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GEOGRAPHICAL MOBILITY AND THE LABOUR MARKET

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Geographical mobility and the labour market*

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Abstract

This paper studies the effect of home-owners' migration costs on migration and unemployment in an economy where workers move both for work- and non-work-related reasons. To this end, a search model with heterogeneous locations is developed and calibrated to the U.S. economy. Consistent with the empirical evidence, the model predicts that home-owners have a lower unemployment rate than renters despite their higher migration costs. The result is due to home-owners' higher transition rate to employment and lower transition rate to unemployment. In addition, the model generates lower inequality in home-owners' local unemployment rates than in renters'. In line with this result, it is documented that, for the period 1996-2013, home-owners had less unemployment dispersion across metropolitan areas than renters.

Keywords: Home-ownership, Unemployment, Labour Mobility
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1 Introduction

Migration is more costly for those who are owners of their house. It is well known that selling and buying a house entails some costs that renters do not need to pay. Therefore, it is not surprising that home-owners migrate at a much lower rate than renters. In the US during 2011, for example, 7.4% of renters migrated compared to only 1.7% of home-owners[1]. Moreover, the empirical evidence shows that being a home-owner has a negative effect on geographic mobility, even after controlling for the different characteristics of home-owners and renters[2].

Oswald (1997, 1999) underscored the possibility that home-owners' lower levels of migration have an effect on the labour market. In particular, what is known as the Oswald hypothesis states that a higher home-ownership rate implies a higher unemployment rate. The main reason behind this idea is that home-owners' mobility costs prevent them from migrating when labour prospects in their location are poor. This implies that it takes longer for them to find jobs and, as a consequence, their unemployment rate is higher. Although this hypothesis has been tested empirically, there is still no consensus on this issue[3].

The mechanism behind the Oswald hypothesis is that higher migration costs hinders mobility for work-related reasons. However, one should also take into account the effect of these costs on the migration for non-work-related reasons. This kind of migration is quantitatively important. According to the Current Population Survey (CPS) only 35% of US inter-county migration was motivated by a work-related reason in 2012. The other 65% was mainly due to family-related reasons and to housing-related reasons. Moreover, non-work-related migration also affects the labour outcomes of workers even if the reason that motivates it is not related to the job market. A clear example is the case of an employed worker: Except for close moves, migration requires that an employed worker quits his job. Therefore, if home-owners' migration costs reduce the rate at which they migrate for non-work-related reasons, their transition rate to unemployment should be lower.

The objective of this paper is to study the effect of home-owners' migration costs on

[1] Inter-county migration rates in 2011 for the US from the Current Population Survey. The same pattern occurs for any year although the migration rate of both renters and owners have been declining over time.

[2] Recent estimates can be found in Caldera and Andrews (2011) and Coulson and Grieco (2013).

[3] The empirical literature includes Van Leuvensteijn and Koning (2004), Munch et al. (2006, 2008), Battu et al. (2008), Coulson and Fisher (2009), Zabel (2012), Taskin and Yaman (2013), Laamanen (2013) and Blanchflower and Oswald (2013).

unemployment. Its main contribution consists in including non-work-related migration and its impact on the labour outcomes of workers. On one hand, work-related migration affects the rate at which unemployed workers find jobs. On the other hand, non-work-related migration affects the rate at which employed workers enter unemployment. Hence, in this paper I focus on the transition rates both into and out of unemployment in order to explain the unemployment rate. The model developed is a model of job search with two locations that differ in the wages they offer and the rate at which job offers arrive. The population consists of home-owners and renters, who only differ in their costs of migration.

The economy is subject to shocks, referred to as local shocks, that affect simultaneously the wage and the arrival rate of job offers in each location. I consider the migration generated by local shocks as work-related-migration. This kind of migration can also be triggered by accepting a non-local job offer or by losing the job. Migration for non-work-related reasons is introduced through the assumption that workers have idiosyncratic preferences on the locations, which are also subject to shocks.

Workers not only can accept or reject the job offers they receive but they can also quit their job. I assume that an employed worker who migrates necessarily quits his job. In this way, migration costs also affect the unemployment rate through the transition rate into unemployment.

I solve the model numerically with the parameters calibrated to match some features of the US labour market. The model generates that home-owners have a lower unemployment rate than renters, despite being restricted by their migration costs. This result is consistent with the empirical evidence in Coulson and Fisher (2009) for the US, who find that home-owners have a lower probability of being unemployed.

I find that both the transition rate into employment and the transition rate into unemployment contribute to the lower unemployment rate of home-owners.

The transition rate into unemployment is driven by how often workers quit their jobs. Conditioning on location and preferences, a home-owner and a renter follow the same policy with respect to quits. Both home-owners and renters who are employed in the location with worse labour conditions (with a lower wage and a lower arrival rate of job offers) quit their job and migrate whenever their preference for their location changes. In contrast, workers who are employed in the location with better labour conditions remain there even if it is not their preferred location, and only some of them will quit their job if a local shock hits the economy. As local shocks arrive less often than preference shocks, an employed worker in the location with better labour conditions has, endogenously, a lower transition rate into unemployment. Home-owners tend to concentrate in this type of location. Renters tend to live in their most preferred location, independently of the labour prospects there. Therefore, despite home-owners having the same quitting policy as renters, their location choice is such that home-owners are less likely to quit their job.

The distribution of home-owners and renters across space also affects their transition rate into employment. Conditioning on location, this transition rate is higher for the renter. This is because of the different behaviour of home-owners and renters in the location with poor labour conditions. While unemployed renters there accept non-local job offers, home-owners do not. However, the fact that unemployed home-owners tend to concentrate in the location where the arrival rate of jobs is higher determines that, overall, they leave unemployment at a higher rate.

The model also predicts the unemployment rates at the local level: I find greater inequality in these rates for the renters than for the home-owners. To look into unemployment dispersion in the data, I use the March Supplement of the CPS for the period 1996-2013. In line with the calibrated model, I find a higher level of geographic dispersion in the unemployment rate of renters than home-owners, both at the aggregate level and for more homogeneous groups of population.

There have been proposed other theoretical models that relate home-owners' migration costs and unemployment. Dohmen (2005) studies how this interaction is affected by workers skills. In Coulson and Fisher (2009) the introduction of firm behaviour implies that despite home-owners having a higher unemployment rate, an increase in the proportion of home-owners does not necessarily lead to higher unemployment at the aggregate level. In Rouwendal and Nijkamp (2010) home-owners and renters not only differ in their mobility costs, but also in their housing costs (for example mortgage payments). Finally, Head and Lloyd-Ellis (2012) develop a model with search frictions both in the labour and the housing market, in which locations are heterogeneous in the level of wages. They find that the locations with higher wages have a higher home-ownership rate and a lower unemployment rate. This result, which is consistent with the empirical evidence, is also true here.

In this literature, migration costs imply that home-owners have a lower transition rate into employment and a higher unemployment rate than renters[4]. The different result found here can be explained by the non-work-related migration and the assumption

[4] In Dohmen (2005) this is so conditional on the level of skills of home-owners and renters.

that the choice of location affects the arrival rate of job offers of the worker. This is not the case in the previous models[5]. In contrast, the assumption that the job prospects of the worker depend on where he locates is common in the literature on regional reallocation, for example Shimer (2007) and Lkhagvasuren (2010).

Models that study the interaction between the housing market, migration and the labour market but that do not take into account housing tenure include van Nieuwerburgh and Weill (2010), Rupert and Wasmer (2012), Davis, Fisher and Veracierto (2013) and Sterk (2015). Among them, the present paper is more closely related to Rupert and Wasmer (2012) who study the role of housing frictions on unemployment in a model that includes non-work-related migration.

The rest of the paper is organized as follows. Section 2 describes the model economy. Section 3 analyses the effect of the cost of migration on workers' employment decisions. Section 4 implements the numerical calibration and Section 5 concludes.

2 The model

2.1 Setting

Time is continuous. The economy is populated by a measure 1 of infinitely lived workers who are risk neutral. They discount the future at a rate r. There are two locations, 1 and 2, indexed by $c \in \{1, 2\}$. Workers utility depend on their income, m and their preference $b \in \{0, 1\}$ for the location they reside in. A worker with income m and preference b has utility $u(m, b) = m + \bar{b}b$ with $\bar{b} > 0$. Workers are subject to preference shocks that arrive at a Poisson rate λ_B. When this kind of shock hits a worker with preference b, his preference turns to $-b$.

Workers can be either employed or unemployed. They receive job offers at some rate that does not depend on their employment status. A worker who lives in location c at time t receives job offers from location c according to a Poisson process with arrival rate α_c^t and from location $-c$ with Poisson rate $\varepsilon\alpha_{-c}^t$. The parameter ε implies that workers that are not resident in a location may receive job offers from that location at a different rate than residents. An offer from the current location of the worker will be

[5] This kind of migration has a different nature to the relocation for non-employment reasons in Head and Lloyd-Ellis (2012). The latter receives this name because it generates random migration (in opposition to directed migration) but the moves are associated with receiving a job offer. Therefore, they do not affect the transition into unemployment. In addition, in their model these kind of moves do not involve any decision from the worker.

referred to as a *local job offer* while an offer that does not come from his location will be referred to as a *non-local job offer*. The rate α_c^t can take two values: α_h or α_l, with $\alpha_h, \alpha_l > 0$. Employed workers live and work in the same location and receive income w_c^t. The wage w_c^t can take the values w_h or w_l with $w_l \leq w_h$. At any time, $\alpha_c^t = \alpha_h$ and $w_c^t = w_h$ in one of the locations whereas in the other $\alpha_{-c}^t = \alpha_l$ and $w_{-c}^t = w_l$. The economy is subject to local shocks that arrive at a Poisson rate λ_Y. When this type of shock hits the economy, in each location the arrival rate of job offers and the wage turn from α_y and w_y to α_{-y} and w_{-y} with $y \in \{h, l\}$. Employed workers are subject to separation shocks with Poisson rate s. A worker hit by a separation shock becomes unemployed. Unemployed workers' income is z with $0 \leq z < w_l$.

There are four types of shocks in the economy: local shocks, preference shocks, separation shocks and job offers. When workers receive any of these shocks they decide whether to quit their job (if they are employed), whether to accept a job offer (if they have received one) and whether to migrate to the other location. If a worker with preference b migrates, his preference turns to $-b$ and he must pay a cost $\overline{C}$. In Section 4, I will simulate this economy assuming that there are two type of workers: workers with migration costs, the "home-owners", and workers with no migration costs, the "renters". The type will be exogenously given. Since being home-owner or renter will only affect the problem of the worker through $\overline{C}$, in this section I omit the housing tenure of the description of the model, which applies for any worker with migration cost $\overline{C} \geq 0$.

2.2 Worker's problem

The state of a location can be summarized by the variable y. I denote the value of a worker with preference b who lives in the location in state y, as $V_e(b, y)$, with $e = w$ if he is employed and $e = u$ if he is unemployed. Since employed workers receive job offers at the same rate as the unemployed, we have that $V_w(b, y) > V_u(b, y)$. This relationship is used to simplify the definitions of the values of the workers below.

The value of an employed worker is defined in equation (1). He has a utility flow $u(w_y, b)$ and can receive four different type of shocks[6]. First, he receives a non-local offer with rate $\varepsilon\alpha_{-y}$. If he receives the offer, he can accept and migrate, reject and migrate, keep the current job in c or quit the job and remain in c. Since $V_w(b, y) > V_u(b, y)$,

[6]According to the setting, he can also receive a local job offer. Since this type of shock does not affect the value of the worker, it is omitted from (1).

neither the second nor the forth case maximize the worker's value, so they are omitted. The worker will obtain the maximum between the value of accepting the non-local offer and migrating, $V_w(-b,-y)-\overline{C}$, and the value of keeping the current job in c, $V_w(b,y)$.

The second type of shock in equation (1) is the separation shock, which comes at a rate s. In this case, the worker will choose between remaining in his location, which gives value $V_u(b,y)$, and migrating, which provides with the value $V_u(-b,-y)-\overline{C}$.

Finally, the worker also receives a preference shock with rate λ_B and a local shock with rate λ_Y. In both cases, the option of quitting the job and remaining in his current location does not maximize his value and is omitted. However, he still has to choose between remaining employed in his current location and migrating. In the case of a preference shock his preference will become $-b$. Therefore, his value will be $V_w(-b,y)$ if he remains in his location. On the other hand, if he moves, he must quit his job. Thus, he will obtain $V_u(b,-y)-\overline{C}$. In the case of a local shock, the state of the current location of the worker turns to $-y$ and the value that the worker will obtain if he remains is $V_w(b,-y)$. On the contrary, if he migrates, his location will be in state y, which implies that he will obtain the value $V_u(-b,y)-\overline{C}$ if he migrates there.

$$\begin{aligned} rV_w(b,y) &= u(w_y,b) \\ &+\varepsilon\alpha_{-y}\left(max\left\{V_w(-b,-y)-\overline{C},V_w(b,y)\right\}-V_w(b,y)\right) \\ &+s\left(max\left\{V_u(-b,-y)-\overline{C},V_u(b,y)\right\}-V_w(b,y)\right) \\ &+\lambda_B\left(max\left\{V_u(b,-y)-\overline{C},V_w(-b,y)\right\}-V_w(b,y)\right) \\ &+\lambda_Y\left(max\left\{V_u(-b,y)-\overline{C},V_w(b,-y)\right\}-V_w(b,y)\right) \end{aligned} \tag{1}$$

The value for a worker who is unemployed, has preference b and lives in the location in state y is $V_u(b,y)$ and is defined in equation (2). He has a utility flow $u(z,b)$ and can receive four different shocks: he can receive a local job offer, a non-local job offer, a preference shock and a local shock. The values he can obtain in each case are derived analogously to the case of the employed worker.

$$
\begin{aligned}
rV_u(b,y) &= u(z,b) \\
&+\alpha_y\left(max\left\{V_u(-b,-y)-\overline{C},V_w(b,y)\right\}-V_u(b,y)\right) \\
&+\varepsilon\alpha_{-y}\left(max\left\{V_w(-b,-y)-\overline{C},V_u(b,y)\right\}-V_u(b,y)\right) \\
&+\lambda_B\left(max\left\{V_u(b,-y)-\overline{C},V_u(-b,y)\right\}-V_u(b,y)\right) \\
&+\lambda_Y\left(max\left\{V_u(-b,y)-\overline{C},V_u(b,-y)\right\}-V_u(b,y)\right)
\end{aligned} \tag{2}
$$

The solution of the system given by (1) and (2) allows to obtain the policy rules of the workers. The optimal migration decision is defined as:

$$m_i(b,y,j) = I\left(V_j(-b,-y)-\overline{C} > V_i(b,y)\right)$$

The function $I(\cdot)$ is the indicator function, which is equal to one if condition $V_j(-b,-y)-\overline{C} > V_i(b,y)$ is satisfied.

2.3 Workers' transition rates and flows

Using the optimal migration rule and the Bellman equations, it is possible to compute workers' transitions between employment and unemployment. According to the Bellman equation of the employed worker, a worker becomes unemployed if he receives a separation shock and if, after a preference or a local shock, he migrates. Therefore, the transition rate from employment to unemployment of a worker with preference b and in the location in state y, $eu(b,y)$, is:

$$eu(b,y) = s + \lambda_B m_w(-b,y,u) + \lambda_Y m_w(b,-y,u)$$

Similarly, from the Bellman equation of the unemployed worker, one can calculate the transition rate to employment of an unemployed worker with preference b and in the location in state y, $ue(b,y)$:

$$ue(b,y) = \alpha_y(1-m_w(b,y,u)) + \varepsilon\alpha_{-y}m_u(b,y,w)$$

On the other hand, in order to know the transition rates between different employment status at the aggregate and at the local level, it is necessary to calculate the distribution of workers. This implies computing the flow of workers between different states. Let $n_t(b,c,e)$ be the measure at time t of a worker with preference b who lives in location c and with employment status e. Equations (3) and (4) state the flows from and into $n_t(b,c,w)$ and $n_t(b,c,u)$ when there is no local shock with the state in location c at time t denoted by y.

The first three lines in equation (3) contain the inflow of workers to $n_t(b,c,w)$. This flow comes both from workers that are employed and unemployed. The unemployed workers that become employed at c with preference b are those who already live in c and have preference b and find a local job, $\alpha_y(1-m_w(b,y,u))\,n_t(b,c,u)$, and those that live in $-c$ have preference $-b$ for their location and find a non-local job, $\varepsilon\alpha_y m_u(-b,-y,w)\,n_t(-b,-c,u)$. For the case of the employed, the flow is composed of those workers who worked in $-c$ had preference $-b$ for their location and migrate to work in c, $\varepsilon\alpha_y m_w(-b,-y,w)\,n_t(-b,-c,w)$, and those that already worked in c, had preference $-b$ and their preference changes into b, $\lambda_B(1-m_w(b,y,u))\,n_t(-b,c,w)$.

$$\begin{aligned}
&\dot{n_t}(b,c,w)=\alpha_y(1-m_w(b,y,u))\,n_t(b,c,u)\\
&+\varepsilon\alpha_y m_u(-b,-y,w)\,n_t(-b,-c,u)\\
&+\varepsilon\alpha_y m_w(-b,-y,w)\,n_t(-b,-c,w)+\lambda_B(1-m_w(b,y,u))\,n_t(-b,c,w)\\
&-(s+\lambda_B+\varepsilon\alpha_{-y}m_w(b,y,w))\,n_t(b,c,w)
\end{aligned} \tag{3}$$

The forth line in (3) contains the outflow from $n_t(b,c,w)$. The outflow rate is composed of the workers who receive a non-local offer and accept and of the workers that receive a separation shock or a preference shock. These last two terms do not depend on the migration rule of the worker since they bring about a change of state irrespectively of his behaviour.

$$\begin{aligned}
&\dot{n_t}(b,c,u)=\lambda_B m_w(-b,-y,u)\,n_t(b,-c,w)\\
&+s(1-m_u(b,y,u))\,n_t(b,c,w)+s m_u(-b,-y,u)\,n_t(-b,-c,w)\\
&+\alpha_y m_w(-b,-y,u)\,n_t(-b,-c,u)\\
&+\lambda_B m_u(-b,-y,u)\,n_t(b,-c,u)+\lambda_B(1-m_u(b,y,u))\,n_t(-b,c,u)\\
&-(\alpha_y+\varepsilon\alpha_{-y}m_u(b,y,w)+\lambda_B)\,n_t(b,c,u)
\end{aligned} \tag{4}$$

The evolution of $n_t(b,c,u)$ is calculated in a similar way as for the employed and is given in equation (4).

3 Relationship between the migration costs and the employment decisions

In this section I study the effect of the migration cost on the labour decisions of the workers. In order to make the analysis simpler, I consider the case in which the two locations have the same wage and the same arrival of job offers, $w_h = w_l$ and $\alpha_h = \alpha_l = \alpha$, and there are no local shocks, $\lambda_Y = 0$. The wage is normalised to 1. These simplifying assumptions are reasonable for an economy whose regions have a low degree of heterogeneity and allow to analyse the role of the preference for the current location, b.

Workers' labour decisions are given by the migration rules included in $ue\,(b, y)$ and $eu\,(b, y)$. The transition rate from unemployment to employment, $ue\,(b, y)$, depends on the migration rules $m_w\,(b, y, u)$ and $m_u\,(b, y, w)$. On the other hand, the transition rate from employment to unemployment, $eu\,(b, y)$, depends only on $m_w\,(b, y, u)$. As the problem is the same in the location in state h and in the location in state l, I omit variable y in this section. Proposition 1 focuses on $m_w\,(b, u)$, present both in $ue\,(b)$ and $eu\,(b)$. It states that, if the worker lives in his preferred location, that is, if $b = 1$, the value of remaining employed in his location is higher than the value of migrating and becoming unemployed, $m_w\,(b, u) = 0$. However, if the worker does not live in his preferred location, this will be true only if the migration cost is greater or equal to threshold R_s.

Proposition 1. $m_w\,(b, u) = 1$ *if and only if* $\overline{C} < R_s$ *and* $b = 0$. R_s *is positive when* $\bar{b} > \frac{r+2\lambda_B+\alpha\varepsilon+s}{\alpha+r+\lambda_B+s}\,(1-z)$.

Proof. See Appendix. □

This result determines the transition rate to unemployment, $eu\,(b)$. As $\lambda_Y = 0$, there are only two reasons for a worker to become unemployed, either he receives a separation shock or he is hit by a preference shock and quits. Proposition 1 implies a worker only quits his job if $\bar{b}$ is sufficiently large, he receives a preference shock that turns his preferences into $b = 0$ and his migration cost is low enough. In this case, $eu\,(b = 1) = s + \lambda_B$.

In principle, the migration rule $m_w\,(b, u)$ can also affect the transition rate from unemployment to employment. This is because I have assumed that a worker can decide to migrate when hit by any kind of shock, which includes the case of an unemployed worker that receives a local offer. According to Proposition 1, the worker never migrates if he lives in his preferred location, $b = 1$, since $m_w(1, u) = 0$ always. Therefore, consider an unemployed worker with preference $b = 0$. If $m_w(0, u) = 1$ and the worker receives a local offer, he rejects and migrates. This does not seem realistic. In fact, if we consider the distribution of workers that the model generates in steady state, this situation will not arise in the model, either. The rule $m_w(0, u) = 1$ requires $V_u(b = 1) - \overline{C} > V_w(b = 0)$, which implies that the optimal migration policies are such that the inflow of workers to $n_t(0, c, u)$ is 0 whereas the outflow rate is positive. Therefore, if we consider the steady state of this economy, with the distribution of workers $n^*(b, c, u)$ and $n^*(b, c, w)$ given by the conditions $\dot{n_t}(b, c, w) = 0$ and $\dot{n_t}(b, c, u) = 0$, we will have that $m_w(0, u) = 1$ implies $n^*(0, c, u) = 0$ for any c. Thus, for any b such that in steady state $n^*(b, c, e) > 0$, a local offer is always accepted.

The other migration rule included in $ue(b, y)$, $m_u(b, w)$, refers to the decision of an unemployed worker that receives a non-local offer. Proposition 2 establishes that a worker accepts a non-local offer provided that the migration cost is below threshold $R_{fo}(b)$.

Proposition 2. *Assume* $\lambda_B < \frac{2\alpha+2s+r}{4}$. *Then* $m_u(b, w) = 1$ *if and only if* $\overline{C} < R_{fo}(b)$. $R_{fo}(b)$ *satisfies* $R_{fo}(1) < R_{fo}(0)$ *and* $R_{fo}(0) > 0$ *always.*

Proof. See Appendix. □

The result depends on the restriction $\lambda_B < \frac{2\alpha+2s+r}{4}$. If $s = 0.0286$, $r = 0.004$ and $\alpha = 0.44$ (which are the values used in the calibration of the model for s, r and α_l), then $\frac{2\alpha+2s+r}{4} = 0.235$. However, the calibrated value for λ_B is 0.011. Therefore, the restriction assumed is consistent with the data.

Proposition 2 determines the transition rate from unemployment to employment, $ue(b)$, for any b with $n^*(b, c, e) > 0$. Since in this case local offers are always accepted, the proposition implies that $ue(b) = (1 + \varepsilon)\alpha$ when the migration cost is below threshold $R_{fo}(b)$ and $ue(b) = \alpha$ otherwise.

We can compare now the transition rates of two workers, a renter and a home-owner, that only differ in their migration costs. Let the cost be zero for the renter and $\overline{C}_o > 0$ for the home-owner. The results in this section imply that the renter's transition rate from employment to unemployment is greater or equal to the home-owner's rate. Furthermore, it is strictly greater if the workers live in their preferred location ($b = 1$), $\bar{b} > \frac{r+2\lambda_B+\alpha\varepsilon+s}{\alpha+r+\lambda_B+s}(1 - z)$ and $\overline{C}_o \geq R_s$. In this case, the home-owner's transition rate to unemployment is s, whereas an employed renter becomes unemployed at rate $s+\lambda_B$. On the other hand, the model implies that, for any b with $n^*(b,c,e) > 0$, the home-owner's transition rate from unemployment to employment is lower or equal to the renter's one, with strict inequality if $0 < R_{fo}(b) \leq \overline{C}_o$.

The next question is how the transition rates of home-owners and renters compare between each other without conditioning for preferences. Notice that an employed renter can have a lower transition rate to unemployment than a home-owner if the renter lives in his preferred location and the home-owner does not. This will be the case if $\overline{C}_o \geq R_s$. Similarly, if an unemployed renter lives in his preferred location and an unemployed home-owner does not, the home-owner's rate to employment can be greater than the renter's one. In particular, if $R_{fo}(1) < 0$ and $\overline{C}_o < R_{fo}(0)$. The unconditional transition rates depend on the distribution of workers with different preferences. In the following section I compute numerically the distribution of workers for the calibrated model and derive the unconditional transition rates of home-owners and renters.

4 Home-ownership, migration and unemployment

In this section I study numerically the role of migration costs on unemployment and migration for the version of the model presented in Section 2. I simulate the model with the parameters calibrated to the US economy for the period 1996-2013. A time period is one month. Following Shimer (2005), I set $r = 0.004$.

Migration costs and wages are taken directly from the data. The wage in the location in state h, w_h, is normalised to 1. In order to obtain w_l, I need a measure of $\frac{w_l}{w_h}$. To obtain this ratio, I use the micro data on nominal weekly earnings from the IPUMS-CPS (King et al.,2010) and deflate it with the local CPI from Moretti (2013)[7]. The local CPI corresponds to the year 2000 so the nominal weekly earnings are also from that year. Since a location in the data should correspond to a labour market, I compute the median real wage by metropolitan statistical area (MSA). In addition, for those workers who do not live in a MSA I compute the median real wage by state. The CPI used has the same geographical level of aggregation. Therefore, deflating the nominal earnings by this indicator allows to measure the differences in the real wage across locations. The data provides with the real wage of 271 locations: 222 MSA and 49 states (for the areas that are not MSA). However, in the model there are only two locations, h and l

[7] Moretti (2013) elaborates two CPI indexes, I use the local CPI 1.

with $w_l \leq w_h$. I group the data into two locations by classifying the workers that live in a MSA/state with a median real wage below the aggregate as living in the location in state l and the remaining as living in the location in state h. Having all workers classified as living in one of the two locations, I just compute the median real wage for the workers in each of these two groups. The ratio is 0.85. Therefore, I set $w_l = 0.85$. With respect to the unemployment income, it is common in the literature to set it equal to 40% of the wage, as in Shimer (2005). I set it to 40% of the average of w_h and w_l, therefore $z = 0.37$.

For the migration costs, I consider that $\overline{C}_o$ are the home-owners transaction costs of selling and buying a house. Gruber and Martin (2003), with data of the Consumption Expenditure Survey (CEX), report that these amount to 9.5% of the value of home-owners houses. In order to obtain the median value of a home-owner house I use the American Housing Survey, that provides this value as a proportion of annual income, with income defined as the income a household receives when the members are employed. I use the surveys from 1997 to 2013, and obtain that the median value of an owner-occupied house is 33 of the monthly income. Therefore, I set $\overline{C}_o = 3.14$ and $\overline{C}_r = 0$.

There are some parameters in the model that do not have a direct counterpart in the data and must be calibrated. These are the preference parameter ($\bar{b}$), the Poisson parameters for the different type of shocks (λ_B, λ_Y, s, α_h, α_l) and the parameter for non-local offers (ε). To find the value of these parameters I use several targets related to the labour market and the migration behaviour of workers.

With respect to the labour market, I include the average unemployment rate and the average transition rate from unemployment to employment (the last target will be denoted as UE). This is standard in the calibration of search models. I calculate both targets from the IPUMS-CPS for the period 1996-2013. The average unemployment rate was 6.1%. The UE is obtained using Shimer (2012) formulation and I find it was 50%. For the differences between the labour market in h and l, I target the ratio of the average unemployment rate in l to the average unemployment rate in h to 1.17 and the ratio of the average UE in l to the average UE in h to 0.88. These values are obtained from the IPUMS-CPS of 2000 using the same classification for h and l as in the calculation of the ratio of wages. Therefore, the model is calibrated so that the location with the higher wage is the one with the higher UE and the lower unemployment rate.

The data on migration is taken from the March Supplement of the CPS. The migration rate used is the annual inter-county migration rate of the population in the labour force. During this period it was 3% for home-owners and 11% for renters. Finally, since 1999 the March Supplement of the CPS includes information about the reasons behind migration. After restricting the sample to the population in the labour force, I find that between 1999 and 2013 the proportion of inter-county migration due to work-related reasons was 36%. Work-related reasons include a new job, a job transfer, a lost job, to look for work and to be closer to work, among others. The remaining 64% was due to housing-related, family-related or other reasons. In the model, I classify all moves either as work-related or non-work related. The migration that arises after receiving a job offer, a separation shock or a local shock is classified as work-related and the migration that arises after a preference shock is classified as non-work-related.

I simulate the arrival time of the Poisson local shocks for a period of 20.000 months. After obtaining the optimal migration rules from (1) and (2) I substitute them into (3) and (4) to compute the evolution of $n_t(b, c, e)$. At time 0, I start with an initial distribution where the proportion of home-owners is 70%. This is the average home-ownership rate of the population in the labour force during the period 1996-2013 according to the March Supplement of the CPS. I also assume that 50% of home-owners and renters prefer location 1 and the other half location 2. Equations (3) and (4) determine the evolution of $n_t(b, c, e)$ until a local shock arrives. Assume that at time t_0 the economy is hit by a local shock and that the measure of workers according to (3) and (4) at t_0 is $n'_{t_0}(b, c, e)$. Let the state in location c after the local shock be y. Then:

$$\begin{aligned} n_{t_0}(b, c, w) &= (1 - m_w(b, y, u))\, n'_{t_0}(b, c, w) \\ n_{t_0}(b, c, u) &= (1 - m_u(b, y, u))\, n'_{t_0}(b, c, u) \\ &\quad + m_w(-b, -y, u)\, n'_{t_0}(-b, -c, w) + m_u(-b, -y, u)\, n'_{t_0}(-b, -c, w) \end{aligned} \tag{5}$$

From t_0 and until the arrival of the following local shock the measure of workers is given again by (3) and (4). At the end of each month, I record the measure of workers and the migration flow of workers during the month. I also compute the mean unemployment rate and job finding rate during the month for each location and for the aggregate economy.

Table 1 reproduces the calibration targets and their values from the model. The model matches the targets very well. The value of the parameters are $\bar{b} = 0.26$, $s = 0.029$, $\alpha_h = 0.51$, $\alpha_l = 0.440$ and $\varepsilon = 0.025$, $\lambda_B = 0.011$ and $\lambda_Y = 0.004$. The value of λ_B implies that the expected time between two preference shocks is 8 years. With respect to the occurrence of local shocks, the parameter λ_Y implies that the expected time between two local shocks is 21 years.

Table 1: Calibration targets

	Data	Model
unemployment rate	6.1%	6.1%
job finding rate	50%	50%
unemployment rate l to h	117%	117%
job finding rate l to h	88%	88%
annual renters' migration rate	11%	11%
annual owners' migration rate	3%	3%
non-work migration to total	64%	61%

Using the monthly data on $n_t(b, c, e)$ generated by the calibrated model, I calculate the unemployment and transition rates of renters and home-owners. These rates are reported in Table 2. I find that renters' unemployment rate is 8% higher than home-owners'. This is consistent with the empirical data. With the 1990 Census supplement of the CPS, Coulson and Fisher (2009) estimated that the home-owners' probability of being unemployed is lower than for renters. Moreover, the model also provides with the transitions of these two groups of workers. Renters have a lower UE and a higher transition rate from employment to unemployment (EU) than home-owners. Therefore, both transitions contribute to renters having a higher unemployment rate. They depend on the policies of the workers in h and l and on the distribution of the population across locations. I focus first on the policies and transitions in each state of a location. The EU in a location that is in state $y \in \{h, l\}$ is calculated as the weighted average across b of $eu(b, y)$ with the weights given by the proportion of workers in the location in state y who have preference b. The UE can be computed in the same way using $ue(b, y)$. These rates depend on the migration policies of the workers. The optimal migration policies of the calibrated model can be found in Table 4 and 5 in the Appendix.

Columns 3 and 4 of Table 2 contain the transition rates of home-owners and renters when they live in the location in state h. Their transition rate from unemployment to employment is the same. In this case, all unemployed workers accept a local offer, and none accepts a non-local offer (from the location in state l), so their UE equals α_h. On the other hand, the home-owners' EU in h is higher than the corresponding one for renters. This is because the transition rate $eu(b, y = h)$ differs with the preference for the location. If $b = 1$, both for the case of a renter and of a home-owner, the migration rules $m_w(0,h,u)$ and $m_w(1,l,u)$ are 0, which implies that $eu(1,h) = s$. Therefore, the worker in this situation only becomes unemployed when hit by a separation shock. On the other hand, if $b = 0$, the migration rule $m_w(1,h,u) = 0$ and $m_w(0,l,u) = 1$ imply that $eu(0,h) = s + \lambda_Y$. Therefore, the worker in this situation becomes unemployed when hit by a separation shock or a local shock. Again, this is true both for a renter and a home-owner. Hence, employed renters and home-owners that have the same preferences and live in h have the same transition rate from employment to unemployment. However, employed home-owners have a higher EU in the location in state h because the proportion with $b = 0$ is higher. As it can be seen in Table 3, on average, 36% of home-owners are employed, live in the location in state h, but their preferred location is the location in state l. They represent 43% of the employed home-owners who live in h. This is only 17% for the case of renters.

Table 2: Unemployment and transition rates in the model

	Whole economy		High location		Low location	
	Renters	Home-owners	Renters	Home-owners	Renters	Home-owners
unemployment rate	6.4%	5.9%	5.8%	6.1%	7.5%	6.1%
UE	48.3%	50.1%	51.0%	51.0%	45.2%	44.0%
- non-local job offer	0.6%	0.0%	0.0%	0.0%	1.3%	0.0%
- local job offer	47.7%	50.1%	51.0%	51.0%	44.0%	44.0%
EU	3.3%	3.1%	2.9%	3.0%	3.9%	3.9%

Columns 5 and 6 of Table 2 contain the transition rates of home-owners and renters when they live in the location in state l. This is the preferred location for all the workers who live in it. Therefore, the only policies that matter are the policies of a home-owner and a renter that lives in the location in state l with $b = 1$. The EU for home-owners and renters is the same. Since $m_w(1,l,u) = 1$ and $m_w(0,h,u) = 0$, the EU equals $eu(1,l) = s + \lambda_B$. Hence, both type of workers become unemployed when hit by a separation shock or a preference shock. With respect to the UE in l, home-owners only accept local job offers, whereas renters also accept the non-local ones. This implies that the UE in l is 2.7% higher for renters than for home-owners.

Summarizing, in a given location, renters' UE is either higher or equal to home-owners' rate. However, in the whole economy, the UE of renters is lower than the UE of home-owners. This can be explained by the distribution of the unemployed across locations. Whereas 86% of unemployed home-owners live in the high location, where the UE is higher, only 53% of renters do. The same argument applies to the EU. In each location, home-owners' EU is either higher or equal to the renters' one. However, at the aggregate level they become unemployed at a lower rate than renters. Again, this is because employed home-owners are more concentrated in the high location, with low EU.

Table 3: Distribution of home-owners and renters in the model*

	Renters		Home-owners	
	h	l	h	l
Employed	56.4	37.2	82.4	11.8
- in preferred location	46.6	37.2	46.9	11.8
- not in preferred location	9.8	0	35.5	0
Unemployed	3.4	3.0	5.1	0.8
- in preferred location	3.4	3.0	3.1	0.8
- not in preferred location	0	0	2.0	0
Total	59.8	40.2	87.5	12.5

*Percentages over total renters and total home-owners, respectively.

The difference in the distribution of home-owners and renters across locations with a given state also affects their local unemployment rates. Home-owners have very similar unemployment rates under both state h and l. It is curious that home-owners' unemployment rate in the whole economy is lower than the rate conditional on the state of the location. But one must take into account that when a local shock hits the economy, a proportion of the employed workers quit their jobs and migrate to the location whose state turns to h. These workers arrive to the location as unemployed, increasing the unemployment rate there above the unemployment rate in the location in state l. Therefore, for some time after a local shock hits the economy, the unemployment rate in h is higher than in l. Using the monthly data recorded from the model, I find that home-owners' unemployment rate in the location in state h the periods in which it is higher than in the location in state l is 9.3%, on average. In those periods, home-owners' unemployment rate in l is 6.1% on average. On the other hand, the proportion of home-owners who live in the location in state h in those periods is 61%. If these numbers were constant, it would mean that home-owners' unemployment rate in the whole economy would be $0.61 \cdot 0.093 + 0.39 \cdot 0.061 = 0.081$. When home-owners' unemployment rate in h is lower than in l, the rates are 5.5% and 6.1% respectively, and the proportion of home-owners in h is 92%. Making the same assumption we would find that the aggregate unemployment rate is $0.92 \cdot 0.055 + 0.08 \cdot 0.061 = 0.055$. This last situation takes place 84% of the periods. Therefore, on average, the aggregate unemployment rate would be $0.84 \cdot 0.055+0.16 \cdot 0.081=0.059$. The same number as in Table 2. On the other hand, the unemployment rate in h would be given by $0.84 \cdot 0.055+0.16 \cdot 0.093=0.061$ and in l it would be $0.84 \cdot 0.061+0.16 \cdot 0.061=0.061$. This shows that the lower unemployment rate of home-owners at the aggregate level with respect to the local rates is due to the lower proportion of home-owners in h when the unemployment rate there is high.

The model generates that renters' unemployment rate in l is 29% higher than in h while the difference is 0 for the case of the home-owners. This implies greater inequality in the unemployment rate across location for renters than for home-owners. The data is consistent with this finding. The ratio of the unemployment rate in l to the unemployment rate in h was 1.16 for the renters and 1.10 for the home-owners during the period 1996-2013. The time period used to obtain these numbers is not the same as the one used to obtain the calibration target of 1.17 for the whole population[8]. However, it shows that the model has the same qualitative feature as in the data: the ratio is higher for the renters than for the home-owners.

Computing the degree of inequality across MSAs also provides with this result. I find that the interquartile range[9] was 0.019 for the home-owners and 0.046 for the renters, on average during the period. On the other hand, I obtain a coefficient of variation of 0.298 and 0.350, respectively. Computing these indicators for more homogenenous groups of workers give similar results. Restricting on workers with an age between 35 and 59, I find that both home-owners and renters without high school degree have a coefficient of variation of 0.75. However, the coefficient for the home-owners with this degree is higher than for renters: 0.43 versus 0.54. The difference among both groups of workers is even greater for those with college degree: 0.55 versus 0.98.

To study renters' (or home-owners) local unemployment rates, it is useful to focus on the periods in which renters' (home-owners') unemployment rate in h is lower than in l. In this way, the periods removed are the ones that take place just after a local shock hits the economy. I find that renters' unemployment rate in h is lower than in l 96% of

[8]The CPS only includes the housing tenure of workers for the month of March. Therefore, instead of calculating the average for all months of 2000, the ratios by housing tenure have been calculated as the average of March 1996-2013. In this later case, the classification of the locations as h or l is based on the median nominal earnings.

[9]To calculate the interquartile range and the coefficient of variation I use the unemployment rates at the MSA level plus the unemployment rates at the state level of those workers who do not live in a MSA. I only include those MSA/states with a labour force above 500000. For the case of the states, the labour force refers to the labour force not in a MSA. Since the number of observations at this geographical unit is small, the dispersion mesures are computed on the average unemployment rates of 3 years. Then I take the average of the values obtained for the periods 1996-1998, 1999-2001, 2002-2004, 2005-2007, 2008-2010 and 2011-2013.

the periods. For home-owners this happens 84% of the periods. Using this restriction, renters' average unemployment rate is 5.6% in h and 7.5% in l whereas home-owners' unemployment rate is 5.5% in h and 6.1% in l. The difference with the unemployment rates when the average is taken across all periods is that now the unemployment rate in h is lower, both for renters and home-owners. However, concentrating on these periods keeps the pattern of greater inequality in renters' local unemployment rates and I can use the fact that the distribution of renters across states is quite stable in those periods. To use the distribution first it is necessary to extend the notation used in Section 2 to include housing tenure. The measure $n_t(b, y, e)$ now becomes $n_t(b, y, e, q)$ with $q \in \{r, o\}$, r standing for renter and o standing for home-owner. Then, the measure of workers in the location y, with employment status e and housing tenure q is given by $\widetilde{n}_t(y, e, q) = n_t(1, y, e, q) + n_t(0, y, e, q)$. I find that the coefficient of variation of $\widetilde{n}_t(l, w, r)$ is 0.03. For $\widetilde{n}_t(l, u, r)$, $\widetilde{n}_t(h, w, r)$ and $\widetilde{n}_t(h, u, r)$, it is even smaller. This allows to compute the population of employed and unemployed renters in l and h using the assumption that $\dot{\widetilde{n}}_t(y, e, q) = 0$. Since $\dot{\widetilde{n}}_t(y, e, q)$ is given by:

$$\dot{\widetilde{n}}_t(y, e, q) = (inflow\, to\, \widetilde{n}_t(y, e, q)) - (outflow\, rate\, from\, \widetilde{n}_t(y, e, q))\, \widetilde{n}_t(y, e, q)$$

This assumption implies that:

$$\widetilde{n}_t(y, e, q) = \frac{inflow\, to\, \widetilde{n}_t(y, e, q)}{outflow\, rate\, from\, \widetilde{n}_t(y, e, q)}$$

In fact, it is possible to derive renters' distribution in steady state assuming no local shocks (but keeping the calibrated optimal migration rules with local shocks) as a function of the parameters of the model. However, the expressions that arise are too complicated for analysing them. It is more useful to compute the flows numerically, taking the average over the periods in which renters' unemployment rate in h is lower. The unemployment rate in the location in state y will be given by:

$$\frac{1}{1 + \frac{\widetilde{n}_t(y,w,q)}{\widetilde{n}_t(y,u,q)}} = \frac{1}{1 + \frac{inflow\, to\, \widetilde{n}_t(y,w,q)}{inflow\, to\, \widetilde{n}_t(y,u,q)} \frac{outflow\, rate\, from\, \widetilde{n}_t(y,u,q)}{outflow\, rate\, from\, \widetilde{n}_t(y,w,q)}} \tag{6}$$

Therefore, renters' unemployment rate in the location in state y depends on the relative size of the inflows to employment and unemployment in such a type of location, $\frac{inflow\, to\, \widetilde{n}_t(y,w,r)}{inflow\, to\, \widetilde{n}_t(y,u,r)}$, and the relative size of the corresponding outflow rates from unemployment and employment, $\frac{outflow\, rate\, from\, \widetilde{n}_t(y,u,r)}{outflow\, rate\, from\, \widetilde{n}_t(y,w,r)}$. I find that renters' inflow to l is 0.00426 in the case of the employed and 0.00414 in the case of the unemployed. The ratio is

1.029. On the other hand, renters' inflow to h is 0.00527 in the case of the employed and 0.00526 in the case of the unemployed. Both inflows to h are larger than the inflows to l. However, the ratio is lower, 1.002, which leads to a larger unemployment rate in h. If we turn to the outflow rates, the ratio is 11.835 for the outflows from l and 17.049 for the outflows from h. Therefore, the pattern of the outflow rates imply a smaller unemployment rate in h. Computing renters' unemployment rates in h and l using this procedure I obtain that the unemployment rate is 5.5% in h and 7.6% in l. These values are close to the 5.6% in h and 7.5% in l that had been computed directly. The computation of the unemployment rate using 6 implies that the differences in unemployment rates are due to the outflow rates. On one hand, the outflow rate from unemployment is $\alpha_h + \lambda_B$ in h and $\alpha_l + \varepsilon\alpha_h + \lambda_B$ in l. Hence, it is larger in h although unemployed renters in l accept non-local offers. On the other hand, the outflow rate from employment is $s + \varepsilon\alpha_l \frac{\widetilde{n}_t(0,h,w,r)}{\widetilde{n}_t(h,w,r)}$ in h and $s + \lambda_B$ in l. It is larger in l since the workers who receive a preference shock there migrate.

With respect to the home-owners, I find that the coefficient of variation of $\widetilde{n}_t\,(h,w,o)$ is 0.09 and $\widetilde{n}_t\,(h,u,o)$ is 0.06. Using (6), home-owners unemployment rate in h is 5.3%, which is close to the 5.5% calculated before. The ratio of the inflows is 0.999 and the ratio of the outflows is 17.832, which is very similar to the renters' case in h. However, the population of home-owners in l is not so stable. I find that the coefficient of variation of $\widetilde{n}_t\,(l,w,o)$ is 1.13 and of $\widetilde{n}_t\,(l,u,o)$ is 1.30. In fact, computing the population distribution in steady state when there are no local shocks I find that the population of home-owners in the l location is 0. However, when the model is simulated, the economy hardly ever reaches this point since another local shock hits the economy before the population of home-owners in one location becomes 0. This feature, together with the higher variation rates of the population, suggests that the computation of the local unemployment rates with the assumption of $\dot{\widetilde{n}}_t\,(l,e,o) = 0$ could give results that are not so close to the actual ones generated by the model. According to (6), home-owners unemployment rate in l is 7.9%, which is far from the 6.1% that the simulation generates. In this last case, the assumption $\dot{\widetilde{n}}_t\,(l,e,o) = 0$ is too strong. Substituting the migration rules and $n_t\,(0,l,u,o) = n_t\,(0,l,w,o) = 0$[10] in (3) and (4), I obtain:

$$\begin{aligned} \dot{\widetilde{n}}_t\,(l,u,o) &= s\widetilde{n}_t\,(l,w,o) - (\alpha_l + \lambda_B)\,\widetilde{n}_t\,(l,u,o) \\ \dot{\widetilde{n}}_t\,(l,w,o) &= \alpha_l\widetilde{n}_t\,(l,u,o) - (s + \lambda_B)\,\widetilde{n}_t\,(l,w,o) \end{aligned} \qquad (7)$$

[10] $n_t\,(0,l,u,o) = n_t\,(0,l,w,o) = 0$ according to Table 3.

If location l had been a closed economy with no migration, the evolution of the unemployed, $\dot{\widetilde{n}}_t(u)$, and the employed, $\dot{\widetilde{n}}_t(w)$, would have been given by $\dot{\widetilde{n}}_t(u) = s\widetilde{n}_t(w) - \alpha_l \widetilde{n}_t(u)$ and $\dot{\widetilde{n}}_t(w) = \alpha_l \widetilde{n}_t(u) - s\widetilde{n}_t(w)$. These equations only differ from (7) in the outflow rate. When home-owners are allowed to migrate they leave location l whenever they receive a preference shock, both if they are employed and unemployed. It is possible to calculate the unemployment rate in l in steady state if it were a closed economy without local shocks. In this case it would be given by the expression $\frac{s}{s+\alpha_l}$. Evaluating this expression gives an unemployment rate of 6.1%. Therefore, home-owners unemployment rate in l equals the rate they would have achieved if l were a closed economy.

Why is renters' unemployment rate in l higher than 6.1%, then? We can apply equation (6) to calculate renters' unemployment rate in l in the case that the l location were a closed economy. Then, the ratio of inflows would be $\frac{inflow\,to\,\widetilde{n}_t(w)}{inflow\,to\,\widetilde{n}_t(u)} = 1$ and the ratio of the outflow rates would be $\frac{outflow\,rate\,from\,\widetilde{n}_t(u)}{outflow\,rate\,from\,\widetilde{n}_t(w)} = \frac{\alpha_l}{s} = 15.386$. As we had seen, this generates an unemployment rate of 6.1%. Comparison with the actual ratios in the model shows that the unemployment rate in the l location is greater than 6.1% because the ratio of the outflows rates, $\frac{outflow\,rate\,from\,\widetilde{n}_t(l,u,r)}{outflow\,rate\,from\,\widetilde{n}_t(l,w,r)} = \frac{\alpha_l+\varepsilon\alpha_h+\lambda_B}{s+\lambda_B} = 11.835$, is smaller. What makes renters unemployment rate in l so high is the migration of workers from the l location generated by the preference shocks.

5 Conclusions

This paper develops a model of job search and migration that allows to study the role of mobility costs in unemployment. Migration has direct effects on the labour situation of workers by triggering quits, allowing the acceptance of new jobs or implying a change in labor income. But it also affects the labour market by relocating the population across space. Moves do not necessarily lead to better labour conditions. Hence, the effect of migration costs depends on the kind of migration they prevent.

The calibrated version of the model generates that home-owners, while incurring higher migration costs than renters, experience less unemployment and a lower inequality in local unemployment rates. The first result can be explained by the different distribution of home-owners and renters across space. Migration costs prevent home-owners from migrating when they live in the location with good job prospects. This implies that they concentrate in this kind of location, which leads them to better labour outcomes. On the other hand, the inequality in renters' local unemployment rates is generated by the relative size of the flows of the employed versus the unemployed.

The results indicate that a model with non-work-related migration and heterogeneous locations delivers a pattern in the unemployment rates of home-owners relative to renters that is qualitatively consistent with the data. Therefore, the model is suitable to be extended for the study of the home-ownership rate at the aggregate level. This would imply the inclusion of the firm side into the labour market and, possibly, externalities in the housing market, as pointed in Blanchflower and Oswald (2013).

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Appendix

Proof to Proposition 1:

The system given by 1 and 2 does not satisfy $V_u(0,y) - \overline{C} > V_w(1,y)$. Therefore, $m_w(1,y,u) = 0$. The condition $V_u(1,y) - \overline{C} > V_w(0,y)$ if and only if $\overline{C} < R_s$ with:

$$R_s = \frac{1}{r+2\lambda_B}\left(\bar{b} - \frac{r+2\lambda_B+\alpha\varepsilon+s}{\alpha+r+\lambda_B+s}(1-z)\right)$$

Proof to Proposition 2:

When $\lambda_B < \frac{2\alpha+2s+r}{4}$, the solution of the system given by 1 and 2 satisfies $V_w(-b,-y) - \overline{C} > V_u(b,y)$ if and only if $\overline{C} < R_{fo}(b)$ with:

$$R_{fo}(1) = \begin{cases} \frac{1}{\phi_3}\left(-(\alpha+r+\lambda_B+s)\bar{b} + (r+2\lambda_B+\alpha\varepsilon+s)(1-z)\right) & if\, \phi_5(1-z) < \bar{b} \\ \frac{1}{(r+2(\lambda_B+\alpha\varepsilon))\phi_2}\left(-\phi_2\bar{b} + \phi_1(1-z)\right) & if\, \frac{\phi_4}{2\phi_2}(1-z) < \bar{b} \leq \phi_5(1-z) \\ \frac{1}{\alpha+r+s}(1-z) - \frac{(\alpha+r+\lambda_B+s)(\alpha(1+\varepsilon)+r+s)}{(\alpha+r+s)\phi_4}\bar{b} & if\, 0 < \bar{b} \leq \frac{\phi_4}{2\phi_2}(1-z) \end{cases}$$

$$R_{fo}(0) = \frac{\bar{b}}{r+2\lambda_B} + \frac{1-z}{\alpha+r+s}$$

and

$\phi_1 = \alpha(r+2\lambda_B) + \alpha^2\varepsilon(1+\varepsilon) + (r+2\lambda_B+2\alpha\varepsilon)(r+2\lambda_B+s)$
$\phi_2 = \alpha^2(1+\varepsilon) + \alpha(2+\varepsilon)(r+\lambda_B+s) + (r+s)(r+2\lambda_B+s)$
$\phi_3 = r^2 + r(\lambda_B+\alpha(1+\varepsilon)+3s) + 2(s+\alpha)(\lambda_B+s+\alpha\varepsilon) - 2\lambda_B^2$
$\phi_4 = (r+2\lambda_B)(r+2\lambda_B+\alpha(1+\varepsilon)+s) + 2\alpha\varepsilon s$
$\phi_5 = \frac{(\alpha\varepsilon(r+2(\lambda_B+\alpha\varepsilon))+\phi_4)}{2\phi_2}$

Table 4: Optimal migration rule of a home-owner in the calibrated model

	$m_w(b,y,w)$		$m_w(b,y,u)$		$m_u(b,y,w)$		$m_u(b,y,u)$	
	$y=h$	$y=l$	$y=h$	$y=l$	$y=h$	$y=l$	$y=h$	$y=l$
$b=1$	0	0	0	0	0	0	0	0
$b=0$	0	1	0	1	0	1	0	1

Table 5: Optimal migration rule of a renter in the calibrated model

	$m_w(b,y,w)$		$m_w(b,y,u)$		$m_u(b,y,w)$		$m_u(b,y,u)$	
	$y=h$	$y=l$	$y=h$	$y=l$	$y=h$	$y=l$	$y=h$	$y=l$
$b=1$	0	0	0	0	0	1	0	0
$b=0$	1	1	0	1	1	1	1	1