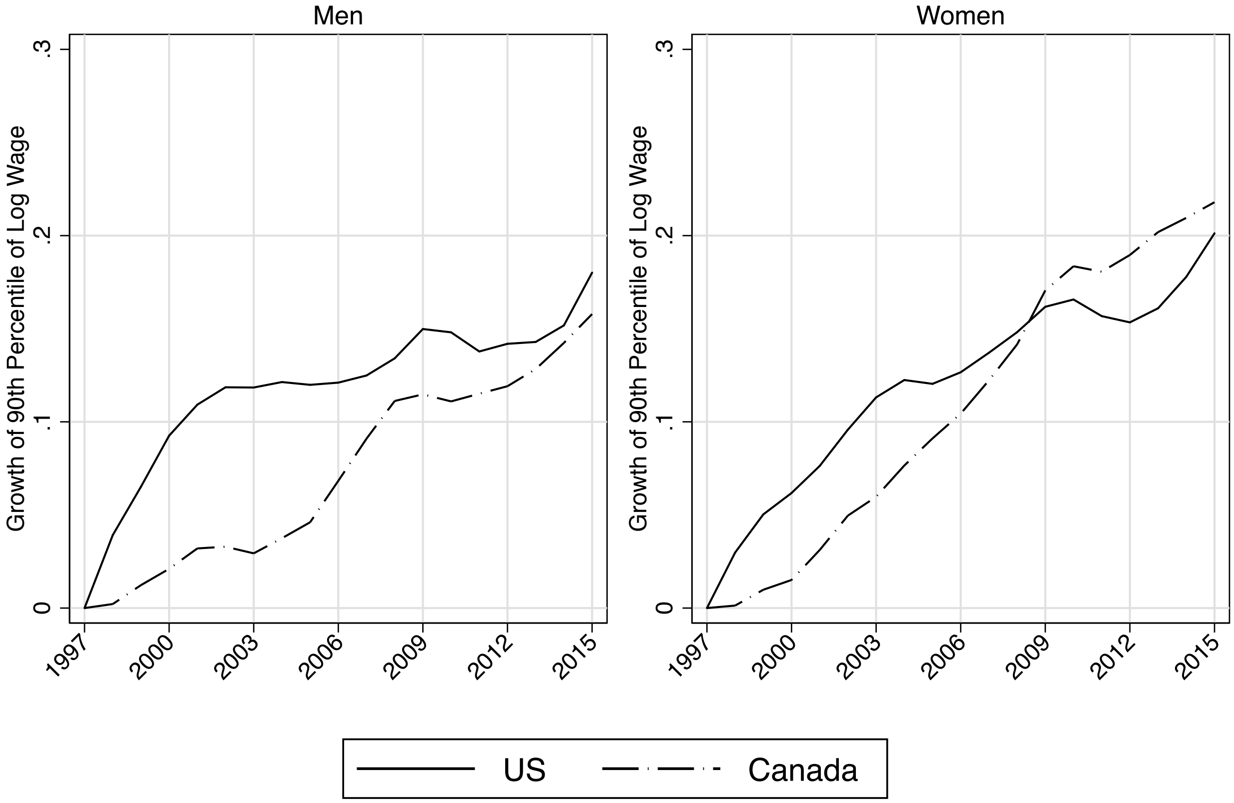

Figure 4: Log 90th Percentile of the Hourly Wage Distribution, Canada and the US, 1997-2015

the proportion of employment in the ER sector in Alberta increased from 0.059 in 2000 to 0.092 in 2013, and Fortin and Lemieux(2015) show that the sector paid a wage premium of 0.27 log points relative to the mean wage in the province after controlling for education, age, and gender. Combining these in a standard shift-share calculation, the increase in the size of the ER sector in Alberta would only imply a 0.9% increase in the overall mean wage for Alberta. However, building on work in Beaudry et al(2012), Fortin and Lemieux(2015) argue that increased employment and wages in the ER sector in Alberta could affect wages in other sectors through bargaining spillovers: workers in, for example, construction in Calgary could bargain a higher wage because they had the improved outside option of going to work in oil fields. They implement an empirical specification that allows for such spillovers and show that once they are taken into account, the ER boom can account for over half of the difference in the increase in mean wages between the ER intensive provinces and Ontario. Our argument is that the same logic may apply to places outside the ER provinces that are linked to those provinces through migration and that, as a result, the ER boom could have

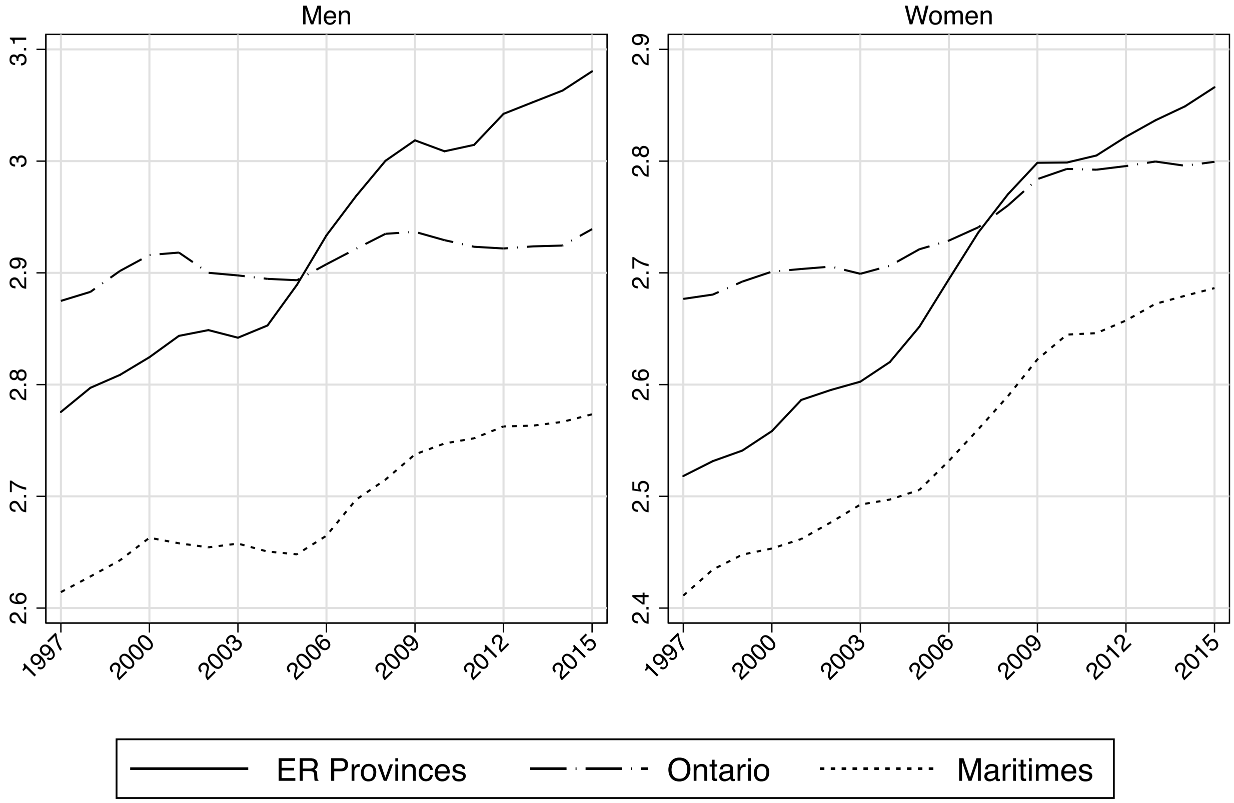

Figure 5: Mean Log Wages by Region, Canada, 1997-2015

had effects on the wage structure across Canada.

Two pieces of evidence indicate that such spillovers might be plausible. First, we show a counterfactual exercise in which we replace the wage increases in the ER provinces with those observed in Ontario. If the only way the ER boom affected overall wages in Canada was through changing wages and employment in the ER provinces and if the only difference between Canada and the US were due to the greater importance of the ER boom in Canada then the resulting counterfactual should look like the US. In figure 7, we re-plot the mean log wage lines for Canada and the US along with the counterfactual line for Canada. Taking out the extra wage increases in the ER provinces mutes the national increase in Canadian wages for both men and women. For men, the increase from 1997 to 2015 is reduced from 0.11 to 0.08, which is remarkable when one notes that employment in the ER intensive provinces make up only 16% of national employment in our sample. But while taking out the wage increases in these provinces moderates the increase, it does not change the overall pattern in which mean wages surge around the time of the oil price increase and do not decline

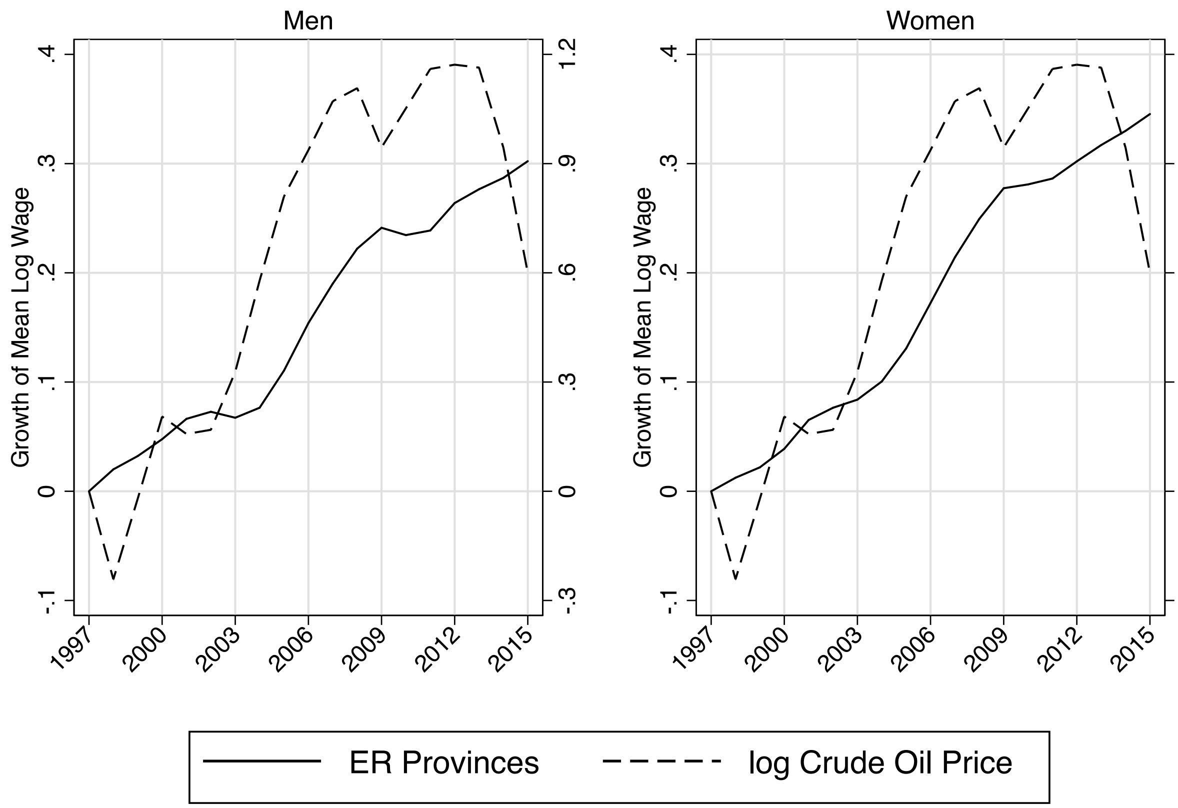

Figure 6: Crude Oil Price and Mean Log Wage in ER Provinces, 1997-2015. Left Scale: Mean Log Wage. Right Scale: Oil Price

persistently after the recession as they do in the US. Put differently, wages in other parts of Canada also have a time pattern that is reminiscent of resource price changes. Given the low proportions of workers in other provinces in the ER sector (only 0.06 in Ontario, for example), this may suggest wage spillovers from the resource sector in the ER intensive provinces to wages in other provinces.

We can see the potential spill-overs, also, when we look at the non-ER regions in Canada separately. In figure 8, we plot the changes in mean log wages for the three Maritime provinces (PEI, Nova Scotia, and New Brunswick) along with those for a matching set of US States (Maine, New Hampshire, and Vermont). Mean log wages again move remarkably differently after 2003 in the two countries,with mean log wages in the US Atlantic states either declining (for males) or flat (for females) while their Canadian counterparts generally increase. In figure 9, we present the same exercise but comparing Ontario, which is generally

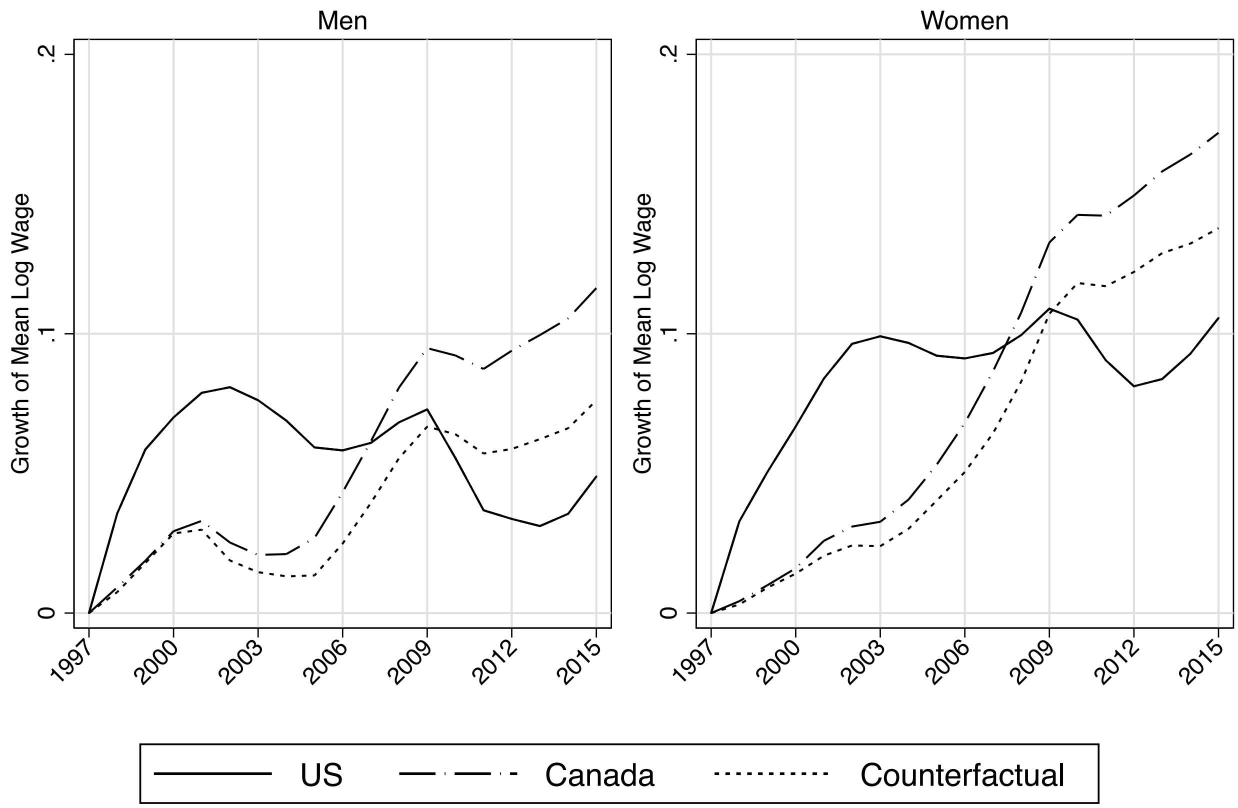

Figure 7: Mean Log Wages with No-ER Province Wage Increase Counterfactual, 1997-2015

seen as Canada's main centre of manufacturing, to a matching set of US States.[4] The wage series from the two countries are more similar in this case, with the main difference being the greater increase in wages in Ontario just before the recession and the lack of a substantial decrease in wages in Ontario after the recession. The decline in male wages in these States in the US that starts just after 2000 and accelerates after during and just after the 2008 recession is reminiscent of the argument in Charle et al(2016) that a decline in manufacturing employment in the US that starts at least as early as 2000 was partially masked by demand from the construction industry during the housing boom. With the collapse of that boom during the recession, conditions in the male labour market also collapsed and the lack of alternative jobs in the manufacturing sector was made apparent. We believe that the resource boom may have played the role of masking the decline in manufacturing employment in Canada. Since resource prices only briefly declined and then recovered during and after the recession, Canadian wages and employment did not suffer the same drops after 2008 as in

[4]The matching set of US States is: Connecticut, Illinois, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and Wisconsin.

the US.

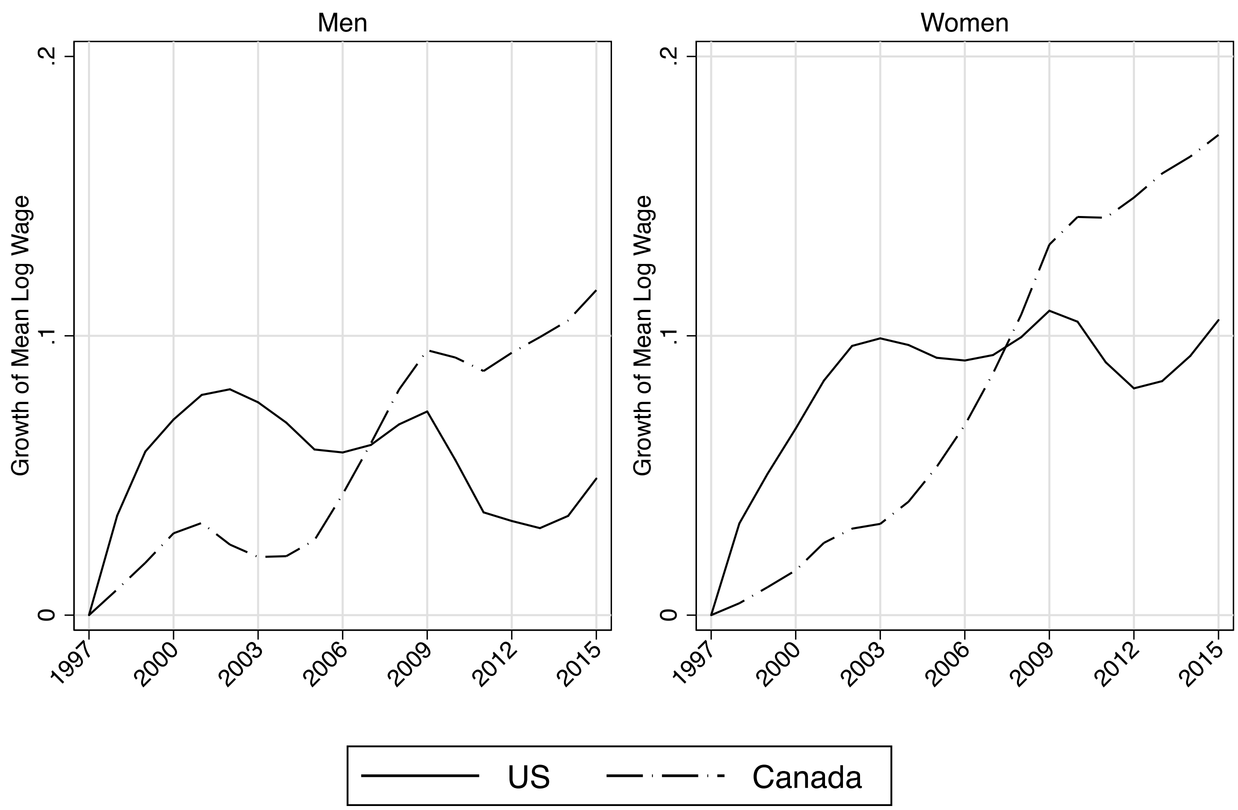

Figure 8: Mean Log Wages in Canadian Maritime Provinces and Matching US States, 1997-2015

Based on this evidence, we believe that spill-overs from the resource sectors in the ER intensive provinces could have played a role in determining the wage movements in other Canadian provinces. We do not view it as sole determination of movements in the Canadian wage structure and their differences relative to the US. Fortin and Lemieux(2015) show that the minimum wage increased continually between 2005 and 2011 in the Maritime provinces and that this increase can account for much of the movement at the bottom of the wage distribution in those provinces over that period. At the other end, wage movements for those with a university degree show a lower regional spread and less clear correlation with resource price movements. To uncover the effects of the resource boom, we need an identification strategy to separate those effects from other driving forces, including movements in the minimum wage. In the next section, we set out a model of wage setting with different regions as the basis for discussing identification issues and solutions.

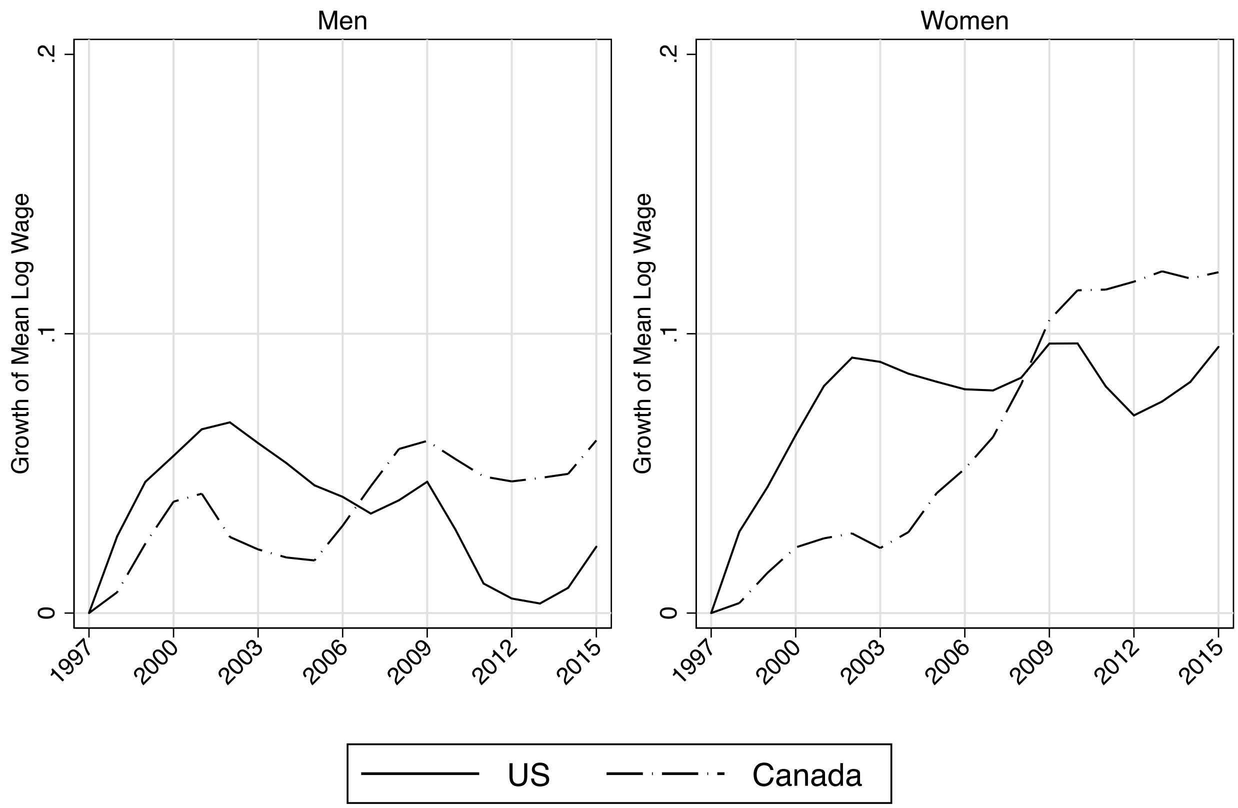

Figure 9: Mean Log Wages in Ontario and Matching US States, 1997-2015

2 Model

In order to frame our investigation of potential labour market spill-over effects from a resource boom, we use a variant of a search and bargaining model with multiple sectors from Beaudry, Green and Sand(2012) and Tschopp(2015). In particular, we consider an environment in which the economy has two geographically separate areas. The first has oil and gas reserves and the second does not. We are interested in the wage and employment outcomes for workers in cities in the non-oil regions during and after an oil price boom. The oil boom makes it more attractive for workers from the non-oil region to migrate to work in the oil region which, has two effects on wages in local labour markets. First, the actual migration of workers reduces labour supply, resulting in an increase in wages. Second, for the workers who do not migrate, the option to migrate makes their bargaining position stronger relative to their employers, also raising wages. Since many workers can present this option in bargaining without actually pursuing it, the latter, spillover type effect could be very wide ranging and large. These wage effects, to the extent they exist, could have effects on firm decisions on whether to open job vacancies and, hence, on the employment rate.

To make this more precise, consider an economy, O (Ontario), which produces a final good Y_O using output from I_O industries:

$$Y_O = \left(\sum_{i=1}^{I_O} a_i Z_i^{\chi} \right)^{1/\chi}, \qquad \text{where } \chi < 1. \tag{1}$$

The price of the final good is normalized to 1, while the price of the good produced by industry i is given by p_i^O. We will assume that there are C local markets (cities) within O, with the industrial goods produced within any of them. Thus, the total amount of industrial good Z_i produced in the economy equals the sum across cities of X_{ic}, the output in industry i in city c.

Next to O is a second economy, A (Alberta), which produces a final good Y_A. Economy A differs from O in that it has oil reserves and, so, produces its output (Y_A) with $I_A = I_O + 1$ inputs, where the last input is oil. Its final good production function is otherwise the same as (1), though its final product will include oil (and could just consist of oil). An oil boom corresponds to a sudden increase in a_{I_A}, which induces an increase in p_{I_A}, the oil price. Our focus is on the direct labour market impacts in region O of that oil price increase. For that reason, we will proceed with the simplifying assumptions that the industrial goods are not traded across the two economies and that oil is not used in the production of O's output. Thus, we are not considering either the effects of oil price increases in altering the costs and, therefore, the composition of industries in O or the effects through impacts on the exchange rates between the currency of the country O + A and those of other countries . As we will discuss, though, some of our estimates will incorporate indirect effects of these types.

Much of what is interesting in the model can be learned from examining the worker and firm Bellman equations. For firms in city c (in region O) and industry, i, the value of a filled vacancy is given by

$$\rho V_{ic}^f = (p_i^O - w_{ic} + \epsilon_{ic}) + \delta(V_{ic}^v - V_{ic}^f), \tag{2}$$

where, ρ is the discount rate (common to workers and firms), δ is the exogenous termination rate of matches, V_{ic}^f is the value of a filled vacancy, V_{ic}^v is the value of an unfilled vacancy,and w_{ic} is the city-industry specific wage. We assume that each firm employs one worker who produces output valued at $p_i^O + \epsilon_{ic}$, with ϵ_{ic} being a city-industry specific advantage such that $\sum_c \epsilon_{ic} = 0$. Thus, the flow profits for the firm are then given by $(p_i^O - w_{ic} + \epsilon_{ic})$. For the moment, we assume that all workers are homogeneous.

The expression for an unfilled vacancy is given by,

$$\rho V_{ic}^v = -r_i + \phi_c(V_{ic}^f - V_{ic}^v), \tag{3}$$

where r_i is the per-period cost of keeping a vacancy open and ϕ_c is the probability a firm fills a vacancy. For simplicity, and without loss of generality, we set $r_i = 0$. As in Beaudry et al(2014), we assume that firms must pay a fixed cost, k_{ic}, to open a vacancy in industry i in city c, with that cost rising in the relative size of industry i in that city:

$$k_{ic} = \left(\frac{N_{ic}}{L_c}\right)^{\lambda} e_{ic} \tag{4}$$

where, N_{ic} is the number of vacancies (both filled and unfilled) in the i-c cell, L_c is the size of the labour force in c, $\lambda > 0$ is a parameter, and e_{ic} is a local idiosyncratic cost component to opening a vacancy. The idea behind this specification is that entrepreneurs are needed for opening a firm and exist in proportion to the population of a city. As a sector expands relative to the size of the city, it must engage less productive (higher cost) entrepreneurs. Entrepreneurs enter the sector freely until $k_{ic} = V^v_{ic}$. As opposed to more typical specifications where entrepreneurs are homogeneous and enter until the value of a vacancy is driven to zero, this approach permits the co-existence of different industries within each city.

Workers in the economy can be either employed or unemployed in a given period. The Bellman equation for a worker employed in industry i in city c is given by,

$$\rho U^e_{ic} = w_{ic} - \gamma p_{hc} + \mathfrak{A}_c + \delta(U^u_c - U^e_{ic}), \tag{5}$$

where U^u_{ic} represents the value associated with being unemployed when the worker's previous job was in industry i, p_{hc} is the price of housing, and $\mathfrak{A}_c$ is the value of local amenities in c.

The Bellman equations to this point are quite standard. The real difference in introducing sectors and regions is seen in the Bellman equation for unemployed individuals. An unemployed worker in c has a set of potential working options. The first option pertains to her initial city. With probability ψ_c, she meets a vacancy in her city, and we assume that in this case she will find jobs in proportion to the relative size of the industry in the city. That is, the probability that she finds a job in industry i in her home city, c, is $\psi_c \eta_{ic}$, where η_{ic} is the proportion of employment in city c that is in industry i. Conditional on not meeting a firm in her home city, the worker considers options in other locations. We will assume that the probability that two or more of these options are available at the same time is zero. Thus, her second option is to move to economy A, which happens with (conditional) probability μ^P_{cA}, where the P superscript refers to a permanent move. The probability, μ^P_{cA}, reflects cross-region frictions, i.e., both the difficulty of finding out about job options in the other economy and the costs of moving. We assume that once in A, the person joins the pool of unemployed workers there and searches for a job. The third option is for the person to work in A but live in c - an option that became more common during the height of the oil boom.[5] We call the probability of a worker taking that option, μ^T_{cA}, where the T stands for temporary. The fifth and sixth options are the same as options three and four except they refer to getting a job in a different city in Ontario. Calling this other city, b, we have probabilities of moving to the other city permanently and undertaking long distance commuting to it as μ^P_{cb} and μ^T_{cb}, respectively.

Given these options, we can write the value associated with being unemployed as,

$$\rho U^u_c = d - \gamma p_{hc} + \mathfrak{A}_c + \psi_c \cdot \left(\sum_j \eta_{jc} U^e_{jc} - U^u_c \right). \tag{6}$$
$$+(1-\psi_c)[\mu^P_{cA}(U^u_A - \theta_{cA} - U^u_c) + \mu^T_{cA}(U^u_{cA} - \tau_{cA} - U^u_c)$$
$$+\sum_b [(\mu^P_{cb}(U^u_b - \theta_{cb} - U^u_c) + \mu^T_{cb} \sum_j (U^u_{cb} - \tau_{cb} - U^u_c)]]$$

where, d is the flow value of unemployment, U^u_A is the value of unemployment for a person living in A, θ_{cA} is the cost of making a permanent move from c to A, U^u_{cA} is the value of search in A for a person who remains living in c, τ_{cA} is a fixed cost of taking up the option of commuting to A, and U^u_b, U^u_{cb}, θ_{cb}, and τ_{cb} are defined analogously for economies, b, in region O. Note that we are assuming that individuals can only search for new options while unemployed, which allows for a transparent empirical specification, as we will see.

It is useful to discuss each of the worker options in more detail. In the home economy, the probability that vacancies and unemployed workers in city c meet is determined by a matching function, $m(L_c - E_c, N_c - E_c)$, where L_c is the size of the labour force in c, E_c is the number of employed workers (and, thus, the number of matches), and N_c is the total number of vacancies (both filled and unfilled). Thus, the number of matches is a function of the number of unemployed workers, $(L_c - E_c)$, and the number of unfilled vacancies, $(N_c - E_c)$. We assume that the matching function is constant returns to scale. Given this, Beaudry et al(2012) show that in steady state the probability a vacancy meets a worker (ϕ_c) and the probability an unemployed worker meets a vacancy (ψ_c) can both be written as a function of the employment rate, ER_c.

Equation (6) says that the value of unemployed search depends, in part, on the composition of employment in the home economy. Using (5), it is straightforward to show that $\sum_j \eta_{jc} U^e_{jc}$ can be written as a function of the average wage in the economy:

$$\sum_j \eta_{jc} U^e_{jc} = \frac{1}{\rho+\delta} \sum_j \eta_{jc} w_{jc} - \frac{\gamma}{\rho+\delta} p_{hc} + \frac{1}{\rho+\delta} \mathfrak{A}_c + \frac{\delta}{\rho+\delta} U^u_c \tag{7}$$

[5] In 2011, what Statistics Canada calls Interprovincial Employees - workers who file their taxes in a different province from where their main employer is located - made up 3% of the paid workforce. That percentage increased by approximately a third between 2004 and 2008, with over 60% of that increase accounted for by workers doing this type of long distance communting to Alberta.

Workers who move to A and join the unemployed pool there face option values that are directly analogous to those faced by searchers in c. That is, they have a probability of meeting a firm, ψ_A, that can be written as a function of the employment rate, ER_A. We again assume that workers search randomly across industries, with the probability a match is in any given industry being proportional to the size of that industry. As a result, we can write:

$$\rho U_A^u = d - \gamma p_{hA} + \mathfrak{A}_A + \psi_A \cdot \left(\sum_j \eta_{jA}^P U_{jA}^e - U_A^u \right). \tag{8}$$

with terms defined analogously to (6) apart from η_{jA}^P which we write with a P superscript to allow for the possibility that the set of industrial options faced by permanent migrants differ from those for prior inhabitants.[6] Given a form for U_{iA} that is analogous to (5), it is straightforward to show that this can be rewritten as a function of the wages in the various industries in A:

$$\rho U_A^u = \frac{\rho + \delta}{\rho + \delta + \psi_A} d - \gamma p_{hA} + \mathfrak{A}_A + \frac{\psi_A}{\rho + \delta + \psi_A} \cdot \left(\sum_j \eta_{jA} w_{jA} \right). \tag{9}$$

Reducing expression (9) to more fundamental terms, Beaudry et al(2012) show that in a similar set-up the average wage term, $\sum_j \eta_{jA} w_{jA}$ can be written as a linear function of the average of industry prices, $\sum_j \eta_{jA} p_j^A$. Thus, an increase in the oil price implies a higher value to relocating to A and searching for a job there. But whether changes in wages and housing prices in Alberta actually affect the value of unemployment (and, through it, the bargained wage) in Ontario is less clear cut. As in a standard Roback model, assume that housing in each location is less than perfectly elastically supplied so that inflows of workers to Alberta will drive up housing prices there and result in house price declines in Ontario. After an oil price increase, workers will move from O to A until house price differentials offset wage differentials and an equilibrium with $U_c^u = U_A^u - \theta_{cA}$ is re-established. Once that is the case, the term related to moving to Alberta drops out of expression (6). In essence, the option of moving to Alberta is only relevant to a worker in c if there are rents to doing so. If any wage gains are exactly offset by higher house prices then the move is a matter of indifference. However, if, in the short run, wages surge ahead of local prices in Alberta then wage effects from the oil boom in Alberta will be relevant for unemployed workers in cities in Ontario. We will proceed by including the Alberta wage effects, treating the question of whether they are relevant (and whether we are in equilibrium) as an empirical matter.

[6] To simplify the exposition, we have written the specification for U_A^u as if the unemployed workers in A do not have the options to either migrate or commute long-distance to O.

We turn, next, to the long-distance commuting option. Here, we assume that unemployed individuals who do not find a job in their home market and do not get the option to permanently migrate, draw a fixed cost of searching for a long-distance commuting job, τ_{cA}, that is distributed according to a mean zero distribution, F. In addition, there is a mean value for commuting costs between c and A, T_{cA}, that varies with factors such as the number of flights per day to A (which could, in turn, be a function of the number of individuals who flew back and forth between c and A in the past). We then have:

$$\rho U^u_{Ac} = d - \gamma p_{hc} + \mathfrak{A}_c + \psi_A \cdot \left(\sum_j \eta^T_{jA} U^e_{jAc} - U^u_{Ac} \right). \tag{10}$$

with,

$$\rho U^e_{iAc} = w_{iAc} - \gamma p_{hc} + \mathfrak{A}_c + \delta(U^u_{ic} - U^e_{iAc}), \tag{11}$$

where, η^T_{ja} refers to the industrial composition of work for temporary (commuter) migrants.

Working from (11), we can generate a similar expression to (7), replacing $\sum_j \eta^T_{jA} U^e_{jAc}$ in (10) with a linear expression in d, p_{hc}, $\mathfrak{A}_c$, U^u_c and the weighted sum of wages, $\sum_j \eta^T_{jA} w_{jAc}$. This case differs from the permanent migration case primarily because the workers continue to face the house price and amenity costs in c. Thus, this flow is not reduced by rising housing prices in A. Instead, equilibrium commuting flows would correspond to a threshold value of costs, τ^*_{Ac}, such that the number of unemployed workers in c with cost values less than τ^*_{Ac} who find jobs in A just equals the number of long distance commuters from c who are laid off.[7] In this sense, the commuting option is just like adding a set of extra industry options for searchers in the home market with the added wrinkle that there is a cost to accessing these options. Finally, the values for permanent moves and long distance commuting to the other cities within O are written in directly analogous ways.

2.1 Deriving the Wage Equation

Once workers and firms meet, they bargain a wage according to a Nash bargaining rule:

$$(V^f_{ic} - V^v_{ic})\kappa = (U^e_{ic} - U^u_c) \tag{12}$$

where, κ is a parameter capturing the relative bargaining strength of workers versus firms. From (2) and (3), we can write:

$$(V^f_{ic} - V^v_{ic}) = \frac{p_i - w_{ic} + \epsilon_{ic}}{\rho + \delta + \phi_c} \tag{13}$$

[7] That is, $(L_c - E_c)(1 - \psi_c)(1 - \mu^P_{Ac})F(\tau^*_{Ac})\psi_A = \delta E_{Ac}$, where E_{Ac} is the number of commuters from c working in A. τ^*_{Ac} is defined by $U^u_{Ac} - U^u_c = T_{cA} + \tau_{Ac}$.

And, from (5), we get:

$$(U_{ic}^e - U_c^u) = \frac{1}{\rho+\delta}[w_{ic} - \gamma p_{hc} + \mathfrak{A}_c] - \frac{\rho}{\rho+\delta}U_c^u \tag{14}$$

We can solve these for the bargained wage:

$$w_{ic} = \frac{(\rho+\delta)\kappa}{(\rho+\delta+\phi_c)+(\rho+\delta)\kappa}(p_i+\epsilon_{ic}) + \frac{(\rho+\delta+\phi_c)}{(\rho+\delta+\phi_c)+(\rho+\delta)\kappa}[\mathfrak{A}_c - \gamma p_{hc}] + \frac{(\rho+\delta+\phi_c)}{(\rho+\delta+\phi_c)+(\rho+\delta)\kappa}U_c^u \tag{15}$$

Then, substituting expressions for U_{jc}^e, U_A^u, U_{cA}^u, U_b^u, U_{cb}^u into (6), we get:

$$w_{ic} = \alpha_0(p_i+\epsilon_{ic}) + \alpha_1 d + \alpha_2(\mathfrak{A}_c - \gamma p_{hc}) + \alpha_3(\mathfrak{A}_A - \gamma p_{hA}) + \alpha_4\psi_c\sum_j \eta_{jc}w_{jc} \tag{16}$$

$$+\alpha_5(1-\psi_c)\mu_{cA}^P\psi_A\sum_j \eta_{jA}^P w_{jA} + \alpha_6(1-\psi_c)\mu_{cA}^T\psi_A\sum_j \eta_{jA}^T w_{jAc}$$

$$+\alpha_7(1-\psi_c)\sum_b \mu_{cb}^P\psi_b\sum_j \eta_{jb^P}w_{jb} + \alpha_8(1-\psi_c)\sum_b \mu_{cb}^T\psi_b\sum_j \eta_{jb}^T w_{jbc}$$

$$+\alpha_9(1-\psi_c)\sum_b \mu_{cb}^P(\mathfrak{A}_b - \gamma p_{hb})$$

The α parameters can be written as explicit functions of structural parameters such as δ, ρ, and ϕ_c. We do not attempt to back out estimates of the underlying structural parameters because our interest is actually in their net effects as reflected in the α's.

Equation (16) captures the idea that in a bargaining environment, the wages for a worker will depend not just on her productivity in that sector (captured by $(p_i + \epsilon_{ic})$ in this case) but also on her outside options. In our environment, those options are reflected in the average wages the individual would expect to earn from returning to unemployment and then getting another job in the local economy or getting a job in another location through either a permanent move or long distance commuting. The relative housing and amenity prices in the home location and potential permanent move locations also have an effect. This expression is derived assuming that we are not in a migration equilibrium. If we were then the average wages associated with a permanent move and the house prices and amenities associated with the other locations would not affect wages in c.

The fact that w_{ic} is expressed as a function of the average wage across sectors in c implies that this wage equation embodies a standard reflection problem. Partly in response to this, Beaudry et al(2012) re-write their analogous wage equation, replacing local wages with the wage premium for industry i relative to an arbitrary base industry 0 at the national level. That is, they show that one can derive a new wage expression in which $\sum_j \eta_{jc}w_{jc}$ is replaced with $R_c = \sum_j \eta_{jc}\nu_j$, where $\nu_j = w_j - w_0$ are the national level wage premia. We will call R_c

the wage rent in city c since it shows the average wage premium across industries in c. Since we are working with homogeneous workers, these premia are interpreted as rents. We also replace the average wages in the other locations with average rent variables. For example, the average wage for permanent migrants to A, $\sum_j \eta^P_{jA} w_{jA}$ is replaced with $R^P_A = \sum_j \eta^P_{jA}\nu_j$. The explicit steps in moving from equation (16) to one in which average wages are replaced by the rent variables in a manner consistent with the model are described in Appendix C.

According to (16) wages are also a function of the employment rate in the local economy through its determination of ψ_c (which appears explicitly in (16)) and ϕ_c (which appears as parts of the α's). We want to make that relationship explicit for reasons that will become apparent in a moment. In addition, note that the average wage in A is multiplied by factors that reflect the probability of finding a job in c (ψ_c), the probability of getting the option to move (μ^P_{cA}), and the probability of finding a job in A (ψ_A). We assume that workers cannot credibly communicate their personal cost of moving when bargaining with their employer. In that case, rather than basing wage bargains on values for the cost of moving and the likelihood of finding a job in Alberta, we assume that it is based on a common estimate of the likelihood that the worker would end up with a job in Alberta if she were to leave the current match. We take that common estimate to be the proportion of workers in c who moved to A and got a job there in a recent period. That is, rather than focusing on the rent variable, R^P_A, on its own, we will work with $X^P_{Ac} = q^P_{Ac} R^P_A$, where q^P_{Ac} is the proportion of workers from c who moved to permanently to A in a recent period. We take q^P_{Ac} to be used by the bargaining agents as a guess of $(1-\psi_c)\mu^P_{cA}\psi_A$, the probability an unemployed worker doesn't get a job in c, moves permanently to A, and gets a job in A. Similarly, we will represent the option of long-distance commuting to A with $X^T_{Ac} = q^T_{Ac} R^T_A$.[8]

In order to make the contribution of the local employment rate explicit, we log linearize (16) around a point where all the locations in O have the same industrial composition and pay the same wage. We then difference it with respect to time in order to eliminate fixed city x industry characteristics. The resulting wage specification is:

$$\Delta \ln w_{ic} = \beta_{0i} + \beta_1 \Delta R_{ct} + \beta_2 \Delta X^P_{Act} + \beta_3 \Delta X^T_{Act} + \beta_4 \Delta X^P_{Bct} + \beta_5 \Delta X^T_{Bct} + \beta_5 ER_{ct} + \xi_{ict} \quad (17)$$

[8]Note that these expressions allow for differences in the probabilities of working in Alberta and differences in the industrial composition of

Note that in our derivations, we allowed for specific wages for the long-distance commuters in A, w_{jAc}. This would arise because, with a different outside option based on where they would live if they left the match, the commuters will bargain a different wage than permanent residents of A when bargaining with the same employer. Indeed, given that housing prices are likely lower in c than in A during the boom, this is the reason employers in A would want to use commuters. However, in our empirical specification, we allow commuters and permanent movers to have different industrial options (i.e., different values of η_{jA}) but do not form a separate rent variable for commuters. We do, though, allow for their proportions of the workforce to be different.

where, X^P_{Bct} is the weighted average of province specific versions of X^P_{bct} for provinces other than the resource intensive provinces and not including the person's home province. The weights are the fraction of workers from location c moving to a non-resource province who move to a specific non-resource province. We use this instead of option values for every possible city in non-resource provinces in order to reduce our computational burden.

One important aspect of specification (17) is that the intercept has an i subscript, which reflects the fact that it contains the industry specific price terms among others. In estimation, we capture this by including a complete set of industry dummies, implying that our estimated effects are within industry over-time estimates. Intuitively, this means that we identify the local wage rent effect (β_1) by comparing the wage changes for workers in the same industry in two different cities that are experiencing different changes in their industrial composition. For example, we are identifying the bargaining effect by comparing wage changes for construction workers in Hamilton, with the loss of its high wage rent steel sector, to workers in, say, Moncton, without the loss of such a sector. The core idea is that the construction workers in Hamilton were able to bargain higher wages than those in Moncton because their outside option included the possibility of getting high wage steel jobs but they lost that advantage with the decline in the steel sector.

With the wage specification, we are in a position to discuss the potential impacts of the resource boom on communities other than those directly involved in the boom. In the model, the boom shows up as an increase in the price of oil that we treat as specifically relevant as an output in A. That increase, in turn, leads to an increase in wages in the oil producing sector that then generate increases in bargained wages in other sectors in A. Fortin and Lemieux(2015) and Marchand(2015) examine the wage spill-over effects of the oil boom in Alberta, showing that the impacts on wages in the non-oil sectors were large. Our work complements theirs in investigating further spill-over effects to other parts of the country. In the context of our bargaining model, the spill-overs do not stop after one round. As wages in construction in Alberta increase because wages in the oil sector have improved, those increased construction wages can then be used as an improved outside option for workers in other sectors, which in turn imply improved outside options for construction and oil workers, etc.. The derivation of the wage specification in terms of the national level wage premia, above, indicates that what we are estimating is a response in city c to the ultimate, total impact of the oil price increase on the average wage in Alberta, taking account of all the feedbacks.

The first effect of the increase of wages in A will be to induce some workers from O to move to A and others to engage in long-distance commuting to jobs in A. The result is a reduction in the supply of workers in the communities in O, inducing an increase in wages there. In the model, this immediate impact arises because the employment rate, ER_c, rises and tighter labour markets benefit workers in wage bargaining. But without any further changes, this will induce a reduction in job vacancy creation that will eventually lead back to an equilibrium with the same wage and employment rate as before the boom. This first, labour-supply channel (whether in the short or long run) is not what is being captured in the β_2 and β_3 coefficients in (17). Because our specification includes a control for the employment rate, effects that necessarily involve an accompanying change in employment (which is the case with a supply shift unless the demand curve is perfectly inelastic) are not what is being captured by our wage rent variables. We will, however, present some results from reduced form specifications in which we do not control for changes in the employment rate in order to capture the total impact of the wage changes in A, including the labour supply effects.

Given our control for the employment rate, we interpret the β_2 and β_3 as capturing wage bargaining effects: workers in c are able to bargain higher wages because the outside option of working in Alberta has become more attractive. From our derivation of the specification based on national level wage premia, above, what we are actually estimating when we use those national level premia is the complete impact of the wage changes in Alberta taking into account all feedbacks within the c economy. Thus, for the Rent variable for the permanent move to Alberta option, the coefficient is $\frac{\gamma_{A1}}{(1-\gamma_{A2})}[\alpha_5 + \frac{\alpha_5\alpha_4^*}{1-\alpha_4^*}]$. The first part of this expression, $(\frac{\gamma_{A1}}{(1-\gamma_{A2})})$, captures the fact that we are working with the total effect of the oil change on wages in Alberta, taking into account all feedback effects. This is then multiplied by α_5, which is the direct, first round effect of the change in the wage in A, plus $\frac{\alpha_5\alpha_4^*}{1-\alpha_4^*}$, which captures the feedback loops within the c economy. These arguments hold in the same form for the other migration/commuting optons.

The effect of the A wage change on wages in c happens through two channels. The first is the change in the Rent in A, holding constant the propensity for people to move or commute to A (the q's in our X_{cA} terms). The second is due to changes in the propensity for people to move or commute to A. The A options could become more salient in bargaining in c for either reason. Finally, changes in the price of oil and/or the exchange rate could have effects by altering the industrial composition of c. For example, if both oil price and exchange rate changes are particularly bad for manufacturing then the shift in industrial composition in O away from the high paying manufacturing sector will imply declines in bargained wages in all sectors in c. Because we include ΔR_c, the change in the average wage rent in the local market, as a regressor, this last channel is not part of our estimated A wage effects. However, we will investigate a reduced form specification in which we do not include R_c to get an estimate of the net effect of the oil boom, including this channel.

Finally, it is important that the wage premia that we work with correspond to rents i.e., wage differences across industries that do not correspond to productivity differences or compensating differentials. If, instead, the wage premia corresponded to compensating differentials for elements of the work in different sectors then workers in other sectors could not use them to bargain a better wage. The higher wage in, say, the asbestos industry would just compensate for an expected loss in health and so there would be no real threat in telling your employer that you will quit to take a higher wage in the asbestos industry if she doesn't raise your wage. As pointed out in Green(2015), whether the industry premia really are rents can be tested empirically in our context: if they are not rents then the average premium should not affect wage setting within sectors.

2.2 Endogeneity and Identification

Another key aspect of the specification - and a benefit of deriving it from theory - is that we know what is in the error term. In particular, the error term has the form, $\xi_{ict} = a_1\Delta\epsilon_{ict} + a_2\Delta\sum_j \eta_{jc}\epsilon_{jct} + a_3\Delta\sum_j \eta_{jA}\epsilon_{jAt} + a_4\Delta\sum_j \eta_{jBt}\epsilon_{jBt}$. That is, it is a function of changes in the productivity shock for the specific industry-city cell and of changes in location specific averages of sector productivity shocks. The immediate implication of the content of the error term is that it implies endogeneity problems. In particular, as discussed in Beaudry et al(2012), the ΔR_{ct} rent variable is a function of changes in the industrial composition of the local economy. That will clearly be related to the changes in the local productivity shocks and their averages that are in the error term. If we are willing to argue that the productivity shocks in Alberta are independent of those in c then the rent in A should not be correlated with the error in the wage equation for location c. However, we would expect that the propensity to move to A is correlated with local productivity shocks. In particular, we would expect larger movements to A, through either commuting or migration, if there have been negative productivity shocks in the local economy. Thus, ΔX^P_{cA}, ΔX^T_{cA}, and the comparable variables for the B locations are likely to be correlated with the error term. Finally, the employment rate in c variable, ΔER_c, is also likely to be correlated with changes in local productivity shocks and their average.

We adopt an instrumental variables approach to addressing these endogeneity issues that is similar in nature to that used in Beaudry et al(2012). In particular, it is straightforward to show that one can decompose ΔR_{ct} as:

$$\Delta R_{ct} = \sum_j \Delta\eta_{jt}\nu_{j-1} + \sum_j \eta_{jt+1}\Delta\nu_t \tag{18}$$

where, $\Delta y_t = y_t - y_{t-1}$. This decomposition says that the change in the average rent variable can be broken down into changes that arise because of changes in the industrial composition, holding the industrial wage premia constant (the first component on the right hand side) and changes that arise because of changes in the premia, holding the local industrial composition constant (the second term on the right hand side). Beaudry et al(2012) argue that each of these components can be seen as the basis for a valid instrument. In particular, they construct a Bartik-style instrument corresponding to the first component as follows. First, construct predicted employment in each industry in economy c using the local employment level in the industry in period $t-1$ together with the national growth rate in employment in the industry, i.e., $\hat{E}_{ict} = E_{ict-1} \cdot (1 + g_{it})$, where E_{ict} is the employment level in industry i in city c at time t, and g_{it} is the growth rate in industry i employment at the national level. Using these predicted employment levels, we can construct predicted shares of employment in each industry in c in period t, $\hat{\eta}_{ict}$, and then construct an instrument as:

$$IV1_{ct} = \sum_j (\hat{\eta}_{jct} - \eta_{jct-1})\nu_{t-1} \tag{19}$$

Beaudry et al(2012) provide a detailed discussion of the conditions under which this is a valid instrument. Here, we will just provide the intuition and direct interested readers to the proofs in Beaudry et al(2012). First, recall that given the inclusion of industry dummies in our specification, the identifying variation we are using is across cities - within industry. That means that what we are concerned with is the cross-city correlation between $IV1_{ct}$ and ξ_{ict}. The cross-city variation in $IV1_{ct}$ comes from cross-city differences in the η_{ict-1}'s.[9] Thus, for $IV1$ to be uncorrelated with the error term, we need that cross-city differences in start-of-period industrial composition is uncorrelated with cross-city differences in the growth in city-average productivity. In other words, industrial composition at the start of a period should not be a predictor for general productivity growth in a city. This is a standard Bartik style instrument argument: start of period composition is uncorrelated with local changes in the error term. In our case, the assumption may not seem entirely credible - at least ex post, it seems possible to identify types of industrial mixes that predict general growth in an area. However, Beaudry et al(2012) argue that the second instrument, which is constructed based on the second component in (18), provides a strong over-identification test.

The second instrument is written as:

$$IV2_{ct} = \sum_j \hat{\eta}_{jct} \Delta\nu_t \tag{20}$$

The cross-city variation for this instrument is also based on differences in η_{it-1} and, so, its validity is also dependent on cross-city differences in industrial composition at the start of the period being uncorrelated with changes in city-level productivity. According to the

[9] To see this, note that $\hat{\eta}_{ict}$ gets its cross-city variation from η_{ict}.

model, the two instruments should give the same estimated effects. In essence, when you bargain with your employer, it doesn't matter to her if the value of your outside option has declined in value because the manufacturing sector has declined in size or because its size hasn't changed but the wage premium it pays has declined. On the other hand, if the core identifying assumption is incorrect then there is a correlation between the η_{ict-1}'s and the error term, and the two instruments weight that non-zero correlation very differently. Thus, if the requirement that industrial composition differences are uncorrelated with changes in city level productivity fails then we would expect the two instruments to give different answers. In $IV1$ the potentially offending correlation is weighted by national industrial growth rates and the start of period industrial wage premia, and in $IV2$ it is weighted by the growth in the industrial premia. In the US data used in Beaudry et al(2012), the two instruments have a correlation of only 0.18, and they show that one cannot reject the over-identifying restriction at any reasonable level of significance.

We will employ these instruments for ΔR_{ct}. We construct similar instruments for each of our other rent-related variables, the X_{ct}'s. However, these instruments emphasize variation coming just from changes in average rents in A and B. As we have seen, the variation in the X_{ct} variables also comes from changes in the proportion of individuals taking up these geographic alternative options. Indeed, more of the variation in the X_{ct}'s come from changes in those proportions (what we have called the q's) than from movements in the average rents. For that reason, we also construct an instrument that emphasizes the impact of the oil boom and which we expect to affect both the average rent and the propensity to migrate (through, for example, affecting the employment rate). In particular, we construct an instrument as the proportion of the population who moved to Alberta in 2000 times the change in the oil price between t and t-1. This instrument gets across city variation for any given time period from differences in original connections to Alberta and gets over-time variation from changes in the oil price. We construct a similar instrument for the long distance commuters as the proportion of individuals undertaking long distance commuting (i.e., filing their taxes in c but being paid on the main job by a firm located in Alberta) in 2000 times the oil price changes.

Finally, to address the endogeneity of ΔER_{ct}, we use a classic Bartik instrument. That is, we predict the overall employment growth in a city using the start of period industrial composition combined with national level employment growth rates. In particular, $IV3_{ct} = \sum_j \eta_{jct-1} g_{jt}$. Thus, to identify our main wage effects, we are effectively comparing two cities whose start of period composition combined with national level industrial growth imply the same expected overall growth. Then, the wage rent instruments pick up the extent to which that same overall predicted growth reflects differences in changes in the predicted industrial composition, where the composition we care about is in terms of industries ranked by their wage premia. The effects for wages in Alberta are identified by differences in start of period propensities to migrate or commute to Alberta across different cities.

3 Data

The data underlying our main regressions comes from a combination of administrative datasets. The first is the T1 Personal Master File (T1PMF), which contains the captured data from the main tax individual tax form (the T1) for all individuals in Canada.[10] From that file, we get the individual's age, gender, and postal code of residence. We work with Economic Regions as our geographic units. Economic Regions are collections of Census Districts that are at approximately the level of major cities and substantial rural areas. For example, Ontario has 11 Economic Regions with the greater Toronto, Hamilton and the Niagara Peninsula, and greater Ottawa areas being three of them. We focus our attention on the non-Extractive Resource provinces (i.e., the seven provinces leaving out Alberta, Saskatchewan, and Newfoundland), within which there are 55 Economic Regions. We work with the years 2000 to 2012 based partly on data availability and partly to focus on the years around the resource boom. We restrict our attention to tax filers who are age 22 to 64 in those years in order to minimize effects of changes in school attendance and/or retirement.

We are interested in whether people resident in the 7 non-ER provinces either worked as long-distance commuters in the ER provinces or moved to those provinces. We capture the latter by comparing the residence on the T1 in year t to the residence in year t+1 and define them as a permanent mover to an ER province if the place of residence in t+1 is in an ER province. To determine long distance commuting status, we use the T4 files attached to an individual's tax filing. T4's are individual forms filed in relation to each employee by the employer. From the T4's we can determine the province of location of the employer and the worker's earnings associated with the job in the calendar year. The location on the T4 is only at the provincial level and so we define long distance commuters from Economic Region, c, as individuals whose residence on their T1 is in region c but whose main job (as determined by their T4 with the largest associated earnings) is at a firm issuing a T4 from an ER province. Because T4's are only issued to employees, we are focused on paid workers not the self-employed, and our measures of earnings will include only paid earnings. Our main outcome variable of interest is annual earnings on the main job. This has the downside of not being the price of labour (i.e., the wage) that is discussed in our model as it will include variation stemming from differences in hours worked.

[10]The T1PMF does not include the 5% of taxfilers who file late but otherwise contains the universe of tax filers.

We are also interested in knowing the industry of employment on the main job since our Rent variables are based on industrial composition in a location and industrial wage premia. To get industry, we link the T4's to Longitudinal Employment Analysis Program (LEAP) file through a business number. The LEAP includes information on firms gathered from firm tax records. Finally, we also link to the IMDB, which contains information on all immigrants arriving to Canada after 1980 to establish immigrant status (or, more properly, whether the tax filer is an immigrant who arrived after 1980).

We are interested in wage outcomes at the local labour market (i.e., Economic Region) by industry level and, so, aggregate to that level and work in 4 year differences: 2000 - 2004; 2004-2008; and 2008-2012. Our industries are at the 3-digit NAICS level, yielding 102 industries in total. Given our 55 economic regions and our 3 four-year differences, this implies at most 16830 location by industry by year observations. We drop cells with fewer than 20 observations to reduce the impact of small cells. We have not weighted the observations in our estimation by cell size because our unit of interest is the location by industry cell and we do not want to introduce added variation that stems from a potentially endogenous variable (cell size). However, we do use robust standard errors that will, in principle, adjust for any size related heteroskedasticity in the standard errors after the estimation.

We use two estimation approaches. To understand the difference between the two, it is useful to define five types of workers: 1) Residents - individuals who reside in location c in year t and who obtain all their income from the province in which c is located[11]; 2) Commuters to ER provinces - individuals who reside in location c in year t but whose main job is in an ER province; 3) Commuters to non-ER provinces - individuals who reside in location c in year t but whose main job is in a different non-ER province; 4) Recent Migrants to ER provinces - individuals residing in an ER province in year t who resided in location c in year t-1; and 5) Recent Migrants to non-ER provinces - individuals residing in a different ER province in year t who resided in location c in year t-1. Individuals in groups 1, 2, and 3 have earnings by definition but some of the group 4 and 5 members (less than 10%) do not show earnings or employment in their new location.

We have two types of earnings variables to construct. The first is the industry rents at the national level. To obtain those, in each year (2000, 2004, 2008, and 2012) we run a regression of individual log annual earnings for all workers in all provinces on a complete set of immigrant by gender interactions, a set of quadratics in age that allow for different age profiles for each immigrant by gender group, and a complete set of industry dummies. We want to interpret the coefficients on the latter dummies as rents but are concerned that

[11] In principle, this means that some of their income could be earned in a different economic region in the same province

they still capture differences in productive characteristics such as education (which is not available in our administrative data). To address that issue, we also tried specifications in which we included dummies representing cells in 7 by 7 matrices defined by the 5 earnings quintiles, self-employment status, and not-employed status in year t-1 on one dimension and the same 7 categories in year t-2 on the other dimension. The earnings quintiles in these matrices are gender*age*province-specific, i.e. are defined for 180 groups defined by province of residence, gender, and 9 age groups (20-24, 25-29, 30-34,... 60-64). This meant that current year industry effects were calculated from differences within these groups among people who had the same broad earnings/employment/self-employment histories over the two preceding years. This is an attempt to put individuals in rough productivity cells and use only the industry variation within those cells. We present estimates where the industry differentials are estimated both with and without the inclusion of those matrix cell indicators.

Once we have the industry dimensions (the ν_j's), we construct a Rent variable corresponding to each of our 5 worker types in each year and location as:

$$R^k_{ct} = \sum_{i=1}^{I} \eta^k_{ict} \nu_{it} \tag{21}$$

where k indexes the 5 types, c indexes the location in the non-ER province, i indexes industry, and t indexes time. As an example, R^4_{ct}, the rent variable for permanent migrants to ER provinces will be a weighted average of industry rents where the weights are the industrial composition of recent arrivals to an ER province from location c. In contrast, R^2_{ct}, the rent for commuters to ER provinces from c will use the industrial composition of employment in the ER provinces of people who live in c but have their main job in an ER province.

To get our dependent variable , we run individual-level regressions for residents of the non-ER provinces. In particular, we run the same regressions as describe above, with the log annual earnings as the dependent variable and individual controls on the left hand side, but replace the industry dummies with a complete set of industry by location dummy variables, with associated coefficients, θ_{ic}, for the industry i, location c dummy. We keep the θ_{ic}'s corresponding to cells with at least 20 observations. Thus, our dependent variable is the mean log wage for an i,c cell purged of individual characteristic effects. As before, we do this with and without the 7 x 7 matrices representing earnings groups for the preceding two years.

In our second main estimation approach, we take advantage of the fact that we have panel data. In particular, we re-run our exercise for getting the θ_{ic}'s but keep only resident type workers who are present in non-ER provinces across all our sample years. The idea is that we will look for effects on wages for a constant group of non-migrating and non-commuting workers. This addresses issues of selectivity of workers out of the region, e.g., that part of what we might pick up is that observed resident average wages change because the best workers have moved or started commuting to the ER region. The group who are resident in all years is, of course, a select group in their own right. But if we assume an efficiency units form for wages, in which a wage can be written as a time varying price per effiency unit times a person-specific (and constant) number of efficiency units then wage movements for a consistent set of workers (however special they may be) will reflect movements in the price of labour, which is what we care about. Because we are using earnings rather than wages, our estimates will include labour supply responses within the local economy by the set of consistent residents. In addition, this approach does not control for changes in selection across sectors within a location and so our measure also reflects responses to the ER price shocks of this type.

3.1 Variable variation

It is helpful for understanding the source of our identifying variation to see some of the differences in industrial composition across our different worker types and regions. In Table 1, we present the percentage of workers in 2-digit industries for our five workers types in 2000 as well as for workers who resided in ER provinces in 2000. Contrary to residents and commuters (who resided in non-ER provinces in 2000), recent migrants resided in non-ER provinces in 1999. Table 2 contains the same industrial distributions for 2012. A few key points stand out from the tables. First, for non-ER province residents the percentage in manufacturing declines from 18.5 in 2000 to 2012 in 12.0 in 2012. This pattern fits with national trends in manufacturing employment and with Charles et al(2016)'s argument for the US that there is an underlying secular trend away from manufacturing in the US as well. Offsetting that movement are increases in construction, health, retail trade, and accomodation and food services, among others. Second, commuters to ER provinces are much more concentrated in construction, mining and oil extraction, and agriculture and forestry than their resident counterparts, and that concentration intensifies over time. For example, the percentage in mining and oil extraction approximately doubles from 8.5% in 2000 to 16.3% in 2012. Interestingly, the permanent migrants to the ER provinces are not as over-represented in the extractive industries and construction as the long distance commuters. Instead, they look more like the existing residents of the ER provinces. The commuting process is more targeted at the high growth industries than either permanent migration or the existing labour force. The commuters to other provinces are dominated by those in public administration jobs, suggesting that many of them may be people who live in Quebec but cross over to Ottawa to work for the federal government.

Tables 1 and 2 show that there is substantial variation in the industrial composition (and, therefore, in the constructed rent variables) across our worker types. However, the number of observations at the bottom of the columns in each table indicate that the proportions of workers who either commute or migrate are small. Commuters to ER provinces are only 0.16% of residents in the non-ER provinces in 2000. Although this triples to 0.52%, the numbers are obviously small. Importantly, though, there is substantial variation across locations in this proportion. For Cape Breton, a relatively poor, ex-mining region in Nova Scotia, the percentage of all workers commuting to an ER province increases from 0.7% in 2000 to 6.5% in 2012. While for Toronto, the percentage change is from 0.1% in 2000 to 0.2% in 2012. Thus, there is considerable cross-location variation in the changes in commuting proportions. In comparison, the percentage of workers in Cape Breton in 1999 who permanently migrated to an ER province by 2000 was 0.50% in 1999, rising to 0.98% for residents in 2011. The same numbers for Toronto are 0.06% in 1999 and 0.19% in 2011. Together, these imply that there is an increase in permanent movement but it is less salient than long distance commuting, especially in the Maritimes. Recall the model that even small numbers of commuters may have substantial effects on non-ER province wages because workers in all sectors can point to the commuting option as a realistic part of their outside option. On the other hand, there were reasons to question the likely impact of permanent migration on bargained wages of the residents.

Table 3 shows the changes in the industry premia (ν_i's) between 2000 and 2012 computed with (first column) and without (second column) the 7 x 7 matrix of earnings/employment/self-employment positions in the previous two years. The estimates show substantial growth in industry premia in oil and gas, mining, and construction across these years. Including the 7x7 matrix generally implies smaller industry premia, implying that there were some movements across earnings types that were associated with industrial changes in this period. We are concerned that those movements reflect selection on ability or education, which is why we estimate specifications including the 7x7 matrix.

4 Results

In Table 4, we present the results from our main specification, using all workers. Recall that we are pooling 4-year differences from three periods: 2000-2004, 2004-2008, and 2008-2012. The first column contains OLS estimates of the specification that emerges from our theory with changes in the mean log wage in a (non-ER province) location x industry cell regressed on the change in the average rent in that location (ΔR_{ct}), the expected gain from moving permanently to an ER province (ΔX^P_{Act} - which incorporates both the probability of a worker from c moving to an ER province and the average rent in ER provinces of recent migrants from c), the expected gain from commuting to an ER province (ΔX^T_{Act} - which incorporates both the probability of a worker from c commuting to an ER province and the average rent in ER provinces of commuters from c), the same variables for non-ER province moves and commuting (ΔX^P_{Bct} and ΔX^T_{Bct}, and the change in the employment rate in c ($\Delta EmpR_{ct}$). The location specific rent and employment rate have positive and significant (at the 5% level) effects on the average wage in the city. These fit with the predictions from our theory: higher average rents in a local economy imply that workers in all sectors can bargain higher wages, and tighter labour markets as reflected in higher employment rates mean that relative bargaining power shifts toward workers. The effects of the rent variables related to the various types of migration/commuting options are not close to statistical significance with the exception of the commuting to ER provinces option, which is significant at the 10% level.

In the second column of Table 4, we present instrumental variables results in which we instrument for all the rent variables and the employment rate variable using the various types of Bartik instruments described earlier. Looking at the F-statistics values at the bottom of the table, the first stages for ΔR_{ct}, ΔX^T_{Act}, and $\Delta EmpR_{ct}$ are all strong, with p-values under 0.05. In contrast, the rent variable associated with permanent moves to ER provinces (ΔX^P_{Act}) and those associated with moving and commuting to non-ER provinces have weaker first stages. The IV estimates reveal that the latter set of variables all have very poorly defined effects, with the standard errors being double or more the point estimates. We believe that the reason for this outcome for the non-ER province moves is found in the relative similarity of the industrial composition of employment for these movers relative to the residents. There is little clear extra advantage to be had from migrating to one of the other non-ER provinces in this period and, so, those options have little impact on negotiated wages. Given this, our preferred estimates do not include the non-ER province rent variables.

The other estimated coefficient is on the permanent move option variable. Recall from our model that the option of moving permanently to an ER province will not affect wage setting in non-ER locations in equilibrium because the wage increases in the ER provinces will be matched with housing price increases. However, in the short run - if there is a period in which housing prices do not keep pace with wage increases - there could be an effect on non-ER province wages. Whether the permanent move option affects wages in our equation can, as a result, be seen as an indicator of whether our 4 year differences represent short or longer term adjustments. In fact, over different specifications we have estimated, the permanent move option effects has estimated sizes and even signs that switch wildly across specifications, but those estimates are never statistically significant and are almost always smaller than their associated standard errors. We take this as evidence that this effect is not well identified and interpret it is as implying that we are in a longer run situation in which the permanent move option is not relevant. For that reason, we also drop this variable in our remaining specifications

The IV estimates omitting the non-ER province rent variables and the permanent ER province move rent variable are given in column 4 (with column 3 containing the OLS estimates for comparison). The estimate of the effect of the change in rent in the local economy is 0.96 and is statistically significantly different from zero at the 5% level. Green(2015) shows that this estimated effect has a direct relationship to a standard shift share calculation of the impact of a shift in industrial composition on the average wage in an economy. A shift in composition toward higher paying industries would alter the mean wage in a manner obtained by multiplying changes in industrial shares times industry premia and then summing across industries (the standard "between" effect). We can call that direct composition shift effect, B. Once we incorporate spill-over effects through bargaining, the total effect of the composition shift is B*(1 + β_1), where β_1 is the estimated coefficient on ΔR_{ct}. So, in our case, the spillover effects imply a doubling of the standard composition effect. This estimate is about a third of the corresponding estimates in Beaudry et al(2012) for the US and Green(2015) for Canada. The smaller size could be related to the fact that we do not have a set of education controls to use when obtaining our rent measures or to our use of annual earnings instead of wages.

The effect of the variable capturing the option of commuting to an ER province (ΔX^T_{Act}) also has the predicted positive effect of wages in non-ER province locations and is statistically significant at the 5% level. To provide some perspective on this estimate, the 10th percentile of the distribution of 4-year changes in the expected value of commuting in our sample is 0. For the 90th percentile city in terms of these changes, the implied effect on the average wage in an industry would be a 1.5% increase over a 4 year period, or about a 3% increase over the expansion part of the boom. For Cape Breton, one of the largest senders of commuters to the ER provinces, the implied effect over the main part of the boom (from 2000 to 2008) was an 8.9% increase in the average wage compared to a 0.1% increase for Toronto. Thus, expansion of the commuting to an ER province option might help in understanding increases in wages in the Maritime provinces but would likely play a small role in urban parts of Ontario.

The employment rate again enters with an effect that has the predicted positive sign. Just as important for us, is the implications of the inclusion of the employment rate for the interpretations of the other coefficients. Effects of changes in the city level rent, ΔR_{ct}, might be interpreted as reflecting general increases in demand in the city and/or negative labour supply effects within most industries as workers move to the higher rent industries. However, in the absence of perfectly inelastic schedules, both of those mechanisms would be associated with changes in employment. The fact that we see wage effects of ΔR_{ct} while holding the employment rate constant fits with an interpretation of that effect as reflecting the wage bargaining spillovers emphasized in the model.[12] Similarly,when we control for the employment rate, the coefficient on ΔX^T_{Act} reflects bargaining effects and does not include effects resulting from reductions in local labour supply because of the increase in commuting.

In column 5, we present a specification in which we drop the employment rate variable. This means that the estimated coefficient on ΔX^T_{Act} reflects both the bargaining effect plus the effect of reducing labour supply as commuters shift their labour to an ER province destination. The resulting estimate is about 20% larger than when including the employment rate. This fits with our claim that direct effects such as through supply shifts will be smaller than wage bargaining effects. Wage bargaining effects can be larger because workers in all sectors in the economy can refer to the commuting option in bargaining with their employer. The estimates when we drop the employment rate imply that the location with the 90th percentile value of ΔX^P_{Act} experienced a 3.6% increase in the average wage because of the increased ER commuting option. For Cape Breton, it would imply an 11% increase.

Finally, in the last column, we present the reduced form, regressing the wage on the oil price based instrument. Recall that this instrument is the change in the oil price times a base year probability of workers from the location commuting to an ER province. The estimated coefficient can be interpreted as the total effect of the oil price increase, operating through the channels we have so far discussed (shifts in bargaining power and labour supply due to the expansion and value of the commuting option) but it will also reflect effects through shifting the industrial composition in the non-ER province location. The latter could arise because of Dutch disease effects arising because of increased wages and exchange rates affecting local, high wage industries. For Cape Breton, the implied effect of the oil price increase was a 2.2% increase in the average wage in an industry. This is smaller than our estimate based on the previous column, implying that other, (possibly Dutch disease related channels) had negative effects on wages.

In Table 5, we repeat the specifications in Table 4 but do not use the 7x7 matrices in the estimations in which we obtain the industry rents and our dependent variable. We view the 7x7 matrices as useful for allowing us to argue that what we are using is, at least roughly, industry rents rather than differences in education and other skills. Industry differentials based on skill differences would not have wage bargaining spillover effects of

[12] Beaudry et al(2012) argue further that the bargaining model implies that IV1 and IV2 should generate the same estimated effect if the identification conditions for the model hold. In our estimates, we find that we cannot reject the over-identifying restriction that estimates using only IV1 or IV2 are the same at any standard level of significance. When we estimate without including the permanent move to ER province option (the equivalent of column 4 in the table), we obtain an estimated coefficient on ΔR_{ct} of 0.98 when we use IV1 and 1.06 when we use IV2.

the type described in our model because, for example, a high school drop-out worker could not point to increases in average wages in town that stem from the arrival of a highly educated sector as a relevant outside option. That means that to the extent that we do not strip skill differences out of our initial stage industry differential estimates, we will be mixing relevant variation (from rents) with variation that we would expect to have zero effect (from skills). To the extent this is true, less complete control for skills should imply smaller estimated rent variable effects. At the same time, we are working with differences in industry differentials as our rent measure. If the educational composition of industries and the returns to education by industry do not vary with time then that differencing could remove any of these concerns. The results including the 7x7 matrices are our preferred estimates but we present the estimates without those controls out of concern that we may be throwing out too much of the relevant variation. These results show the same broad patterns as those in Table 4. In particular, the location rent variable and the commuting to ER provinces effects are positive and generally statistically significant in the IV specifications. The employment rate continues to have a positive effect on wages and removing it from the specification leads to an increase in the coefficient on ΔX^T_{Act}. The estimated effects for ΔR_{ct} are of similar size to those in Table 4 but the coefficients on ΔX^T_{Act} are considerably smaller. However, the values for ΔX^T_{Act} are larger. For Cape Breton, the increase in ΔX^T_{Act} from 2000 to 2008 combined with the estimate from the specification including the employment rate and permanent move to the ER provinces option but not the moves to non-ER provinces implies a 9.5% increase in the average wage, compared to 8.9% using the same specification in the previous table. When we also drop the permanent move to ER provinces option, the implied effect is a 13% increase in the average wage in Cape Breton from the increase in the commuting option compared to 11% in the previous specification. Thus, the results from the two approaches are similar in size.

To this point, we have presented specifications in which we use instrumental variables to address issues of endogeneity of our right hand side variables; trying to make sure that our rent variables, in particular, are not actually picking up shifts in demand conditions in a location. Without this approach, we might expect that we will capture a greater propensity to migrate out of regions currently having economic troubles and, indeed, our instrumental variables estimates of the impact of the commuting to ER provinces option are larger than our OLS estimates of that effect. But these instruments do not address the other potential endogeneity concern: the selectivity of migrants. Recall that our wage regressions are estimated using the population of people who remain resident in (and do not commute from) the non-ER provinces. But if the people who migrate and commute are, for example, less good workers then we would expect a positive effect from larger values of ΔX^T_{Act} simply because of the composition change of the non-commuting workers.[13] We attempt to address this by using our panel sample of workers. This consists of the set of workers who work in non-ER provinces for all 4 of our data years. As stated earlier, while this is undoubtedly a select group, it is a consistent group across years and thus does not change in terms of its composition of observable or unobservable characteristics.

The results using our consistent panel of workers are presented in Table 6. Focussing on our preferred specifcation in column 4, we observe an estimated effect for ΔR_{ct} that is very similar to that in Table 5 and, once again, statistically significant.[14] The estimated effect of ΔX^T_{Act} is also very similar to what we estimated using the pooled data, though slightly larger in magnitude. As before, when we drop the employment rate variable in column 5, the effect of the commuting option increases in size - in this case by about 14%. The implied effects of the change in the commuting option for Cape Breton are a 12.8% increase when controlling for employment rate effects and a 14.6% effect when not. Thus, these results suggest that the selection of migrants and commuters generated a (not statistically significant) downward pressure on the estimated spillover effects of the commuting option onto non-commuters.

5 Conclusion

To this point, we have found that the resource boom in Alberta, Saskatchewan and Newfoundland did have substantial effects in terms of raising wages for workers who neither migrated nor commuted in locations outside of those provinces. We are currently constructing final counterfactuals in order to be able to specify the extent of these spillover effects and how much of the US-Canada difference in wages they can account for.

6 Appendix A: LFS and CPS Data

6.1 Labour Force Surveys

Our Labour Force Survey extracts come from the Public Use files for the years 1997-2015. Since the survey follows individuals for 6 month periods, we choose to use two months from each yearly survey to construct an annual panel by stacking the observations from May and November. From this extract, we further limit the sample by restricting attention to those between the ages of 20 and 54 who do not report being full- or part-time students. All wage

[13] Recall that ΔX^T_{Act} is partly a function of the proportion of people from the location who commute.

[14] Note that we did not use the 7x7 matrices in the initial data stages when creating the data used in the Table 6 specifications and, so, the relevant comparison is to Table 5.

Table 1: Industrial Composition for Residents, Commuters, and Migrants, 2000

	Residents	ER provs Commuters	Connections Migrants	with Other provs Commuters	Migrants	Workers residing in ER provinces
			percent			
Agriculture	1.7	4.1	2.5	1.8	1.4	2.2
Mining, Oil	0.6	8.5	4.1	0.8	0.6	5.0
Utilities	0.9	0.4	0.4	0.2	0.3	0.9
Construction	4.6	18.2	9.3	6.0	3.2	6.7
Manufacturing	18.5	5.9	10.6	9.1	12.3	9.2
Wholesale	5.4	3.4	4.6	4.6	4.5	5.3
Retail	9.8	5.0	9.9	4.3	8.5	10.4
Transportation	4.5	7.7	5.7	5.5	4.9	5.2
Culture	2.5	1.3	1.9	2.6	3.3	2.4
Finance	4.9	1.9	3.3	2.6	4.6	3.6
Reall Estate	1.3	1.5	1.4	0.8	1.2	1.6
Professional	4.9	6.2	5.5	4.3	7.0	5.3
Management	0.5	0.9	0.5	0.5	0.5	0.6
Waste	4.0	5.1	5.4	5.9	6.3	3.4
Education	7.9	4.5	6.2	6.6	8.2	8.7
Health	9.8	2.7	6.5	4.2	7.7	9.2
Arts	1.2	1.7	1.6	1.5	1.7	1.1
Accomodation	4.8	9.8	9.1	3.8	6.6	5.3
Services	3.9	3.0	3.8	3.2	3.7	4.4
Public Admin	8.3	8.4	7.9	31.8	13.8	9.9
No. of obs	9,028,875	14,406	17,034	106,208	64,744	1,697,408

Note: Numbers may not add to 100.0 due to rounding. Except for migrants, the sample consists of paid workers who resided in non-oil-producing provinces in 2000.

Table 2: Industrial Composition for Residents, Commuters, and Migrants, 2012

		Connections with				Workers residing in ER provinces
		ER provs		Other provs		
	Residents	Commuters	Migrants	Commuters	Migrants	
			percent			
Agriculture	1.4	1.9	1.2	1.4	1.2	1.4
Mining, Oil	0.6	16.3	6.6	1.9	1.0	6.5
Utilities	0.8	0.7	0.7	0.2	0.3	1.2
Construction	6.0	33.7	12.1	5.7	3.8	9.3
Manufacturing	12.0	2.9	6.9	6.4	6.3	6.8
Wholesale	5.0	2.9	3.9	5.7	3.6	4.7
Retail	10.4	2.6	9.7	3.9	9.5	9.8
Transportation	4.4	7.2	5.2	4.9	3.7	4.8
Culture	2.3	0.5	1.4	1.9	2.8	1.6
Finance	5.1	0.8	2.5	2.5	4.1	3.2
Reall Estate	1.6	2.0	1.9	0.8	1.3	1.8
Professional	5.9	6.6	7.1	5.8	7.7	6.6
Management	0.8	0.4	0.6	0.6	0.6	0.6
Waste	4.9	5.9	6.8	5.2	6.1	3.9
Education	8.3	2.3	5.0	7.7	8.6	7.8
Health	11.8	1.6	6.7	5.2	9.0	8.1
Arts	1.2	0.8	1.2	1.3	1.6	1.1
Accomodation	5.2	5.6	8.3	3.6	8.6	5.0
Services	3.9	2.4	3.9	2.9	3.9	4.3
Public Admin	8.6	3.0	8.4	32.6	16.5	11.6
No. of obs.	10,053,946	52,611	33,837	122,076	54,420	2,116,328

Note: Numbers may not add to 100.0 due to rounding. Except for migrants, the sample consists of paid workers who resided in non-oil-producing provinces in 2012.

Table 3: Growth in adjusted log earnings, 2000-2012, Selected Industries

Version 1	Version 2	Industry
0.17	0.24	oil and gas
0.14	0.23	Mining
0.10	0.25	Utlities
0.02	0.14	Bldg Constr
0.07	0.20	Heavy Const
-0.05	-0.11	Textile prods
-0.07	-0.18	Wood prod
0.03	0.02	Petr prod
-0.05	-0.09	Chem manf
-0.17	-0.14	comp manf
-0.08	-0.16	trans manf
0.15	0.25	gas distrib
-0.10	-0.12	furniture store
-0.12	-0.09	elec stores
-0.10	-0.18	air transp
0.27	0.30	pipelines
-0.10	-0.09	financial
-0.06	-0.07	education
-0.04	-0.05	health
-0.12	-0.13	recreation
-0.04	-0.04	accomod.
-0.03	-0.02	food retail
-0.14	0.11	public admin

Note: Changes measured relative to base group: crop production. Version 1: log wage regressions include the 7x7 matrices corresponding to earnings quintiles, nonemployment, and self-employment as well as full interactions of gender, immigrant status, and a quadratic in age.. Version 2 based on log wage regressions with full interactions of gender, immigrant status, and a quadratic in age but without the 7x7 matrices.

Table 4: Estimation Results, Non-Panel Based, Including 7x7 Matrices

	OLS	IV	OLS	IV	IV	OLS
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_{ct}	1.00*	0.84*	1.00*	0.96*	1.19*	-
	(0.32)	(0.41)	(0.31)	(0.34)	(0.37)	
ΔX^P_{Act}	-7.37	-9.23	-	-	-	-
	(8.06)	(17.82)				
ΔX^T_{Act}	2.84	5.48*	2.32	6.75*	8.04*	-
	(1.46)	(2.37)	(1.30)	(2.07)	(2.06)	
ΔX^P_{Bct}	-4.00	-6.06	-	-	-	-
	(3.24)	(14.60)	-			
ΔX^T_{Bct}	0.21	0.75	-	-	-	-
	(0.40)	(3.34)				
$\Delta EmpR_{ct}$	0.41*	0.77*	0.42*	0.45	-	-
	(0.08)	(0.20)	(0.08)	(0.29)		
Oilta						0.024*
						(0.005)
Industry	yes	yes	yes	yes	yes	yes
Year	yes	yes	yes	yes	yes	yes
Observations	14,247	14,247	14,247	14,247	14,247	14,247
R^2	0.41		0.41			0.4
Instr		IV1's-IV2's		IV1's-IV2's	IV1's-IV2's	
Set		IV3 Oilta		Iv3 Oilta	Oilta	
		Oilpa				
First Stage F-Statistic						
ΔR_{ct}		230.99		384.16	454.61	
ΔX^P_{Act}		3.16		-	-	
ΔX^T_{Act}		13.54		25.15	21.96	
ΔX^P_{Bct}		2.44		-	-	
ΔX^T_{Bct}		0.78		-	-	
$\Delta EmpR_{ct}$		4.36		3.12	-	
Sanderson - Windmeijer F-Stats						
ΔR_{ct}		17.93		14.89	176.16	
ΔX^P_{Act}		4.51		-	-	
ΔX^T_{Act}		23.47		8.34	40.55	
ΔX^P_{Bct}		4.92		-	-	
ΔX^T_{Bct}		2.56		-	-	
$\Delta EmpR_{ct}$		3.66		2.39	-	

Note: Standard errors, in parentheses, are clustered at the economic region level. The asterisk (*) denotes significance at the 5% level. All models are estimated using 55 economic region by 102 industry cells in four year differences. ΔR_{ct} is average rent in the economic region. ΔX^P_{Act} is the change in: the probability a person from location c moves permanently to an ER province times the average rent of new migrants in ER provinces. ΔX^T_{Act} is the change in: the probability a person from location c commutes to an ER province times the average rent of commuters in ER provinces. ΔX^P_{Bct} and ΔX^T_{Bct} are defined analogously for non-ER province destinations. $\Delta EmpR_{ct}$ is the change in the economic region level employment rate.

Table 5: Estimation Results, Non-Panel Based, Not Including 7x7 Matrices

	OLS	IV	OLS	IV	IV	OLS
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_{ct}	0.87*	0.62	0.82*	1.13*	1.18*	-
	(0.20)	(0.50)	(0.21)	(0.36)	(0.31)	
ΔX^{P}_{Act}	-7.12*	-18.06	-	-	-	-
	(2.99)	(9.32)				
ΔX^{T}_{Act}	0.96	3.36*	0.35	3.28*	3.42*	-
	(0.53)	(1.58)	(0.57)	(1.23)	(1.26)	
ΔX^{P}_{Bct}	3.92*	-8.65	-	-	-	-
	(1.82)	(12.67)				
ΔX^{T}_{Bct}	1.39	0.52	-	-	-	-
	(2.15)	(12.64)				
$\Delta EmpR_{ct}$	0.33*	0.68*	0.35*	0.12	-	-
	(0.07)	(0.26)	(0.07)	(0.47)		
Oilta						0.031*
						(0.009)
Industry	yes	yes	yes	yes	yes	yes
Year	yes	yes	yes	yes	yes	yes
Observations	14,247	14,247	14,247	14,247	14,247	14,247
R^2	0.21		0.20			0.2
Instr		IV1's-IV2's		IV1's-IV2's	IV1's-IV2's	
Set		IV3 Oilta		IV3 Oilta	Oilta	
		Oilpa				
First Stage F-Statistic						
ΔR_{ct}		14.94		27.94	32.80	
ΔX^{P}_{Act}		3.97		-	-	
ΔX^{T}_{Act}		9.35		13.93	13.67	
ΔX^{P}_{Bct}		1.42		-	-	
ΔX^{T}_{Bct}		2.97		-	-	
$\Delta EmpR_{ct}$		3.35		2.77	-	
Sanderson - Windmeijer F-Stats						
ΔR_{ct}		1.83		11.94	24.97	
ΔX^{P}_{Act}		2.97		-	-	
ΔX^{T}_{Act}		8.25		3.67	23.63	
ΔX^{P}_{Bct}		0.79		-	-	
ΔX^{T}_{Bct}		1.22		-	-	
$\Delta EmpR_{ct}$		3.58		1.64	-	

Note: Standard errors, in parentheses, are clustered at the economic region level. The asterisk (*) denotes significance at the 5% level. All models are estimated using 55 economic region by 102 industry cells in four year differences. ΔR_{ct} is average rent in the economic region. ΔX^{P}_{Act} is the change in: the probability a person from location c moves permanently to an ER province times the average rent of new migrants in ER provinces. ΔX^{T}_{Act} is the change in: the probability a person from location c commutes to an ER province times the average rent of commuters in ER provinces. ΔX^{P}_{Bct} and ΔX^{T}_{Bct} are defined analogously for non-ER province destinations. $\Delta EmpR_{ct}$ is the change in the economic region level employment rate.

Table 6: Estimation Results, Panel Based, Not Including 7x7 Matrices

	OLS	IV	OLS	IV	IV	OLS
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_{ct}	1.04*	0.71	1.00*	1.10*	1.18*	-
	(0.19)	(0.47)	(0.20)	(0.30)	(0.27)	
ΔX^P_{Act}	-4.20	-20.81*	-	-	-	-
	(2.70)	(9.33)				
ΔX^T_{Act}	-0.09	1.11	-0.33	3.72*	4.24*	-
	(0.39)	(1.63)	(0.44)	(1.58)	(1.39)	
ΔX^P_{Bct}	2.40*	1.41	-	-	-	-
	(1.13)	(5.38)				
ΔX^T_{Bct}	-0.27	1.38	-	-	-	-
	(0.40)	(3.45)				
$\Delta EmpR_{ct}$	0.28*	1.03	0.31*	0.23	-	-
	(0.10)	(0.53)	(0.10)	(0.38)		
Oilta						0.028*
						(0.008)
Industry	yes	yes	yes	yes	yes	yes
Year	yes	yes	yes	yes	yes	yes
Observations	12,003	12,003	12,003	12,003	12,003	12,003
Instr		IV1's-IV2's		IV1-IV2	IV1-IV2	
Set		IV3 Oilta		IV3 Oilta	Oilta	
		Oilpa				
First Stage F-Statistic						
ΔR_{ct}		38.60		77.43	99.73	
ΔX^P_{Act}		17.32		-	-	
ΔX^T_{Act}		7.62		11.31	14.51	
ΔX^P_{Bct}		1.69		-	-	
ΔX^T_{Bct}		1.25		-	-	
$\Delta EmpR_{ct}$		3.83		9.18	-	
Sanderson - Windmeijer F-Stats						
ΔR_{ct}		5.48		37.78	88.98	
ΔX^P_{Act}		3.93		-	-	
ΔX^T_{Act}		4.43		12.31	35.53	
ΔX^P_{Bct}		2.59		-	-	
ΔX^T_{Bct}		4.28		-	-	
$\Delta EmpR_{ct}$		2.10		5.80	-	

Note: Standard errors, in parentheses, are clustered at the economic region level. The asterisk (*) denotes significance at the 5% level. All models are estimated using 55 economic region by 102 industry cells in four year differences.
ΔR_{ct} is average rent in the economic region. ΔX^P_{Act} is the change in: the probability a person from location c moves permanently to an ER province times the average rent of new migrants in ER provinces. ΔX^T_{Act} is the change in: the probability a person from location c commutes to an ER province times the average rent of commuters in ER provinces. ΔX^P_{Bct} and ΔX^T_{Bct} are defined analogously for non-ER province destinations. $\Delta EmpR_{ct}$ is the change in the economic region level employment rate.

calculations use a sub-sample of currently employed, wage and salary workers. Workers paid by the hour report their hourly wage directly. Those not paid by the hour have their wages converted to an hourly measure by Statistics Canada. Wages are converted to 2000 dollars using the CPI deflator obtained form http://www5.statcan.gc.ca/cansim/a26?id=3260020.

6.2 MORG Current Population Survey

Our Current Population Survey Merged Outgoing Rotation Group data for 1997-2015 are downloaded from the National Bureau of Economic Research.[15] From these data, we extract a sample of individuals between the ages of 20 and 54 who do not report being full- or part-time students. The construction of our wage data closely follows **?**. Wage data is based on those who report employment in reference week as wage and salary workers. In all wage calculations, we set allocated wages to missing. Our hourly wage measure is based on reported hourly wage for those who report hourly payment and not adjusted for topcoding. For workers who are not paid hourly, we use edited weekly earnings and divide by the result by usual hours worked per week. We topcode the result by multiplying the weekly earnings topcode by 1.4 and dividing by 35. We convert wages to 2000 dollars using a CPI deflator and winsorize wages below 2 dollars.[16] All calculations using the earnings weight provided.

[15] The link is http://www.nber.org/data/morg.html

[16] CPI data from http://data.bls.gov/cgi-bin/surveymost?cu and includes all items.

6.3 Resource Employment and Region Groups

US Resource Employment

State	ER	West	Eastern	West Coast	Atlantic
AK	3.30	3.30			
LA	3.97				
NM	3.01				
ND	2.28				
OK	3.04				
TX	2.24				
UT	2.22				
WV	4.63				
WY	12.07				
CA		0.20			
HI		0.03			
OR		0.10		0.10	
WA		0.17		0.17	
CT			0.06		
IL			0.15		
IN			0.31		
ME			0.08		0.08
MA			0.07		
MI			0.13		
NH			0.10		0.10
NJ			0.05		
NY			0.08		
OH			0.31		
PA			0.42		
RI			0.05		
VT			0.27		0.27
WI			0.10		
Region	2.78	0.23	0.17	0.14	0.12

Notes: Each cell shows the fraction of employed wage and salary workers in the resource sector. This sector is defind as Oil and gas extraction (211), Metal ore mining (2122), Nonmetallic mineral mining and quarrying (2123) Not specified type of mining, Support activities for mining (213). Data from the MORG 1997-2015.

Canadian Resource Employment

Province	ER	West	Eastern	West Coast	Maritimes
Newfoundland	4.07				
Saskatchewan	4.94	4.94			
Alberta	8.01	8.01			
British Columbia		1.07		1.07	
Ontario			0.55		
Prince Edward Island					0.37
Nova Scotia					0.94
New Brunswick					1.42
Region	7.09	4.47	0.55	1.07	1.10

Notes: Each cell shows the fraction of employed wage and salary workers in the resource sector. This sector is defind as NAICS insutry Mining and Oil and Gas Extraction. Data from the LFS 1997-2015.

6.4 Canada in year 2000

Canadian Resource Employment in Year 2000

Province	ER	West	Eastern	West Coast	Maritimes
Newfoundland	2.54				
Saskatchewan	3.32	3.32			
Alberta	5.87	5.87			
British Columbia		0.64		0.64	
Ontario			0.53		
Prince Edward Island					0.13
Nova Scotia					0.96
New Brunswick					1.36
Region	5.05	3.06	0.53	0.64	1.07

Notes: Each cell shows the fraction of employed wage and salary workers in the resource sector. This sector is defind as NAICS insutry Mining and Oil and Gas Extraction. Data from the LFS 1997-2015.

6.5 Canada in year 2013

Canadian Resource Employment in Year 2013

Province	ER	West	Eastern	West Coast	Maritimes
Newfoundland	6.34				
Saskatchewan	5.39	5.39			
Alberta	9.22	9.22			
British Columbia		1.55		1.55	
Ontario			0.58		
Prince Edward Island					0.29
Nova Scotia					0.81
New Brunswick					1.56
Region	8.33	5.43	0.58	1.55	1.08

Notes: Each cell shows the fraction of employed wage and salary workers in the resource sector. This sector is defind as NAICS insutry Mining and Oil and Gas Extraction. Data from the LFS 1997-2015.

6.6 Employment Shares by Region

US Employment Shares

State	ER	West	Eastern	West Coast	Atlantic
AK	0.23	0.23			
LA	1.40				
NM	0.59				
ND	0.23				
OK	1.14				
TX	7.94				
UT	0.84				
WV	0.55				
WY	0.18				
CA		11.74			
HI		0.41			
OR		1.21		1.21	
WA		2.21		2.21	
CT			1.20		
IL			4.43		
IN			2.18		
ME			0.43		0.43
MA			2.30		
MI			3.30		
NH			0.47		0.47
NJ			2.99		
NY			6.35		
OH			3.91		
PA			4.17		
RI			0.36		
VT			0.22		0.22
WI			2.01		
Region	13.10	15.80	34.32	3.43	1.12

Notes: Each cell shows the fraction of employed wage and salary workers in the US. Data from the MORG 1997-2015.

Canadian Employment Shares

Province	ER	West	Eastern	West Coast	Maritimes
Newfoundland	1.43				
Saskatchewan	2.91	2.91			
Alberta	11.51	11.51			
British Columbia		12.36		12.36	
Ontario			39.60		
Prince Edward Island					0.41
Nova Scotia					2.79
New Brunswick					2.28
Region	15.86	26.79	39.60	12.36	5.49

Notes: Each cell shows the fraction of employed wage and salary workers in Canada. Data from the LFS 1997-2015.

6.7 Manufacturing Employment

Manufacturing Employment: Canada vs US

	Canada		US	
Year	All	Ontario	All	Eastern
1997	15.7	18.9	17.1	19.6
1998	16.0	19.2	16.8	19.4
1999	16.4	19.8	16.1	18.7
2000	16.5	20.2	16.0	18.5
2001	16.0	19.4	15.0	17.3
2002	16.2	19.7	14.1	16.6
2003	15.9	19.5	13.8	16.2
2004	15.8	19.4	13.3	15.6
2005	14.8	17.9	12.8	15.0
2006	14.0	16.8	12.7	14.8
2007	13.0	15.7	12.4	14.6
2008	12.5	14.5	12.2	14.1
2009	11.6	13.1	11.3	12.6
2010	11.2	12.8	11.1	12.7
2011	10.8	12.1	11.2	12.9
2012	11.0	12.8	11.2	13.0
2013	10.4	11.8	11.2	13.2
2014	10.3	11.7	10.8	12.7
2015	10.1	11.4	10.7	12.7

Notes: Each cell shows the fraction of employed wage and salary workers in the manufacturing sector. US data from the MORG, Canadian data from the LFS.

7 Appendix B: Other Plots

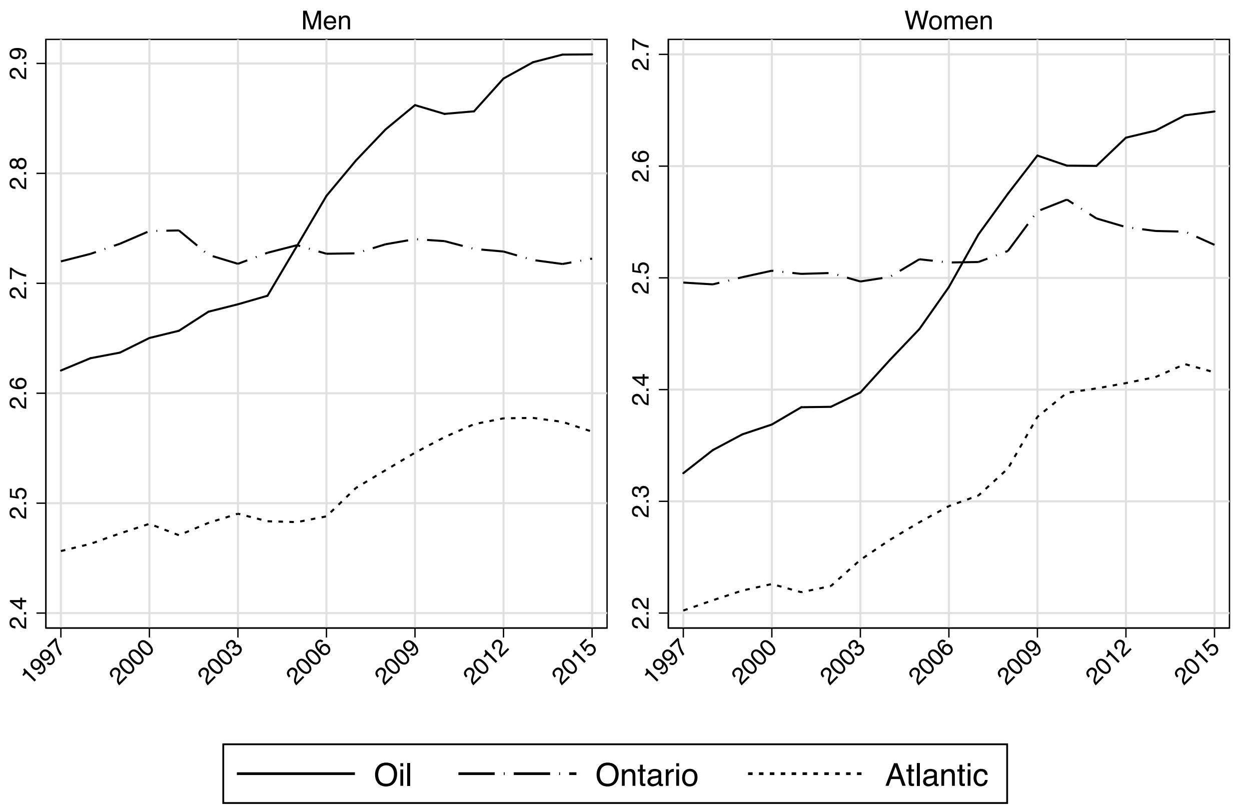

Figure 10: Mean Log Wages by Region, High School or Less Education, Canada, 1997-2015

8 Appendix C: Steps in the Move from Average Wages to Rents

In this Appendix, we set out explicit steps for moving from average wages to our rent variables in equation (17) in a manner consistent with the model. The first step in moving to working with national level premia is to re-write the wage equation (16) as a function of the average of national level prices rather than the average of local wages. To do this, first get the weighted average of (16) using the city c employment weights:

$$\sum_i \eta_{ic} w_{ic} = \alpha_0 \sum_i \eta_{ic}(p_i + \epsilon_{ic}) + \alpha_1 d + \alpha_2(\mathfrak{A}_c - \gamma p_{hc}) + \alpha_3(\mathfrak{A}_A - \gamma p_{hA}) + \alpha_4 \psi_c \sum_j \eta_{jc} w_{jc} \quad (22)$$

$$+\alpha_5(1-\psi_c)\mu^P_{cA}\psi_A \sum_j \eta^P_{jA} w_{jA} + \alpha_6(1-\psi_c)\mu^T_{cA}\psi_A \sum_j \eta^T_{jA} w_{jAc}$$

$$+\alpha_7(1-\psi_c)\sum_b \mu^P_{cb}\psi_b \sum_j \eta^P_{jb} w_{jb} + \alpha_8(1-\psi_c)\sum_b \mu^T_{cb}\psi_b \sum_j \eta_{jb} w^T_{jbc}$$

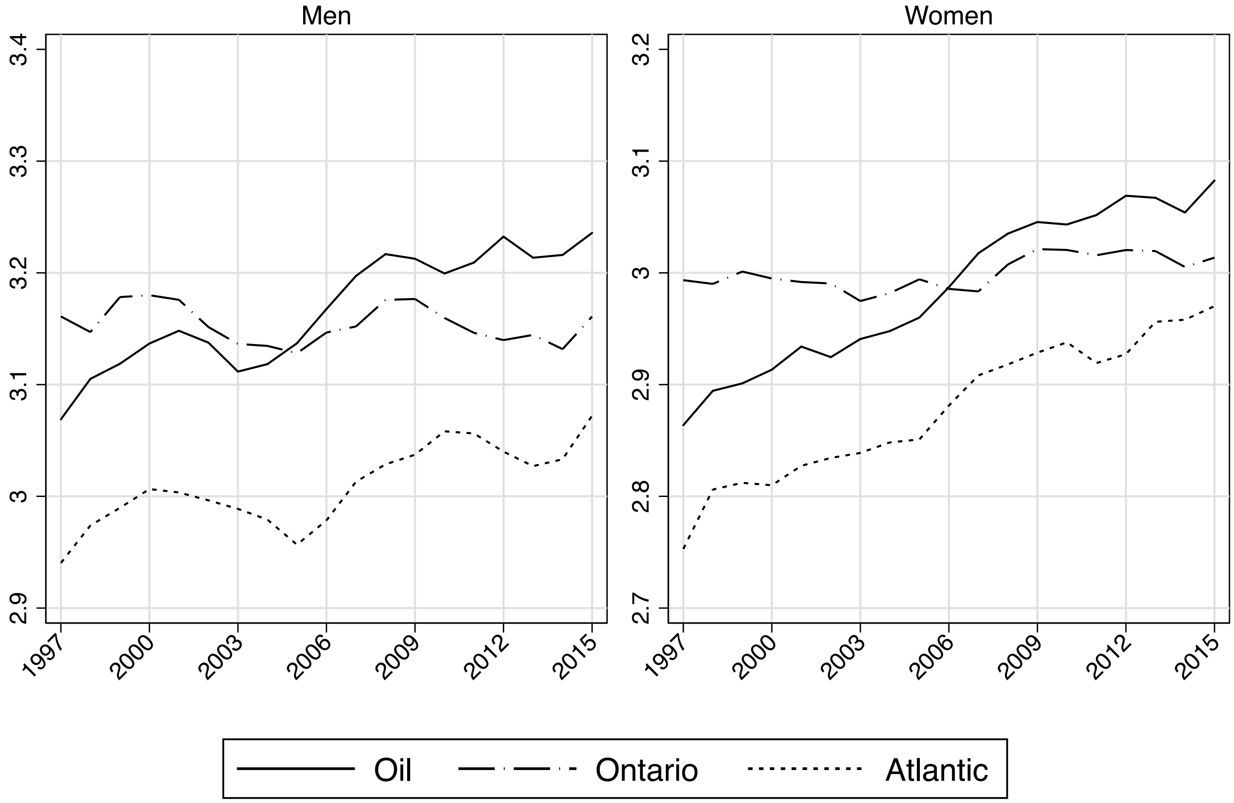

Figure 11: Mean Log Wages by Region, BA or More Education, Canada, 1997-2015

$$+\alpha_9(1-\psi_c)\sum_b \mu^P_{cb}(\mathfrak{A}_b - \gamma p_{hb})$$

Next, solve for $\sum_i \eta_{ic} w_{ic}$ and substitute the resulting expression into (16), at the same time re-expressing the industry prices as differences relative to a base category, p_1.

$$w_{ic} = \frac{\alpha_4\psi_c}{1-\alpha_4^*}p_1 + \alpha_0(p_i+\epsilon_{ic}) + (1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_1 d + (1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_2(\mathfrak{A}_c - \gamma p_{hc}) \tag{23}$$

$$+(1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_3(\mathfrak{A}_A - \gamma p_{hA}) + \frac{\alpha_4\psi_c}{1-\alpha_4^*}\sum_j \eta_{jc}(p_j - p_1)$$

$$+(1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_5(1-\psi_c)\mu^P_{cA}\psi_A\sum_j \eta^P_{jA}w_{jA} + (1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_6(1-\psi_c)\mu^T_{cA}\psi_A\sum_j \eta^T_{jA}w_{jAc}$$

$$+(1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_7(1-\psi_c)\sum_b \mu^P_{cb}\psi_b\sum_j \eta^P_{jb}w_{jb} + (1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_8(1-\psi_c)\sum_b \mu^T_{cb}\psi_b\sum_j \eta^T_{jb}w_{jbc}$$

$$+(1+\frac{\alpha_4^*}{1-\alpha_4^*})\alpha_9(1-\psi_c)\sum_b \mu^P_{cb}(\mathfrak{A}_b - \gamma p_{hb})$$

where, $\alpha_4^* = \alpha_4 * \psi_c$.

But, we also want to replace the average wages in the other locations with averages of the national level prices minus the base industry price. For example, assuming the same bargaining structure in A (and that workers in A don't consider options outside A partly for simplicity and partly to reflect the nature of Albertans), we can write:

$$\sum_j \eta_{jA}^P w_{jA} = \frac{\gamma_{A0}}{1-\gamma_{A2}} + \frac{\gamma_{A1}}{1-\gamma_{A2}} \sum_j \eta_{jA}^P (p_j - p_1) + \frac{\gamma_{A1}}{1-\gamma_{A2}} \sum_j \eta_{jA}^P \epsilon_{iA} \qquad (24)$$

where, the γ's are analogous to the α's above and γ_{A2} is the direct effect of a change in the average wage in A on the wage in one particular industry in A. We can substitute this expression for $\sum_j \eta_{jA}^P w_{jA}$ in (23) and then carry out the same exercise for all locations. Finally, Beaudry et al(2012) show that the industry wage premia (ν_i) are proportional to the industry prices (p_i). Making that substitution yields a wage equation with the rent variables on the right hand side.

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