# UNPACKING MOVING*


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**Abstract**

We develop a dynamic life-cycle spatial equilibrium model with housing stock and a liquid asset under incomplete markets. The model captures the role of age, monetary and utility mobility frictions, credit constraints, city-specific housing supply elasticities and amenities. The features of the model are motivated by empirical evidence on the heterogeneous mobility patterns of different demographic groups. Individuals with lower ability to borrow, younger and non-homeowners move, on average, more. Instead, more able to borrow, younger and non-homeowners are more likely to move to "opportunity" than their respective counterparts. We calibrate the model to the 28 largest Canadian labor markets. We validate it by comparing the results with the empirical evidence above. We, then, perform counterfactual analysis in three dimensions. First, we compare sources of mobility restrictions, utility and monetary costs, and we find that utility moving costs matter quantitatively more than the monetary ones. When utility moving costs decrease by 10%, mobility rates almost double, but the share of individuals that move to "opportunity" decreases since move is less selective. Second, if unemployed agents in the Canadian "Rust Belt" were given moving vouchers, welfare in those cities would be 0.4% higher and and most of it would come from individuals with low networth. Third, if in Vancouver, housing regulations, such as zoning, were less stringent, welfare in the long-run would approximately 5% higher in Vancouver and 0.57% higher in the overall Canada.



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# 1 Introduction

Location choice is a life-shaping decision as the place of residence determines current and future job opportunities, access to education and health care, among others. Living in a location with poor economic and social conditions not only impacts the current living situation but also affects family prospects. Therefore, understanding individuals' location choices and the main mobility barriers that impact their decision has been a central issue in recent research. One would expect individuals to move to "opportunity" or to use migration as a way to buffer income shocks. However, evidence suggests that some demographic groups do not move to "opportunity" and that the use of migration to attenuate the negative impact of shocks is limited.[1] Several explanations have been proposed to rationalize such empirical findings. The most predominant ones are large migration costs, indivisibility of housing and aging of population. More recently, Bilal and Rossi-Hansberg (2018) have put forward the notion of location as an asset in which individuals in response to a negative shock may move but to worse locations.

A large body of empirical and quantitative research has studied each of these channels separately. However, there are no quantitative studies of location decisions within a comprehensive dynamic structural model of household behavior, where households vary by *key* demographic characteristics. This gap in the literature is troubling since migration as a short-term response to income shocks is paramount for macroeconomists and policy makers to alleviate inequality and spur growth. Identifying the determinants of different individuals moving decisions is crucial in shaping local economic policies, such as *housing regulations* or *moving subsidies*, and in assessing whether income shocks can have vastly different welfare effects under different local macroeconomic conditions. Against this background, we aim at "unpacking" the migration decisions and quantifying how much each of these channels, in isolation and in interaction, affect their migration responses.

The paper consists of three parts. First, we exploit a rich individual credit bureau dataset for Canada to give motivational evidence of heterogeneous migration patterns by different demographic groups in terms of how much they move as well as the destination they pick.[2] We study the characteristics of those that move. In particular, we look at home-ownership, age and ability to borrow. We find that homeowners move less than renters, younger individuals move more and those that are less able to borrow move more. On average, higher credit score, younger and renters are more likely to move to locations with higher house prices, higher

[1]See recent work from Autor et al. (2014) that looks at the migration response of the China shock and Chetty, Hendren and Katz (2016) that looks at evidence on heterogeneous moving to "opportunity".

[2]In the Appendix we study the migration response to an international oil shock that affected heterogeneously different regions of Canada in 2014.

wages and higher amenities.[3]

In the second part of the paper, motivated by the findings above, we develop a dynamic life-cycle spatial model with incomplete markets, consumption-saving and housing stock to understand and quantify the disaggregated labor market effects resulting from changes in the local economic environment. The model recognizes the role of labor mobility frictions, geographic factors, amenities, housing demand, heterogeneous housing supply, age and unemployment in shaping the effects of shocks across different labor markets. Hence, our model delivers consumption-saving, housing and labor market dynamics. Our framework allows us to "unpack moving" by decomposing and quantifying how different migration frictions affect the moving decisions in the steady-state and also in response to a negative income shock. Our model is structural in the sense that it generates rich heterogeneity in moving probabilities and moving directions across different groups of individuals without imposing different moving costs. Last but not the least, it allows us to examine the welfare implications of local policies such as housing regulation changes and moving subsidies for targeted locations.

In the third part of the paper, we bring the model to the data by calibrating it using a mix strategy of reduced form estimation and simulated method of moments, similarly to a growing recent macro literature (i.e., Nakamura and Steinsson (2014), Beraja, Hurst and Ospina (2016), Acemoglu and Restrepo (2017) and Jones, Midrigan and Philippon (2011)). In our setting, the main ingredients and mechanisms present in the model are strongly informed by the empirical evidence on heterogeneous migration behaviour. We estimate the production function using regional variation to obtain a series of city-level productivities and we collect information on local amenities to build an amenity index. The other salient parameters of the model are estimated using simulated method of moments. Overall, they match the data quite satisfactorily.[4] To understand how the model's mechanisms work, we reduce migration frictions' elements such as monetary migration costs and bilateral moving utility losses. Finally, we analyze two main counterfactuals: (i) what would be the impact of migration subsidies on the overall mobility patterns and the moving to "opportunity"? We find that a monetary migration subsidy to liquidate the house has very little impact on the moving decisions but a moving utility subsidy does substantially. (ii) how would the welfare effects be if *housing*

[3]We also exploit an unanticipated drop in international oil prices, following Kilian and Zhou (2018), to study the characteristics of those that responded to such income shock. As a response to the shock, instead, homeowners move less than renters, younger individuals move more and less able to borrow move more. We interpret the latter result as suggestive of the fact that the more credit constrained have harder time buffering the shock locally, so they have to move, incurring the monetary and utility cost of doing so. We then look at the characteristics of the new location chosen by the movers.

[4]To validate the model, we also replicate our oil shock experiment to check whether it reproduces our empirical results and so it does. We complement the empirical findings by looking at the transition path.

*regulations* were less stringent in Vancouver? We find evidence an increase in landing permits for construction were 50% higher in Vancouver, welfare in the long-run would be 5% in higher in Vancouver and 0.57% higher in overall Canada. Most of the welfare gains would accrue to low networth individuals

**Literature Review** This paper relates to several branches of the spatial and macro literatures. The most related works are recent papers that develop dynamic quantitative spatial equilibrium models such as Desmet and Rossi-Hansberg (2014), Desmet, Nagy and Rossi-Hansberg (2018), Giannone (2017), Lagakos, Mobarak and Waugh (2018), Lyon and Waugh (2018), Bilal and Rossi-Hansberg (2018) and Caliendo, Dvorkin and Parro (2019) and Eckert and Kleineberg (2019). We complement this class of models by accounting explicitly for life-cycle, location choices by heterogeneous agents with borrowing constraint and housing stock. Specifically, our model allows us to evaluate how agents with different levels of assets, age and homeownership status sort across different locations and how they respond to individual and local shocks differently. Among other dimensions, e depart from the above by considering a life-cycle component, which is crucial to identify and quantify the role of age in the migration decisions, which we find both empirical and theoretically, very relevant. This frameworks sets the ground for a variety of counterfactuals and policy evaluations such as aging population and housing policies. In contemporaneous work, Greany (2019) develops a related model focused on understanding how regional inequality affects the wealth distribution.

This paper also relates to empirical analyses that aim at quantifying migration patterns and responses to negative demand shocks such as Topalova (2010), McCaig (2011), Autor et al. (2014), Dix-Carneiro and Kovak (2017), Kilian and Zhou (2018) and Greenland, Lopresti and McHenry (2019). We highlight two main differences from these papers to ours. First, the fact that besides looking at the response of the shock, using the panel feature of our data, we analyze what are the characteristics associated with those that moves more. Second, thanks to the large size and geographic and longitudinal details of the data, we unpack which locations they decide to go based on house prices, wages, amenities and unemployment rates of the locations.

Overall, we highlight three main departures of our paper from the previous literature. First, most of the existing papers rely on heterogeneous moving costs among different demographic groups in order to obtain migration effects that vary by groups. Our model allows us to have the same monetary and non-monetary moving cost for all groups, but still obtain different moving responses, which is a more realistic feature of the data. This behaviour comes from incorporating the consumption-saving decision. Second, relative to other recent dynamic discrete choice models of labor reallocation, we include a wide range of mechanisms such as housing stock, life-cycle, amenities and sorting by assets, and we endogenously determine local house prices and wages. The resulting framework allows us to study a wider range of policy experiments compared to previous work. This allows us to take the model to data at a highly disaggregated level as we do. Finally, our paper complements reduced-form studies on the effects of the unemployment shocks, at regional or individual level. Besides measuring the differential impact across labor markets, we can also compute employment effects and measure the welfare effects taking into account general equilibrium channels. At the same time, it allows us to make welfare comparisons of policies, often discussed by policymakers, such as moving vouchers or changes in housing regulations, among others.

The rest of the paper is divided in the following sections. Section 2 describes the Canadian *Transunion* data, the rest of the data and the empirical regularities on migration patterns. Section 3 develops the theoretical framework. Section 4 reports the estimation and the calibration strategy. Section 5 reports counterfactual analysis by reducing the moving frictions, giving a moving voucher and decreasing housing regulations. Finally, section 6 concludes.

# 2 Empirical Motivation

In this section, we present motivational evidence of heterogeneous migration patterns along the following dimensions: age, home-ownership and ability to borrow. We start by describing the data used and then we present stylized evidence of heterogeneous migration rates by the demographic groups under consideration. We, then, analyze how locations to which people move to compare to the origin locations. In specific, we sort cities in several dimensions, as house prices, income, amenities, among others, and identify which demographic groups are more likely to move to different locations based on the cities' characteristics. These empirical regularities show a great degree of heterogeneity across groups both in terms of the decision to migrate and of the chosen destination. Appendix D shows evidence of heterogeneous response by demographic groups to an oil shock that affected the labor demand disproportionally more in certain cities.

## 2.1 Data description

Our main data source is *Transunion* in Canada. *Transunion* is one of the two credit reporting agencies in Canada and collects individual credit history on about 35 million individuals which covers nearly every consumer in the country with a credit report. The data are available from 2009 onwards at monthly frequency. The consumer credit reports include information on borrowers' characteristics such as age, credit scores and Forward Sortation Area (FSA) that corresponds to the first 3 digits of the individual's postal code, which allows us to track individual's change of residence within Canada. It also reports for each month a snapshot of the consumer's balance sheet. In specific, we observe credit limits, balances, payments, and delinquency status for different credit accounts as mortgages, auto loans, credit cards, and lines of credit. Although homeownership status is not directly observed, we infer that an individual is a homeowner if it has a current mortgage account with a positive outstanding balance or if the mortgage was fully paid and the consumer kept residing in the same FSA.

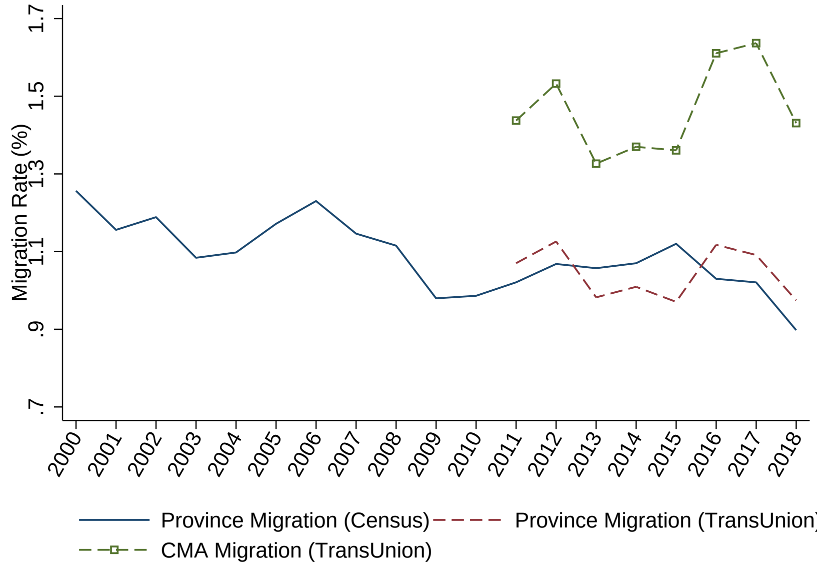
In order to characterize the place of residence we obtained, from several data sources, statistics on house prices, income and employment, among others. FSA level house price index at a quarterly frequency is obtained from the Teranet-National Bank House Price Index dataset. This house price index is constructed using a repeat-sales method for single-family homes and covers 82% of all Canadian FSAs. From *Statistics Canada*, we obtain city[5] level information on total population, unemployment rate and income. Following the methodology in Diamond (2016), we construct a city level amenity index for Canada. To build this index we complement the income statistics with the mean residential fine particulate matter (PM2.5) exposure, several incident-based crime statistics, government spending on different education levels, sales revenues at retail stores and eat and drinking places.

## 2.2 Heterogeneous Migration Patters in Canada

Before describing the migration patterns in Canada for different demographic groups using *TransUnion* in the recent years, we show that the *Transunion* dataset is able to track the aggregate movement of people across space in Canada consistently with the official statistics. Figure 1 shows the inter-provincial migration rates obtained using individual data from *Transunion* and aggregate statistics from Statistics Canada. Both migration rates are very similar both in terms of magnitudes and time. The green dashed line presents the migration rates between CMAs, which, unsurprisingly, are clearly higher than the migration rates between provinces by approximately .4p.p..

[5] A city is defined as a census metropolitan area (CMA) or a census agglomeration (CA) that are formed by one or more adjacent municipalities centered on a population core. A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the core. A CA must have a core population of at least 10,000. To be included in the CMA or CA, other adjacent municipalities must have a high degree of integration with the core, as measured by commuting flows derived from previous census place of work data.

Figure 1: Migration Patters in Canada: Census vs TransUnion Data

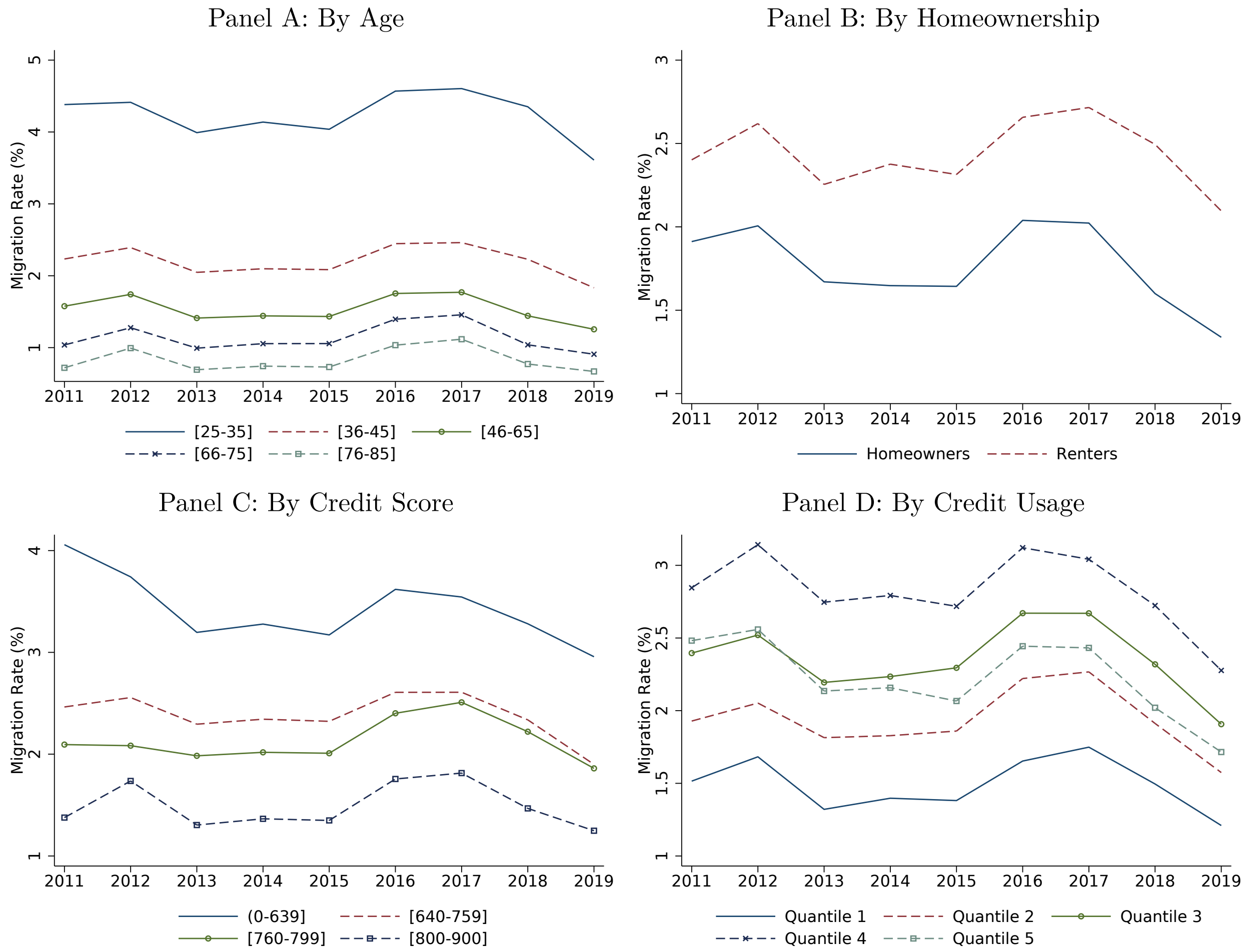



*Note:* Figure 1 plots the migration rates between Canadian provinces between 2000 and 2018 using Census data (blue solid line) and TransUnion (red dashed line). Migration rate is defined by the number of people leaving a certain province divided by the total population in the year before. The green dashed-squared line plots the migration rates among CMAs, defined by the total number of people moving across CMAs divided by total CMA population in the year before. *Source:* Statistics Canada and *TransUnion*.

Figure 2 presents the migration rates across Canadian Cities (CAs) for different individuals characteristics: homeownership status (renter vs homeowner), age (25-35, 36-45, 46-55, 66-75, 76-85) and credit score (0-639, 640-759, 760-799, 800-900) and five quantiles of credit usage. Credit Usage is defined as the total outstanding debt balance divided by the credit limit. We consider any open credit account besides mortgages. In specific we consider credit cards, installments, auto-loans and lines of credit.

Panel A shows a monotonically decreasing relationship between age and migration flows for individuals between 25 and 85 years of age. Specifically, individuals between 25 and 35 move, average, roughly twice as much as people between 36 and 45 and more than four times individuals above 65. Panel B shows the difference in migration rates between homeowners and renters. Renters, on average across the whole sample, are 25% more likely to move than homeowners. Both of these results are consistent with findings for migration flows across US states as in . Panel C and panel D show evidence of differential migration rates by two measures of credit access. According to both measures, more constraint individuals tend to move more. Specifically, panel C shows migration rate is monotonically decreasing with credit score. Panel D shows that individuals with higher credit usage rate (more constraint) also move mre on average, although the monotonic relationship no longer holds. These last two results are new to the literature since standard survey or census data generally used to study flows of population in a country do not have information on individual's finances and credit score.

Figure 2: Migration Patters in the Canada by Demographic Groups




*Note:* Figure 2 plots the migration rates between Canadian Cities (CAs) between 2000 and 2018 by age (panel A), homeownership status (panel B), credit score (panel C) and credit usage (panel D). Migration rate is defined by the number of people moving across cities divided by the total population in the same set of cities in the year before. *Source:* TransUnion.

### 2.2.1 Regression Framework

In order to account for potential joint effects of the different variables and to formally assess these correlations, we regress the moving decisions on individual characteristics. In specific, we run specification 1:

$$Move_{i,z,t} = \beta_0 + \beta_1 X_{i,t-1} + \delta_z + \theta_t + \epsilon_{i,z,t} \tag{1}$$

where Move$_{i,z,t}$ is a dummy variable that equals 100 if individual $i$ in location $z$ at time $t$ moves to a different city. $X_{i,t-1}$ are individual characteristics such as age, homeownership and credit score. Our main specification also includes quarter fixed effects and city fixed effects. The quarter fixed effects, $\theta_t$, absorb overall trends in migration rates and any potential aggregate shock to the economy. The city fixed effects, $\delta_z$, control for city characteristics as amenities, long-run productivity levels, quality of life, among others. We also employ alternative empirical specification where we include city-by-quarter fixed effects to absorb any other potential local shock or changes in local economic conditions that occur simultaneously to the oil shock. We cluster our standard errors at city level.

The main coefficients of interest for our analysis is $\beta_1$ that measures how individuals with different characteristics migrate differently. In other words, it characterizes how different demographics, $X_{i,t-1}$, relate with the probability of moving out of a certain location. In specific, we look at homeownership status, five age group categories (26-35, 36-45, 45-55, 56-65 and 66-85) and four credit score brackets (0-6639, 640-759, 760-799 and 800-900). We interpret that higher the credit score individuals are able to access credit more easily than those with lower credit scores, and therefore, they have higher ability to smooth shocks through borrowing. Similarly, those that have on average a permanent higher credit balance out of their credit limit have less room to adjust their effective borrowing when faced by any shock. In other words, we interpret that lower credit scores or higher credit usage correlate with tighter financial constraints.

Table 1 reports the results of the main specification described in equation 1 for individuals live and move across CAs. Columns differentiate based on the set of explanatory variables and fixed effects implemented. In the first 4 columns we use City and year Fixed Effects while in the last four we use City×Year Fixed Effects. The results are unchanged with the different Fixed Effects implemented. Overall, the regression framework confirms the graphical analysis before both in sign of the differences and magnitudes. This suggests that the propensity to migrate across different individual characteristics is similar across cities and not driven by a subset of large cities. Columns (4) and (8) show that the likelihood of a homeowner moving is, on average, 0.57p.p. smaller than for renters. Regarding age, the probability of moving is lower as individuals become older. Individuals between 36 and 45 have a probability of moving 1.96p.p. lower than those between 25 and 35. This difference increases monotonically up to 3.53p.p. in the group 76-85. When using the credit score as proxy for borrowing constraints, we conclude that constraint individuals tend to move more. The probability of moving for individuals with credit score between 640 and 759 is 0.76p.p. smaller than the moving probability of those with a lower credit score and this difference monotonically increases as credit score goes up.

Table 1: Heterogeneous Migration Responses

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | Move=100 | | | | |
| Homeowner | -0.900*** | | | -0.571*** | -0.900*** | | | -0.571*** |
| | (0.119) | | | (0.124) | (0.119) | | | (0.124) |
| Age [36-45] | | -2.117*** | | -1.958*** | | -2.116*** | | -1.956*** |
| | | (0.229) | | (0.208) | | (0.229) | | (0.208) |
| Age [46-65] | | -2.859*** | | -2.615*** | | -2.859*** | | -2.615*** |
| | | (0.305) | | (0.274) | | (0.304) | | (0.274) |
| Age [66-75] | | -3.374*** | | -3.153*** | | -3.373*** | | -3.152*** |
| | | (0.370) | | (0.350) | | (0.370) | | (0.349) |
| Age [76-85] | | -3.659*** | | -3.529*** | | -3.658*** | | -3.528*** |
| | | (0.386) | | (0.380) | | (0.386) | | (0.380) |
| Credit Score [640-759] | | | -1.052*** | -0.760*** | | | -1.055*** | -0.762*** |
| | | | (0.168) | (0.117) | | | (0.167) | (0.117) |
| Credit Score [760-799] | | | -1.341*** | -0.884*** | | | -1.344*** | -0.887*** |
| | | | (0.196) | (0.123) | | | (0.196) | (0.123) |
| Credit Score [800-900] | | | -1.975*** | -1.119*** | | | -1.977*** | -1.121*** |
| | | | (0.241) | (0.130) | | | (0.241) | (0.130) |
| Observations | 146602877 | 146602877 | 146602877 | 146602877 | 146602877 | 146602877 | 146602877 | 146602877 |
| Adjusted $R^2$ | 0.101 | 0.106 | 0.101 | 0.107 | 0.101 | 0.106 | 0.102 | 0.107 |
| City Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| Year Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| City $\times$ Year Fixed-Effects | No | No | No | No | Yes | Yes | Yes | Yes |

*Note:* This table reports the OLS estimates for the regressions in 1. The dependent variable is the decision on whether to move or not. The sample is restricted to individuals in CAs. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

In Appendix A, we produce a battery of robustness checks for the findings in table 1. In table 12 we used credit usage as a definition of credit access rather than credit score. Tables 13 and 12 replicate, respectively, 1 and 12 but restricting the sample only to CMAs. Due to data limitations, we calibrate the model to the Canadian CMAs, so this exercise makes the data and the model comparison closer. Overall, the results are qualitatively similar and go in the same direction.

## 2.3 Who Moves Up?

In this section, we analyze how the characteristics of the destination cities compare to their city of the origin across different demographic groups. Are individuals more likely to move to places with higher income than their previous locations? First, we conduct a decomposition by destination and migrants characteristics. Second, we test formally in a regression setting which characteristics determine the type of location they choose to move to. We do so by running the following specification:

$$MoveTO_{i,z,z',t} = \alpha + \beta_1 X_{i,t-1} + \delta_z + \theta_t + \epsilon_{i,z,t} \tag{2}$$

where $MoveTO_{i,z,z',t}$ equals 100 if the new location $z'$ can be considered a "move up" than the previous location $z$. We define "move up" if the new location has higher income (or wages, amenities, TFP) or lower unemployment (or housing prices). Although we observe the FSA code, we consider most of the labor market variables at the city level since individuals may commute within the city. However, housing prices are determined at FSA level.

## 2.4 Results

Table 2 reports the results of specification 2. In column (1), the dependent variable is a dummy equal 100 when individual $i$ moves to a location with lower median housing price. Overall, homeowners are .574% more likely to places with lower housing prices conditional on moving. Older people are between 3 and 5% more likely to move to place with lower housing prices. Individuals with lower credit score are approximately 2% less likely to move to places with lower housing prices.

When we look at unemployment rate, we observe that homeowners are more likely to move to place with larger unemployment than their counterparts. Older people are less likely to move to places with lower unemployment while there are no statistical differences across credit score bins. In column (3), we look at amenities where the only statistically significant difference is between age group 25-25 and 36-45 where it suggests that individuals in 36-45 are .6% more likely to move to locations with higher amenities. In column (4), the dependent variable is a dummy equal to 100 if population is higher at the destination than the place of origin. Homeowners are 2.35% less likely to move to higher populated locations. Younger individuals in the 25-35 range move .91% more than those in 36-45 range to larger cities. This relationship monotonically increases with age. When we look at credit score, individuals with credit score in the 640-759 range are 3.77% more likely to move to higher populated locations than those with lower credit score. The relationship monotonically increases with credit score and individuals with credit score between 800 and 900 are 5.3% more likely to move to bigger cities than those with a credit score below 640.

In column (5), we look at individuals that move to locations with higher total income than the origin. The estimates are similar to the ones about population. In column (6), the dependent variable is whether an individual moves to a location with higher average wages than the origin. Homeowners are 1.15% less likely to move to places with higher wages. Individuals in the 25-35 range are 1.18% more likely to move there than those in the 36-35 range and the relationship monotonically increases with age. Individuals with credit score less than 640 are 1.88% less likely to move to locations with higher wages than those with credit score in the 640-759 range. This difference stays relatively constant even for higher levels of credit score.

In columns (7) and (8), we analyze the ratios between average income and average wage in a city and the median house price in the zip code of residence. These ratios proxy for "real" income and wages, respectively. They also speak for heterogeneity within city. Although homeowners are more likely to go to cities with lower income, we do not find find statically significant differences between homeowners and renters in terms of real income. When we look at age differences, we find that individuals in the 45-65 range are 1.87% and 1.33% more likely to move to locations with higher income to house prices and wages to house prices. This relationship monotonically increases with age. When we look at credit score, we find that individuals with credit score in the 640-759 range are 1.49% and 1.56% more likely to move to locations with higher income and wages to house prices, respectively, although they tend to move to cities with lower income. These relationships monotonically increase with credit score.

In Appendix A, we run the same robustness tests as above. Table 14 reports a change in the definition of “move up". Our "Definition II" considers moving up as moving to a location with weakly higher characteristics than the origin. Tables 15 and 16 report the results for CMAs only, for the strict and weak definition of "moving up", respectively. Table 23, 18 and 19 report the results of a decomposition exercise showing the different migration patterns by homeownership, age and credit access.

Table 2: Moving Where?

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| Homeowner | 0.574** | 0.557*** | -0.991 | -2.347*** | -0.482 | -1.155** | 0.427 | 0.277 |
| | (0.275) | (0.195) | (0.908) | (0.595) | (0.476) | (0.578) | (0.337) | (0.399) |
| Age [36-45] | 0.483 | -0.506** | 0.606* | -0.910*** | -1.180*** | -1.455*** | 0.090 | -0.126 |
| | (0.320) | (0.211) | (0.332) | (0.284) | (0.233) | (0.239) | (0.332) | (0.338) |
| Age [46-65] | 3.217*** | -1.386*** | -0.490 | -4.394*** | -4.682*** | -6.184*** | 1.932*** | 0.512 |
| | (0.611) | (0.495) | (0.762) | (0.912) | (0.885) | (0.924) | (0.617) | (0.663) |
| Age [66-75] | 5.218*** | -2.384*** | -1.474 | -6.912*** | -7.338*** | -10.154*** | 3.169*** | 0.524 |
| | (0.870) | (0.769) | (1.593) | (1.392) | (1.301) | (1.439) | (0.795) | (0.840) |
| Age [76-85] | 3.963*** | -2.330*** | -1.545 | -6.182*** | -6.605*** | -8.787*** | 2.255*** | 0.299 |
| | (0.825) | (0.655) | (1.835) | (1.307) | (1.252) | (1.440) | (0.779) | (0.818) |
| Credit Score [640-759] | -1.868*** | -0.028 | 0.623 | 3.768*** | 1.955*** | 1.876*** | -1.785*** | -1.706*** |
| | (0.318) | (0.461) | (0.851) | (0.772) | (0.489) | (0.483) | (0.356) | (0.369) |
| Credit Score [760-799] | -2.320*** | 0.188 | 0.649 | 5.231*** | 2.319*** | 1.997*** | -2.414*** | -2.512*** |
| | (0.444) | (0.700) | (1.144) | (1.143) | (0.675) | (0.644) | (0.557) | (0.591) |
| Credit Score [800-900] | -2.296*** | 0.695 | 0.134 | 5.321*** | 2.902*** | 1.846*** | -2.347*** | -2.660*** |
| | (0.524) | (0.681) | (1.084) | (1.156) | (0.688) | (0.554) | (0.663) | (0.710) |
| Observations | 3270066 | 2410812 | 1768011 | 3242807 | 3188731 | 3188532 | 2785001 | 2784668 |
| Adjusted $R^2$ | 0.306 | 0.396 | 0.339 | 0.407 | 0.358 | 0.350 | 0.279 | 0.273 |
| City $\times$ Year Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for the regressions in 2 at CA level. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

# 3 Model

Motivated by the empirical evidence above, we now analyze migration through the lens of a life-cycle model with incomplete markets, consumption-saving decisions and housing tenure choice. The model can be portrayed as a quantitative spatial equilibrium model that meets Kaplan, Mitman and Violante (2017) in the characterization of the housing sector. The first subsection presents the household's optimization problem. The second subsection describes production of the final good and the housing sector. The third subsection characterizes the equilibrium.

## 3.1 Households and Directed Migration

**Space** The economy is defined by $N$ locations (cities) indexed by $l \in \{1, 2, ..., N\}$. Below, location subscripts are omitted unless necessary. Locations differ in four dimensions: productivity ($z^l$), amenities ($A^l$), labor market risk ($\pi^l$,$M^l$) and housing supply characteristics ($\bar{L}^l$, $\kappa^l$).

**Demographics and Income** The economy is populated by a measure-one continuum of finitely-lived households. Each cohort of agents lives deterministically for $\bar{Q}$ periods. In each period, a measure of $1/\bar{Q}$ agents are born and their initial location is distributed according to $G^0(l)$. The agents work in the initial $Q$ periods and retires after that. Age is indexed by $q = \{1, 2, ..., \bar{Q}\}$. During her working period, she receives either a labor income or an unemployment benefit, both of which are age and location specific. Specifically, the age-spefic income in location $l$ is $w^l(q)\epsilon$, where $\epsilon \in \{1, \epsilon_l\}$ represents the employment status, unemployment or full-time employment, respectively. When an agent first enters a location, say $l$, her initial employment status is drawn from distribution $\pi^l$. Afterwards, the employment status evolves according to the Markov transition matrix $M^l$. Upon retired, an agent receives a fixed retirement benefit of $\bar{w}(q)$, regardless of her location. Unemployment and retirement benefits are funded by the government and we allow the government to run an unbalanced budget.

**Preferences** Agents in our model value (non-housing) consumption $c$, housing services, $h$ and location-specific amenities $A$. We assume that the utility function $U(c, h, A)$ is CRRA as follows:

$$U(c, h, A) = \frac{(c^\alpha h^{1-\alpha} A^\gamma)^{1-\sigma} - 1}{1 - \sigma}, \tag{3}$$

When agents are born, their initial wealth is distributed according to $F^o(a)$, which is assumed to be independent of their initial location and initial employment status. Agents discount the future with a factor of $\beta$.

To be consistent with observed savings after retirement, we assume a bequest function a la De Nardi (2004):

$$\varphi(a) = \theta \frac{(a+\phi)^{1-\sigma} - 1}{1-\sigma} \tag{4}$$

where $\varphi(a)$ represents the terminal value that an individual obtains from leaving assets, $a$, to his or her heirs. $\theta$ captures the intensity of the bequest motive and $\phi$ determines the curvature of the bequest function and hence the extent to which bequests are a luxury good.

**Housing** In each period, agents choose the level of housing services they would like to consume. Housing services can be acquired through either renting ($I_h = R$) or owning ($I_h = H$). We allow agents to have intrinsic preference for homeownership: owning a house of size $h$ provides $\omega h$ units of effective housing services, while a rental property of same size only provides $h$ units of housing services.

To rent a house of size $h$, an agent in location $l$ pays a rent of $p_r^l h$. To purchase a house of size $h$, an agent pays a price of $p^l h$ and a proportional transaction cost of $Fp^l h$. Finally, to maintain a house of size $h$, an agent needs to pay a home maintenance cost of $\delta h$ and a property tax of $sh$. Transaction and maintenance costs and the property tax are additional expenses associated with homeownership.

**Liquid Asset and Networth** Agents can borrow or save through an one-period financial asset $b$ in the international financial market at the exogenous interest rate $r$. Agents face a limit to unsecured borrowing, $\underline{b}$ when do not own a house, but borrowing cannot exceed $\underline{b} + \kappa p^l h$ if she owns a house of size $h$. Owners' total net worth $a$ is the combination of financial wealth $b$ and housing value $p^l h$.

**Location Choice** Agents in our model can move across locations in any period of their life. Agents can direct their migration towards specific locations subject to idiosyncratic location preference shocks and mobility frictions. Specifically, we assume that every period agents draws a vector of $N$ independent Type 1 extreme value shocks with a scale parameter $\nu$. To move, all agents incur an utility moving cost, $\tau^{l,l'}$, which depends on origin and destination locations. In addition to the utility moving cost, agents also incur a monetary moving cost $F_m$. One prominent feature of our model is that the location choice interacts extensively with agents consumption, saving decisions and housing choices. This allows us to generate distinct migration patterns for individuals in different idiosyncratic states, without introducing any state-contingent migration costs.

**Timeline** The timeline of the decision-making of an agent in location $l$ with age $q$ and current networth $a$ is as follows:

1. Consumption and saving decisions are made; transaction costs are paid for homeowners who adjust housing consumption;
2. Return of liquid saving realizes; owners pay home maintenance cost and property tax;
3. A vector of idiosyncratic preference shocks realizes;
4. Migration happens and moving costs are paid if moving occurs;
5. Labor supply shock realizes; agents choose between renting and owning;
6. State variables evolve according to the exogenous shock processes and individual decisions.

We now formalize the individual's problem. A renter with individual states $(l, a, \epsilon, q)$, where $l$ is her location, $a$ is her current asset holding, $\epsilon$ is her employment status and $q$ is age, solves the following Bellman equation:

$$V_t^R(l, a, \epsilon, q) = \max_{c,b,h'} U(c, h', A^l) + \nu \log(\sum_k \exp(\beta \mathbb{E}^k \tilde{V}_t(k, a'(k), \epsilon', q+1, 0) - \tau^{l,k})^{\frac{1}{\nu}}),$$

$$s.t. \quad c + b + p_{r,t}^l h' = w_t^l(q)\epsilon + a$$

$$a'(k) = (1+R)b - F_m(k \neq l)$$

$$b \geq \underline{b};$$

A homeowner with individual states $(l, a, \epsilon, q, h)$, where $l$ is her location, $a$ is her current asset holding, $\epsilon$ is her employment status, $q$ is age and $h$ is the amount of housing carried over, solves the following Bellman equation:

$$V_t^H(l, a, \epsilon, q, h) = \max_{c,b,h'} U(c, \omega h', A^l) + \nu \log(\sum_k \exp(\beta \mathbb{E}^k \tilde{V}_t(k, a'(k)\epsilon', q+1, h'(k=l)) - \tau^{l,k})^{\frac{1}{\nu}}),$$

$$s.t. \quad c + b + p_t^l h' = w_t^l(q)\epsilon + a - F(h' \neq h)$$

$$a'(k) = (1+R)b + p^l h' (1 - \delta - s) - F_m(k \neq l)$$

$$b \geq \underline{b} - \kappa p^l h';$$

where

$$\tilde{V}_t(k, a'(k), \epsilon', q+1, h') = \max \left[ V_t^R(k, a'(k), \epsilon', q+1), V_t^H(k, a'(k), \epsilon', q+1, h') \right]$$

is the continuation value immediately after labor supply shocks realize.

Following McFadden (1973), Type 1 Extreme value assumption on location preference shock implies a closed-form solution to the migration probabilities. In particular, the probability of moving to location $k$ for an agent with individual states $(l, a, \epsilon, q, h)$ is

$$\mu_t(k; l, a, \epsilon, q, h) = \frac{\exp(\beta \mathbb{E}^k \tilde{V}_t(k, \tilde{a}_t(k), \epsilon', q+1, \tilde{h}_t(k=l)) - \tau^{l,k})^{\frac{1}{\nu}}}{\sum_{l'=0}^{N} \exp(\beta \mathbb{E}^{l'} \tilde{V}_t(l', \tilde{a}_t(l'), \epsilon', q+1, \tilde{h}_t(l'=l)) - \tau^{l,l'})^{\frac{1}{\nu}}}. \tag{5}$$

where $\tilde{a}_t$ and $\tilde{h}_t$ are policy functions derived from agents' optimization problems.

## 3.2 Production and Housing Supply

**Production** The production side of the economy is standard. The production function of an unique consumption good is assumed to be $\exp(z^l)(L^l)^\eta$, where $L^l$ is total employment in location $l$. The equilibrium city-level wage in location $l$ is then given by

$$w_t^l = \eta \exp(z^l)(L_t^l)^{\eta-1} \tag{6}$$

We assume the profit from production accrues to foreign agents.

**Housing Sectors** Following Kaplan, Mitman and Violante (2017), we assume that risk-neutral foreign investors can arbitrage between the owned-housing market and the rental market, which connects housing prices and rents in the following way[6]:

$$p_{r,t}^l = p_t^l - (1 - \delta - s)\, \frac{p_{t+1}^l}{1+r} \tag{7}$$

Also as in Kaplan, Mitman and Violante (2017), there is a foreign-owned competitive construction sector that operates in each city a city specific production technology $I^l = \left(z^l N_h^l\right)^{\frac{1}{k^l}} (\bar{L}^l)^{1-\frac{1}{k^l}}$, where $\frac{1}{k^l}$ is city $l$ housing supply elasticity, $N_h^l$ is the quantity of labor services employed and paid $w_l$ and $\bar{L}^l$ is the amount of new available buildable land.[7] The housing investment that solves a profit maximization of a developer is given by:

$$I_t^l = \left(\frac{1}{1+\kappa^l} p_t^l\right)^{1/\kappa^l} \bar{L}^l \tag{8}$$

[6]As presented in Kaplan, Mitman and Violante (2017), this formula can be derived from the optimization problem of a competitive rental market that can frictionlessly buy and sell housing units and rents them to households

[7]Government issues and sells new permits equivalent to $\bar{L}^l$ units of land in a competitve market price to developers as assumed in Kaplan, Mitman and Violante (2017).

where $\bar{L}^l$ is a location-specific constant.

The overall housing stock in location $l$ evolves according to

$$H^l_{s,t} = (1-\delta)H^l_{s,t-1} + I^l_t. \tag{9}$$

Housing market clearing requires that the overall housing stock coincides with the total demand for housing services in location $l$, that is

$$H^l_{s,t} = \int \cdots \int_{a,\epsilon,q,I_h,h} \tilde{h}_t(l,a,\epsilon,q,I_h,h). \tag{10}$$

## 3.3 Equilibrium

The stationary equilibrium of the economy consists of: price vectors $\mathbf{w},\mathbf{p},\mathbf{p}_r$; policy functions $\mu,\tilde{a},\tilde{I}_h,\tilde{h}$; a law of motion $\Gamma$, a housing stock $H_s$ and a stationary distribution over individual states $L$ such that:

1. Given $\mathbf{w},\mathbf{p},\mathbf{p}_r$, the policy functions, $\mu,\tilde{a},\tilde{I}_h,\tilde{h}$, solve the agent's problems;
2. Labor market clears according to (6);
3. Housing markets clear following (7)-(10);
4. The law of motion $\Gamma$ is consistent with policy functions $\mu,\tilde{a},\tilde{I}_h,\tilde{h}$ and exogenous processes for $\epsilon$;
5. The distribution over individual states $L$ is invariant with respect to $\Gamma$, , i.e.,

$$L = \Gamma L.$$

Outside of the stationary equilibrium, we can characterize the transition path of the economy for any initial distribution over individual states $L_0$. In this case, the equilibrium of the economy consists of: the path of price vectors $\{\mathbf{w}_t,\mathbf{p}_t,\mathbf{p}_{r,t}\}_{t=0}^{\infty}$; a path of policy functions $\{\mu_t,\tilde{a}_t,\tilde{I}_{ht},\tilde{h}_t\}_{t=0}^{\infty}$; and a path of distributions over individual states $\{L_t\}_{t=0}^{\infty}$ such that for each $t$:

1. Given the path of price vectors $\{\mathbf{w}_t,\mathbf{p}_t,\mathbf{p}_{r,t}\}_{t=0}^{\infty}$, the policy functions, $\mu_t,\tilde{a}_t,\tilde{I}_{ht},\tilde{h}_t$, solve the agent's problems;
2. Labor market clears according to (6);
3. Housing markets clear following (7)-(10);

4. The law of motion $\Gamma_t$ is consistent with policy functions $\mu_t, \tilde{a}_t, \tilde{I}_{ht}, \tilde{h}_t$ and exogenous processes for $\epsilon$;

5. The distribution over individual states $L_{t+1}$, evolves according to $\Gamma_t$, i.e.,

$$L_{t+1} = \Gamma_t L_t.$$

# 4 Taking the Model to the Data

This section provides a summary of the data sources and measurements used to take the model to the data, with further details provided in the Appendix. We report the mix of reduced-form analysis and simulated method of moments that we pursued to calibrate some of the parameters of the model. We obtain estimates for location specific productivities, $z^l$, amenities, $A^l$, labor market risks, $\{\pi^l, M^l\}$, and housing supply elasticities, $\kappa^l$. We also estimate the labor demand elasticity, $\eta$. Then, we internally calibrate several household utility parameters, $\{\beta, \nu, \omega\}$, bilateral moving costs and borrowing limit, $\{\tau^{l,l'}, \delta^l, \underline{b}\}$ and land availablity $\bar{L}^l$. The rest of the parameters $\{\alpha, \sigma, F_m, F, \epsilon, \gamma, \theta, \delta, r, \kappa, s\}$ is taken from the literature or read directly from the data as explained below in further details.

Finally, in the last subsection, we report the main results of simulating the calibrated model and we check how some non-targeted moments match the data.

## 4.1 Data, Space, Age Groups and Measurement

We calibrate the model to the Canadian economy pre-2014 oil shock. The geographic units of analysis are the 28 largest Census Metropolitan Areas (CMAs) in Canada. There are about 35 CMAs in Canada with more than 100,000 inhabitants, but due to data limitations we restrict our analysis to 28 CMAs.

**Productivities (TFP) and Elasticity of Labor Demand** In order to estimate the elasticity of labor demand $\eta$ and local TFP, $z^l, \forall l$, we estimate the wage equation 6 by using an instrumental variable approach. Specifically, we use measures of housing regulations interacted with shocks *a la Bartik*. The intuition is that housing regulations move the labor supply without moving the labor demand for a given shock of housing. This pins down $\eta$. Once we estimate $\eta$, we predict wages and back out from the residuals $z^l$ for all CMAs. We report the distribution of TFP by city in panel A of figure 17.

**Amenities** We construct a measure of amenities at CMA-level following Diamond (2016).

We run a principal component analysis using information on government spending on K-12 education per capita, availability of restaurants, level of pollution measured as particles in the air and crime rates. All this data is extracted from Statistics Canada. For robustness, we also conducted a factor analysis and the results are unchanged. Diamond (2016) amenity's index is much richer than ours. Unfortunately, for Canada there are not as many available variables as in the US. We report the distribution of amenities by city in panel A of Figure 17.

**Housing Elasticities** We estimate CMA-level housing price elasticities following Guren et al. (2018). Their approach exploits systematic differences in cities responses to regional house price cycles. As pointed out by the authors, when a house price boom occurs in a given region, some cities systematically experience larger house prices increase than others. The reserve is true for downturns. Therefore, the authors regress change in city house prices on changes in region house prices and control for city and region×time fixed effects. The housing supply elasticity corresponds then to the inverse of the estimated city-level sensitivity parameter.[8] We report the distribution of housing elasticities by city in panel C of figure 17.

**Employment Shocks** We select the CMA-specific employment shock transition matrices $M^l$ to meet two requirements. First, the steady state unemployment rate in each CMA equals the average unemployment rate between 2000 and 2011 in the data; second, the average monthly employment-to-unemployment (EU) rate equals 1.5% following Statistics Canada.[9]

## 4.2 Model Parameters

In order to obtain estimates on the set of parameters $\{\underline{b}, \beta, \tau_0, \tau_1, \nu, \omega, \xi\}$, we use simulated method of moments and target seven moments: share of individuals with negative assets, 20th and the 50th percentile of the net worth-to-income ratio distribution, the correlation between in-migration and distance and the correlation between out-migration and distance, the homeownership rate and the number of total movers divided by the population. We target the share of individuals with negative assets to pin down $\underline{b}$. We use two percentiles of the net worth-to-income ratio distribution to discipline $\beta$ and $\xi$. Then, the correlation between in-migration and distance help us pin down $\tau_0$ while the correlation between out-migration and distance pins down $\tau_1$. Targeting the homeownership share allows us to identify $\omega$. Table 3 reports the value of each of these targeted moments both in the data and the ones generated by the model. Overall, the differences between moments in the data and in the model are in

[8] An alternative approach would be to use land availability, geographic characteristics and housing regulation to build housing supply elasticities for Canadian cities following Saiz (2010). However, data limitations prevent us from doing so.

[9] https://www.bankofcanada.ca/wp-content/uploads/2019/01/san2019-4.pdf

the order of the second digit after the comma and they allow us to pin down the parameters in table 4 below.

Table 3: Results of Simulated Method of Moments

| **Moment** | Data Value | Model Value |
|---|---|---|
| av.out-migration | 0.0144 | 0.0149 |
| corr.(distance,out-migration) | -0.2004 | -0.187 |
| corr.(prod,in-migration) | 0.9322 | 0.9204 |
| sh. pop. negative assets | 0.069 | 0.049 |
| 20th perc. networth/income distribution | 0.475 | 0.54 |
| 50th perc. networth/income distribution | 3.828 | 3.85 |
| homeownership share | 0.69 | 0.695 |

Notes: This table reports the seven targeted moments that we use to perform simulated method of moments. The data moment for comparison are taken from Statistics Canada.

Table 4 reports the values of all the parameters we use in the rest of the analysis. We assume that individuals enter the model when they are 25 years of age and they die when they 85 years old ($\bar{Q}$), living, therefore, for 60 periods. Agents retire when they are 65 years old ($Q$).

Regarding the preferences' parameters, we set the share non-housing consumption, $\alpha$, to 0.85 as in Kaplan, Mitman and Violante (2017). $\sigma$ from the CRRA is taken from Kaplan, Mitman and Violante (2017) and set to be equal to 2, which gives an elasticity of intertemporal substitution equal to 0.5. We internally calibrate the discount rate $\beta$ and we find that it is equal to 0.96. The elasticity on the amenity, $\gamma$, is taken from Diamond (2016) that estimates it in a spatial equilibrium model using variation in housing supply interacted with local Bartik productivity shocks. The bequests' parameters are taken from De Nardi (2004) that looks at the wealth inequality across generations. Finally, among the preference parameter we internally pin down $\omega$ as the utility an agent receives from owning a house. The parameter value is 1.05. The probability of the employment shock $\epsilon$ is calculated directly from the unemployment statistics in Canada.

We internally calibrate $\nu$ that shapes the variance of the T1EV and we found it to be equal to 4.99. The estimate of $\nu$ is the same as in Caliendo, Dvorkin and Parro (2019). In order to account for the bilateral utility moving costs, $\tau^{l,l'}$, we linearize the expression to $\tau^{l,l'} = \tau_0 + \tau_1 dist^{l,l'}$, where $dist^{l,l'}$ is the distance between any two pair of locations. The intercept $\tau_0$ and the slope, $\tau_1$, are internally calibrated to 34.3 and 0.026, respectively. By reading data from the Association of Movers, we find that, on average, moving costs approximately CAD 5,660.00. We set the monetary moving costs, $F_m$, to this value.

We, then, move to the housing parameters. The housing maintenance cost $\delta$ is taken

Table 4: Parameter Values

| Parameter | Interpretation | Internal | Value |
|---|---|---|---|
| **Space** | | | |
| $N$ | Number of Locations | N | 28 |
| **Demographics** | | | |
| $\bar{Q}$ | Length of Life (years) | N | 60 |
| $Q$ | Working Life (years) | N | 35 |
| **Preferences** | | | |
| $\alpha$ | Non-housing consumption share | N | 0.85 |
| $\beta$ | Discount factor | Y | 0.96 |
| $\sigma$ | Risk aversion | N | 2 |
| $\nu$ | Scale of Type 1 E.V. shocks | Y | 4.99 |
| $\tau_0$, $\tau_1$ | Utility moving costs | Y | 34.3; 0.026 |
| $F_m$ | Monetary moving cost | N | 0.1 |
| $\epsilon_l$ | Replacement rate | N | .5 |
| $\gamma$ | Amenities elasticity | N | 1 |
| $\theta$,$\phi$ | Bequest | N | 100; 7.7 |
| $\omega$ | Additional utility from owning | Y | 1.05 |
| **Technology** | | | |
| $\eta$ | Labor Elasticity | N | 0.37 |
| $z^l$ | Local productivity | N | |
| **Housing** | | | |
| $\delta$ | Housing maintenance cost (depreciation) | N | 0.015 |
| $\kappa^l$ | Local elasticities | N | |
| $\bar{L}^l$ | Local land permits | Y | |
| $F$ | Housing transaction Costs | N | 0. 07 |
| **Financial Instruments** | | | |
| $r$ | Interest rate | N | 0.025 |
| $\underline{b}$ | Unsecured borrowing limit | Y | -0.25 |
| $\kappa$ | Leverage constraint | N | 0.8 |
| $s$ | Property tax rate | N | 0.01 |

Note: This table reports the parameters' values used in the calibration stating whether they are internally calibrated with simulated method of moment or calibrated externally. The model is calibrated at a bi-year frequency but all the parameters shown in this table are annualized.

from Kaplan, Mitman and Violante (2017) and set to be 0.015 per year.The housing tax is set to .01 as in Kaplan, Mitman and Violante (2017) that set this tax to be the median tax across US states. The housing local elasticities for each location, $\kappa^l$ are estimated with the methodology explained in 4.1. $F$ is the fixed cost that homeowners pay when they adjust the quantity of housing that they own. We set it to 7% of the value of the house as in Kaplan, Mitman and Violante (2017). At last, we impose in the stead-state the median house price to income in each city, which allow us to back-up the location-specific land permits $\overline{L}^l$. We normalize the land permits in order to match the 20th and 50th percentile of the empirical net worth-to-income ratio distribution.

Finally, we turn to the description of the financial instruments. The interest rate, $r$, is set to 2.5%. We internally calibrate $\underline{b}$ which is the minimum level of assets to hold. We find a value of $-0.25$.

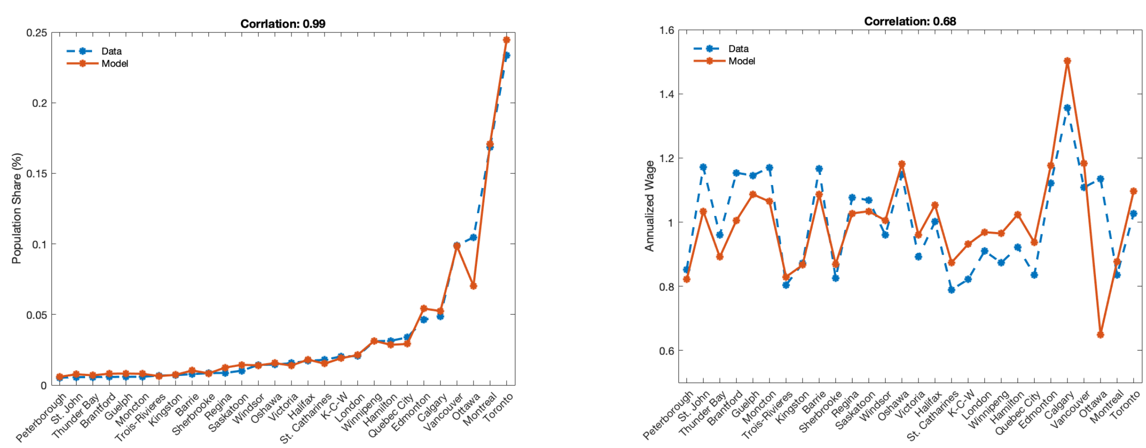
## 4.3 Model Matching Data

In this section, we report the results of the calibrated model with the parametrization above to analyze how the model matches the data on some non-targeted moments of interest. We are both interested in understanding how the networth to income distribution and the house value to income distribution is matched. At the same time, given our focus on heterogeneous migration patters by demographic groups, we test a battery of migration moments by homeownership, age and networth groups.

Figure 3: Population and Income

Panel A: Population

Panel B: Income

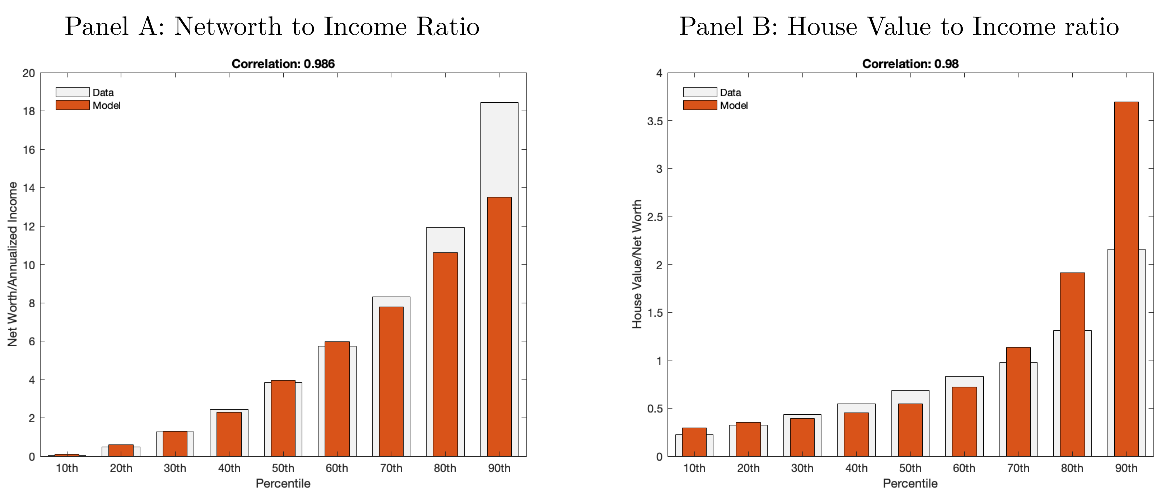



Notes: Figure 3 plots the population and income by CMA both in the data and in the model. Panel A plots population and Panel B plots income. Population and income in the data are computed using official migration rates from Statistics Canada and TransUnion.

**Population and Income** Panel A and panel B of figure 3 show how the model matches population and income per capita by location. The model matches population quite closely to the data. The city that diverges the most is Ottawa where the model suggests that Ottawa should be smaller than it actually is. One reason could be that being Ottawa the capital of Canada, there are forces outside the model that induce population and higher wages there. The match between data and model related to income per capita is also quite close. As for population, the city that differs the most is Ottawa.

**Networth and House Value** The distribution of networth to income and the distribution of house value to income ratio are shown in panel A and panel B of figure 4, respectively. The model matches closely the networth to income distribution for all of the income percentiles, except the 90th percentile. This might be due to the fact that we do not have any force in the model that generates households to keep extremely high levels of networth. Simialrly to the networth to income ratio, we match the distribution of house price to income ratio well outside the 90th percentile. The two panels suggest that in the model people have higher housing networth to income than in the data but lower financial wealth. This is a direct consequence of housing being the only illiquid asset in the model.

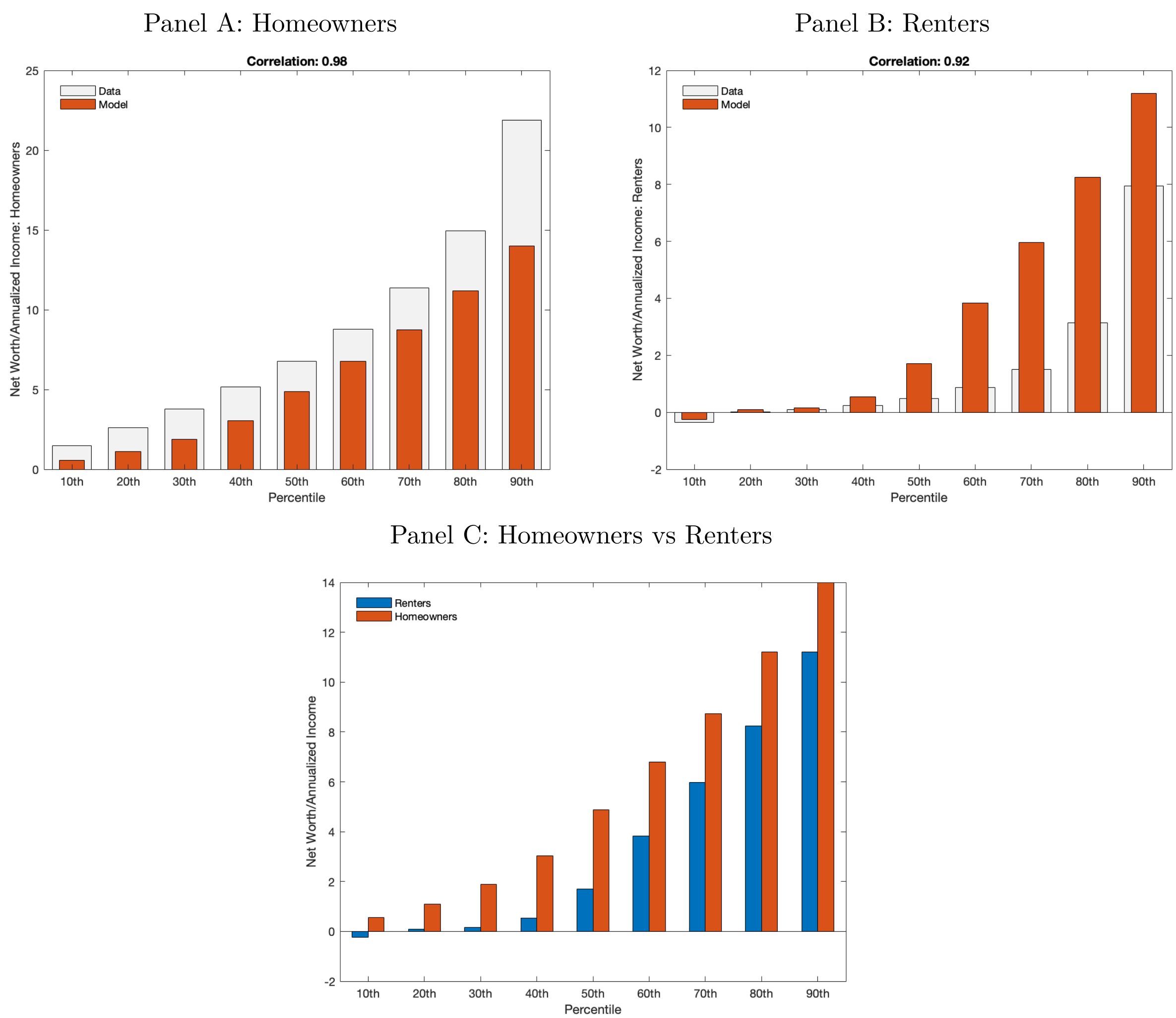
Figure 4: Distributions of Networth and House Value (divided by Income)




Notes: Figure 4 plots the networth to income ratio and the house value to income ratio by CMA both in the data and in the model. Panel A plots networth to income ratio and Panel B plots house value to income ratio. Networth to income ratio and the house value to income ratio are computed using official data from Statistics Canada.

To validate the model on the networth distribution moments by different groups of agents, we compare data and model on networth to income distribution by homeownership status and age group. Panel A of Figure 5 shows that the model and the data have a positive correlation in the networth distribution of the homeowners but the model produces a lower level of networth for homeowners than the data. Panel B shows the same distribution for renters where the correlation between model and data is 0.91. Although the model overstates the networth distribution for renters when compared to the data, panel C shows that the networth is always higher for homeowners than renters. Overall, homeowners have a distribution much more skewed to the right than the renters.

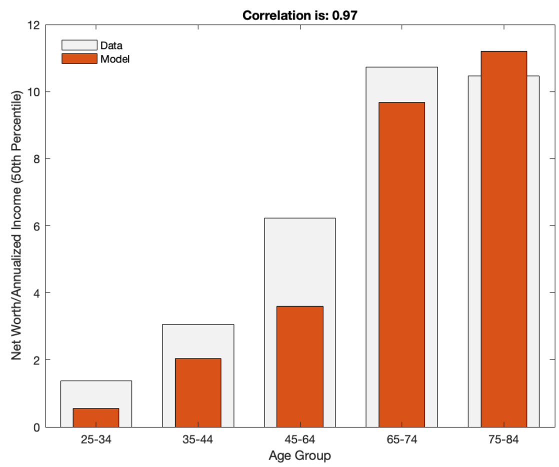
Figure 5: Data Matching Model: Networth-to-Income Ratio by Homeownership Status




Notes: Figure 5 plots the networth to income distribution for homeowners and renters, respectively, in panel A and in panel B. It compares the distributions both in the data and in the model. Panel C plots the comparison data vs model.

In figure 6 we report the 50th percentile of the networth to income distribution by age group. The correlation between data and model is 0.97 and the two distribution follow each other closely, especially for the older age groups.

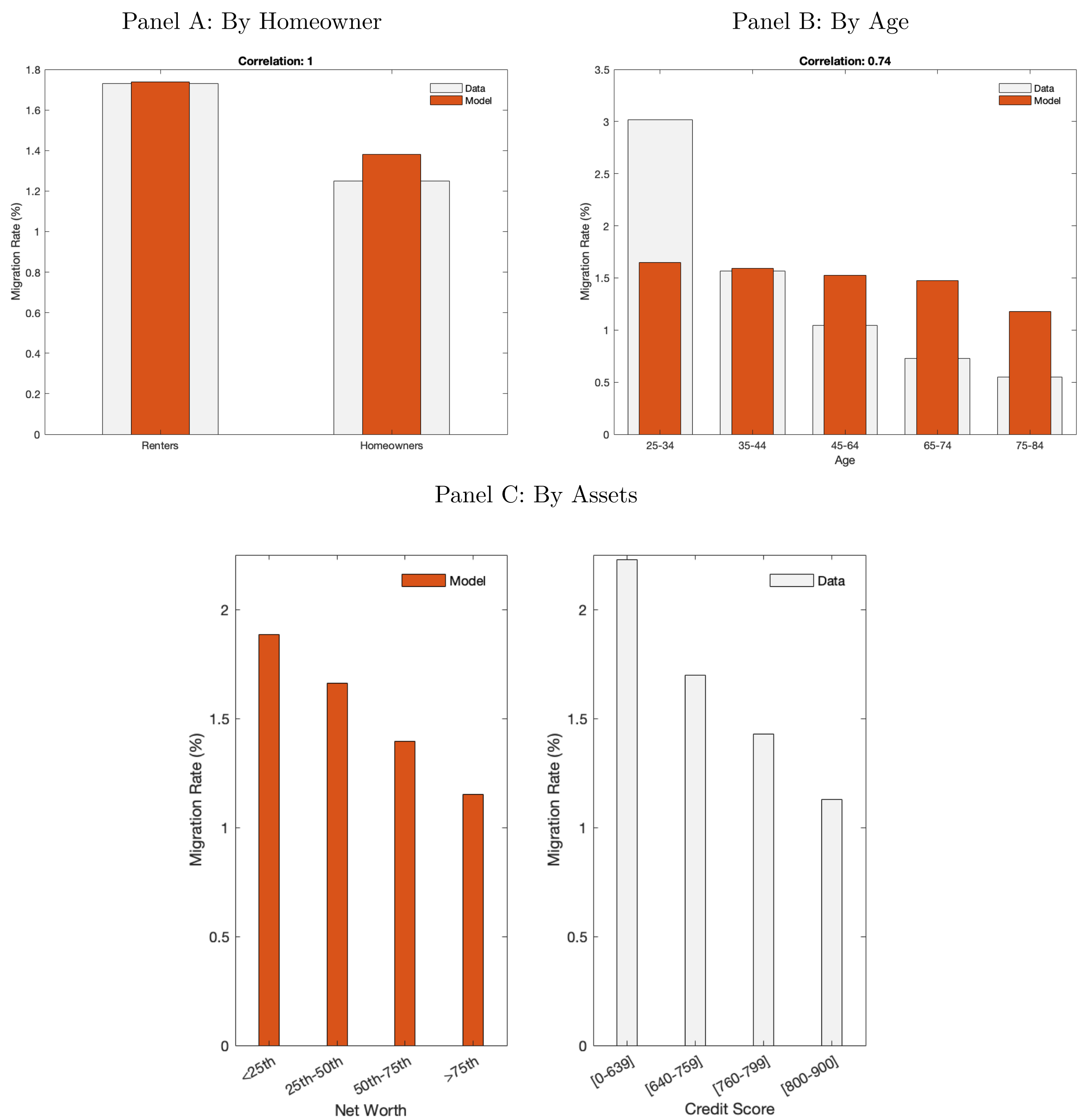
Figure 6: Data Matching Model: Networth-to-Income Ratio (50th Percentile) by Age Groups




Notes: Figure 6 plots the 50th percentile of the networth to income distribution by age group and compares the distributions both in the data and in the model.

**Heterogeneous Migration Patterns** We now replicate our empirical evidence regarding migration patterns by demographic groups both in the data and in the model. We separately describe migration patterns by homeownership status, age and networth. Panel A of figure 7 depicts the migration probabilities by homeownership status. Overall, the differences between data and model are in the second decimal after the comma. As in the data, migration rate is higher for renters than homeowners. Panel B reproduces the migration rates by age group. The patterns suggest that there is much more variation in the data than in the model. The correlation is positive but the magnitudes differ, especially for the youngest group that seem to move more in the data than in the model. The left figure of Panel C shows the distribution of migration rates by networth in the model. We observe that individuals with higher networth move monotonically less than individuals with lower networth. We cannot directly compare this distribution with the data since we do not have data on networth. Our approach is to consider credit score as our measure of ability to borrow such networth is in the model. The right figure of panel C shows the migration rates in the data as in the empirical section. Both the model and the data suggest that migration rates decline with ability to borrow.

Figure 7: Data Matching Model: Migration

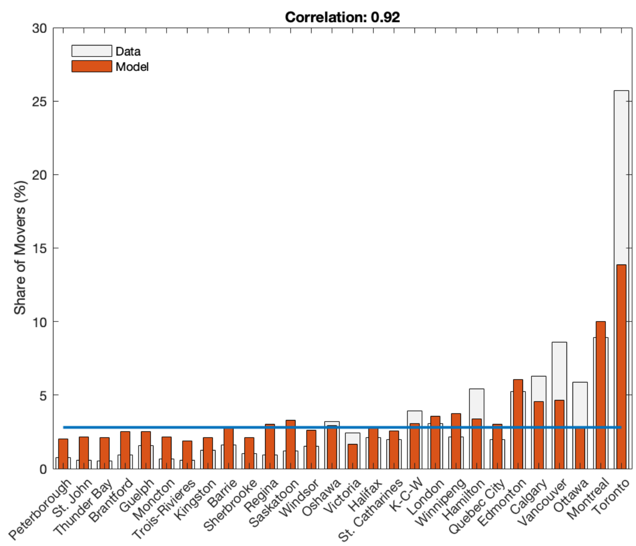



Notes: Figure 7 plots the migration rates in the model by each of the demographic group of interest. Panel A plots it by homeowner status, panel B by age and panel C by networth on the left and by credit score on the right.

**Where are the movers going?** Given our interest on differential sorting of individuals to different locations based on the destination's characteristics, we analyze now in a more systematic way the city's characteristics that attract more agents.

Figure 8 shows how the model matches the data in terms of city "attractiveness". Which cities have the highest levels of in-migration rates? The attraction of cities, measured in terms of in-migration rates, is very heterogeneous. Overall, we observe that Toronto is the city that receives most migrants followed by Montreal. The red horizontal line indicates the average of in-migration rates. The model tends to underestimate in-migration in the cities with the highest median house prices as Toronto and Vancouver. This goes in line with the fact that house prices are a stronger determination of moving decisions in the model than in the data. This may reflect, in part, the house price heterogeneity within cities that is not present in the model. In fact, in the data, migrants tend to move to cities with higher median house prices, but choose to live in neighborhoods with house prices below the median.

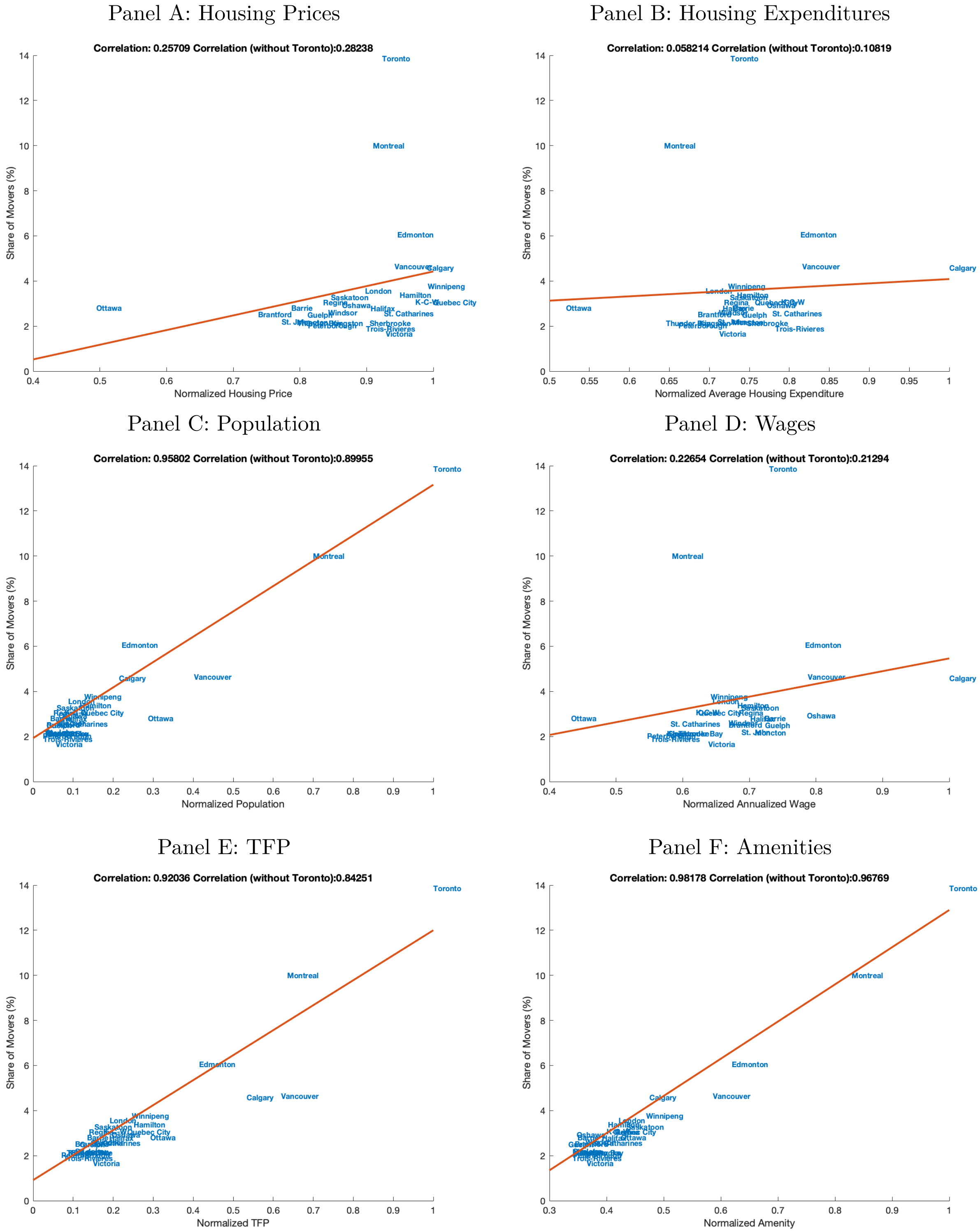
Figure 8: In-Migration by cities




Notes: Figure 8 plots the in-migration rates in the model and in the data by destination. Cities are ordered in ascending order by population.

In panel A and panel B of Figure 9, respectively, we correlate in-migration rates by house rents and housing expenditures. We observe that the correlations are positive and equal to 0.26 and 0.10, respectively. Panel C and panel D, respectively, report the correlations between share of movers and population and wages. The correlations are positive and equal to .95 and 0.21. Finally, panel E and F report the correlations between TFP and amenities, respectively. Both correlations are larger than 0.9 suggesting that there is a great degree of heterogeneity of where movers decide to go int he model. Table 5 reports the correlation of the figures comparing with the correlations in the data. All the correlations go in the same direction both in the data and in the model. The largest difference between data and model is in the house prices correlation. The model suggests that there is a correlation of 0.26 while in the data it is less strong and set at 0.15. The other correlations are quantitatively closer between model and data.

Figure 9: Correlation between In-Migration and City's Characteristics




Notes: Figure 9 plots the correlation between in-migration rates and city characteristics. Panel A and Panel B plot the correlation between in-migration rates and housing rents and housing expenditures, respectively. Panel C and Panel D, respectively, plot the correlation between in-migration rates and population and wages. Panel E and F, instead, plot the correlation between in-migration rates and TFP and amenities, respectively. In each of the last four panels, the correlation with and without Toronto are reported.

Table 5: Share of Migrants and Cities' Characteristics

| | Correlation | |
|---|---|---|
| Characteristics | Data | Model |
| Housing Prices | .15 | .26 |
| Housing Expenditures | .09 | .06 |
| Population | .93 | .96 |
| Wages | .17 | .23 |
| TFP | .93 | .92 |
| Amenities | .9 | .98 |

Notes: This table reports the correlation between share of movers and characteristics of the cities where they move to. The same moment from data and model is reported.

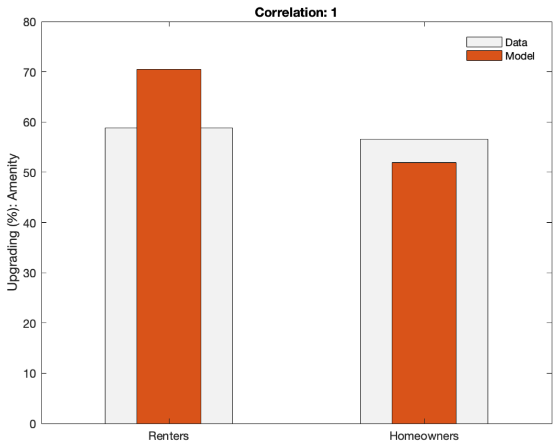
**Are Movers Upgrading?** An important part of our analysis is related to the *upgrading* or *downgrading* behaviour of agents. In other words, comparing two agents that move, they might choose different destinations which might affect the future stream of wages. In order to make the right policies, it is important to understand what are the characteristics of the agents that upgrade. We define upgrade in terms of housing prices and income as in the data section. In figure 10 we plot the upgraders based on their assets and age. Consistently with the data, we observe that middle age seem to upgrade more than young and old. In panel B, when we plot wages, younger upgrade consistently more than older and the relationship is monotonic. In panel C, we plot upgrading by asset level. When it comes to housing prices, the relationship is not very strong, but in the case of wages, it is clear that agents with higher levels of assets upgrade more to cities with higher wages.

# 5 Counterfactual Analysis

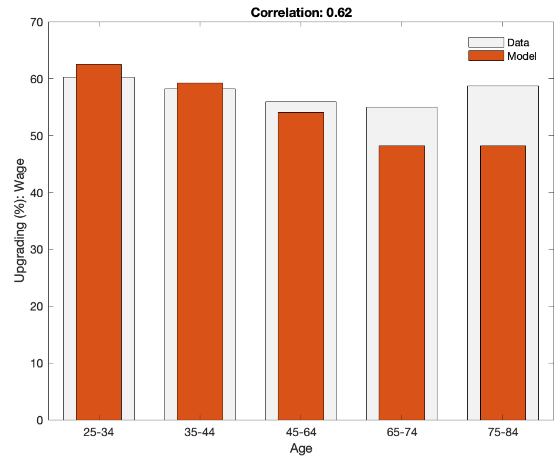
In this section, we conduct counterfactual analysis in several dimensions. First, we decrease migration costs, either monetary or non-monetary, by the same percentage. This could be interpreted as a moving subsidy. Second, we give a *moving voucher* to individuals in the Canadian Rust Belt. Third, we decrease housing regulations in Vancouver, replicating a potential decrease in zoning regulations.

Figure 10: Upgrading On Wages

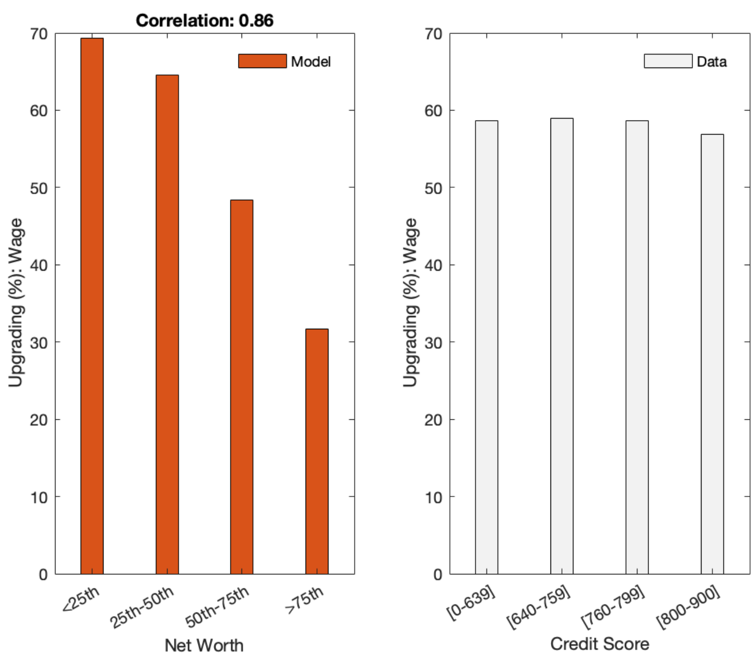
Panel A: By Homeowner




Panel B: By Age




Panel C: By Assets




Notes: This figure 10 plots the upgrading share over wages by each of the demographic group of interest. Panel A plots it by homeowner status, panel B by age and panel C by networth on the left and by credit score on the right.

## 5.1 Decomposing the Moving Choice

In this section, we unpack moving choices by looking at the implications of reducing the migration costs, both monetary and non-monetary, on the moving probabilities and on the share of population moving to locations with better prospects. We do so by comparing steady-states with different moving costs in table 6. The first column (Baseline) reports the steady-state computed above. In the second column we report a steady-state with utility moving costs 10% lower. In the third and last column we present a steady state with monetary moving costs, $F_m$, 50% lower than in the baseline case.

The upper panel shows the migration probabilities, both aggregate and by demographic groups. We observe that in a steady-state with utility moving cost 10% lower than in the baseline case, out-moving probabilities increase for all demographic groups. Utility moving costs are crucial to determine moving decisions, as out-moving probabilities almost double for all groups when utility costs are 10% lower. Utility costs impact all demographic groups in a similar way as the doubling effect seems to be consistent cross groups.

In the bottom part of the panel, we describe the mobility patterns to locations that might have lower house prices or higher wages, locations that we define as the ones with more "opportunities". Given that utility moving costs do not impact agent's budget constraint, the city-specific preference shocks gain preponderance in the new steady-state. Since preference shocks are iid with respect to city characteristics, some individuals may face a high shock to move to city with poorer conditions. In the presence of a high $\tau$, the preference shock is not strong enough to make people move and forgone wages or pay a higher house price. With lower $\tau$, the net benefit to move to such locations increases and some people find optimal to move. In fact, as shown in Figure 18, the cities with higher relative population with respect to the baseline steady-state are smaller cities and with lower productivity. The share of individuals migrating to Toronto decreases by 1.3p.p..

Therefore, lower utility migration costs induce the marginal agents to move to cities with lower wages and higher house prices. The overall share of individuals moving to locations with lower house prices decreases by 0.61p.p. and the share of those moving to locations with higher wages decreases by 5.24p.p. However, the patterns for house prices are broadly heterogeneous among demographic groups. In the low $\tau$ steady-state, the share of renters moving to more cheaper locations increases but the same share for homeowners decreases. Agents in the bottom of the asset distribution move relatively more to cheaper locations, while those in the top of the distribution move relatively more to expensive areas. Finally, older individuals are now more likely to move to cities with higher house prices.

In terms of wages, overall, we observe that all demographic groups move consistently less to locations with higher wages.

Table 6: Monetary vs Utility Moving Cost

| | **Baseline** | **Utility Cost** Low $\tau$ (10%) | **Monetary Cost** Low $F_m$ (50%) |
|---|---|---|---|
| Av. Out-migration | 1.4902% | 2.9544% | 1.4985% |
| Av. Out-migration: Homeowners | 1.3822% | 2.6211% | 1.3805% |
| Av. Out-migration: Renters | 1.7390% | 3.6115% | 1.7878% |
| Av. Out-migration: Net Worth ($<$ 25th) | 1.8847% | 3.6483% | 1.9012% |
| Av. Out-migration: Net Worth (25th-50th) | 1.6196% | 3.2693% | 1.6333% |
| Av. Out-migration: Net Worth (50th-75th) | 1.3895% | 2.8027% | 1.3667% |
| Av. Out-migration: Net Worth ($>$ 75th) | 1.1495% | 2.3133% | 1.1715% |
| Av. Out-migration: Age $[25-34]$ | 1.6480% | 3.1062% | 1.6532% |
| Av. Out-migration: Age $[35-44]$ | 1.5916% | 3.0676% | 1.5977% |
| Av. Out-migration: Age $[45-64]$ | 1.5248% | 3.0508% | 1.5318% |
| Av. Out-migration: Age $[65-74]$ | 1.4762% | 3.0350% | 1.4892% |
| Av. Out-migration: Age $[75-84]$ | 1.2256% | 2.5185% | 1.2377% |
| **Moving to "Opportunity" Share** | | | |
| House Price | 46.73% | 46.11% | 46.94% |
| House Price, Homeowners | 45.72% | 44.36% | 46.23% |
| House Price, Renters | 52.95% | 54.67% | 51.49% |
| House Price, Net Worth ($<$ 25th) | 36.48% | 38.42% | 35.88% |
| House Price, Net Worth (25th-50th) | 42.85% | 42.01% | 42.95% |
| House Price, Net Worth (50th-75th) | 48.98% | 46.18% | 49.83% |
| House Price, Net Worth ($>$ 75th) | 60.34% | 57.89% | 61.07% |
| House Price, Age $[25-34]$ | 44.13% | 45.04% | 42.09% |
| House Price, Age $[35-44]$ | 45.54% | 44.60% | 46.44% |
| House Price, Age $[45-64]$ | 47.21% | 46.25% | 47.52% |
| House Price, Age $[65-74]$ | 48.54% | 47.71% | 49.17% |
| House Price, Age $[75-84]$ | 47.59% | 47.10% | 48.37% |
| Wage | 54.52% | 49.28% | 54.77% |
| Wage, Homeowners | 51.93% | 46.05% | 52.35% |
| Wage, Renters | 70.51% | 65.14% | 70.33% |
| Wage, Net Worth ($<$ 25th) | 69.36% | 61.43% | 69.60% |
| Wage, Net Worth (25th-50th) | 64.55% | 56.75% | 64.27% |
| Wage, Net Worth (50th-75th) | 48.38% | 47.69% | 48.79% |
| Wage, Net Worth ($>$ 75th) | 31.71% | 31.06% | 32.10% |
| Wage, Age $[25-34]$ | 62.49% | 56.41% | 63.91% |
| Wage, Age $[35-44]$ | 59.20% | 52.65% | 58.78% |
| Wage, Age $[45-64]$ | 54.06% | 48.24% | 54.43% |
| Wage, Age $[65-74]$ | 48.19% | 44.42% | 48.33% |
| Wage, Age $[75-84]$ | 48.19% | 45.66% | 47.99% |
| In-migration to Toronto | 13.86% | 12.65% | 13.70% |

Note: This table reports the results of moving rates generated in the steady state in the model as in the previous section in the baseline column (1). Column (2) describes the migration patterns for an economy where $\tau^{l,l'}$ are 10% lower in all the locations. In column (3) reports the results for an economy where $F_m$ is 50% lower than in the baseline in all locations.

To compare how differently moving costs behave in our model, we consider an economy with the monetary moving costs, $F_m$, 50% lower than in the baseline case for all the individuals in Canada. We find that the overall out-migration increases but only marginally. We find that migration rate remains almost unchanged, or decreases slightly, for homeowners, but increases almost 0.05p.p. for renters.

More interesting, we find that the patterns of moving to "opportunity" go in opposite direction of those find in an economy with lower utility moving costs. Overall, a moving subsidy to everyone in the country increases the share of individuals moving to locations with lower house prices by 0.21p.p. and with higher pages by 0.25p.p.. Unsurprisingly, a lower monetary moving costs impacts mostly homeowners, younger and low networth individuals. Since the change in monetary cost is not high enough to induce more people to move than in the baseline economy, those that move use the monetary benefit to move to cities with higher wages and higher house prices. Therefore, people are more likely to choose new locations that gives them higher future wage streams, which cities that have usually higher house prices. This effect is stronger for younger and low networth individuals.

## 5.2 Moving Voucher from the Canadian "Rust Belt"

Ontario, as north-eastern the United States, was industrialized until 1980ies. Cities like London, Windsor, Thunder Bay and Peterborough were industrial powerhouses. With desindustrialization, poverty, crime, drug abuse, homelessness have been issues affecting these areas and job stagnation has been a severe issue. Similar issues have been rising in the US, in cities like Detroit and Cleveland, among others. Policymakers have been discussing changes in policy to lift individuals out of these areas to move to better "opportunity". Recently, during the US democratic presidential campaign, a former candidate, Andrew Yang, proposed a moving voucher to each individuals that decided to move out of unemployment areas. Through the lens of our model, we evaluate a related policy change giving a moving voucher to those unemployed living in what we define as the Canadian "Rust Belt". The experiment consists in giving a moving voucher for the value of $F_m$ to the unemployed individuals in London, Windsor, Thunder Bay and Peterborough.

Table 7 reports the results of in terms of migration rates out of these regions. Out-migration rates from these regions increase slightly, but when we decompose by demographic groups, we observe some degree of heterogeneity. For instance, homeowners seem to be more responsive than renters. The out-migration increases the most also for groups in the middle quartile of the networth distribution. When looking at age, we observe that younger people are the ones that react the most.

Table 7: Moving Voucher from the “Rust Belt": The Unemployed

| | **Baseline** | **Moving Subsidy**<br>Remove $F_m$ |
|---|---|---|
| Av. Out-migration | 3.1444% | 3.1626% |
| Av. Out-migration: Homeowners | 3.0248% | 3.1064% |
| Av. Out-migration: Renters | 3.3021% | 3.2566% |
| Av. Out-migration: Net Worth ($<25$th) | 3.2794% | 3.2974% |
| Av. Out-migration: Net Worth (25th-50th) | 3.2239% | 3.2495% |
| Av. Out-migration: Net Worth (50th-75th) | 2.9580% | 2.9864% |
| Av. Out-migration: Net Worth ($>75$th) | 2.7374% | 2.7510% |
| Av. Out-migration: Age $[25-34]$ | 3.0836% | 3.1116% |
| Av. Out-migration: Age $[35-44]$ | 3.1265% | 3.1255% |
| Av. Out-migration: Age $[45-64]$ | 3.1825% | 3.2055% |
| **Moving to “Opportunity" Share** | | |
| House Price | 23.78% | 23.25% |
| House Price, Homeowners | 23.98% | 23.18% |
| House Price, Renters | 22.92% | 23.68% |
| House Price, Net Worth ($<25$th) | 22.83% | 21.21% |
| House Price, Net Worth (25th-50th) | 22.77% | 22.41% |
| House Price, Net Worth (50th-75th) | 25.27% | 25.36% |
| House Price, Net Worth ($>75$th) | 27.14% | 26.83% |
| House Price, Age $[25-34]$ | 25.20% | 24.86% |
| House Price, Age $[35-44]$ | 24.75% | 23.61% |
| House Price, Age $[45-64]$ | 23.20% | 22.78% |
| Wage | 68.16% | 68.29% |
| Wage, Homeowners | 66.67% | 67.70% |
| Wage, Renters | 74.42% | 71.67% |
| Wage, Net Worth ($<25$th) | 73.74% | 75.40% |
| Wage, Net Worth (25th-50th) | 69.86% | 69.98% |
| Wage, Net Worth (50th-75th) | 60.87% | 59.79% |
| Wage, Net Worth ($>75$th) | 67.00% | 65.87% |
| Wage, Age $[25-34]$ | 70.79% | 70.10% |
| Wage, Age $[35-44]$ | 69.70% | 70.43% |
| Wage, Age $[45-64]$ | 67.16% | 67.20% |
| In-migration to Toronto | 16.52% | 16.33% |

Note: This table reports the results of moving rates generated in the steady state in the model as in the previous section in the baseline column (1). In column (2) reports the results for an economy where $F_m$ is set to 0 for all the unemployed that move out from the “Rust Belt" cities.

In the bottom part of table 7, we describe how individuals would move to "opportunity" by upgrading to locations with lower house prices or higher wages than the ones were they are originally from. Since, cities in the rust belt tend to have lower house prices and wages, people tend to move to places with higher house prices and wages. Overall, we observe that there is a 0.5p.p. increase in individuals that would move to locations with higher house prices. At the same time, there is a .13p.p. increase in individuals that would move to locations with higher wages.

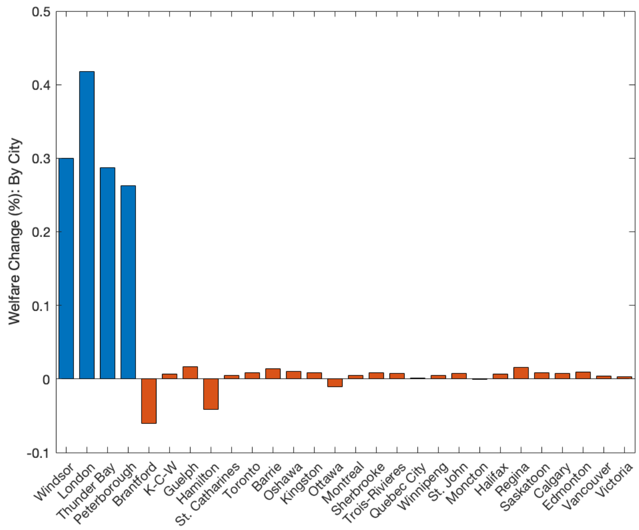
Table 8: Welfare Change(%): Moving Voucher from the "Rust Belt"

| | Whole Canada | Whole Ontario | Rust Belt |
|---|---|---|---|
| All | 0.0242 | 0.0467 | 0.3927 |
| Homeowners | -0.1386 | -0.2786 | -0.2790 |
| Renters | 0.2438 | 0.4906 | 0.9593 |
| Low Net Worth | 0.0656 | 0.1041 | 0.4714 |
| High Net Worth | -0.0421 | -0.1070 | 0.0668 |
| Young (<45) | 0.0119 | 0.0275 | 0.3366 |
| Mature ($\geq$ 45) | 0.0301 | 0.0550 | 0.3475 |

Note: This table reports the welfare changes by different demographic groups generated in the new steady state in the model where $F_m$ is set to 0 for all the unemployed that move out from the "Rust Belt" cities.

Table 8 reports the estimates of welfare changes for the whole country in column (1) and for the "Rust Belt" cities in column (2) overall and by demographic groups. Overall, welfare for individuals from "Rust Belt" areas would increase, on average, by 0.39% while Canadian welfare would increase by only 0.0242%. This small number is not surprising given the small weight of these cities in the overall Canadian economy. When examining figure 11, we observe that the large increase in welfare are coming mostly from the "Rust Belt" cities, however, the large cities, especially the closest ones, are impacted negatively.

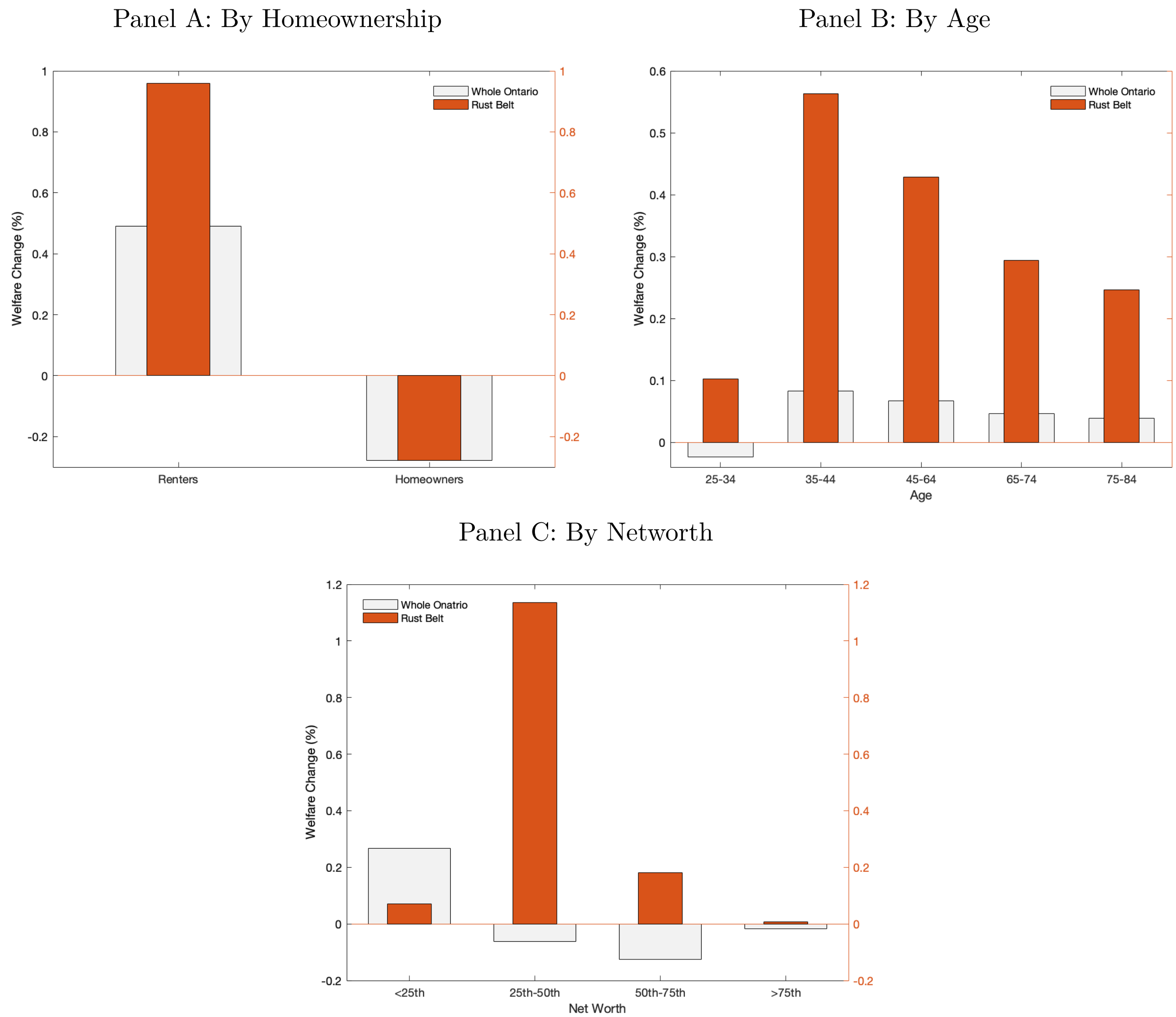
Figure 11: Welfare Changes by City (%): Moving Voucher from the “Rust Belt"




Note: This figure describes the welfare changes in each city generated in the new steady state in the model where $F_m$ is set to 0 in all the “Rust Belt" cities.

Individuals with low networth would benefit the most and renters as well. Figure 12 depicts the full picture by analyzing the welfare effects by demographic groups. In panel A we plot the welfare effects by homeowners and renters. We observe that the effect is positive for renters but negative for homeowners. This is due to several factors. After the subsidy more renters become homeowners. This shifts the distribution of homeowners to the left, which drives down the welfare of homeowners. When we decompose by age in panel B, we find that the biggest increase in welfare is for the group between 36-45 and it starts declining after that.

Figure 12: Welfare Effect by Group




Notes: This figure 12 plots the upgrading share over wages by each of the demographic group of interest. Panel A plots it by homeowner status, panel B by age and panel C by networth on the left and by credit score on the right.

## 5.3 Releasing Housing Regulations in the Top Cities: The Vancouver Experiment

Recently, policy makers, politicians and economists have discussed changes in housing regulations in several cities with very high house prices. Zoning restrictions are a constraint to the supply of housing and have been pointed out as one of the main factors that explains the tremendous increase in house prices. Cities such as Vancouver in Canada or San Francisco in the US, are among the most expensive cities in the world. Yet, regulations to build are really tight. In Vancouver, for instance, 52% of the land can only have single family houses. What if, according to the discussion in the media, such regulations were lifted? Exploiting the rich structure of our model, we implement a plausible counterfactual experiment that decreases housing regulations in zoning in the city of Vancouver by 50%. How the welfare of different agents would be impacted? Would some individuals upgrade rather downgrade? Could more people move to Vancouver? To map the potential change of housing regulations to our model, we increase the land permits for construction, $\bar{L}$, by 50%. This is the experiment that we run through the lens of our model.

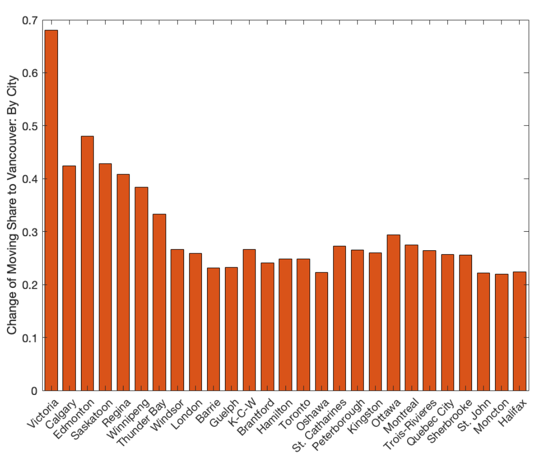
Figure 13: Impact of Higher Construction Permits in Vancouver


*Note:* Figure 13 plots the percentage difference between the steady state with higher $\bar{L}$ in Vancouver and the baseline economy for population (panel A), wages (panel B), house prices (panel C) and homeownership rate (panel D).

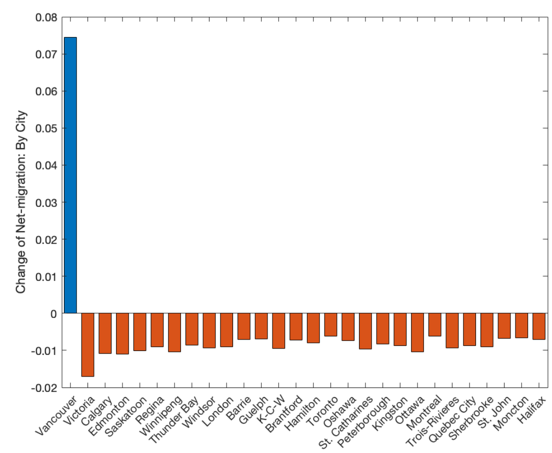
An increase in the land permits for construction has immediate consequence an expansion of the housing supply and a decrease in house prices. As shown in panel A of figure 13 the house price in Vancouver is 35% lower in the steady state with the higher $\bar{L}$ than in the baseline economy. Such a lower price in a city like Vancouver attracts people from all over Canada. In Panel B we see that population in Vancouver is 40% higher than in the baseline economy. This higher population is driven by a higher retention of population in Vancouver and by the fact that any migrant is much more likely to move to Vancouver in the new steady state (Panel A of figure 14). Not surprisingly, the closer to Vancouver, the relative higher probability of moving to Vancouver conditional on moving. Moreover, we see in panel B that Vancouver is the only city that has a higher net-migration rate in the new steady-state when compared to the baseline economy. In all the other cities, net-migration is lower.

Figure 14: Moving Responses by City

Panel A: Change of Moving Share to Vancouver




Panel B: Change of Net-migration




Note: Panel A of this figure describes the change in moving share from each city in the sample to Vancouver between the baseline economy and the economy where $\bar{L}$ in Vancouver is set to be 1.5 times higher than in the baseline. Cities are ordered from left to right with increasing distance from Vancouver. Panel B describes the change in moving share from each city in the sample to Vancouver between the baseline economy and the economy where $\bar{L}$ in Vancouver is set to be 1.5 times higher than in the baseline. Cities are ordered from left to right with increasing distance from Vancouver.

The higher concentration in Vancouver leads to lower wages in Vancouver. However, house prices fall relatively more than wages when compared to the initial steady-state, which implies a higher "real wage", which reinforces the attractiveness of Vancouver and explains why relatively more people choose this city when decide to migrate.

Table 9: A Decrease in Housing Regulations in Vancouver

| | **Baseline** | **Low Vancouver $\overline{L}$** |
|---|---|---|
| Av. Out-migration | 1.4902% | 1.4893% |
| Av. Out-migration: Homeowners | 1.3822% | 1.3679% |
| Av. Out-migration: Renters | 1.7390% | 1.7893% |
| Av. Out-migration: Net Worth ($<$ 25th) | 1.8847% | 1.8945% |
| Av. Out-migration: Net Worth (25th-50th) | 1.6196% | 1.6182% |
| Av. Out-migration: Net Worth (50th-75th) | 1.3895% | 1.3968% |
| Av. Out-migration: Net Worth ($>$ 75th) | 1.1495% | 1.1388% |
| Av. Out-migration: Age $[25-34]$ | 1.6480% | 1.6481% |
| Av. Out-migration: Age $[35-44]$ | 1.5916% | 1.5915% |
| Av. Out-migration: Age $[45-64]$ | 1.5248% | 1.5235% |
| Av. Out-migration: Age $[65-74]$ | 1.4762% | 1.4741% |
| Av. Out-migration: Age $[75-84]$ | 1.2256% | 1.2245% |
| **Moving to “Opportunity" Share** | | |
| House Price | 46.73% | 46.97% |
| House Price, Homeowners | 45.72% | 45.66% |
| House Price, Renters | 52.95% | 55.09% |
| House Price, Net Worth ($<$ 25th) | 36.48% | 37.12% |
| House Price, Net Worth (25th-50th) | 42.85% | 44.08% |
| House Price, Net Worth (50th-75th) | 48.98% | 50.73% |
| House Price, Net Worth ($>$ 75th) | 60.34% | 56.85% |
| House Price, Age $[25-34]$ | 44.13% | 43.16% |
| House Price, Age $[35-44]$ | 45.54% | 46.30% |
| House Price, Age $[45-64]$ | 47.21% | 47.88% |
| House Price, Age $[65-74]$ | 48.54% | 48.60% |
| House Price, Age $[75-84]$ | 47.59% | 47.36% |
| Wage | 54.52% | 55.72% |
| Wage, Homeowners | 51.93% | 53.16% |
| Wage, Renters | 70.51% | 71.56% |
| Wage, Net Worth ($<$ 25th) | 69.36% | 69.89% |
| Wage, Net Worth (25th-50th) | 64.55% | 65.63% |
| Wage, Net Worth (50th-75th) | 48.38% | 49.24% |
| Wage, Net Worth ($>$ 75th) | 31.71% | 33.27% |
| Wage, Age $[25-34]$ | 62.49% | 63.11% |
| Wage, Age $[35-44]$ | 59.20% | 60.60% |
| Wage, Age $[45-64]$ | 54.06% | 55.43% |
| Wage, Age $[65-74]$ | 48.19% | 49.38% |
| Wage, Age $[75-84]$ | 48.19% | 49.06% |
| In-migration to Toronto | 13.86% | 13.80% |
| In-migration to Vancouver | 4.64% | 4.93% |

Note: This table reports the results of moving rates generated in the steady state in the model as in the previous section in the baseline column (1). In column (2) reports the results for an economy where $\bar{L}$ for Vancouver is 50% permanently lower than in the baseline economy.

Despite a different distribution of people across space in the new steady-state, average out-migration remains at similar level than in the previous economy, as reported in 9. In the long-run, an economy with lower house prices in Vancouver does not induce higher migration flows, only affects the destination of those that decide to migrate. In other words, although more people move to Vancouver, migration rate remains unchanged because people that would otherwise move to other cities move now to Vancouver and the outflow from Vancouver decreases.

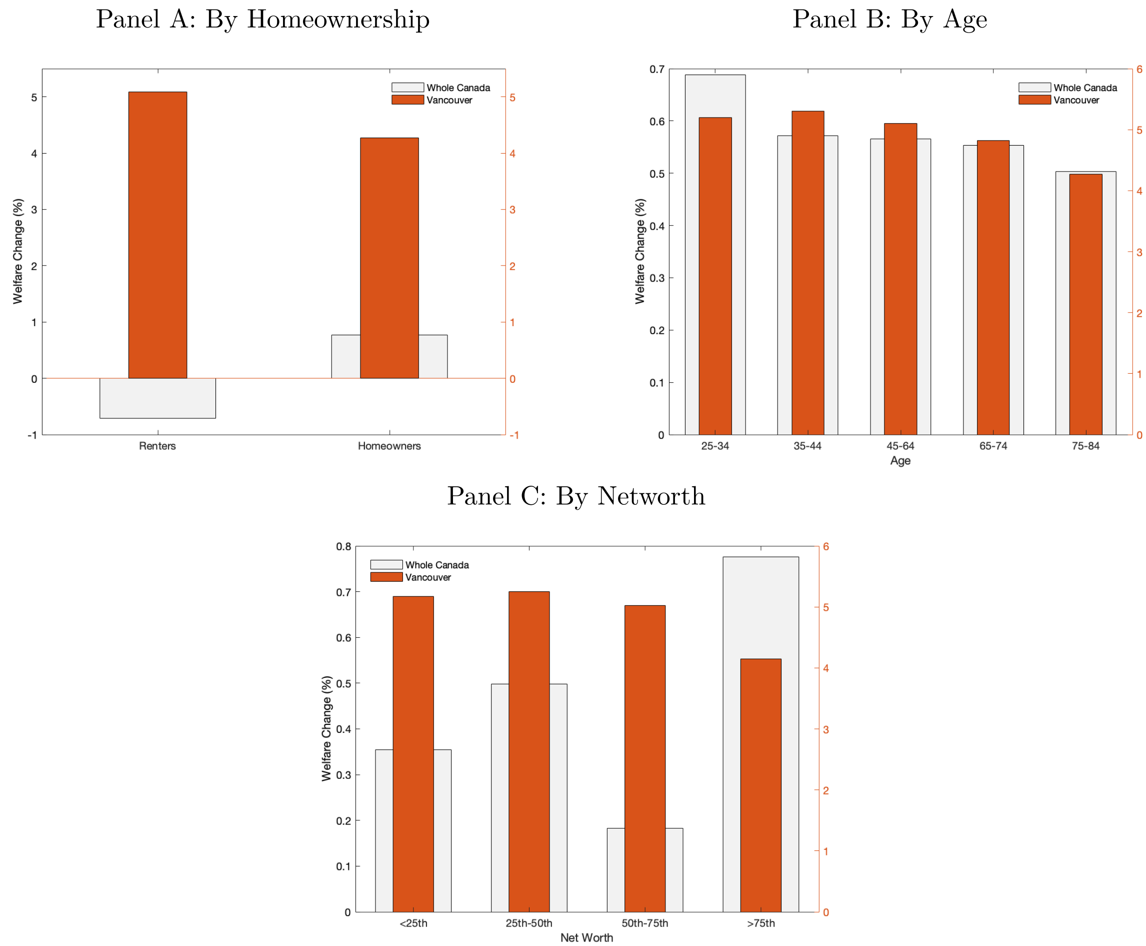
However, there are some differences across groups. Specifically, the out-migration rates for renters would increase by 0.05p.p. in the entire Canada. When we look at out-migration by networth, we observe that it would increase by 0.01p.p. for the ones with lowest networth. When we look at age groups, we differences are extremely tiny. In the bottom part of the table, that describes the characteristics of the places where individuals would move, we observe there would be an increase of .24p.p. in the share of individuals moving to places with higher house prices and 1.2% in the share of individuals moving to locations with higher wages. Decomposing by demographic groups, we observe that renters benefit the most in terms of moving to locations with higher house prices. In terms of networth, the model suggest that individuals with lower networth are the once moving to locations with higher house prices. Difference across age groups do not seem to be striking. Instead, regarding wages, both homeowners and non-homeowners are moving more to locations with higher wages. The same is true for individuals splitted by networth. The same is true when we divide demographic groups by age.

Table 10: Welfare Change (%): A Decrease in Housing Regulations in Vancouver

| | Whole Canada | Vancouver |
|---|---|---|
| All | 0.5744 | 4.9453 |
| Homeowners | 0.7698 | 4.2757 |
| Renters | -0.7122 | 5.0917 |
| Low Net Worth | 0.4423 | 5.2456 |
| High Net Worth | 0.6755 | 4.7760 |
| Young (<45) | 0.6312 | 5.2518 |
| Mature ($\geq 45$) | 0.5471 | 4.8266 |

Note: This table reports the results of moving rates generated in the steady state in the model as in the previous section in the baseline column (1). In column (2) we report the welfare changes for an economy where $\bar{L}$ for Vancouver is 50% permanently lower than in the baseline economy. In column (3) we report the welfare changes for those in Vancouver.

Figure 15: Welfare Effect




Notes: This figure 15 plots the upgrading share over wages by each of the demographic group of interest. Panel A plots it by homeowner status, panel B by age and panel C by networth on the left and by credit score on the right.

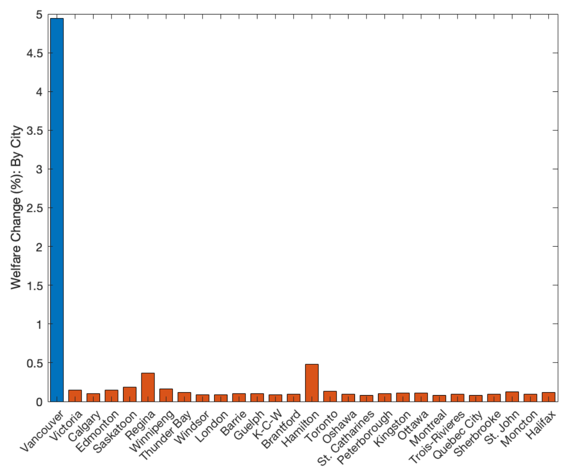
Although in short run, a decrease in wages and house prices may affect negatively welfare in Vancouver, mainly to homeowners, in the long-run the welfare gains are very significant. This is explained by the increase in "real income" in the long-run induced by this policy. Table 10 reports the welfare calculation of the change in policy in Vancouver for Canada as a whole in column (1) and for Vancouver, specifically in column (2). This table reports that in the new steady-state, welfare in Vancouver would be approximately 5% higher. The biggest beneficiaries would be young renters with low networth. Homeowners benefit less, despite the increase in "real income" since lower house prices induce lower house wealth at the end of their lives. Housing in fact becomes less attractive as a saving mechanism as house prices drop.

The welfare in the overall Canada are also significant. Overall, welfare in Canada would 0.57% higher. The main benefit comes from the higher wages in the other locations induced by the higher concentration of people in Vancouver. House prices decrease very little, so "real income" increases across Canada. Most of the welfare gains come from homeowners, while for renters, in aggregate the effect is negative. This is due to a compositional effect. Higher wages induce a higher homeownership rate. Those that remain renters are those which have on average lower welfare. When we look at welfare by networth, we observe that high networth would benefit the most, overall, following the same reasoning. Finally, when decomposing by age group, we find that both young and mature would benefit, with youngest the most.

In figure Figure 15, we present a graphical detailed decomposition of the welfare gains for different demographic groups.

Figure 16 reports the welfare gain in each Canadian city. Cities are plotted with increasing distance from Vancouver. Welfare gains are similarly distributed across cities with the highest spikes in Regina and Hamilton.

Figure 16: Welfare Changes by City (%): A Decrease in Housing Regulations in Vancouver




Note: This figure describes the welfare changes in each city generated in the new steady state in the model where $\bar{L}$ in Vancouver is set to be 1.5 times than in the baseline. Cities are ordered from left to right with increasing distance from Vancouver, which welfare effect is reported in blue.

# 6 Conclusions

Location is one of the most important decisions in life. However, evidence suggests that some demographic groups have hard time moving and, also, moving to “opportunity". Several reasons have been pointed out. We developed a dynamic model with agents that differ in assets, age, endogenous housing status and where individuals sort into different locations based on these characteristics.

This is the first quantitative dynamic location model to feature sorting of agents across locations based on their assets, age and home-ownership status. We motivate the main assumptions of the model by exploiting evidence on migration patterns by demographic groups in Canada. We apply the model to the data by calibrating it to 28 Canadian cities, with a mix of reduced form and structural estimation. We validate the model by comparing key moments, such as the networth distribution and the migration decisions, with the data.

We, then, use the model to run several counterfactuals. First, we “unpack moving" by reducing the moving costs. A 10% subsidy in moving, if disbursed in utility terms, would increase the migration rates by almost 50%. At the same time, would induce a lower share of movers to move to “opportunity". Second, we, apply the model to study a decrease in housing regulation in one of the most expensive cities in the world, Vancouver. We find that removing zoning in Vancouver might increase welfare by approximately 5% in Vancouver and by .57% in Canada overall.

Understanding how individuals make their location decisions and how this affects welfare, both in the short and in the long-run, is a question that many economists and policy makers are after. Through the lens of our model several complementary analyses can be conducted. First, how can an aging population affect the overall slow down in mobility rates in the US? Second, how a temporary unemployment shock to the family can translate to permanent consequences if individuals move to a worse neighborhood characterized by less positive spillover effects. All these questions are in need for an answer. We believe that our framework provides a benchmark to shade new lights on an important decision such as location choice and can serve as a tool to continue in the quest for “unpacking moving".

# References


**Acemoglu, Daron, and Pascual Restrepo.** 2017. “Secular stagnation? The effect of aging on economic growth in the age of automation.” *American Economic Review*, 107(5): 174–79.

**Autor, David H, David Dorn, Gordon H Hanson, and Jae Song.** 2014. “Trade adjustment: Worker-level evidence.” *The Quarterly Journal of Economics*, 129(4): 1799–1860.

**Beraja, Martin, Erik Hurst, and Juan Ospina.** 2016. “The aggregate implications of regional business cycles.” National Bureau of Economic Research.

**Bilal, Adrien, and Esteban Rossi-Hansberg.** 2018. “Location as an Asset.” National Bureau of Economic Research.

**Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro.** 2019. “Trade and labor market dynamics: General equilibrium analysis of the china trade shock.” *Econometrica*, 87(3): 741–835.

**Chetty, Raj, Nathaniel Hendren, and Lawrence F Katz.** 2016. “The effects of exposure to better neighborhoods on children: New evidence from the Moving to Opportunity experiment.” *American Economic Review*, 106(4): 855–902.

**De Nardi, Mariacristina.** 2004. “Wealth inequality and intergenerational links.” *The Review of Economic Studies*, 71(3): 743–768.

**Desmet, Klaus, and Esteban Rossi-Hansberg.** 2014. “Spatial Development.” *American Economic Review*, 104(4): 1211–43.

**Desmet, Klaus, Dávid Krisztián Nagy, and Esteban Rossi-Hansberg.** 2018. “The Geography of Development.” *Journal of Political Economy*, 126(3): 903–983.

**Diamond, Rebecca.** 2016. “The Determinants and Welfare Implications of US Workers’ Diverging Location Choices by Skill: 1980-2000.” *American Economic Review*, 106(3): 479–524.

**Dix-Carneiro, Rafael, and Brian K Kovak.** 2017. “Trade liberalization and regional dynamics.” *American Economic Review*, 107(10): 2908–46.

**Eckert, Fabian, and Tatjana Kleineberg.** 2019. “Can we save the American dream? A dynamic general equilibrium analysis of the effects of school financing on local opportunities.” *Unpublished Manuscript, Yale University.*

**Giannone, Elisa.** 2017. "Skilled-biased technical change and regional convergence." In *Technical Report*. University of Chicago Working Paper.

**Greany, Brian.** 2019. "The Distributional Consequences of Unequal Growth." Yale University Working Paper.

**Greenland, Andrew, John Lopresti, and Peter McHenry.** 2019. "Import competition and internal migration." *Review of Economics and Statistics*, 101(1): 44–59.

**Guren, Adam M, Alisdair McKay, Emi Nakamura, and Jón Steinsson.** 2018. "Housing Wealth Effects: The Long View."

**Jones, Callum, Virgiliu Midrigan, and Thomas Philippon.** 2011. "Household leverage and the recession." National Bureau of Economic Research.

**Kaplan, Greg, Kurt Mitman, and Giovanni L Violante.** 2017. "The Housing Boom and Bust: Model Meets Evidence." National Bureau of Economic Research Working Paper 23694.

**Kilian, Lutz, and Xiaoqing Zhou.** 2018. "The propagation of regional shocks in housing markets: Evidence from oil price shocks in Canada."

**Lagakos, David, Ahmed Mushfiq Mobarak, and Michael E Waugh.** 2018. "The welfare effects of encouraging rural-urban migration." National Bureau of Economic Research.

**Lyon, Spencer, and Michael E Waugh.** 2018. "Quantifying the losses from international trade." *Unpublished manuscript, NYU Stern.*

**McCaig, Brian.** 2011. "Exporting out of poverty: Provincial poverty in Vietnam and US market access." *Journal of International Economics*, 85(1): 102–113.

**McFadden, D.** 1973. "Conditional Logit Analysis of Qualitative Choice Behaviour." In *Frontiers in Econometrics.* , ed. P. Zarembka, 105–142. New York, NY, USA:Academic Press New York.

**Nakamura, Emi, and Jon Steinsson.** 2014. "Fiscal stimulus in a monetary union: Evidence from US regions." *American Economic Review*, 104(3): 753–92.

**Saiz, Albert.** 2010. "The Geographic Determinants of Housing Supply." *Quarterly Journal of Economics*, 125(3): 1253–1296.

**Topalova, Petia.** 2010. "Factor immobility and regional impacts of trade liberalization: Evidence on poverty from India." *American Economic Journal: Applied Economics*, 2(4): 1–41.

# A Tables

Table 11: Heterogeneous Migration Responses (CMAs)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | Move=100 | | | | |
| Homeowner | -0.677*** | | | -0.446*** | -0.676*** | | | -0.446*** |
| | (0.090) | | | (0.095) | (0.090) | | | (0.095) |
| Age [36-45] | | -1.548*** | | -1.435*** | | -1.548*** | | -1.435*** |
| | | (0.177) | | (0.164) | | (0.177) | | (0.164) |
| Age [46-65] | | -2.123*** | | -1.966*** | | -2.124*** | | -1.966*** |
| | | (0.221) | | (0.204) | | (0.221) | | (0.204) |
| Age [66-75] | | -2.449*** | | -2.331*** | | -2.448*** | | -2.330*** |
| | | (0.264) | | (0.252) | | (0.264) | | (0.252) |
| Age [76-85] | | -2.614*** | | -2.570*** | | -2.614*** | | -2.570*** |
| | | (0.282) | | (0.279) | | (0.282) | | (0.279) |
| Credit Score [640-759] | | | -0.447*** | -0.249*** | | | -0.448*** | -0.251*** |
| | | | (0.064) | (0.044) | | | (0.064) | (0.044) |
| Credit Score [760-799] | | | -0.603*** | -0.290*** | | | -0.605*** | -0.292*** |
| | | | (0.076) | (0.059) | | | (0.076) | (0.060) |
| Credit Score [800-900] | | | -1.099*** | -0.474*** | | | -1.100*** | -0.476*** |
| | | | (0.121) | (0.083) | | | (0.121) | (0.083) |
| Observations | 122045401 | 122045401 | 122045401 | 122045401 | 122045401 | 122045401 | 122045401 | 122045401 |
| Adjusted $R^2$ | 0.100 | 0.104 | 0.100 | 0.105 | 0.100 | 0.104 | 0.100 | 0.105 |
| City Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| Year Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| City $\times$ Year Fixed-Effects | No | No | No | No | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 12: Heterogeneous Migration Responses

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | Move=100 | | | | |
| Homeowner | -0.900*** | | | -0.919*** | -0.900*** | | | -0.918*** |
| | (0.119) | | | (0.127) | (0.119) | | | (0.127) |
| Age [36-45] | | -2.117*** | | -1.971*** | | -2.116*** | | -1.969*** |
| | | (0.229) | | (0.216) | | (0.229) | | (0.216) |
| Age [46-65] | | -2.859*** | | -2.622*** | | -2.859*** | | -2.622*** |
| | | (0.305) | | (0.286) | | (0.304) | | (0.286) |
| Age [66-75] | | -3.374*** | | -3.132*** | | -3.373*** | | -3.130*** |
| | | (0.370) | | (0.366) | | (0.370) | | (0.366) |
| Age [76-85] | | -3.659*** | | -3.418*** | | -3.658*** | | -3.416*** |
| | | (0.386) | | (0.391) | | (0.386) | | (0.391) |
| Credit Use - Qt2 | | | 0.409*** | 0.407*** | | | 0.409*** | 0.407*** |
| | | | (0.037) | (0.037) | | | (0.037) | (0.037) |
| Credit Use - Qt3 | | | 0.846*** | 0.640*** | | | 0.844*** | 0.639*** |
| | | | (0.099) | (0.079) | | | (0.099) | (0.079) |
| Credit Use - Qt4 | | | 1.319*** | 0.844*** | | | 1.319*** | 0.844*** |
| | | | (0.150) | (0.117) | | | (0.151) | (0.117) |
| Credit Use - Qt5 | | | 0.670*** | 0.801*** | | | 0.672*** | 0.803*** |
| | | | (0.077) | (0.082) | | | (0.077) | (0.081) |
| Observations | 146602877 | 146602877 | 127821028 | 127821028 | 146602877 | 146602877 | 127821028 | 127821028 |
| Adjusted $R^2$ | 0.101 | 0.106 | 0.102 | 0.108 | 0.101 | 0.106 | 0.102 | 0.108 |
| City Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| Year Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| City $\times$ Year Fixed-Effects | No | No | No | No | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 13: Heterogeneous Migration Responses (CMA)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | Move=100 | | | | |
| Homeowner | -0.677*** | | | -0.653*** | -0.676*** | | | -0.653*** |
| | (0.090) | | | (0.084) | (0.090) | | | (0.084) |
| Age [36-45] | | -1.548*** | | -1.460*** | | -1.548*** | | -1.459*** |
| | | (0.177) | | (0.170) | | (0.177) | | (0.170) |
| Age [46-65] | | -2.123*** | | -1.996*** | | -2.124*** | | -1.996*** |
| | | (0.221) | | (0.211) | | (0.221) | | (0.211) |
| Age [66-75] | | -2.449*** | | -2.351*** | | -2.448*** | | -2.350*** |
| | | (0.264) | | (0.263) | | (0.264) | | (0.263) |
| Age [76-85] | | -2.614*** | | -2.545*** | | -2.614*** | | -2.544*** |
| | | (0.282) | | (0.287) | | (0.282) | | (0.287) |
| Credit Use - Qt2 | | | 0.276*** | 0.272*** | | | 0.276*** | 0.271*** |
| | | | (0.039) | (0.035) | | | (0.039) | (0.035) |
| Credit Use - Qt3 | | | 0.529*** | 0.375*** | | | 0.529*** | 0.374*** |
| | | | (0.107) | (0.097) | | | (0.107) | (0.097) |
| Credit Use - Qt4 | | | 0.775*** | 0.426*** | | | 0.775*** | 0.426*** |
| | | | (0.152) | (0.141) | | | (0.152) | (0.141) |
| Credit Use - Qt5 | | | 0.333*** | 0.441*** | | | 0.335*** | 0.442*** |
| | | | (0.089) | (0.095) | | | (0.089) | (0.095) |
| Observations | 122045401 | 122045401 | 106578851 | 106578851 | 122045401 | 122045401 | 106578851 | 106578851 |
| Adjusted $R^2$ | 0.100 | 0.104 | 0.102 | 0.107 | 0.100 | 0.104 | 0.102 | 0.107 |
| City Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| Year Fixed-Effects | Yes | Yes | Yes | Yes | No | No | No | No |
| City $\times$ Year Fixed-Effects | No | No | No | No | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 14: Moving Where? - Definition II

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| Homeowner | 0.944*** | 0.615*** | -0.964 | -2.363*** | 0.016 | -0.801 | 0.755** | 0.633 |
| | (0.285) | (0.214) | (0.908) | (0.601) | (0.547) | (0.592) | (0.320) | (0.394) |
| Age [36-45] | 0.632** | -0.375** | 0.639* | -0.905*** | -1.130*** | -1.463*** | 0.142 | 0.067 |
| | (0.307) | (0.174) | (0.338) | (0.283) | (0.210) | (0.301) | (0.327) | (0.334) |
| Age [46-65] | 3.502*** | -1.226*** | -0.443 | -4.452*** | -4.303*** | -6.356*** | 1.929*** | 0.620 |
| | (0.550) | (0.183) | (0.764) | (0.925) | (0.711) | (0.925) | (0.565) | (0.596) |
| Age [66-75] | 5.679*** | -1.932*** | -1.368 | -6.993*** | -6.535*** | -10.071*** | 3.149*** | 0.813 |
| | (0.835) | (0.381) | (1.597) | (1.409) | (1.124) | (1.438) | (0.759) | (0.758) |
| Age [76-85] | 4.832*** | -1.862*** | -1.394 | -6.244*** | -5.677*** | -8.333*** | 2.395*** | 0.639 |
| | (0.730) | (0.462) | (1.842) | (1.323) | (1.060) | (1.439) | (0.729) | (0.775) |
| Credit Score [640-759] | -2.627*** | 0.036 | 0.551 | 3.727*** | 1.877*** | 1.799*** | -2.017*** | -1.998*** |
| | (0.398) | (0.401) | (0.856) | (0.771) | (0.418) | (0.555) | (0.382) | (0.396) |
| Credit Score [760-799] | -3.392*** | 0.154 | 0.566 | 5.192*** | 2.338*** | 1.815** | -2.783*** | -2.912*** |
| | (0.536) | (0.587) | (1.149) | (1.146) | (0.639) | (0.849) | (0.573) | (0.615) |
| Credit Score [800-900] | -3.546*** | 0.647 | 0.067 | 5.278*** | 2.933*** | 1.384 | -2.787*** | -3.237*** |
| | (0.619) | (0.551) | (1.090) | (1.163) | (0.708) | (0.941) | (0.674) | (0.744) |
| Observations | 3270066 | 2410812 | 1768011 | 3242807 | 3188731 | 3188532 | 2785001 | 2784668 |
| Adjusted $R^2$ | 0.294 | 0.420 | 0.332 | 0.409 | 0.328 | 0.322 | 0.280 | 0.265 |
| City × Year Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 15: Moving Where? (CMAs)

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| Homeowner | 0.332 | 0.780* | -0.416 | -1.529** | -0.571 | -0.769 | 0.233 | 0.288 |
| | (0.362) | (0.418) | (0.556) | (0.594) | (0.725) | (0.562) | (0.361) | (0.375) |
| Age [36-45] | 0.421 | -0.329 | 0.683* | -0.242 | -0.829** | -0.879*** | 0.178 | 0.052 |
| | (0.401) | (0.250) | (0.366) | (0.299) | (0.325) | (0.286) | (0.366) | (0.362) |
| Age [46-65] | 2.478*** | -0.965 | 0.093 | -1.787** | -3.650*** | -4.043*** | 1.873*** | 1.330** |
| | (0.568) | (0.603) | (0.649) | (0.735) | (0.531) | (0.428) | (0.579) | (0.589) |
| Age [66-75] | 3.969*** | -1.505 | -0.588 | -3.591*** | -5.849*** | -7.031*** | 2.904*** | 1.824** |
| | (0.832) | (1.075) | (1.188) | (1.240) | (0.910) | (0.742) | (0.755) | (0.728) |
| Age [76-85] | 3.250*** | -1.251 | -0.566 | -3.780*** | -5.198*** | -6.175*** | 2.343*** | 1.692** |
| | (0.693) | (0.962) | (1.326) | (1.255) | (1.123) | (0.987) | (0.680) | (0.671) |
| Credit Score [640-759] | -1.498*** | -0.333 | 0.375 | 2.649*** | 1.052** | 0.985*** | -1.498*** | -1.560*** |
| | (0.290) | (0.656) | (0.722) | (0.920) | (0.390) | (0.341) | (0.382) | (0.397) |
| Credit Score [760-799] | -1.808*** | -0.168 | 0.174 | 3.299** | 1.060* | 0.878* | -1.941*** | -2.167*** |
| | (0.509) | (0.992) | (0.896) | (1.216) | (0.534) | (0.469) | (0.553) | (0.560) |
| Credit Score [800-900] | -1.702** | 0.340 | -0.390 | 2.962** | 1.568** | 0.880 | -1.733*** | -2.074*** |
| | (0.633) | (0.938) | (0.829) | (1.184) | (0.646) | (0.631) | (0.601) | (0.608) |
| Observations | 1781695 | 1781695 | 1571674 | 1781695 | 1781695 | 1781695 | 1551194 | 1551194 |
| Adjusted $R^2$ | 0.304 | 0.412 | 0.392 | 0.510 | 0.455 | 0.438 | 0.306 | 0.306 |
| City $\times$ Year Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 16
Moving Where? - Definition II ( CMAs)

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| Homeowner | 0.737* | 0.879** | -0.393 | -1.470** | 0.379 | -0.060 | 0.600 | 0.727* |
| | (0.428) | (0.417) | (0.556) | (0.586) | (0.499) | (0.416) | (0.368) | (0.400) |
| Age [36-45] | 0.497 | -0.134 | 0.717* | -0.226 | -0.686** | -0.735** | 0.207 | 0.282 |
| | (0.392) | (0.175) | (0.373) | (0.302) | (0.256) | (0.300) | (0.375) | (0.367) |
| Age [46-65] | 2.350*** | -0.683*** | 0.137 | -1.800** | -3.080*** | -3.871*** | 1.738*** | 1.403** |
| | (0.509) | (0.192) | (0.651) | (0.739) | (0.429) | (0.450) | (0.524) | (0.526) |
| Age [66-75] | 4.000*** | -0.809* | -0.490 | -3.618*** | -4.462*** | -6.178*** | 2.674*** | 2.050*** |
| | (0.824) | (0.450) | (1.191) | (1.245) | (0.563) | (0.682) | (0.744) | (0.681) |
| Age [76-85] | 3.288*** | -0.795 | -0.420 | -3.781*** | -3.826*** | -4.822*** | 2.404*** | 1.978*** |
| | (0.657) | (0.520) | (1.332) | (1.261) | (0.616) | (0.745) | (0.661) | (0.674) |
| Credit Score [640-759] | -1.806*** | -0.434 | 0.294 | 2.555*** | 0.926*** | 0.659 | -1.732*** | -1.861*** |
| | (0.348) | (0.569) | (0.726) | (0.898) | (0.307) | (0.467) | (0.449) | (0.484) |
| Credit Score [760-799] | -2.229*** | -0.455 | 0.087 | 3.164** | 1.018** | 0.271 | -2.313*** | -2.558*** |
| | (0.531) | (0.839) | (0.902) | (1.185) | (0.456) | (0.756) | (0.621) | (0.674) |
| Credit Score [800-900] | -2.212*** | 0.028 | -0.464 | 2.845** | 1.470** | -0.116 | -2.221*** | -2.680*** |
| | (0.629) | (0.778) | (0.837) | (1.163) | (0.597) | (0.955) | (0.681) | (0.749) |
| Observations | 1781695 | 1781695 | 1571674 | 1781695 | 1781695 | 1781695 | 1551194 | 1551194 |
| Adjusted $R^2$ | 0.314 | 0.445 | 0.385 | 0.522 | 0.396 | 0.384 | 0.302 | 0.293 |
| City $\times$ Year Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

Table 17: Moving Decomposition - Definition II

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| All | 57.05 | 60.55 | 24.07 | 48.58 | 62.61 | 56.38 | 53.97 | 54.24 |
| Homeowners | 57.93 | 60.41 | 23.22 | 47.5 | 61.72 | 54.35 | 54.26 | 54.07 |
| Renters | 56.87 | 60.72 | 24.41 | 48.78 | 62.77 | 57 | 54.02 | 54.45 |
| Age [25-35] | 55.11 | 60.35 | 24.61 | 50.48 | 63.68 | 58.6 | 52.62 | 53.24 |
| Age [36-45] | 57.51 | 61.81 | 25.05 | 47.91 | 62.74 | 56.57 | 54.6 | 55.01 |
| Age [46-65] | 58.94 | 60.24 | 23.16 | 46.76 | 61.14 | 53.68 | 55.15 | 54.84 |
| Age [66-75] | 59.65 | 59.18 | 21.08 | 46.18 | 61.29 | 52.94 | 55.59 | 55.26 |
| Age [76-85] | 56.22 | 58.8 | 21.06 | 50.89 | 64.44 | 58.32 | 52.81 | 54.18 |
| Credit Score [0-639] | 57.21 | 60.7 | 24.8 | 49.29 | 62.37 | 57.25 | 54.12 | 54.73 |
| Credit Score [640-759] | 56.97 | 60.83 | 24.29 | 48.6 | 62.89 | 57.05 | 54.06 | 54.44 |
| Credit Score [760-799] | 56.53 | 60.29 | 24.09 | 48.95 | 63.04 | 56.64 | 53.51 | 53.8 |
| Credit Score [800-900] | 57.36 | 60.14 | 23.21 | 47.79 | 62.1 | 54.48 | 54 | 53.8 |
| Credit Usage - Qt 1 | 55.93 | 60.62 | 25.12 | 48.81 | 62.79 | 56.27 | 53.22 | 53.43 |
| Credit Usage - Qt 2 | 56.88 | 60.74 | 24.19 | 48 | 62.7 | 55.5 | 54.05 | 54.12 |
| Credit Usage - Qt 3 | 57.39 | 60.73 | 23.57 | 48.08 | 62.36 | 55.95 | 54.29 | 54.53 |
| Credit Usage - Qt 4 | 57.53 | 60.64 | 23.81 | 48.8 | 62.12 | 56.44 | 54.14 | 54.45 |
| Credit Usage - Qt 5 | 58 | 60.45 | 23.29 | 47.55 | 62.2 | 55.49 | 54.54 | 54.59 |

Table 18: Moving Decomposition (CMAs)

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| All | 51.07 | 51.62 | 25.67 | 47.72 | 49.22 | 48.91 | 49.48 | 49.76 |
| Homeowners | 51.91 | 51.57 | 25.04 | 46.42 | 47.25 | 46.52 | 49.82 | 49.81 |
| Renters | 51.03 | 51.83 | 25.89 | 47.89 | 49.72 | 49.56 | 49.57 | 49.95 |
| Age [25-35] | 48.91 | 51.22 | 25.97 | 50.18 | 51.08 | 51.24 | 47.65 | 48.25 |
| Age [36-45] | 52.05 | 53.12 | 26.62 | 45.99 | 49.18 | 48.62 | 50.52 | 50.78 |
| Age [46-65] | 53.27 | 51.37 | 25.04 | 45.64 | 46.9 | 46.22 | 51.2 | 51.11 |
| Age [66-75] | 53.99 | 50.5 | 22.93 | 44.8 | 45.63 | 44.51 | 51.63 | 51.24 |
| Age [76-85] | 50.78 | 49.48 | 22.96 | 48.06 | 48.69 | 48.13 | 48.83 | 49.06 |
| Credit Score [0-639] | 50.83 | 51.31 | 26.69 | 47.87 | 49.65 | 49.6 | 49.44 | 49.72 |
| Credit Score [640-759] | 50.96 | 51.81 | 25.85 | 47.79 | 49.67 | 49.53 | 49.51 | 49.93 |
| Credit Score [760-799] | 50.75 | 51.57 | 25.55 | 48.38 | 49.45 | 49.17 | 49.13 | 49.39 |
| Credit Score [800-900] | 51.61 | 51.56 | 24.74 | 47.1 | 48.07 | 47.31 | 49.67 | 49.73 |
| Credit Usage - Qt 1 | 50.39 | 51.67 | 26.69 | 48.03 | 49.8 | 49.33 | 48.97 | 49.22 |
| Credit Usage - Qt 2 | 51.44 | 52.2 | 25.76 | 47.32 | 49.12 | 48.5 | 49.7 | 49.98 |
| Credit Usage - Qt 3 | 51.71 | 52.11 | 25.03 | 46.97 | 48.37 | 48.03 | 49.97 | 50.19 |
| Credit Usage - Qt 4 | 51.32 | 51.78 | 25.32 | 47.57 | 48.5 | 48.43 | 49.56 | 49.86 |
| Credit Usage - QtE | 51.88 | 51.43 | 24.98 | 46.87 | 48.24 | 47.75 | 50.01 | 50.1 |

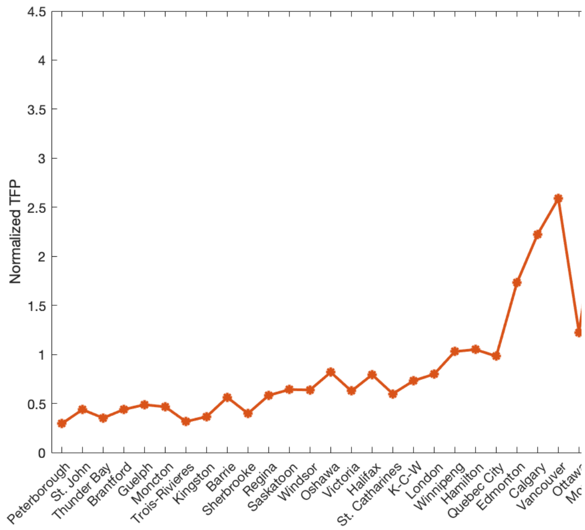
Table 19: Moving Decomposition - Definition II (CMAs)

| | Lower Hp | Lower Unempl. | Higher Amenities | Higher Population | Higher Income | Higher Wages | Higher Income/Hp | Higher Wages/Hp |
|---|---|---|---|---|---|---|---|---|
| All | 55.5 | 61.34 | 25.92 | 48.79 | 63.82 | 58.31 | 53.76 | 54.52 |
| Homeowners | 56.56 | 61.52 | 25.31 | 47.5 | 62.87 | 56.57 | 54.33 | 54.88 |
| Renters | 55.33 | 61.47 | 26.12 | 48.93 | 64.06 | 58.82 | 53.76 | 54.58 |
| Age [25-35] | 53.3 | 60.68 | 26.18 | 51.3 | 64.86 | 60.24 | 51.9 | 52.88 |
| Age [36-45] | 56.65 | 62.91 | 26.88 | 47.11 | 63.98 | 58.16 | 54.9 | 55.67 |
| Age [46-65] | 57.65 | 61.36 | 25.33 | 46.67 | 62.29 | 55.87 | 55.51 | 55.97 |
| Age [66-75] | 58.27 | 60.66 | 23.26 | 45.63 | 61.92 | 54.94 | 55.7 | 56.08 |
| Age [76-85] | 55.11 | 59.53 | 23.33 | 48.87 | 64.15 | 58.67 | 53.17 | 54.05 |
| Credit Score [0-639] | 55.64 | 61.65 | 27.05 | 49.15 | 63.39 | 58.62 | 54.01 | 54.88 |
| Credit Score [640-759] | 55.4 | 61.62 | 26.08 | 48.83 | 64.22 | 58.99 | 53.82 | 54.68 |
| Credit Score [760-799] | 55.04 | 60.96 | 25.76 | 49.36 | 64.25 | 58.63 | 53.27 | 54.06 |
| Credit Score [800-900] | 55.84 | 60.92 | 24.96 | 48.15 | 63.19 | 56.83 | 53.8 | 54.3 |
| Credit Usage - Qt 1 | 54.4 | 61.26 | 26.84 | 48.94 | 63.91 | 58.05 | 52.95 | 53.51 |
| Credit Usage - Qt 2 | 55.47 | 61.49 | 25.92 | 48.32 | 63.88 | 57.77 | 53.76 | 54.31 |
| Credit Usage - Qt 3 | 56.09 | 61.63 | 25.25 | 47.99 | 63.55 | 57.89 | 54.27 | 55.03 |
| Credit Usage - Qt 4 | 56.05 | 61.5 | 25.62 | 48.73 | 63.37 | 58.34 | 54.03 | 54.91 |
| Credit Usage - QtE | 56.5 | 61.54 | 25.27 | 47.93 | 63.5 | 57.64 | 54.47 | 55.2 |

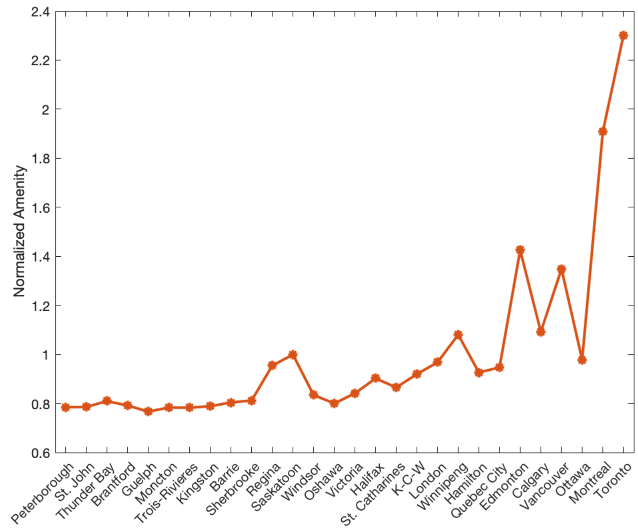
# B Figures

Figure 17: Estimates of TFP, Amenities and Housing Elasticities

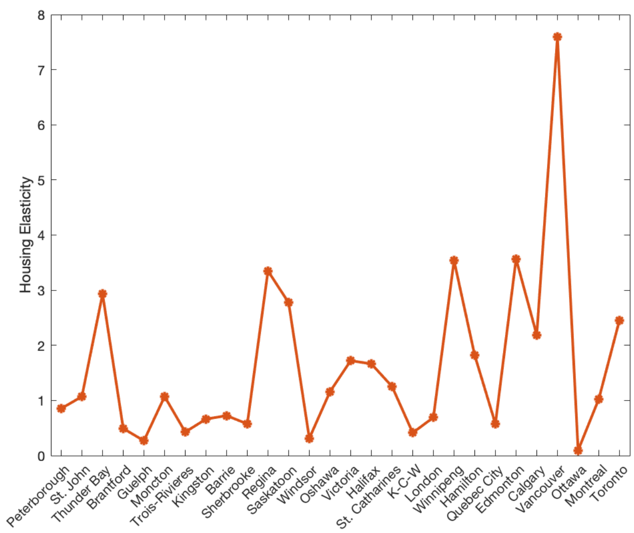
Panel A: TFP




Panel B: Amenities

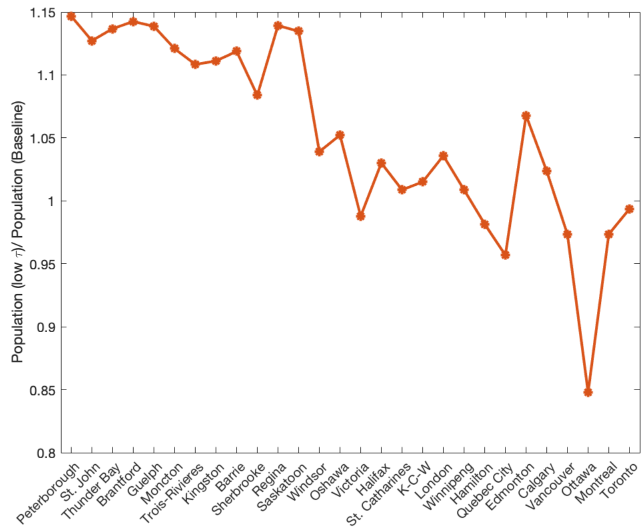



Panel C: Housing Elasticities




Notes: This figure reports the distribution of the estimates of TFP, amenities and housing elasticities calculated with the methods described in section 4.1, respectively in panel A, B and C. On the x-axis the cities are distributed by size.

Figure 18: Population Change induced by the Moving Subsidy in the Rust-Belt




Notes: This figure reports the ratio of the population in the steady-state with moving subsidies in the Rust-Belt to the baseline economy for different cities

# C Definitions

- *Migrants*: We define migrants all the individuals in our dataset that report living in a different CMA than the one in the previous period.
- *Homeowners*: We define homeowners all the individuals that report having an active mortgage or has a line of credit above CAD 50,000 or paid their entire mortgage.
- *Credit Usage*: We define credit usage as the total outstanding debt balance divided by the credit limit. We consider any open credit account besides mortgages. In specific, we consider credit cards, installments, auto-loans and lines of credit.

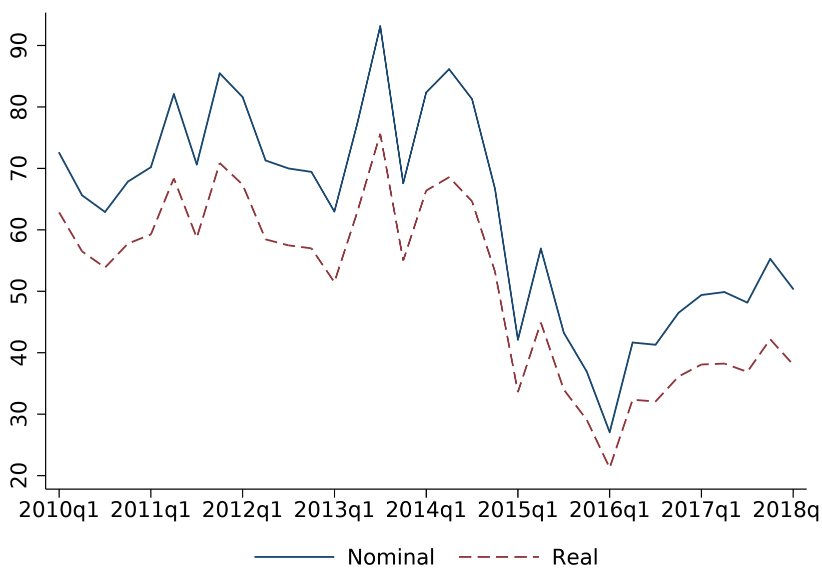
# D The Oil Shock in Canada

Canada is the fifth largest oil producer in the world and most of its crude oil production is exported. Although being one five biggest oil producers in the world, the share of the Canadian oil production relative to the worldwide production is relative small, which make oil price variations plausibly exogenous with respect to the Canadian economy. Thus, we will use changes in the oil price as a source of exogenous shocks to real income in Canada.We follow the identification strategy of Kilian and Zhou (2018) who showed that real oil price shocks in Canada constitute exogenous shocks to regional real income.

We obtain oil prices from the Canadian Association of Petroleum Producers. We follow Kilian and Zhou (2018) in focusing on the WCS crude oil price measured in Canadian dollars. WCS is the reference price for heavy crude oil (e.g. blended bitumen) delivered at Hardisty, Alberta. WCS is representative of the price of oil from the oil sands, the most common type of oil produced in Canada.[10] To construct the *Oil Price shock* used in the empirical analysis, we also obtain total employment statistics by education, industry and city in 2011 from *Statistics Canada*. We define the oil industry according to the *2111 - Oil and Gas Extraction* classification of the North American Industry Classification System (NAICS) of 2007.

Figure 19 reports the evolution of the Western Canadian Select (WCS) crude oil price measured in Canadian dollars. Between 2010 and 2014, oil price was relatively stable, but it dropped around 62 percent between 2014 and 2016 both in nominal and real terms.[11] Although it started slowly recovering, current oil prices remain almost 40 percent lower the average value before 2014.

Figure 19: Oil Price Evolution




[10]It takes more energy to produce refined products (e.g. gasoline) from heavy crudes, therefore WCS trades at a discount to lighter crudes.

[11]Real oil price is computed by deflating WCS by the national wide Canadian consumer price index (CPI). WCS is the oil price measured also used by Kilian and Zhou (2018)

Although changes in oil prices may indirectly affect the entire Canadian economy, the impact of oil price shocks on income vary substantially by region. 95% of the total oil production is located in only three Canadian provinces: Alberta, Saskatchewan, and Newfoundland and Labrador. These three provinces that concentrate almost oil production are usually denominated by the *Oil Provinces*. Thus, oil price shocks constitute sizable regional income shocks in Canada.

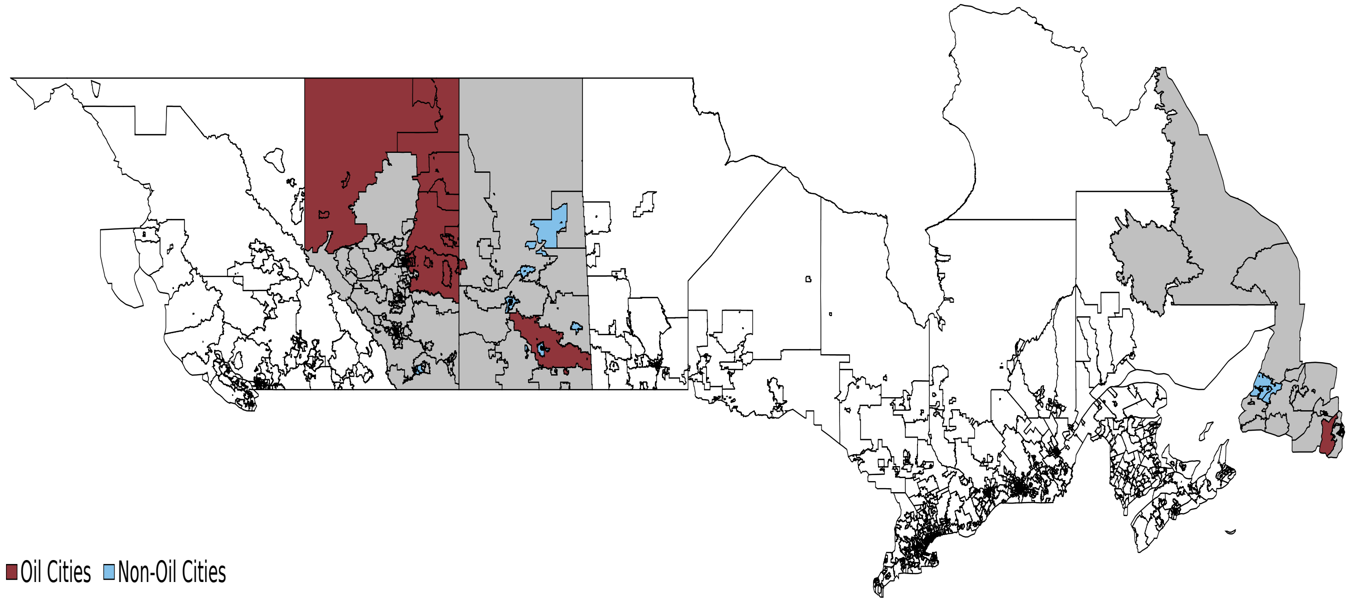
The ideal identification strategy would capture those that are directly impacted by this shock. Given that we are not able to observe who is directly affected, we identify small regions where oil industry is disproportionately relevant. These are naturally the closest FSAs to Thermal in-situ facilities of Bitumen production, Mining facilities, Upgraders of bitumen and heavy oil and Refineries. We manually collect the location of these facilities from the *Oil Sands Magazine* that offers a large set of statistics on oil and gas prices, energy statistics and oil sands operating metrics, as monthly production by facility. We therefore define as an *Oil City* all FSAs located within a 10 miles radius of each of the facilities.

Most of the facilities are located close to Oil sands that are a natural mixture of sand, water and bitumen (oil that is too heavy or thick to flow on its own). The oil sands are found in main three regions within the provinces of Alberta and Saskatchewan: Athabasca, Cold Lake and Peace River, which combined cover an area more than 142,000 square kilometres. The oil sands are located at the surface near Fort McMurray, but deeper underground in other regions. Oil sands are recovered using two main methods: drilling (in situ) and mining. The method used depends on how deep the reserves are deposited. In Newfoundland and Labrador, most of the production occurs offshore. Although some of the refineries are presented outside the *Oil Provinces*, given their small relevance to the local economy, we restrict our analyses to the three provinces that constitute the *Oil Provinces*.

Given the proximity to the oil production facilities and the relevance of the oil industry in these areas, we conjecture that the oil shock will have highest impact in the *Oil Cities*. Individuals in these cities are highly affected by an oil shock, either directly or indirectly, which minimizes concerns about the heterogeneous effect of the shock within these regions. As a control group, we select all areas of the *Oil Provinces* with an employment share in the oil industry below 1%.[12]

[12] We then exclude regions with an employment share in the oil industry above 1% but that are not close to one of the oil facilities. In these areas, we expect that the shock is less likely to affect all individuals in a similar way, which would introduce noise in our analysis. Therefore, we decide to exclude them. However, as robustness, we present in the appendix the results including such locations. Results remain unchanged.

Figure 20: Oil Cities and Non-Oil Cities within the Oil Provinces




In Figure 20 we present a map of Canada where we identify the *Oil Cities* in red and the *Non-oil Cities* in blue. Both groups of cities are not adjacent to each other which attenuates concerns about commuters across cities.

As in Kilian and Zhou (2018), we build a city specific *Oil Shock* taking into account the employment share in the oil industry in each of the *Oil Cities*. In specific, we build a measure of regional exposure to the oil shock that resembles the standard *Bartik* shocks as follows:

$$OilShock_{z,t} = -\alpha_z log(\text{OilPrice})_t \tag{11}$$

where $\alpha_{z,t-1}$ is the share of employment in the oil sector in city $z$ in 2011. $log(\text{OilPrice})_t$ is the logarithm of the real oil price at quarter $t$. As in Kilian and Zhou (2018), we interpret the results causally under the assumption that variations in the oil price are exogenous to the Canadian economy and not correlated with other macroeconomic variables relevant for our analysis.

Since our analysis lies in a period of decline in oil prices, we measure the Oil shock as negative shock to the local economy. Therefore, a higher value of *Oil Shock* corresponds to a larger negative shock.

## D.1 Summary Statistics

We now present some summary statistics for both Movers and Stayers by *Oil Cities* and *Non-Oil Cities*. For migrants, we analyze the individual characteristics one quarter before the moving date and for stayers we consider the median quarter among those that the individual is present in the sample. We restrict the analysis to the period between 2013 and 2016, the period that registered a decline in oil prices. We restrict the sample to individuals that are present in the sample for at least 8 consecutive quarters and whose age is above 18 and below 75. We observe a total of 810,305 individuals in both *Oil Cities* and *Non-Oil Cities*. We define as Migrants everyone that moves out of a given city to other city within or outside the *Oil Provinces*. We also consider everyone that moves from a city to a rural area.[13] Individuals that move across FSAs within the same city are classified as Stayers.

Overall, as reported in Table 20, migrants are younger and have lower credit score than stayers. In the *Oil Cities*, while about 65% of the migrants are less than 45 years old, only 50% of the stayers are in the same age range. 55% of the migrants are considered Prime borrowers with an average credit score of 722, which contrast with the stayers that have on average a credit score of 750. The share of homeowners among migrants is smaller than the one among stayers and they have larger credit usage even excluding mortgages. The migrant population in the *Oil Cities* seems to be quite selected. Although *Oil Cities* and *Non-Oil Cities* seem to differ slightly in some demographic characteristics, these differences are not significant and are valid for both migrants and stayers.

## D.2 The Heterogeneous Migration Behaviour

In this section, we analyse how distinct individuals migrate and also how they respond differently to a negative oil shock. In specific, we look at homeownership, age and ability to borrow (measured in terms of credit score). We adapt the Bartik-style panel regression model proposed by Kilian and Zhou (2018) to study the regional propagation of oil price shocks in Canada. The authors demonstrate that under empirically plausible conditions the derivative of the dependent variable with respect to the oil price shock in their regression can be given a causal interpretation. We depart from them by looking also at how such individual-level characteristics interact with a negative shock to the local economy through the following specification:

[13] Since we focus on our analysis on *Oil Cities*, we exclude from the sample those that potentially move from rural areas into cities, but not the other way around. This happens because we need to match each location to the city-level Oil shock, whose for data limitations we cannot define for rural areas. Given that we don't match the Oil shock with the destination city, we consider everyone that moves from a city to a rural area.

Table 20: Summary Statistics for *Transunion* Variables

| | **Oil Cities** | | **Non-oil Cities** | |
|---|---|---|---|---|
| | Migrants | Stayers | Migrants | Stayers |
| Age(Mean) | 40.33 | 45.81 | 38.42 | 46.82 |
| Old (share %) | 34.83 | 50.45 | 29.63 | 53.04 |
| Credit Score (Mean) | 721.96 | 750.21 | 724.94 | 753.33 |
| Prime (share %) | 54.99 | 66.76 | 57.43 | 68.68 |
| Homeowners (share %) | 35.51 | 45.85 | 30.28 | 43.28 |
| Home Equity (Mean) | 20.04 | 23.38 | 19.85 | 22.81 |
| Number Credit Accounts (Mean) | 1.91 | 1.9 | 1.81 | 1.83 |
| Credit Usage (Mean) | 55.78 | 51.07 | 54.27 | 48.67 |
| Credit Use except Mortg. (Mean) | 49.85 | 47.46 | 48.31 | 45.82 |
| Credits 90+ day (Mean) | 1.19 | 1.15 | 1.16 | 1.13 |
| Credits 90+ day (share %) | .2 | .13 | .18 | .12 |
| Mortgages 90+ day (share %) | 2.47 | 1.55 | 1.99 | 1.36 |
| Observations | 49679 | 404788 | 42370 | 313468 |

Note: This table reports the summary statistics of the variables from *TransUnion* use in the empirical specification. We divide the sample between cities with oil industry and cities without. For each of these groups, we divide the sample between migrants and stayers. We cover the years between 2013 and 2016.

$$\begin{aligned} Move_{i,z,t} = &\beta_0 + \beta_1 OilShock_{z,t-1} X_{i,z,t-1} + \beta_2 X_{i,t-1} + \beta_3 OilShock_{z,t-1} \\ &+ \beta_4 W_{i,z,t-1} + \gamma_i + \delta_z + \theta_t + \epsilon_{i,z,t} \end{aligned} \tag{12}$$

where $\text{Move}_{i,z,t}$ is a dummy variable that equals 1 if individual $i$ in location $z$ at time $t$ moves to a different city. $X_{i,t-1}$ are individual characteristics such as age, homeownership and credit score. We also control for other time varying characteristics $W_{i,t-1}$ as credit usage, home equity and delinquencies.

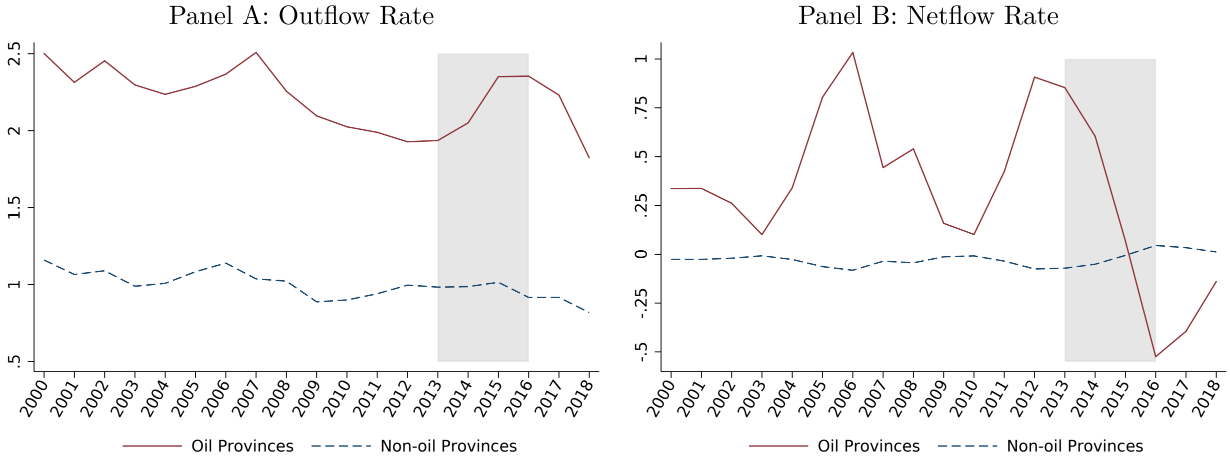
Our main specification also includes individual fixed effects, quarter fixed effects and city fixed effects. The individual fixed effects, $\gamma_i$, controls for unobservable individual heterogeneity as different preferences for moving. It also ensures that all results are estimated exploiting individual variation over time rather than across individuals. The quarter fixed effects, $\theta_t$, absorb overall trends in migration rates and any potential aggregate shock to the economy. The city fixed effects, $\delta_z$, control for city characteristics as amenities, long-run productivity levels, quality of life, among others. We also employ alternative empirical specification where we include city-by-quarter fixed effects to absorb any other potential local shock or changes in local economic conditions that occur simultaneously to the oil shock. We cluster our standard errors at city level.

The main coefficients of interest for our analysis is $\beta_1$ that measures how individuals with different characteristics respond to the same local oil shock. In other words, it identifies how different demographics, $X_{i,t-1}$, affect the probability of moving out of location $z$ given the *Oil Shock*. In specific, we look at homeownership status, age and credit score as proxy for individual's ability to borrow. In the main specification we consider five age group categories: 26-35, 36-45, 45-55, 56-65 and 66-85. In terms of credit scores, we group the individuals in five groups: 300-640, 640-719, 720-759, 760-799 and 800-900. A borrower is considered Prime if their credit score is above 720. We interpret that higher the credit score, higher the ability to smooth shocks through borrowing.

$\beta_2$ measures the unconditional migration probability and $\beta_3$ can be interpreted as the impact of one standard deviation increase in the exposure to the oil shock in the probability of moving out of location $z$. The rest of the variables serve as controls. As explained before, we consider two set of cities. A "treated" city is a city that surrounds an oil facility and a "control" city are those cities in the *Oil Provinces* where the employment share in the oil industry is residual. We explore heterogeneity across the "treated" cities by computing the city level exposure to the oil shock given the share of oil industry employment in the city, as defined in equation 11. By construction, the *Oil Shock* in the "control" cities is zero. By restricting the treatment group to areas close to oil facilities allow us to capture at a greater extent the workers in the oil sectors, those that must be directly impacted by the decline in oil price.

Before turning to the results, we present some evidence of outflows from and to the oil regions. Figure 21 plots migration rates for Oil Regions and Non-Oil regions between 2000 and 2018 using official statistics from Statistics Canada. Outflow rate (Panel A) and Netflow Rate (Panel B) has been very stable for Non-Oil Regions throughout the entire period. The Non-Oil regions show a nearly constant Outflow rate of 1% that seems to be compensated by a constant inflow of similar magnitude. However, migration ratios for Oil-Regions are much more volatile and of higher magnitudes. The outflow was around 2.5% per year until 2005 when started to decline and reach its lowest value of 2% in 2013. After 2013, outflow rate seemed to follow the oil price pattern. While oil price declined between 2013 and 2016, the number of people leaving the Oil Regions increased. The pattern reversed when oil prices started recovering. More striking is the behavior of the netflow rate during the same period. In 2012, the netflow rate was positive around 1% and reached the negative level of -0.25% in 2016. These results are suggestive that individuals react to oil shocks by leaving at higher rate the *Oil Provinces* but above all negative oil shocks seem to reduce the incentives to migrate into these provinces. The high correlation between oil prices and migration flows both in

Figure 21: Migration Patterns in Canada




Note: Figure 1 plots the Migration patterns in Canada between 2000 and 2018 for Oil Provinces and Non-oil Provinces. Panel A plots the Outflow Rate and Panel B plots the netflow Rate. Outflow Rate is defined by the number of people leaving a certain set of provinces divided by the total Population in the same set of provinces in the year before. Netflow Rate is defined by the difference between the number of people entering and leaving a set of provinces divided by the total Population in the same set of provinces in the year before. Data is Statistics Canada.

terms of the direction and timing presented in this figure gives us confidence that oil shocks are an important driver of individuals migration decisions in the regions with higher exposure to the oil industry. This also suggest that the changes in the migration rates at national level are coming mostly from the oil regions.

Table 21: Heterogeneous Migration Responses

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | Move=100 | | | | |
| Oil Shock | 0.527*** | | 0.708*** | | 0.613*** | | 0.859*** | |
| | (0.106) | | (0.051) | | (0.064) | | (0.071) | |
| Homeowner | -0.119*** | -0.126** | | | | | -0.165*** | -0.173*** |
| | (0.037) | (0.043) | | | | | (0.025) | (0.027) |
| Age [26-35] | | | 0.951*** | 0.923*** | | | 0.955*** | 0.926*** |
| | | | (0.146) | (0.151) | | | (0.146) | (0.149) |
| Age [36-45] | | | 1.022*** | 0.985*** | | | 1.028*** | 0.990*** |
| | | | (0.158) | (0.161) | | | (0.154) | (0.155) |
| Age [46-55] | | | 0.808*** | 0.777*** | | | 0.814*** | 0.781*** |
| | | | (0.155) | (0.153) | | | (0.147) | (0.141) |
| Age [56-65] | | | 0.511*** | 0.488*** | | | 0.516*** | 0.491*** |
| | | | (0.121) | (0.128) | | | (0.107) | (0.110) |
| Age [66-90] | | | 0.110 | 0.118 | | | 0.111 | 0.117 |
| | | | (0.118) | (0.148) | | | (0.101) | (0.127) |
| Credit Score [640-719] | | | | | -0.047* | -0.047** | -0.047** | -0.047** |
| | | | | | (0.024) | (0.021) | (0.021) | (0.018) |
| Credit Score [720-759] | | | | | -0.033 | -0.035 | -0.031 | -0.035* |
| | | | | | (0.031) | (0.026) | (0.025) | (0.019) |
| Credit Score [760-799] | | | | | 0.011 | 0.008 | 0.010 | 0.005 |
| | | | | | (0.051) | (0.047) | (0.046) | (0.040) |
| Credit Score [800-900] | | | | | -0.008 | -0.012 | -0.012 | -0.017 |
| | | | | | (0.057) | (0.055) | (0.048) | (0.042) |
| Oil Shock × Homeowner | -0.196*** | -0.269*** | | | | | -0.116*** | -0.177*** |
| | (0.034) | (0.031) | | | | | (0.036) | (0.029) |
| Age [26-35] × Oil Shock | | | -0.195*** | -0.325*** | | | -0.160** | -0.282*** |
| | | | (0.063) | (0.057) | | | (0.067) | (0.060) |
| Age [36-45] × Oil Shock | | | -0.330*** | -0.489*** | | | -0.279** | -0.422*** |
| | | | (0.098) | (0.088) | | | (0.102) | (0.090) |
| Age [46-55] × Oil Shock | | | -0.370** | -0.527*** | | | -0.305** | -0.446*** |
| | | | (0.132) | (0.120) | | | (0.131) | (0.118) |
| Age [56-65] × Oil Shock | | | -0.282 | -0.458** | | | -0.211 | -0.372** |
| | | | (0.184) | (0.159) | | | (0.181) | (0.156) |
| Age [66-90] × Oil Shock | | | -0.440 | -0.570** | | | -0.375 | -0.497** |
| | | | (0.278) | (0.220) | | | (0.268) | (0.211) |
| Credit Score [640-719] × Oil Shock | | | | | -0.118*** | -0.113*** | -0.098*** | -0.085*** |
| | | | | | (0.027) | (0.026) | (0.024) | (0.023) |
| Credit Score [720-759] × Oil Shock | | | | | -0.184*** | -0.183*** | -0.150*** | -0.135*** |
| | | | | | (0.039) | (0.036) | (0.034) | (0.032) |
| Credit Score [760-799] × Oil Shock | | | | | -0.238*** | -0.253*** | -0.191*** | -0.188*** |
| | | | | | (0.046) | (0.039) | (0.037) | (0.032) |
| Credit Score [800-900] × Oil Shock | | | | | -0.304*** | -0.327*** | -0.226*** | -0.220*** |
| | | | | | (0.081) | (0.068) | (0.061) | (0.051) |
| Observations | 12990210 | 12990210 | 12990210 | 12990210 | 12990210 | 12990210 | 12990210 | 12990210 |
| Adjusted $R^2$ | 0.102 | 0.104 | 0.103 | 0.104 | 0.102 | 0.104 | 0.103 | 0.104 |
| Individual Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| Quarter Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| City × Quarter Fixed-Effects | No | Yes | No | Yes | No | Yes | No | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 12. The dependent variable is the decision on whether to move or not. Standard errors are presented in parentheses and are clustered at the quarter-city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively.

## Table 22: Heterogeneous Migration Behavior

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | Move=1 | | | | | |
| Oil Shock | 0.428*** | | 0.707*** | | 0.517*** | | 0.845*** | |
| | (0.051) | | (0.100) | | (0.043) | | (0.119) | |
| Homeowner | -0.132*** | -0.130*** | | | | | -0.173*** | -0.173*** |
| | (0.033) | (0.038) | | | | | (0.017) | (0.020) |
| Age [26-35] | | | 0.654*** | 0.637*** | | | 0.656*** | 0.637*** |
| | | | (0.146) | (0.151) | | | (0.142) | (0.146) |
| Age [36-45] | | | 0.673*** | 0.659*** | | | 0.679*** | 0.663*** |
| | | | (0.177) | (0.183) | | | (0.169) | (0.173) |
| Age [46-55] | | | 0.499*** | 0.495** | | | 0.505*** | 0.499*** |
| | | | (0.174) | (0.182) | | | (0.164) | (0.170) |
| Age [56-65] | | | 0.322** | 0.320** | | | 0.328** | 0.326** |
| | | | (0.144) | (0.155) | | | (0.132) | (0.141) |
| Age [66-90] | | | 0.106 | 0.110 | | | 0.108 | 0.113 |
| | | | (0.106) | (0.125) | | | (0.094) | (0.112) |
| Credit Score [640-719] | | | | | -0.029* | -0.028 | -0.029** | -0.029** |
| | | | | | (0.017) | (0.017) | (0.013) | (0.012) |
| Credit Score [720-759] | | | | | -0.030 | -0.030 | -0.028 | -0.028 |
| | | | | | (0.026) | (0.026) | (0.019) | (0.017) |
| Credit Score [760-799] | | | | | -0.000 | 0.001 | -0.004 | -0.005 |
| | | | | | (0.042) | (0.042) | (0.032) | (0.031) |
| Credit Score [800-900] | | | | | -0.026 | -0.023 | -0.031 | -0.030 |
| | | | | | (0.051) | (0.054) | (0.034) | (0.034) |
| Oil Shock × Homeowner | -0.234*** | -0.278*** | | | | | -0.140*** | -0.175*** |
| | (0.056) | (0.051) | | | | | (0.032) | (0.027) |
| Age [26-35] × Oil Shock | | | -0.214*** | -0.295*** | | | -0.171*** | -0.246*** |
| | | | (0.063) | (0.052) | | | (0.057) | (0.047) |
| Age [36-45] × Oil Shock | | | -0.430*** | -0.533*** | | | -0.364*** | -0.458*** |
| | | | (0.127) | (0.116) | | | (0.114) | (0.103) |
| Age [46-55] × Oil Shock | | | -0.502*** | -0.607*** | | | -0.422*** | -0.516*** |
| | | | (0.154) | (0.144) | | | (0.137) | (0.127) |
| Age [56-65] × Oil Shock | | | -0.479*** | -0.601*** | | | -0.391** | -0.502*** |
| | | | (0.173) | (0.162) | | | (0.153) | (0.143) |
| Age [66-90] × Oil Shock | | | -0.632*** | -0.751*** | | | -0.554*** | -0.666*** |
| | | | (0.185) | (0.180) | | | (0.166) | (0.162) |
| Credit Score [640-719] × Oil Shock | | | | | -0.125*** | -0.125*** | -0.094*** | -0.088*** |
| | | | | | (0.027) | (0.028) | (0.018) | (0.019) |
| Credit Score [720-759] × Oil Shock | | | | | -0.191*** | -0.194*** | -0.138*** | -0.132*** |
| | | | | | (0.041) | (0.042) | (0.027) | (0.027) |
| Credit Score [760-799] × Oil Shock | | | | | -0.243*** | -0.258*** | -0.168*** | -0.170*** |
| | | | | | (0.051) | (0.050) | (0.028) | (0.028) |
| Credit Score [800-900] × Oil Shock | | | | | -0.346*** | -0.368*** | -0.218*** | -0.219*** |
| | | | | | (0.088) | (0.086) | (0.046) | (0.045) |
| Observations | 44079715 | 44079715 | 44079715 | 44079715 | 44079715 | 44079715 | 44079715 | 44079715 |
| Adjusted $R^2$ | 0.096 | 0.097 | 0.096 | 0.097 | 0.096 | 0.097 | 0.096 | 0.097 |
| Individual Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| Quarter Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| City × Quarter Fixed-Effects | No | Yes | No | Yes | No | Yes | No | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 1. The dependent variable is the decision on whether to move or not.

As expected, the probability of moving out of a city increases with a negative oil shock. A standard deviation increase in the exposure to the oil shock increases the moving probability between 0.5% and 0.871%.

Without the presence of the *Oil Shock*, homeowners tend to migrate less less than non-homeowners. Age also seems to matter as older individuals tend to migrate less than younger ones. The exception seems to be the individuals whose age belongs to the 36 to 45 group, as individuals in this group presents higher unconditional migration probabilities. However, credit score seems to not be a relevant margin to the migration decision when individuals do not face any negative shock. These results are robust to the inclusion of city and quarter fixed effects and city $\times$ quarter fixed effects, as they are similar both in sign and in magnitude. The unconditional probabilities are also similar if we run each of the characteristics separate or jointly.

Such characteristics seem to become even more relevant when individuals are hit by a negative and unexpected shock that can impact directly or indirectly their employment status or income.

Homeowners tend to move less than non-homeowners when exposed to the same shock. For a given *Oil Shock*, homeowners move on average between 12 and 18 bps less than renters and this difference increases as the exposure to the oil shock rises. Overall, homeowners buffer less the shock by moving than renters, even when conditional on other observables.

Older individuals also seem to react less than younger ones to the oil shock. Although we find that individuals older than 36 and younger than 45 years old migrate more unconditionally in respect to younger individuals, when we look at the interaction between age and the oil shock, they are less likely to move than the very young, for a given level of exposure to the oil shock. So, younger individuals buffer more the shock by moving than old, especially those that are expected to be out of the labor force (above 65 years old).

Although credit score seems to not be important for migration decisions in areas not exposed to a shock, it seems to play an important role when it comes to respond to the shock. Individuals with lower credit score, on average, move more than those with higher credit score. The moving response to the shock is monotonic regarding the credit score. Specifically, individuals with credit score between 640-719 move around 9 bps less than individuals with credit score less than 640. Individuals with very high credit score (800-900) moved 22 bps less than individuals with lower credit score. This result suggests that higher credit score individuals use their borrowing capacity to buffer a temporary shock without moving. Those that are less likely to access credit markets in times of distress see in moving to a new location their way to smooth shocks.

In the Appendix, we run different specifications as robustness. In Table 22, we consider a "Continuous" *Oil Shock*. In specific, we use the definition of the oil shock in equation 11 without restricting to the Cities around the oil facilities. Although magnitudes vary depending on the specification, we find nevertheless the same relationship between moving probabilities and homeowneship, age and credit score.

## D.3 Where People Move to?

In this section, we analyze the cities' characteristics to which individuals migrate to in response to the shock. Are individuals more likely to move to places with higher income than their previous locations? Do house prices matter when individuals move due to a shock? We perform this analysis in two dimensions. First, we conduct a decomposition by destination and migrants characteristics. Second, we test formally in a regression setting which characteristics determine the type of location they choose to move to. We do so by running the following specification:

$$MoveTO_{i,z,z',t} = \alpha + \beta_1 X_{i,t-1} + \beta_2 OilShock_{z,t-1} + \beta_3 W_{i,t-1} + \gamma_i + \delta_z + \theta_t + \epsilon_{i,z,t} \tag{13}$$

where $MoveTO_{i,z,z',t}$ equals 100 if the new location $z'$ is "better" than the previous location $z$. For instance, if the new location has higher income or amenities. We control for the strength of the Bartik shock in location $z$ and for other individual characteristics as in equation (12).

Table 23: Moving Decomposition

**Panel A**

| | Oil Provinces | | House Prices | | | Population | | | Unemployment Rate | | | Amenities | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inside | Outside | Higher | Same | Lower | Higher | Same | Lower | Higher | Same | Lower | Higher | Lower |
| All | 22.28 | 77.72 | 27.19 | 35.25 | 37.56 | 51.1 | 15.78 | 33.12 | 70.41 | .54 | 29.05 | 33.11 | 66.89 |
| Homeowners | 24.27 | 75.73 | 24.5 | 34.74 | 40.77 | 49.69 | 16.29 | 34.02 | 68.52 | .64 | 30.83 | 32.87 | 67.13 |
| Renters | 21.39 | 78.61 | 28.4 | 35.49 | 36.11 | 51.68 | 15.58 | 32.75 | 71.21 | .5 | 28.29 | 33.21 | 66.79 |
| Young | 20.78 | 79.22 | 28.4 | 35.83 | 35.77 | 51.49 | 15.97 | 32.54 | 72.13 | .53 | 27.34 | 33.69 | 66.31 |
| Old | 25.41 | 74.59 | 24.67 | 34.05 | 41.28 | 50.11 | 15.32 | 34.58 | 66.29 | .57 | 33.14 | 31.49 | 68.51 |
| Non-Prime | 19.97 | 80.03 | 26.65 | 36.05 | 37.3 | 50.15 | 14.52 | 35.33 | 69.25 | .51 | 30.25 | 32.03 | 67.97 |
| Prime | 24.08 | 75.92 | 27.61 | 34.63 | 37.76 | 51.76 | 16.68 | 31.56 | 71.25 | .57 | 28.18 | 33.78 | 66.22 |

**Panel B**

| | Total Income (Nom) | | | Median Income (Nom) | | | Total Income (Real) | | | Median Income (Real) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Higher | Same | Lower | Higher | Same | Lower | Higher | Same | Lower | Higher | Same | Lower |
| All | 65.45 | 5.91 | 28.65 | 30.12 | 14.46 | 55.42 | 65.13 | 1.27 | 33.6 | 38.53 | 7.38 | 54.09 |
| Homeowners | 63.67 | 6.07 | 30.26 | 25.37 | 13.87 | 60.76 | 64.32 | 1.57 | 34.11 | 36.75 | 7.65 | 55.6 |
| Renters | 66.2 | 5.84 | 27.96 | 32.14 | 14.72 | 53.15 | 65.48 | 1.14 | 33.38 | 39.29 | 7.26 | 53.45 |
| Young | 66.81 | 6.18 | 27 | 32.32 | 14.98 | 52.7 | 66.23 | 1.2 | 32.56 | 39.03 | 7.29 | 53.68 |
| Old | 62.17 | 5.24 | 32.59 | 24.85 | 13.21 | 61.94 | 62.5 | 1.43 | 36.07 | 37.34 | 7.57 | 55.09 |
| Non-Prime | 64.78 | 5.39 | 29.83 | 30.25 | 14.29 | 55.46 | 64.47 | 1.15 | 34.38 | 39.35 | 7.32 | 53.32 |
| Prime | 65.93 | 6.28 | 27.79 | 30.03 | 14.58 | 55.39 | 65.61 | 1.36 | 33.03 | 37.94 | 7.41 | 54.64 |

Similarly, we control for individual, origin city and quarter fixed effects. The main coefficient of interest is $\beta_1$ that tell us which individuals are more likely to "move up".

### D.3.1 Results

Table 23 reports the share of individuals that move to certain locations for different individual characteristics. We only consider individuals that moved after the oil shock and identify the individual characteristics in the quarter before they move. Approximately 78% of individuals that faced an *Oil Shock* moved to a city outside the oil regions. Renters, younger and non-prime members moved outside the *Oil Provinces* more than their respective counterparts. Regarding housing prices, we see that only 27% of the movers went to areas with higher house prices while about 35% moved to regions with similar house prices.[14] Therefore, 73% of the individuals move to places where house prices are similar or lower than the median house prices in their previous location. Renters, younger and prime members tend to move more to places with higher house price.

51% of the movers tend to move to larger cities, while only 33% move to smaller cities. This trend to be very similar across all individuals. Interestingly, when we look at unemployment rates, 70% of the individuals, on average, move to cities with higher unemployment rates. Renters, younger and prime-members move more to cities with higher unemployment rates, which tend to be correlated with city size. When we look at amenities, we observe that only 33% of the movers go to locations with higher amenities. Renters, young and prime members then to go more to these locations than their counterparts.

[14] We define a similar region to the previous location when the difference between the two cities of variable of interest is less than 5% in absolute terms

## Table 24: Where are Movers Going?

**Panel A**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Higher House Prices | | Outside Oil Provinces | | Higher Population | | Unemployment Rate | | Higher Amenities | |
| Oil Shock | 0.272 | | -0.749 | | -0.242 | | -22.552*** | | 30.200 | |
| | (0.626) | | (0.737) | | (0.739) | | (4.540) | | (12.458) | |
| Homeowner | -2.519*** | -2.482*** | -1.067* | -1.039 | -3.834*** | -3.854*** | -0.147 | -0.087 | -0.761 | -0.781 |
| | (0.593) | (0.612) | (0.574) | (0.585) | (0.635) | (0.629) | (0.900) | (0.997) | (1.890) | (1.835) |
| Age [26-35] | -0.458 | -0.454 | 3.735*** | 3.712*** | 1.038 | 1.031 | 2.902* | 2.494 | 4.014 | 4.059 |
| | (0.798) | (0.792) | (0.518) | (0.495) | (1.769) | (1.770) | (1.408) | (1.496) | (2.610) | (2.604) |
| Age [36-45] | -1.320 | -1.364 | 4.293*** | 4.276*** | 0.304 | 0.271 | 3.001 | 2.412 | 5.554 | 5.660 |
| | (0.904) | (0.890) | (0.900) | (0.875) | (2.375) | (2.361) | (2.186) | (2.421) | (2.295) | (2.284) |
| Age [46-55] | -2.881** | -2.879** | 4.418*** | 4.455*** | -3.045 | -3.060 | 3.490* | 2.606 | 4.714 | 4.810 |
| | (1.228) | (1.192) | (0.839) | (0.819) | (2.315) | (2.297) | (1.626) | (1.847) | (2.048) | (2.039) |
| Age [56-65] | -4.749*** | -4.742*** | 6.038*** | 5.989*** | -8.362*** | -8.391*** | 1.672 | 1.428 | 2.157 | 2.229 |
| | (1.413) | (1.366) | (0.713) | (0.712) | (2.171) | (2.117) | (1.427) | (1.603) | (1.329) | (1.349) |
| Age [66-90] | -4.470*** | -4.368*** | 6.313*** | 6.439*** | -8.786*** | -8.712*** | 2.335 | 1.262 | 3.538 | 3.433 |
| | (1.351) | (1.336) | (0.583) | (0.566) | (2.453) | (2.490) | (1.248) | (1.023) | (2.071) | (2.054) |
| Credit Score [640-719] | 0.664 | 0.660 | 2.108** | 1.988** | 2.421*** | 2.427*** | -0.131 | -0.573 | 0.452 | 0.282 |
| | (0.591) | (0.590) | (0.714) | (0.710) | (0.601) | (0.629) | (0.382) | (0.509) | (0.553) | (0.542) |
| Credit Score [720-759] | 2.069** | 2.099** | 2.033* | 1.970* | 5.563*** | 5.514*** | 0.436 | 0.354 | 0.599 | 0.506 |
| | (0.780) | (0.776) | (1.092) | (1.084) | (1.282) | (1.290) | (0.637) | (0.520) | (0.880) | (0.901) |
| Credit Score [760-799] | 4.414*** | 4.367*** | 5.470*** | 5.394*** | 6.661*** | 6.591*** | 0.020 | 0.166 | 1.010 | 0.907 |
| | (0.848) | (0.857) | (1.652) | (1.666) | (1.801) | (1.806) | (0.663) | (0.641) | (1.531) | (1.485) |
| Credit Score [800-900] | 5.103*** | 5.074*** | 5.727*** | 5.582*** | 6.882*** | 6.819*** | 0.317 | -0.264 | 0.045 | -0.135 |
| | (0.679) | (0.679) | (1.633) | (1.642) | (1.426) | (1.440) | (1.053) | (0.900) | (1.185) | (1.126) |
| Observations | 95785 | 95785 | 95795 | 95795 | 59603 | 59603 | 45574 | 45574 | 21717 | 21717 |
| Adjusted $R^2$ | 0.385 | 0.389 | 0.169 | 0.180 | 0.168 | 0.171 | 0.319 | 0.496 | 0.349 | 0.354 |
| Individual Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| Quarter Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| City $\times$ Quarter Fixed-Effects | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |

Note: This table reports the OLS estimates for every year for the regressions in 13. The dependent variable is reported in the respective columns. Standard errors are presented in parentheses and are clustered at the quarter-city level. The ***, **, and * represent statistical significance at the 0.001, 0.01, and 0.05 levels respectively. Differently from table 1 we impose that if a city does not have any oil plant, the value of the Bartik is equal to 0. If a city does not have oil plants, the Bartik is set to be 0.

Table 24: Where are Movers Going? (Cont'd)

**Panel B**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Higher Total Inc (Nom) | | Higher Median Inc (Nom) | | Higher Total Inc (Real) | | Higher Median Inc (Real) | |
| Oil Shock | -1.632 | | 5.540*** | | -1.266** | | 0.026 | |
| | (1.035) | | (1.209) | | (0.581) | | (0.449) | |
| Homeowner | -3.566*** | -3.557*** | -0.316 | -0.330 | -2.317** | -2.364** | -0.548 | -0.706 |
| | (0.718) | (0.700) | (0.702) | (0.671) | (0.924) | (0.946) | (1.224) | (1.300) |
| Age [26-35] | 1.098 | 1.153 | -0.521 | -0.514 | 1.333 | 1.356 | 1.732 | 1.668 |
| | (1.774) | (1.774) | (1.257) | (1.252) | (1.857) | (1.850) | (1.243) | (1.242) |
| Age [36-45] | 0.981 | 0.947 | -2.363* | -2.228* | 1.378 | 1.360 | 2.708* | 2.557* |
| | (2.268) | (2.275) | (1.179) | (1.201) | (2.453) | (2.452) | (1.424) | (1.418) |
| Age [46-55] | -1.449 | -1.494 | -4.652*** | -4.514*** | -0.768 | -0.798 | 1.495 | 1.361 |
| | (1.848) | (1.847) | (1.312) | (1.378) | (1.896) | (1.881) | (1.182) | (1.180) |
| Age [56-65] | -6.247*** | -6.477*** | -6.896** | -6.709** | -4.852** | -4.964** | 2.612 | 2.835 |
| | (1.669) | (1.640) | (2.505) | (2.417) | (1.835) | (1.805) | (1.636) | (1.657) |
| Age [66-90] | -6.564** | -6.565** | -8.436*** | -8.449*** | -5.903** | -5.955** | 2.250 | 2.283 |
| | (2.457) | (2.419) | (2.666) | (2.636) | (2.239) | (2.200) | (1.721) | (1.692) |
| Credit Score [640-719] | 2.334*** | 2.296*** | 0.282 | 0.437 | 2.142** | 2.113** | -1.023 | -1.190 |
| | (0.526) | (0.558) | (0.619) | (0.610) | (0.730) | (0.755) | (1.400) | (1.500) |
| Credit Score [720-759] | 4.443*** | 4.570*** | 2.284** | 2.336*** | 4.138** | 4.131** | -1.603 | -1.857 |
| | (1.234) | (1.244) | (0.748) | (0.687) | (1.439) | (1.442) | (1.449) | (1.539) |
| Credit Score [760-799] | 5.695*** | 5.843*** | 0.660 | 0.612 | 4.904** | 4.895** | -2.846 | -2.958 |
| | (1.575) | (1.594) | (1.146) | (1.090) | (1.885) | (1.883) | (1.664) | (1.681) |
| Credit Score [800-900] | 5.274*** | 5.316*** | 1.266 | 1.371 | 4.845** | 4.841** | -3.457 | -3.789 |
| | (1.350) | (1.394) | (0.976) | (0.891) | (1.874) | (1.897) | (2.411) | (2.599) |
| Observations | 59648 | 59648 | 59648 | 59648 | 59648 | 59648 | 59648 | 59648 |
| Adjusted $R^2$ | 0.326 | 0.335 | 0.398 | 0.413 | 0.370 | 0.373 | 0.272 | 0.296 |
| Individual Fixed-Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| City Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| Quarter Fixed-Effects | Yes | No | Yes | No | Yes | No | Yes | No |
| City × Quarter Fixed-Effects | No | Yes | No | Yes | No | Yes | No | Yes |

We know analyze income in terms of their income statistics. In panel B of Table 23, we start by analyzing cities total nominal income. This variable is positively correlated with city size, and we find that 65% of individuals move to areas with similar or higher total nominal income, a similar value of those that move to cities with similar or bigger size. However, we find that renters and younger individuals move more to these cities, while no significant differences in terms of credit score.

Larger cities tend to have higher total income, but not necessarily higher median income. In fact, 55% of the individuals choose to move to a city with lower median income in nominal terms. Once again we find differences between across age and homeownership status. We find similar results if we look at real income statistics. We compute real income statistics by dividing city level income by median house prices. All these variables are strongly correlated with city size, so these results suggest that most of the individuals tend above all to choose big cities. Moreover, renters, young and prime seem to move *up* more than their counterparts.

We now look deeper into this decomposition exercise by analyzing in a regression setting which individuals characteristics are associated with moving to certain locations. In table 24, we report the estimates of specification 13 where the dependent variables are Higher house prices, larger population, higher unemployment rate and higher amenities, higher total income (nominal and real) and higher median income (nominal and real). Overall, we find that homeowners tend to move more to lower house prices and to lower population cities. Older people tend to move more to lower house prices areas, outside the oil Provinces and smaller cities. Finally, we observe that individuals with higher credit scores tend to move relatively more to areas with more expensive housing, outside the Oil Provinces and to larger cities. We find that demographic characteristics do not determine the sorting based on unemployment rate and amenities. Regarding income, homeowners and older older individuals move relatively less to larger places although, both in nominal and real terms. Individuals with higher credit score move monotonically more to larger places and to places with higher median income, although the income effect is lower than the size effect.

# E Algorithm

## E.1 Stationary Equilibrium

To solve the stationary general equilibrium of the economy, we first set up a discrete grid space for asset and housing. We start with guessing a vector of wages $\mathbf{w}^0$ and a vector of house prices $\mathbf{p}^0$ where each element of the vector corresponds to a location, and from the non-arbitrage condition in Equation (7), we obtain a vector of house rents $\mathbf{p}_r^0$. In each period, new age 25 group is born. They start their lives as renters. The distribution of the age 25 group over asset is read directly from the 2012 Survey of Financial Security and is assumed to be the same across locations. At each asset level, the share of unemployed in each location is set to be equal to the location-specific average unemployment rate from 2000 to 2011. The mass of the age 25 group in each location equates the total population in that location divided by 30 (total number of age groups). For groups of age 26 and beyond, the mass is the same as the age 25 group. Together with some initial guess of distribution across asset and employment for these age groups, we have the initial population distribution $L^{R0}(l, a, \epsilon, q)$ and $L^{H0}(l, a, \epsilon, q, h)$.

**Step 1.** Given $\mathbf{w}^0, \mathbf{p}^0$, value functions and policy functions can be solved using backward induction, starting from the problem of age 84 group. The consumption and saving problem for age $q$ group can be solved, given the value functions over asset for age $q+1$ group across locations. Given the value function, the migration probabilities can be constructed using Equation (5). Then using the migration probabilities and policy functions, based on guessed distribution $L^{R0}(l, a, \epsilon, q), L^{H0}(l, a, \epsilon, q, h)$, new distribution $L^{R1}(l, a, \epsilon, q), L^{H1}(l, a, \epsilon, q, h)$ is computed following the transition of endogenous states (housing, saving, homeownership status policies, and location choice) and exogenous states (employment status shock, age).

**Step 2.** Given the new distribution $L^{R1}(l, a, \epsilon, q), L^{H1}(l, a, \epsilon, q, h)$, we update wages $\mathbf{w}^1$ and housing rents $\mathbf{p}^1$ using labor market clearing condition in Equation (6) and housing market clearing condition implied by Equations (8) $-$ (10).

**Step 3.** Now using the new distribution and updated wages and prices, we return to Step 1. We follow Step 1 and then Step 2 until wages and prices in all the locations converge.

## E.2 Transition Path

To compute the transitional path after some shock, we first use the algorithm listed in Section E.1 to compute the pre-shock stationary equilibrium, and the new stationary equilibrium after the shock. The economy starts with the population distribution in the pre-shock stationary equilibrium, then shock occurs in period 1. We assume after some period $T$, the economy reaches the new stationary equilibrium. Given $T$, we guess a wage path $\{\mathbf{w}_t^0\}_{t=1}^T$ and a house price path $\{\mathbf{p}_t^0\}_{t=1}^T$. After period $T$, wages and house prices are equal to those in the post-shock stationary equilibrium. We use Equation (7) to obtain a path of house rent.

**Step 1.** Given guessed paths of wages, house prices and rents, we solve the value functions and policy functions along the path backward starting from period $T$, since in period

$T+1$, value functions and policy functions are known, given by those in the new stationary equilibrium. Then migration probabilities can be constructed as well using Equation (5). Next, given the initial population (old stationary equilibrium distribution), we can compute a path of population $\{L_t^R(a,\epsilon,q,l), L_t^H(a,\epsilon,q,l,h)\}_{t=1}^T$ following the transition of endogenous states (housing, saving, homeownership status policies, and location choice) and exogenous states (employment status shock, age).

**Step 2.** Given the path of distribution $\{L_t^R(a,\epsilon,q,l), L_t^H(a,\epsilon,q,l,h)\}_{t=1}^T$, we can update wage path $\{\mathbf{w}_t^1\}_{t=1}^T$ and house price path $\{\mathbf{p}_t^1\}_{t=1}^T$ using the using labor market clearing condition in Equation (6) and house stock evolution conditions implied by Equations $(8)-(10)$.

**Step 3.** Given updated wage and house price path, we return to Step 1. We follow Step 1 and then Step 2 until wage and price paths in all the locations converge.

**Step 4.** Then we check whether in period $T$, wages and prices reach the corresponding levels in the after-shock stationary equilibrium. If not, we increase $T$.