A Search Model of Migration & Unemployment

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Abstract

Search models have been used extensively to explain differences in unemployment rates, and are often used to compare labor markets across countries. However, much of what we know about labor markets in developed economies ignores who is moving for what reasons, and is largely limited to within-country studies, despite evidence that migration is increasing over time. I build a theoretical model to follow workers’ employment status and location, and utilize differences in labor market institutions to show that capturing these worker flows across borders is an important aspect of migration and unemployment that has been largely ignored. This sheds light on the considerations workers take when moving and highlights the role labor market structures play in equilibrium unemployment across countries. An application of the model shows that the model is capable of generating large migration flows comparable to between US states, as well as smaller flows as observed between European countries.
1 Introduction

Search models have been used extensively to explain differences in unemployment rates, and are often used to compare structural differences across labor markets. These comparisons, however, ignore significant amounts of migration across national borders. Additionally, much of what we know about labor markets in developed economies at a theoretical level is largely limited to within country studies.

A frequent application of search and matching models is to generate cross-country differences in unemployment rates by calibration of a single-country model to match structural characteristics. These structural differences then result in differences in unemployment rates. Significant differences in labor market conditions across space are indeed present throughout the recent past. As an example, I use the context of US and European labor markets to illustrate a series of stylized facts. Shown in Table 1, unemployment across the US and between European countries varies over time, as measured by the coefficient of variation across states/countries in a given year. Taking the average within-year variation over the last 36 years, the US has much lower differences in unemployment rates across states than is seen across European countries. Importantly, this pattern remains regardless of the subset of time periods or countries chosen, and is not undermined by a core group of European economies (France, Germany, and Italy), or by the euro zone countries.¹

One explanation for this difference in unemployment rates is the structural similarities in labor markets across US states relative to European countries. If labor market characteristics are more similar, we would expect to see more similar labor market outcomes through time. Certainly fewer differences in labor market structures exist within the US than across European countries. During this time, however, European nations saw a dramatic increase

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¹The Schengen countries are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Lichtenstein. EU countries are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom. Euro zone countries are: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.
Table 1: Average Unemployment Variation Over Time

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>2.282</td>
<td>3.137</td>
<td>1.176</td>
<td>2.653</td>
</tr>
<tr>
<td>Schengen</td>
<td>17.578</td>
<td>16.209</td>
<td>15.082</td>
<td>23.186</td>
</tr>
<tr>
<td>EU</td>
<td>21.091</td>
<td>23.741</td>
<td>16.706</td>
<td>22.858</td>
</tr>
<tr>
<td>Euro</td>
<td>20.342</td>
<td>22.669</td>
<td>14.149</td>
<td>25.883</td>
</tr>
<tr>
<td>France, Germany, Italy</td>
<td>22.661</td>
<td>23.386</td>
<td>21.551</td>
<td>22.618</td>
</tr>
</tbody>
</table>

Source: FRED and Eurostat; Values are Within-Year Variation Averaged for the Given Spans

in legislative changes pushing for convergence in labor market policies across national borders. For European Union (EU) countries, in particular, these changes were mandated and implemented quickly. Given that there is only a small decline in the variation in unemployment through time, regulatory unification doesn’t seem to be the only driver of differences in unemployment rates.

A second common explanation for aggregate convergence in unemployment rates is migration. Perfectly mobile labor should work to equalize unemployment rates across space, all else equal. Cross-state migration in the US is higher than across Europe: on average, about 5% of US workers move across a state border each year (Bonin et al. (2008)). Figure 1 shows that in Europe, migration has increased over time in terms of both total numbers moving, and the percentage of the population for Schengen Agreement countries. Migration in the Schengen area goes from almost zero prior to 1998, to almost 1% of the population each year by 2015. The upward trend is reversed briefly during the financial and euro zone crises, but resumes following the resolution of the Greek debt crisis in 2010.

Despite the increased labor mobility across Europe since the late 20th century, unemployment variation persists. A small decline in unemployment variation can be seen in Table 1 as migration flows increased for the years following the Schengen Agreement in 1995 until the global financial crisis. There is a relationship between migration and unemployment rate variation as evidenced by relatively high-migration, low unemployment variation in the US and low migration, high unemployment variation in Europe. The lack of cross-border labor

\[2\] The Schengen Agreement opened up European countries to visa-free movement of labor for all member citizens, and eliminated almost all legal barriers to movement across much of Europe. A similar, more exaggerated pattern is evident for EU and euro zone countries shown in Appendix B Figures 17 and 18.
mobility in theoretical search and matching models limits understanding of labor market conditions in an increasingly globalized economy. Coupled with remaining differences in labor market characteristics like productivity, unemployment benefits, and labor market flexibility, migration in the context of search and matching provides an avenue for further analysis. There are also public policy implications from outlining factors to encourage (or discourage) migration, and potentially lower unemployment rates.

For this reason, I build a theoretical model that embeds the relationship between migration, unemployment, and labor market structures. This paper embeds both the ability and decision to migrate in the classical Diamond, Mortensen, and Pissarides search model of unemployment. I utilize differences in labor market institutions across countries to show that capturing the subsequent worker flows across borders is an important aspect of migration and unemployment that has been overlooked. The tradeoffs workers face in the search and migration decision in turn generate migration flows and unemployment rate differences across space in equilibrium. General equilibrium impacts of potential differences in labor market structures from migration on worker allocations and employment are also captured using this framework.
The contribution of this paper is to join the study of unemployment, migration incentives, and wage dispersion by providing a framework to evaluate competing empirical estimations. Additionally, the search and migration framework here is ideally suited to simultaneously examine the sending and receiving country outcomes while separating out general equilibrium employment and wage effects on both natives and migrants. Existing search and matching literature is limited in the scope of analysis of the role of migration, and focuses largely on intra-country migration across regions within a single country. This work is unable to evaluate the role of structural differences across labor markets in catalyzing or diminishing the equalizing unemployment rates across space, and is limited in its ability to address the importance of real and/or perceived barriers to movement. Migration literature on the other hand, focuses on the expected value of a job, the effects on wages of natives and migrants, or the selection of a particular type of migrant. This thread of the literature lacks a unified framework to address the probability and value of a particular match occurring, the wage dispersion effects in the origin and destination countries, and the general equilibrium effects of migration on firm and worker incentives in the presence of frictions. This paper seeks to fill this void in our understanding of the relationship between migration and unemployment at the national level.

In the theoretical model presented here I emphasize the role that even small differences in labor market structures like productivity, job posting and maintenance costs to firms, unemployment benefits, and workers’ bargaining power play in determining variation in unemployment across countries. Workers face a tradeoff in searching; they are faced with a combination of the expected value of a job and the probability of matching with that job. These characteristics are inversely related: a high value job receives more interest from all workers, lowering the probability any given worker matches with that job. Workers do not internalize this externality when making search decisions. This is a key feature of this model, and search and matching models more generally.

Using a competitive equilibrium characterization and a planner’s problem, I distinguish between market outcomes and the first-best outcome to compare model predictions. I also provide an example of parameterizations of the model to match a high-migration, low unem-
ployment variation equilibrium and a low-migration, high unemployment variation equilibrium to demonstrate the model’s predictive powers qualitatively.

I find that productivity and unemployment benefit differentials can be more important in driving the differences in labor market conditions than previous work has found.\(^3\) One reason I observe a larger impact is the ability to observe each workers’ movements where other models focus only on market tightness, which changes differently from unemployment and worker allocation across countries. There are also large differences in which workers are impacted from structural differences in terms of the impact on migrant and native unemployment rates and wages. For this reason I pay particular attention to population distribution and unemployment across countries in addition to the standard emphasis on market tightness.

The study of migration follows a long line of research ranging from factor allocation models of trade to geographic gravity models and networks. A large focus of theoretical models has been on expected income, wages, or amenities in determining workers’ movements. For examples, see Harris and Todaro (1970), Becker (1974), and Greenwood (1985). Much of this research has emphasized the influence of expected wages on migration, but I am unaware of any that utilizes labor market differences to explore unemployment in the context of labor migration between two countries.

Utilizing the search framework in the context of labor migration enables the study of cross-border labor market differences, and the impacts of an increasingly mobile labor force. A theoretical model that allows for many differences between labor markets is an important part of understanding differences in labor market conditions, particularly when conditions might be expected to be more similar. A first step for this analysis has been to document and explain migration within-countries. Single-market matching can work fairly well to empirically predict within-country unemployment variation (Epstein (2012), Postel-Vinay and Robin (2002)), but European models focusing primarily on within-country and between-country comparisons miss the millions of EU citizens moving across European borders each year.\(^4\)

\(^3\)See Nickell (1997, 2006).
Focusing instead on segmented labor markets, as seen in Albrecht and Vroman (2002) and Blázquez and Jansen (2003) and others, can be helpful as an additional intermediate step between a truly single labor market and a model of multiple countries with migration without the complication that multiple markets entails. Stavrunova (2007), Gautier (2002) and Lazear (1990) analyze the impact of job heterogeneity on labor market outcomes through search externalities and unemployment rates within a single labor market. Lkhagvasuren (2012) utilizes productivity shocks to generate migration between regions in equilibrium, but uses labor market structural parameters to calibrate a model to match US unemployment rates and correlation between unemployment rates across states rather than looking directly at the impacts from changes in those characteristics. Ridder and Berg (2003) and Schmutz and Sidibé (2015) estimate implied labor market search frictions for migration within individual countries, and across cities within a single country, to better understand the matching mechanism at work within countries' labor markets. Additionally, Ortega and Peri (2013) use OECD data to examine the effects of income and immigration policies on migration across OECD countries empirically, without emphasizing other institutional differences across boundaries or employment outcomes. The absence thus far of such a theoretical framework for international migration through labor market search limits our understanding of migrants' decisions, and their impacts on both origin and destination markets.

Search models are also useful to examine the existence of wage dispersion in economies, but have typically relied on either search costs or worker heterogeneity to generate different wages in equilibrium. For example, Gaumont et al. (2005) are able to generate no more than two wages in equilibrium in their models, while Albrecht and Vroman (2002) generates three equilibrium wages in the pooling equilibrium with heterogeneous workers. Existing work is typically limited to generating wages based on either worker or firm heterogeneity.

Empirically, Borjas (1985), Card (1990), Borjas (2003), and Card et al. (2012) captures part of an on-going discussion on the impact of migrants on wages in the receiving countries, but lack a unified theory explaining both disparate wage effects, and migration incentives.5 Empirical studies typically must differentiate across workers’ skills in order to estimate any

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5 For selected others, see Butcher and Card (1991), Gerfin et al. (2010), and Ottaviano and Peri (2012).
effects of migrants on native workers. Migrants are found to have very little impact on native wages as in Card (1990), to pull down native wages in the directly competing native population as in Borjas (2003), or to increase native wages as in Gerfin et al. (2010). Ottaviano and Peri (2012) finds an important nuance to the wage effect on natives such that least skilled natives see wages fall while slightly higher skilled natives see wages rise following a migrant influx. New immigrants also have a negative effect on previous immigrants’ wages.

2 Model

2.1 Model Environment

The model is in continuous time, and all values represent total flow value for the given agent. Both countries share a single time discount factor for agents, $r$, as well as job destruction rate, $\delta$. All workers within a country, regardless of origin and unemployment location, have the same productivity or skill, $y_k$, based upon location of employment, $k$. Jobless benefits, $b_k$, worker bargaining power, $\beta_k$, and costs to posting a vacancy, $c_k$, also vary by country. Differences are determined by the current location of the worker or firm, so a migrant cannot transfer his origin jobless benefit or bargaining power by moving. Migration ability is limited to workers from the foreign country, $F$, and it is costless both to move and to be away from one’s origin country.

Workers can be either employed or unemployed, while firms can have either filled or unfilled vacancies. There is no on-the-job search, and one job is offered by each firm. Firms post a vacancy based on the eventual firm hiring location, independent of the worker origin and unemployment location: They cannot target a particular worker type based on nationality or current location.

Each period, a fixed proportion of matches, $\delta$, is destroyed, and the total unemployment pool begins to search in either the home or foreign market. Next, matches occur with a probability dependent on the number of vacancies offered by firms and the number of workers

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"This is one margin I have not chosen to exploit in examining the margins of the migration decision, but that could easily be incorporated into the framework by making $\delta$ country- or match-specific."
searching in that market. Newly matched workers move, if necessary. Finally production
occurs and unemployment benefits for remaining unemployed workers are collected and wages
paid. The interdependence of the two labor markets through the unemployment pool builds-
in the concept of spillovers in the market tightnesses of each market while maintaining the
externalities imposed by individuals failing to account for their impacts on each market. The
impact of each market on the other through the overlap of market tightness helps to explain
the persistence in differences in unemployment rates observed in the data (See Table 1). All
variables are denoted with a triplet \( i, j, k \) = \( H, F \) so that variable \( X \) is identified: \( X_{ij}^k \),
where \( i \) denotes country of origin, \( j \) gives current location, and \( k \) gives the location of the job
or benefit received.

Matching parameters can vary by worker origin, worker unemployed location, worker
employed location, or remain uniform across countries. The probability of matching is inde-
pendent of search effort, which is costless. The model presented here makes use of the Den
Haan, Ramey, and Watson form of matching.\(^7\)

Matching brings together unemployed workers and open vacancies in the labor market,
and places them randomly into a matched, filled job with an employed worker:

\[
M(u_k, v_k) = m(1, \frac{v_k}{u_k})u_k = q_k(\theta_k)u_k. \tag{1}
\]

Market tightness, \( \theta = v/u \), is defined as the ratio of open vacancies to unemployed workers.
The probability that an unemployed worker in country \( k \) matches with a firm in country \( k \) is
given by \( q_k(\theta_k) \), and the probability that an unfilled vacancy in country \( k \) becomes filled is
given by \( \theta_k q_k(\theta_k) \). Matching is governed by \( Z_k \), the elasticity of matching in the country of
the match:

\[
q_k(\theta_k) = (1 + \theta_k^{Z_k})^{-1/Z_k} \tag{2}
\]

with \( \partial q_i/\partial \theta_i < 0 \) and \( \partial q_i/\partial \theta_j < 0 \). Where, \( i \) indicates the workers’ origin country, \( j \) gives the

\(^7\)The Den Haan, Ramey, and Watson form of matching is chosen in order to utilize the probability limits built
into the functional form without adding an additional parameter to the model as it requires only one rather than
two as in more traditional Cobb-Douglas matching.
workers’ unemployment location, and $k$ indicates the job matching location. Market tightness depends only on firm location, $k$.

Unemployed workers choose where to search, with the flow value of unemployment equal across searching in either country in equilibrium. This value is determined by workers’ country of origin, country of unemployment, and the net value of finding a job in either country:

$$rU_{ij} = b_j + \max_k \{\theta_k q_k(\theta_k)(N_{ij}^k - U_{ij}^k)\}$$  \hspace{1cm} (3)$$

The trade off between job finding rates and the value of that job is seen in the second term. When the value of a job is high, more workers are likely to search in that market, thus offsetting overall value by lowering the job finding rate. These forces off-set one another in equilibrium so that workers become indifferent between markets.

The flow value of employment to the worker, $rN$, is given by the discounted value of the wage less the value of moving into unemployment in that country:

$$rN_{ij}^k = w_{ij}^k + \delta(U_{ik} - N_{ij}^k)$$  \hspace{1cm} (4)$$

Upon loss of employment in country, $k$, workers gain unemployment benefits, $b_k$, and the value of unemployment, but lose the wage. These workers begin search in country $k$, and only move if they are matched in the other country.

Firms choose whether to post a vacancy based on the cost to post as well as the probability weighted value of filling the vacancy and moving into production without differentiating between workers of different location. This gives the flow value of posting a vacancy, $rV$:

$$rV_i = -c_i + \frac{q^i(\theta^i)}{(u_{ii} + u_{ij})}[u_{ii}(J_{ii}^i - V_i) + u_{ij}(J_{ij}^i - V_i)]$$ \hspace{1cm} (5)$$
in country $i$, and

$$rV_j = -c_j + \frac{q^j(\theta^j)}{(u_{ii} + u_{ij} + u_{jj})}[u_{ii}(J_{ii}^j - V_j) + u_{ij}(J_{ij}^j - V_j) + u_{jj}(J_{jj}^j - V_j)]$$ \hspace{1cm} (6)$$
in country $j$. 

The flow value of a filled vacancy, $rJ$, to the firm is again the discounted value of productivity less the cost to posting, the wage payment, and the probability weighted value of the match dissolving:

$$rJ^k_{ij} = y_k - w^k_{ij} - c_k + \delta(V_k - J^k_{ij})$$  \(7\)

Wages are bargained based on production surplus for the type of match, $S$, bargaining power, $\beta$, in job location $k$, and costs to establishing a vacancy, $c$, in location $k$. Bargaining partially captures the large power of labor unions in many countries, and allows differences in outside options to migration to be reflected in wages through unemployment values.

Workers employed in country $k$ always receive share $\beta_k$ of the match surplus, $S^k_{ij}$, where

$$S^k_{ij} = J^k_{ij} + N^k_{ij} - U_{ij} - V^k_{ij}.$$  

Thus wages increase whenever total surplus increases, or when $\beta$ increases (holding the size of the surplus constant):

$$w^k_{ij} = \beta_k S^k_{ij}$$  \(8\)

Firms in country $k$ receive share $(1 - \beta_k)$ of the match surplus: $(1 - \beta_k)S^k_{ij}$.

### 2.2 Equilibrium

The equilibrium concept employed here is a stationary equilibrium which is imposed by setting changes in unemployment and population allocations to zero. This means that in equilibrium, flows between countries off-set one another so that the net migration is zero. Gross migration varies based on the relative probabilities of finding a job and the structural differences of the labor markets. The stationary equilibrium can be characterized in terms of market tightness determined by the labor market bargaining for wages and the free-entry condition for firms, $rV = 0$.

Wages can now be described by labor supply and demand equations as functions of parameters and market tightness. Labor demand, $w^k_{ij} = y_k - c_k - \frac{c_k(r+\delta)}{q_k(\theta_k)}$, gives a negative relationship between wages and market tightness. A larger market tightness, $\theta$, lowers the probability the open vacancy will match with a worker, so the wage required for the firm’s
zero profit condition is lower when $\theta$ is larger. For example, increases in productivity increase labor demand, holding other wages and market tightnesses constant. Labor supply for workers, $w_{ij}^k = \beta_k (y_k - c_k) + (1 - \beta_k) r U_{ij}$ given the appropriate $r U$, gives a positive relationship between wages and market tightness. A larger market tightness increases the probability an unemployed worker meets a vacancy, but also implies a larger value of unemployed workers for firms which increases the eventual wage paid.

The determination of the wages and market tightness for a typical market can be seen by plotting the labor supply and demand schedules as in Figure 2. In the stationary equilibrium, market tightness is determined by the firms’ and workers’ optimization, before accounting for particular migration conditions. The effects of changes in parameters on equilibrium wages and market tightness work through shifts in the labor supply or demand decision, and are shown in the comparative statics below.

Figure 2: Labor Supply and Demand
Market tightness is defined for each country as:

\[ \theta_F = \frac{v_F}{u_{FF} + u_{FH}} \]  
\[ \theta_H = \frac{v_H}{u_{FF} + u_{FH} + u_H} \]  

The market tightnesses depend on overlapping subsets of the unemployment pool. In search and matching models without migration, population is normalized to 1 so that \( v \) and \( u \) are both the vacancy (unemployment) level and rate. Here, migration means that equilibrium populations are not necessarily 1, and so \( v \) and \( u \) reflect the levels only. Figure 3 shows the flows of workers across employment status and migration patterns.

**Figure 3: Worker Flows**

![Flow Diagram](image)
Equality of job creation and destruction at the country-level is given by two conditions. Equation 11 represents the flow out of employment for foreign workers into employment in the foreign country on the left hand side, and the flow out of foreign employment on the right hand side. The left hand side of Equation 11 is represented in Figure 3 by the summation of arrows 1 and 2. The right hand side is represented by arrow 3. Equation 12 equates the flow into and out of employment in the home country. The right hand side of Equation 12 is represented in Figure 3 by the summation of arrows 4, 5, and 6. The right hand side is represented by arrows 7 and 8.

\[
\theta_F q^F(\theta_F)(u_{FF} + u_{FH}) = \delta n_F
\]

\[
\theta_H q^H(\theta_H)(u_{FF} + u_{FH} + u_H) = \delta n_H
\]

The number of migrants into each country must equal the number of migrants out to keep population constant in equilibrium: Equation 13 is represented in the bottom panel of Figure 3 by the equality of arrow 2 and 4.\(^8\)

\[
\theta_F q^F(\theta_F)u_{FH} = \theta_H q^H(\theta_H)u_{FF}
\]

In the remainder of the paper, workers are categorized as either foreign stayers, prior foreign migrants, foreign returning migrants, new migrants, or home workers. A foreign stayer is a foreign national who spent his/her previous unemployment spell in the foreign country, and is subsequently matched in the foreign country. A prior foreign migrant is a foreign native who migrated to the home country prior to his most recent unemployment spell, and subsequently matches in the home country. A returning migrant is a worker who previously migrated to the home country, lost employment, and subsequently matches in the foreign country. A home worker is always employed and unemployed in the home country due to the migration constraint on those workers. Employed workers are characterized as foreign workers, foreign migrant workers, or home workers. Foreign workers are foreign nationals

\(^8\)This does not imply that populations must be equal.
employed in the foreign country. Foreign migrants are foreign nationals employed in the home country. Home workers are home nationals employed in the home country. This is summarized in Table 2.

<table>
<thead>
<tr>
<th>Category</th>
<th>Nationality</th>
<th>Most Recent</th>
<th>Most Recent</th>
<th>Next Employment</th>
<th>Migrating for Employment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Stayer</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>No</td>
</tr>
<tr>
<td>Prior Foreign Migrant</td>
<td>F</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>No</td>
</tr>
<tr>
<td>Foreign Returning Migrant</td>
<td>F</td>
<td>H</td>
<td>H</td>
<td>F</td>
<td>Yes</td>
</tr>
<tr>
<td>New Migrant</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>H</td>
<td>Yes</td>
</tr>
<tr>
<td>Home Worker</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>No</td>
</tr>
</tbody>
</table>

Initial populations in each country are the number of staying employed and unemployed, plus the number who have moved and either remain employed or who have lost employment and are unemployed abroad. Initial populations are given by:

\[
P^F_o = u_{FF} + u_{FH} + n_F + \frac{\theta_H q^H(\theta_H)(u_{FF} + u_{FH})}{\delta}
\]

\[
P^H_o = u_H + \frac{\theta_H q^H(\theta_H)u_{HH}}{\delta}
\]

Given the overlap of the markets, it can be difficult to track workers’ movements and employment status. Workers employed in the home country must be divided into the two origin groups by inference rather than explicitly.

### 2.3 Comparative Statics

The effects on labor market conditions from changes in parameter values filters through the firms’ and workers’ optimization problems. First, parameters determine the equilibrium wage and market tightness. Then, the migration and job creation and destruction conditions determine unemployment and worker allocations. The effect of parameter changes on labor
supply and demand on market tightnesses and wages, and subsequent effects on unemployment and migration are shown in two steps. I separate across labor supply and demand effects on market tightness and wages, evaluate the overall effect, and follow with the impact on unemployment for workers from changes in market tightness.

Increasing productivity or decreasing posting and maintenance costs increases the demand for labor for all types of workers. Specifically, increasing foreign productivity (decreasing posting and maintenance costs) increases demand for all matches in the foreign country, without changing the demand for home workers. Increasing home productivity (decreasing posting and maintenance costs) increases demand for all matches in the home country.

Increasing home productivity or decreasing posting and maintenance costs increases labor supply for all workers except foreign stayers. Increasing foreign productivity or decreasing posting and maintenance costs increases labor supply for all foreign workers except those already in the home country.

Combining the supply and demand effects, increasing foreign productivity or decreasing posting and maintenance costs increases foreign market tightness, but has an indeterminate effect on wages. Increasing home productivity or decreasing posting and maintenance costs increases home tightness and also has an indeterminate effect on wages. Figure 4 shows this effect for the increase in home productivity on the home market on the left. The labor demand shifts from curve A to curve B while the labor supply shifts from curve C to D. Since both supply and demand have increased, the market tightness in the home market unambiguously increases, but the wage effects depend on which curve shifts more. In the figure, I have given the potential outcome where wages do not change, but this is not necessarily the case for any given change in productivity. In the foreign country, when the home productivity increases, only the labor supply increases. Supply moves from B* to C* and labor demand remains unchanged at A*, thus increasing market tightness and wages in the foreign country, shown on the right of Figure 4.
Increasing foreign unemployment benefits increases the supply of foreign stayers only. Increasing home unemployment benefits increases the supply of all workers except foreign stayers who are unaffected.

Increasing foreign unemployment benefits increases foreign market tightness and lowers wages. Increasing home unemployment benefits increases home market tightness and lowers wages.

Changes in bargaining power have a clear effect on foreign stayers, home workers, and prior migrants. New migrants experience indeterminate effects from changes in bargaining power. Increasing foreign bargaining power decreases labor supply for foreign stayers. Increasing home bargaining power decreases labor supply for home workers and prior migrants.

Increasing foreign bargaining power decreases foreign market tightness and increases wages. Increasing home bargaining power decreases home market tightness and increases wages.

Given the changes in market tightness from parameter changes, I now evaluate the changes in unemployment. When foreign productivity or unemployment benefits increase or posting and maintenance costs decrease, unemployment for foreign stayers decreases as long as home market tightness is sufficiently large. Unemployment for foreign migrants decreases and there is no change in unemployment for home workers. When home productivity decreases and there is no change in unemployment for home workers. When home productivity or unemployment benefits increase or maintenance costs decrease, unemployment for foreign stayers and home workers decreases. Unemployment for foreign migrants decreases as long as foreign market tightness is sufficiently large.

When foreign bargaining power increases, unemployment for foreign stayers decreases if
home market tightness is sufficiently large. Unemployment for foreign migrants increases and unemployment for home workers is unaffected. When home bargaining power increases, unemployment for foreign stayers and home workers increases. Unemployment for foreign migrants decreases if foreign market tightness is sufficiently large.

I now turn to a numerical exercise to give a potential result of these changes in parameters across otherwise symmetric countries.

### 2.4 Parameterization

Given the lack of analytical solution for market tightnesses and the indeterminate comparative statics above, a numerical parameterization of the model is performed. Parameters are chosen both for ease of comparability between the market outcome and the planner’s outcome as well as to match data and search and matching literature more generally. In the following exercises, the two countries are given symmetric baseline parameterizations and one parameter in the foreign country is changed to follow the change in stationary equilibrium resulting from that particular asymmetry. This does not describe the transition between the equilibria, but only gives a snapshot of the equilibrium once it has been attained.

The baseline parameterization is chosen for comparability across all specifications of the model. Population, $P_o$, and productivity, $y$, are set to one; matching elasticity, $Z$, is 1.25 to match Petrosky-Nadeau and Zhang (2013); workers’ bargaining power, $\beta$, and unemployment benefits, $b$, are 0.5. Costs to firms to posting vacancies, $c$, are set slightly below the value in Albrecht and Vroman (2002) and Beine et al. (2013) at 0.2, compared with 0.3. The discount rate, $\delta$, is set at 0.05 and the job destruction rate, $r$, at 0.15 to match the literature. A summary can be found in Table 3.\(^9\)

\(^9\)Bounds and equilibrium values were found using a multiple complementarity solver in GAMS.
2.5 A Numerical Experiment

The home country is set to the baseline parameterization, with one parameter in the foreign country changing at a time. The remaining foreign country parameters are set to the baseline values.

Increasing the initial population in the foreign country doesn’t change optimal behavior of firms or workers relatively, but does change allocations of workers (Figure 5). Workers from the foreign country migrate to offset greater competition with the increase in the population until the unemployment numbers for foreign workers are equalized across the two countries. Home workers’ inability to move keeps them at home, and they are unaffected by the increase in foreign workers due to the increase in vacancies offered keeping the market tightness in the home country constant. Home workers have higher unemployment until the foreign population is triple that of the home population. Wages are unchanged by changes in initial population in the foreign country; however, not all workers receive the same wage. Foreign workers remaining in the foreign country receive a slightly higher wage than other workers.

Figure 7 illustrates the impact from an increase in productivity in the foreign country from parity with the home country to quadruple that of the home country. Workers still choose to move even when the foreign country is far more productive, though fewer move as the foreign country becomes increasingly productive. Higher productivity also results in many more vacancies opened in the foreign country as firms seek more workers (second panel). Unemployment for home workers increases in this case, as foreign workers migrate less and firms open fewer vacancies to entice workers due to the high opportunity cost to foreign workers to leave their home country (third panel). Again, home workers always have higher unemployment than foreign workers. Increasing foreign productivity increases wages for foreign workers remaining in the foreign country and new migrants, but decreases wages for home workers and foreign migrants who had their most recent unemployment spell in the home country. Increases are most dramatic for foreign workers who never move followed by foreign workers returning from the home country and foreign workers migrating to the home country for the first time.

Moving from costless to very costly (right to left) posting in the foreign country, fewer
foreign workers are located in the foreign country until no workers remain when costs absorb approximately one third of the value of production to the firm (Figure 9). Market tightness in the home economy does not change since workers move from the foreign country as firms more than compensate by opening more vacancies (second panel). This is contrasted with the case in the foreign country where posting becomes prohibitively costly, and firms post increasingly fewer and fewer new vacancies as the available pool of workers becomes smaller and smaller (first and second panels). Unemployment in the foreign country drops to around 1% at the upper limit of costs, and the unemployment of foreign migrants converges up to meet that of home workers (third panel). Wages decrease with cost increases for foreign workers who never migrate, and for new migrants. The decrease is largest for foreigners who never move followed by returning migrants and then new migrants into the home country. Home workers and foreign workers who migrated prior to their most recent unemployment see a very slight increase in wages once the foreign posting cost is larger than in the home country.

Changes in unemployment benefits have relatively little impact on the equilibrium distribution of workers between countries. As the foreign country becomes more generous, more workers locate in the foreign country, but the change is small, as seen in Figure 11. Market tightness in the home country drops by about 25% as firms are less inclined to draw foreign workers who would have a higher outside option in bargaining from the increasingly generous benefits they receive in their native country (second panel). Firms in the foreign country offer relatively more vacancies as benefits increase, but the change is small, and seeks to induce workers to leave unemployment. Unemployment increases for home workers as the number of vacancies falls, increases slightly for foreign stayers as the total foreign population increases, and decreases for foreign workers due to lower migration rates from the generosity of foreign unemployment benefits. Foreign workers always have lower unemployment than home workers. This relatively small impact from changes in unemployment benefits supports the empirical evidence put forth in Nickell (1997, 2006). Increasing unemployment benefits results in higher wages for foreign stayers and new migrants with the largest increase accruing to stayers. Home workers and migrants who moved previous to the most recent period of unemployment see a decrease in wages as the foreign country becomes more generous to the
unemployed.

When workers in the foreign country gain bargaining power, moving from receiving almost none of the surplus of the match to 86% of the surplus, fewer foreign workers choose to locate in the foreign country until no foreign workers remain (Figure 13). This is due to the erosion of firms’ incentives to post vacancies where increases in workers’ bargaining power in the foreign country mean that home firms have no incentive to maintain open vacancies when the demand for those positions drops significantly. Foreign firms change their posting behavior relatively little as vacancies increase in line with the larger foreign population. Unemployment is increasing in the home country as fewer vacancies are posted as well as for foreign stayers since the job market becomes more competitive with the population increase from the increased bargaining power. Foreign migrants face lower unemployment due to their dwindling numbers. Wages for foreign stayers and returning migrants increase with the increase in bargaining power while all other workers experience no change in wage. Home workers and foreign workers who migrated previous to the most recent episode of unemployment receive the highest wages until they are surpassed by foreign stayers when bargaining power is greatest. New migrants to the home country are better off than foreign stayers and returning migrants until foreign bargaining power surpasses the power in the home country.

Changes in unemployment benefits have the smallest overall impact on unemployment in both countries. Productivity, posting costs, and bargaining power can cause large differences in population allocation, unemployment and wages across groups of workers.

When firms are only permitted to post jobs according to the location of the firm, and not using workers’ characteristics, home workers are affected by foreign workers’ migration decisions. I interpret the increase in home workers’ unemployment rates as arising from the crowding out of home workers by foreign workers when the home country is a more desirable place for workers to live. More workers are migrating to the home country on average than is observed in the data.\(^\text{10}\) The inability of home workers to leave the home market means that the unemployment predicted by the model is an upper bound on the negative effects on

\(^{10}\)Near the bounds of some parameterizations, fewer workers will migrate in the model than in the data, but these are often caused by unrealistic parameter values, i.e. workers are four times as productive in the foreign country as in the home country.
home workers’ unemployment from migrants. While home workers and foreign migrants who were in the home country during the last unemployment experience are relatively unaffected by changes in foreign country parameters. This is in contrast to other workers who are often compensated for disadvantages from lower surplus, bargaining power, or benefits.

A modification of the market equilibrium can be made to allow firms to target a particular subset of workers. I refer to this as discrimination. This is not meant to be discrimination in the idiomatic sense. Discrimination in this world is defined such that the employer chooses to open a position to workers based on worker country of origin and current unemployment location. This makes the equilibrium segmented, and is the most restricted version of the model. Discrimination in this sense is not completely unrealistic: firms looking to post a vacancy may want to search specifically for skills known to be possessed by a subset of the unemployed that would limit potential applicants to only foreign migrants. Even though the constrained nature of the discrimination set-up may not represent real world employment and migration decisions, it establishes a baseline model to describe a worker’s migration decision based on varying labor market characteristics. For a full description of the model environment, comparative statics, and numerical experiments, see Appendix C.

3 Efficient Allocations

Next, I consider the allocation of workers and their employment status, across the two countries by a benevolent social planner. Typically in models of labor search and matching, it is possible to evaluate welfare and efficiency of the market outcome by comparing the workers’ bargaining power in the market outcome to the elasticity of the matching function. When the two match, this is known as the Hosios condition for efficiency of the market equilibrium given the search frictions the planner faces. There are a number reasons this is not possible here. The first reason is that the markets here are not symmetric. In contrast to Davis et al. (1996), the ex ante separation of markets via geography does not allow for a comparison due to the ability of workers to effectively change their type by migrating. It is also not possi-

\[\text{See Hosios (1990).}\]
ble to reach the equivalent condition for each market individually due to market and worker heterogeneity, and worker ability to change type.\footnote{A second reason is that the Den Haan, Ramey and Watson matching function employed does not yield a comparable functional statistic for the first derivative as in the commonly used Cobb-Douglas form for the Hosios condition. Even with a Cobb-Douglas matching function, it is not analytically possible to reduce the free-entry conditions for firms to compare across the planner’s allocation and the market allocation in equilibrium as is typically done. If a Cobb-Douglas matching function were used in the context of this paper, the equality of workers’ bargaining power and the elasticity of the matching function does not yield a first-best outcome because of the asymmetry of the markets.}

The planner’s objective is to maximize total social surplus shared between firms and workers without prioritizing how the surplus is divided. The planner is subject to the same matching frictions as in the competitive equilibrium, and faces the same costs to posting jobs.

The planner maximizes:

\[
\int_0^\infty e^{-rt} [(y_F - c_F)n_{FF} + (y_H - c_H)(n_{FH} + n_{HH}) + b_F u_{FF} + b_H(u_{FF} + u_{FH}) - c_F \theta_F(u_{FF} + u_{FH}) - c_H \theta_H(u_{FF} + u_{FH} + u_{HH})]
\]  

The first four terms are the net benefits for workers from a given allocation across space and employment. The final two terms are the costs of unfilled vacancies to society.

The planner is subject to the laws of motion for unemployment:

\[
\dot{u}_{FF} = \delta n_F - \theta_F q_F u_{FF} 
\]
\[
\dot{u}_{FH} = \delta n_{FH} - \theta_F q_F u_{FH} - \theta_H q_H u_{FH} 
\]
\[
\dot{u}_{HH} = \delta n_{HH} - \theta_H q_H u_{HH} 
\]
\[
\dot{n}_{FF} = \theta_F q_F (u_{FF} + u_{FH}) - \delta n_{FF} 
\]
\[
\dot{n}_{FH} = \theta_H q_H (u_{FF} + u_{FH}) - \delta n_{FH} 
\]
\[
\dot{n}_{HH} = \theta_H q_H u_{HH} - \delta n_{HH} 
\]

These six constraints represent the same evolution of employment and unemployment as in the competitive equilibrium. The planner is also subject to the same equilibrium conditions as in the market equilibrium on population, market tightness definitions, and migration which
ensure a stationary equilibrium Equations (9 - 15). These equations match the flow descriptions in the market outcome. The difference in the planner’s allocations all work through the choice of market tightness before migration conditions are imposed.

Wages are determined exactly as in the competitive equilibrium models shown in equation (27), with firms and workers sharing the surplus of the match according to worker’s bargaining productivity, $\beta_k$ while firms in country $k$ receive $(1 - \beta_k)$ of the match surplus, although the planner is indifferent to the sharing rule, $\beta$.

3.1 Comparative Statics

Comparative statics for changes in parameters under the planner are identical to those for the market equilibrium. The planner is subject to the same laws of motion for job turnover and migration conditions. The difference lies in that the planner will choose different market tightnesses from the competitive equilibrium outlined above.

Once again, a numerical experiment is used to show how the planner’s allocations differ from those of the market behaviors.

3.2 Parameterization

Again, I use the same baseline parameterization from the competitive equilibria to better understand how the planner allocates jobs, and employed and unemployed workers across countries.

3.3 A Second Numerical Experiment

Allocation of equilibrium population between countries is the same under the planner as in the competitive equilibrium when the initial population of the foreign country is increased (Figure 6). Since all other parameters between the countries are symmetric, the planner chooses the same equilibrium population allocation dynamic as both competitive markets. The planner chooses to open more vacancies in the home country when the foreign population is smaller than the home population, and adds fewer additional vacancies as the foreign population
surpasses that of the home country (second panel). Migrant workers face slightly higher unemployment than the foreign workers who remain in the foreign country. This is due to the planner partially internalizing the extra crowding that happens when workers relocate to the home country. Foreign workers face increasing unemployment as they become less scarce; home workers’ unemployment is not affected, but is higher than for foreign workers until there are three times as many foreign workers as home workers.

As foreign firms’ productivity increases, the planner moves fewer workers to the home country. Once the foreign firms are three times as productive, the planner has equal numbers of workers in each country. This maximizes total match surplus since the foreign matches are significantly more productive than home matches. Figure 8 shows that workers are compensated for the comparatively larger population, with more open vacancies as more productive matches generate more social surplus from matching. Unemployment is increasing for home workers as the planner opens fewer vacancies in the less productive country, and more vacancies in the foreign country from which home workers are excluded. Migrant workers experience falling unemployment due to the paucity of migrant workers under the planner under the planner’s application of the most extreme productivity differential.

The planner reacts to increases in vacancy posting and maintenance costs as in the competitive equilibria shown in Figure 10. As vacancies become more costly in the foreign country, fewer workers are allocated there until it is so costly that the planner chooses to put all workers in the home country. Market tightness in the foreign country decreases as costs increase until no open vacancies are maintained at all. The planner more than makes up for the increased population in the home country by posting more vacancies as the costs in the foreign country increase. Unemployment in the foreign country decreases as workers are moved into the home country, and unemployment rates for foreign migrants converges upward to that of home workers.

As unemployment benefits increase in the foreign country, the planner allocates more workers there, but the change is small (Figure 12). The planner also decreases market tightness in both countries as benefits increase because the planner is less concerned about drawing people out of unemployment when it is more generous: matches under high benefits in the
foreign country generate less surplus. Unemployment for all workers increases due to the
decrease in vacancies posted, though home workers see the largest increase, and always have
higher unemployment.

Reassuringly, Figure 14 shows that the planner does not react to changes in workers’ bar-
gaining power as he is agnostic about the allocation of the match surplus, and only seeks to
keep the total surplus as large as possible given the values of the other parameters. Popu-
lations, market tightness, and unemployment do not vary with bargaining power under the
planner.

3.4 Comparison of the Market and Planner’s Problem

Now, looking at how far from the planner’s allocations the competitive equilibrium under
non-discrimination falls, Figures 5 and 6 show the impact of increasing the foreign-born
population. In terms of allocation of people, the planner always allocates more workers to
the home country, and always keeps slightly more than half of the foreign-born workers in the
home country. The planner keeps market tightness in the foreign country lower, and home
country tightness higher than in the competitive equilibrium, but home market tightness
decreases as the population increases. Unemployment for home workers is slightly less than
1% lower under the planner, and foreign migrants face slightly lower unemployment than
foreign stayers even though the competitive equilibrium shows foreign workers kept equal.
The planner more generously compensates migrants for the decreased probability of finding
a job as the population becomes large in the home country.

When productivity increases in the foreign country, the planner increases the equality
of worker allocation as in the competitive equilibrium (Figures 7 and 8), but begins with a
less equal distribution and ends with a more equal distribution when foreign productivity
is highest than in either market outcome. Market tightness also begins at parity under the
planner when the countries are symmetric, but tightness diverges more dramatically under
the planner (Figure 8 shows a large drop in the home country along with the increase in the
foreign country). This is more extreme when the countries are more similar, and changes
less as the populations equate and almost no foreign workers are moved to the home country.
Unemployment increases in the home country as the planner employs many workers in the more productive country, and almost none in the less productive country. Unemployment drops for the few workers who are still moved to the home country, and foreign workers always experience lower unemployment under the planner.

The planner also mimics the competitive equilibria when posting costs increase in the foreign country, but reacts more aggressively. Workers are moved out of the foreign country more quickly as posting costs to firms increase, and all workers locate in the home country under lower foreign posting cost than in the market outcomes. Figures 9 and 10 reflect this same desire to move foreign workers away from the increasing cost as market tightness begins lower in the foreign country, and more quickly moves toward zero as costs in the foreign country increase. The planner also compensates for the population changes by increasing market tightness in the home country. Unemployment for all workers follows the same pattern under the planner as in the market, but migrants’ unemployment converges with that of home workers once all workers are located there whereas the market maintains foreign workers at lower unemployment levels than home workers, even when all workers are in the home country.

Qualitative changes in allocations under the planner when unemployment benefits in the foreign country change are very similar to changes under non-discrimination. The planner chooses a slightly less equal population distribution, shown in Figures 11 and 12. However, market tightness decreases in both countries as foreign benefits increase. The planner keeps more foreign workers in unemployment due to the high value of being unemployed, and opens fewer home vacancies due to lower rates of migration than in the market outcome. Figures 11 and 12 show relatively small changes for all workers under the planner, even when unemployment benefits increase. The planner employs more home workers than the market and similar numbers of foreign workers. Overall, for changes in unemployment benefits, the market outcomes are not far from those under the planner (with the exception of the number of unfilled vacancies maintained) as the planner keeps the non-profit generating activities to a minimum while the market cannot as easily allocate efficiently.

Although the planner does not make changes according to changes in bargaining power as the market does, I still examine the difference between the two. Compared to the mar-
ket, the planner initially has a less unequal population distribution when foreign bargaining power is low, but has a more unequal distribution when power is high. Figures 13 and 14 show that while the planner chooses a slightly lower market tightness for the foreign country, the home market has a lower market tightness than under the market when bargaining power is low, and higher levels when bargaining power is high. There are equal outcomes when workers bargaining power is equal in both countries. The planner chooses an unemployment level for home workers almost ten percentage points higher than the market when bargaining power is low, but home workers experience lower unemployment under the planner when bargaining power is greater in the foreign country. Foreign migrants experience lower unemployment under non-discrimination. Foreign stayers have lower unemployment under non-discrimination only when foreign workers receive less than 48% of the match surplus, and have lower unemployment under the planner otherwise.

Under the numerical example provided, we see that the market allocation frequently diverges from the efficient allocation. The lack of an analytical solution prevents a more careful construction of differences for a general choice of parameters.

4 An Application of the Model

This section presents two calibrations of the model to match with the high-migration, low difference in unemployment rates case (exemplified by the US) and the low-migration, large difference in unemployment rates case (exemplified by Europe) outlined in the Introduction.

I chose parameters for the model that are realistic in the sense that they represent economies which are relatively similar, but predict different stationary equilibria. Table 4 shows the different values for the two cases. The particular parameters here generate the different equilibria that are targeted, but are not the only parameterizations that generate the qualitative differences I target.

In the high-migration, low difference in unemployment rates case, parameters reflect very similar economies in the two countries. The case shown in Table 4 gives the model prediction from the case where both countries (or US states) are perfectly symmetric. In this scenario,
workers still choose to migrate, though the model does not require non-zero migration flows. Table 5 shows that over 75% of workers in the foreign country leave for the thicker market in the home country. Overall unemployment rates are high—37.5% and 41.1%, but reflect the similarities across the two markets. There is also significant wages dispersion across the different workers. Workers in the foreign country, whether they never left or are newly returning, receive the lowest wages followed by new migrants into the home country. Previous migrants and home workers receive the highest wages.

In the low-migration, large difference in unemployment rates case, parameters reflect fairly similar economies, but ones that vary in ways that create large differences in unemployment rates across the two countries. In this case, the foreign country is more attractive in some ways, but less attractive in other ways compared to the home country. The foreign country is more productive and has higher bargaining power, but lower unemployment benefits and higher costs to posting and maintaining a vacancy for firms. This trade-off results in much lower migration into the home country: now only 24% of foreign workers locate in the home country, and unemployment rates are much different from the US proxy scenario. Unemployment rates are 39.7% and 66.7% in the foreign and home country. Again, these overall rates are very high, but the levels were not the target moment for this parameterization.

(Table 5 here)

This points to one avenue of policy that countries can employ to keep workers at home: increasing productivity decreases out migration and increases wages. Countries hoping to keep more of their most highly skilled workers would do well to institute national policy helping workers and firms to be more productive. Countries hoping to limit in-migration from other countries could provide FDI in common sending countries that works toward improving productivity abroad.\textsuperscript{13} Aside from efforts to improve productivity in common sending countries, the countries seeking to make unemployment rates more similar could also work to decrease labor market frictions for matching, and to open up all markets to be more flexible. Although not explored in great detail in this section, the role of unemployment benefits in generating unemployment could also be targeted. Lower, or shorter term unemployment benefits have

\textsuperscript{13}Many would argue that the Brexit vote was driven by anti-immigrant sympathies among lower skilled Brits.
been shown to decrease overall unemployment rates in the numerical exercises above, and in empirical literature.\textsuperscript{14} The role of workers’ bargaining power is an additional mechanism put forth for explaining the differences between US and European labor markets. Perhaps since migration may not be enough for labor market conditions to converge, these other policy avenues would more efficiently use resources in improving the market equilibrium.

5 Conclusion

Despite the focus on the role of migration as a convergent factor for unemployment rates within the US, the model in this paper shows that migration alone may not be the driving force in keeping US unemployment rates more similar than those across European countries.

Workers choose to move not only based on productivity and expected wages in the receiving country, but also based on the likelihood of gaining employment upon migrating. While the model presented in this paper prevents a subset of workers from migrating, the equilibrium impact from some workers migrating is insufficient to generate equal (or near equal) unemployment rates across countries in all but a handful of special cases which are highly dependent on the particular parameters chosen. Wage effects for home workers are highly dependent on the mechanism for generating migration. When productivity difference across countries generate the move, home workers suffer very little as in Card (1990), but when the mechanism is business environment as for posting costs, home workers suffer larger losses akin to those in Borjas (2003). Including worker heterogeneity in a model of search with migration would shed light on this debate.

In a model of matching with restricted migration, the movement of workers across asymmetric states has been shown to be insufficient to generate a convergence in unemployment rates across countries for a variety of parameterizations. For this reason, one potential extension to study unemployment rate variation at the country level should focus on those factors which are most salient to those moving: costs to move and be away from home.

\textsuperscript{14}See Nickell (1997, 2006) for examples concerning the comparison between the US and Europe.
References


6 Figures & Tables

Figure 5: Non-Discrimination Changing Initial Population

Figure 6: Planner Changing Initial Population
Figure 7: Non-Discrimination Changing Productivity

Figure 8: Planner Changing Productivity
Figure 9: Non-Discrimination Posting and Maintenance Costs Changing

Figure 10: Planner Posting and Maintenance Costs Changing
Figure 13: Non-Discrimination Changing Bargaining Power

Figure 14: Planner Changing Bargaining Power
Table 3: Baseline Parameterization

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Table 5: Outcomes

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A Country Classifications

Schengen: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Lichtenstein

EU: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom

Euro: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain

EU not Euro: Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, and the United Kingdom
B Other Figures

Unemployment Variation Figures (with and without euro crisis)

Figure 15: Unemployment Rates and Variation

Source: Eurostat

Figure 16: Unemployment Rates and Variation

Source: Eurostat
Figure 17: Unemployment Rates and Variation

Source: Eurostat

Figure 18: Unemployment Rates and Variation

Source: Eurostat
C Discrimination

Since firms post vacancies according to unemployed workers’ origin and current location under discrimination, each job acts as a segmented labor market. This is similar to the segmented equilibrium for a two-skill, one-country model in Albrecht and Vroman (2002) and Blázquez and Jansen (2003).

Separate markets mean that the market tightness in each sub-market, $\theta_{ij}^k$, is nominally independent: Spillovers happen only due to a worker’s change of employment or location status. For example, if a worker moves to another country for employment and then loses that employment, the relevant market tightness has changed. Importantly in the search framework, his effect on his original, and his new, market tightness is not considered when making the decision to migrate or search. Migration can only happen when moving out of unemployment.\(^{15}\)

For workers, the flow value of search across markets must be the same in equilibrium. This makes workers indifferent between the perceived return from searching in any particular market. The flow value of unemployment to the worker, $r_U$, depends on the unemployment benefit and the expected value of matching in that market. The expected value is given by the product of the probability of finding a job in each market and the net value of moving from unemployment into employment. While unemployed in country $j$, the worker receives unemployment benefit, $b_j$, and chooses to search in either country based on the expected probability of matching with a job, $\theta_{ij}^k q_{ij}^k (\theta_{ij}^k)$, and the net gain from employment in that market, $(N_{ij}^k - U_{ij}^k)$. Search is costless, and all workers share the same work effort. This gives the flow value of unemployment as:

$$r_{U_{ij}} = b_j + \max_k \{ \theta_{ij}^k q_{ij}^k (\theta_{ij}^k)(N_{ij}^k - U_{ij}^k) \}$$

The flow value of employment to the worker, $r_N$, is the discounted value of the wage less the value of moving into unemployment:

$$r_{N_{ij}}^k = w_{ij}^k + \delta(U_{ik} - N_{ij}^k)$$

Firms choose whether to post a vacancy based on the cost to post, $c_k$, as well as the probability weighted value to the firm of filling the vacancy and moving into production, $q(\theta)(J - V)$. This gives the flow value of posting a vacancy, $r_V$, in country $k$ for a worker from country $i$ living in country $j$:

$$r_{V_{ij}}^k = -c_k + q_{ij}^k (\theta_{ij}^k)(J_{ij}^k - V_{ij}^k)$$

The flow value of a filled vacancy, $r_J$, to the firm is the value of production less the cost to posting in country $k$, the wage payment to a worker from $i$ unemployed in $j$ matching in $k$, and the probability weighted value to the firm of the match dissolving, $\delta(V - J)$:

$$r_{J_{ij}}^k = y_k - w_{ij}^k - c_k + \delta(V_{ij}^k - J_{ij}^k)$$

Wages are bargained based on production surplus for the type of match, $S$, bargaining power, $\beta$, in job location $k$, and costs to establishing a vacancy in location $k$. Bargaining partially captures the large power of labor unions in many countries, and allows differences in outside options to migration to be reflected in wages through unemployment values.

\(^{15}\)I make this assumption for simplification, but Kawata et al. (2014) show that in equilibrium this holds, regardless of moving costs, in a similar framework.
Workers employed in country \( k \) always receive share \( \beta_k \) of the match surplus, \( S_{ij}^k \), where
\[
S_{ij}^k = J_{ij}^k + N_{ij}^k - U_{ij} - V_{ij}^k
\]

\[
w_{ij}^k = \beta_k S_{ij}^k
\]  \hspace{1cm} (27)

Firms in country \( k \) receive share \((1 - \beta_k)\) of the match surplus: \((1 - \beta_k)S_{ij}^k\).

C.1 Equilibrium

Market tightness is the number of open vacancies, \( v \), of each of the five types divided by the total population of "eligible" unemployed, \( u \), to fill those vacancies:

\[
\theta_{FF}^F = \frac{v_{FF}^F}{u_{FF}^F}
\]  \hspace{1cm} (28)

\[
\theta_{FF}^H = \frac{v_{FF}^H}{u_{FF}^H}
\]  \hspace{1cm} (29)

\[
\theta_{FH}^F = \frac{v_{FH}^F}{u_{FH}^F}
\]  \hspace{1cm} (30)

\[
\theta_{FH}^H = \frac{v_{FH}^H}{u_{FH}^H}
\]  \hspace{1cm} (31)

\[
\theta_{HH}^H = \frac{v_{HH}^H}{u_{HH}^H}
\]  \hspace{1cm} (32)

Initial populations are the sum of all unemployed and employed workers from each country, regardless of current location:

\[
P_{o}^F = u_{FF}^F + u_{FH}^F + n_{FF}^F + n_{FH}^F + n_{FH}^H + n_{HH}^F
\]  \hspace{1cm} (33)

\[
P_{o}^H = u_{HH}^H + n_{HH}^H
\]  \hspace{1cm} (34)

The Figure 19 summarizes the next group of conditions which ensures a stationary equilibrium.

Job creation and destruction conditions ensure that the total stock of employed and unemployed in each submarket remains constant in equilibrium. For example, Equation (35) describes the number of foreign unemployed workers who are in the foreign country and match with a firm in the foreign country on the left hand side, and are represented by arrow 1 in the diagram. The right hand side is the number of foreign workers employed in the foreign country who lose their job, and are represented by arrow 2 in the diagram. Equation 36 equates the flow of foreign unemployed into the home country with the destruction of those jobs, and is represented by arrows 3 and 4 in the diagram. Equation 37 equates previous foreign migrants returning to the foreign country for employment and the subsequent loss of those jobs by prior workers, and is represented by arrows 5 and 6 in the diagram. Equation 38 equates newly matched unemployed foreign migrants with the destruction of their jobs in the home country, and is represented by arrows 7 and 8 in the diagram. Equation 39 represents the flow into and out of unemployment for home workers, and is given by arrows 9 and 10 in the diagram. Equations (35) through (39) ensure that every job sub-market is in equilibrium:
The migration condition ensures that populations at the country-level remain constant in equilibrium while allowing people to move in and out of each market. Equation 40 is represented by the equality of arrows 3 and 5 in the diagram.

\[ \theta_{FH}^E q_{FH}^E (\theta_{FH}^E) u_{FH} = \delta n_{FH} \]  
\[ \theta_{FH}^H q_{FH}^H (\theta_{FH}^H) u_{FH} = \delta n_{FH}^H \]  
\[ \theta_{FH}^E q_{FH}^E (\theta_{FH}^E) u_{FH} = \delta n_{FH} \]  
\[ \theta_{FH}^H q_{FH}^H (\theta_{FH}^H) u_{FH} = \delta n_{FH}^H \]  
\[ \theta_{FH}^F q_{FH}^F (\theta_{FH}^F) u_{FH} = \delta n_{FH} \]  
\[ \theta_{FH}^H q_{FH}^H (\theta_{FH}^H) u_{FH} = \delta n_{FH}^H \]

Together with wage bargaining and the zero profit condition on firms, the market tightness definitions, the population definitions, the creation-destruction conditions, and zero net migration conditions fully define a stationary equilibrium.

C.2 Comparative Statics

The equilibrium impact of changes in parameters on wage and market tightness in a particular sub-market can be evaluated using the changes to labor supply and demand from changes in parameters. The effects on labor supply are straightforward for foreign stayers, home natives, and prior foreign migrants in the home country. The impacts on new migrants' supply decisions are less clear. Labor demand effects are also straightforward. I separate
equilibrium impacts into the effects on market tightness and wages, and then taking those
changes as given, evaluate the impact on equilibrium unemployment.

Increasing productivity or decreasing posting and maintenance costs increases the demand
for labor for all types of workers. Specifically, increasing foreign productivity (decreasing
posting and maintenance costs) increases demand for all matches in the foreign country,
without changing the demand for home workers. Increasing home productivity (decreasing
posting and maintenance costs) increases demand for all matches in the home country.

On the supply side, increasing foreign productivity increases labor supply for all foreign
workers except migrants remaining in the home country, without changing the supply of
home workers and foreign migrants already in the home country. Increasing home produc-
tivity increases supply for all workers except foreign stayers. Increasing foreign posting and
maintenance costs decreases the supply of labor for all foreign workers except migrants re-
maining in the home country, and has no impact on the supply of home workers and foreign
migrants already in the home country. Increasing home posting and maintenance costs de-
creases the supply of labor for all workers except foreign stayers who are unaffected. Increasing
foreign unemployment benefits increases the supply of foreign stayers only. Increasing home
unemployment benefits increases the supply of all workers except foreign stayers who are
unaffected. Increasing foreign bargaining power increases the supply of new foreign migrants
into the home country, unclear effects on all other foreign workers except prior migrants who
are unaffected along with home workers. Increases in home bargaining power have no impact
on foreign stayers and unclear effects on the supply of all other workers.

Combining the supply and demand effects, increasing foreign productivity increases mar-
ket tightness for all foreign workers except those who migrated prior to their previous unem-
ployment. Home workers’ and prior foreign migrants’ market tightnesses are unaffected by
changes in foreign productivity. Increasing home productivity increases market tightness for
all workers except foreign stayers who are unaffected. Decreasing posting and maintenance
costs has the same effect on market tightnesses as increases in productivity. The effect on
wages is unclear for each of the changes in productivity and posting and maintenance costs.

Increasing foreign unemployment benefits increases market tightness for foreign stayers,
and has no effect on any other workers’ market tightness. Foreign stayers also experience a
decline in wages. Increasing home unemployment benefits increases the market tightness for
all workers except foreign stayers. Wages decrease for all workers except foreign stayers.

Changes in both foreign and home bargaining power have an indeterminate effect on
market tightness for all workers except foreign migrants newly moving to the home country
in the case of changes to foreign bargaining power. For these workers, market tightness
increases and wages decrease when foreign bargaining power increases.

Given the changes on market tightness, it is possible to analyze the effect on unemploy-
ment, employment and vacancies in both countries for changes in parameters except when
changes to market tightness are unclear.

When foreign productivity increases or posting and maintenance costs decrease, the impact
on unemployment levels in both countries is unclear. If the effect on market tightness for
foreign migrants returning to the foreign country is large enough, this will outweigh the
negative effects of market tightness for foreign stayers and foreign workers newly migrating
to the home country to yield a net increase in unemployment for foreign stayers. Otherwise,
increasing foreign productivity or decreasing posting and maintenance costs will decrease
unemployment for foreign stayers. Changes to unemployment for foreign migrants similarly
depends on whether the effect of market tightness for returning migrants is larger than that
of newly leaving migrants. If this is the case, unemployment for foreign workers living in the home country will decrease. Home workers see no change in unemployment from changes in foreign productivity or posting and maintenance costs.

When home productivity increases or home posting and maintenance costs decrease, it is similarly unclear what happens to unemployment for workers. Foreign stayers’ unemployment levels will decrease is the effect from prior foreign migrants and new migrants outweighs the effect from returning migrants. Foreign migrants’ unemployment will decrease if the effect from prior migrants and returning migrants outweighs the effect from new migrants. Home workers see a decrease in unemployment levels from the increase in home productivity or the decrease in home posting and maintenance costs.

Increasing foreign unemployment benefits decreases unemployment levels for foreign stayers, and has no impact on any workers in the home country. Increasing home unemployment benefits has an indeterminate effect on unemployment for foreign workers in both countries. For foreign stayers, unemployment will increase if the effect of returning migrants outweighs the effect of prior and newly leaving migrants. For foreign workers living in the home country, unemployment will increase if the effect of new migrants outweighs the effect of returning migrants and prior migrants. Home workers experience an increase in unemployment when home unemployment benefits increase. Changes in bargaining power in either country have an indeterminate effect on unemployment for all workers.

Given the frequently unclear effects from changes in parameters on unemployment in either country, I pursue a numerical experiment to evaluate in a more concrete way what happens to workers in either country when parameters change.

Productivity is bounded below by the sum of the cost to posting a vacancy and unemployment benefits: 
\[ y > c + b, \]

or by the discounted value of the costs to posting a vacancy:
\[ y > c(q(\theta) + (r + \delta)/q(\theta)), \]

whichever is larger.

Costs to posting and maintaining a vacancy are restricted by the same inequality as productivity: 
\[ c < y - b \text{ or } 0.335, \]

whichever is smaller, and is kept to positive values.\(^\text{16}\)

Unemployment benefits are kept strictly positive, and face the same constraint as productivity and posting costs: 
\[ b < y - c. \]

Workers’ bargaining power is also kept positive, and must remain below 0.9 (indicating that no equilibrium exists under the baseline specification when workers receive a share of match surplus that is 90\%, or larger).

The job destruction rate is bound between zero and 0.7. While the discount rate must be positive and no larger than 0.55. Matching elasticity must be larger than 0.33, but is unbounded above. Initial population may take any non-negative value. The numerical bounds on all parameters vary somewhat depending on particular parameter values for the baseline, but are locally insensitive.

C.3 Comparative Statics

The equilibrium impact of changes in parameters on wage and market tightness in a particular sub-market can be evaluated using the changes to labor supply and demand from changes in parameters. The effects on labor supply are straightforward for foreign stayers, home natives, and prior foreign migrants in the home country. The impacts on new migrants’ supply decisions are less clear. Labor demand effects are also straightforward. I separate

\(^{16}\)Negative cost parameters could be used to identify government subsidies to firms wishing to stimulate job growth, but is left out of this paper.
equilibrium impacts into the effects on market tightness and wages, and then taking those changes as given, evaluate the impact on equilibrium unemployment.

Increasing productivity or decreasing posting and maintenance costs increases the demand for labor for all types of workers. Specifically, increasing foreign productivity (decreasing posting and maintenance costs) increases demand for all matches in the foreign country, without changing the demand for home workers. Increasing home productivity (decreasing posting and maintenance costs) increases demand for all matches in the home country.

On the supply side, increasing foreign productivity increases labor supply for all foreign workers except migrants remaining in the home country, without changing the supply of home workers and foreign migrants already in the home country. Increasing home productivity increases supply for all workers except foreign stayers. Increasing foreign posting and maintenance costs decreases the supply of labor for all foreign workers except migrants remaining in the home country, and has no impact on the supply of home workers and foreign migrants already in the home country. Increasing home posting and maintenance costs decreases the supply of labor for all workers except foreign stayers who are unaffected. Increasing foreign unemployment benefits increases the supply of foreign stayers only. Increasing home unemployment benefits increases the supply of all workers except foreign stayers who are unaffected. Increasing foreign bargaining power increases the supply of new foreign migrants into the home country, unclear effects on all other foreign workers except prior migrants who are unaffected along with home workers. Increases in home bargaining power have no impact on foreign stayers and unclear effects on the supply of all other workers.

Combining the supply and demand effects, increasing foreign productivity increases market tightness for all foreign workers except those who migrated prior to their previous unemployment. Home workers’ and prior foreign migrants’ market tightnesses are unaffected by changes in foreign productivity. Increasing home productivity increases market tightness for all workers except foreign stayers who are unaffected. Decreasing posting and maintenance costs has the same effect on market tightnesses as increases in productivity. The effect on wages is unclear for each of the changes in productivity and posting and maintenance costs.

Increasing foreign unemployment benefits increases market tightness for foreign stayers, and has no effect on any other workers’ market tightness. Foreign stayers also experience a decrease in wages. Increasing home unemployment benefits increases the market tightness for all workers except foreign stayers. Wages decrease for all workers except foreign stayers.

Changes in both foreign and home bargaining power have an indeterminate effect on market tightness for all workers except foreign migrants newly moving to the home country in the case of changes to foreign bargaining power. For these workers, market tightness increases and wages decrease when foreign bargaining power increases.

Given the changes on market tightness, it is possible to analyze the effect on unemployment, employment and vacancies in both countries for changes in parameters except when changes to market tightness are unclear.

When foreign productivity increases or posting and maintenance costs decrease, the impact on unemployment levels in both countries is unclear. If the effect on market tightness for foreign migrants returning to the foreign country is large enough, this will outweigh the negative effects of market tightness for foreign stayers and foreign workers newly migrating to the home country to yield a net increase in unemployment for foreign stayers. Otherwise, increasing foreign productivity or decreasing posting and maintenance costs will decrease unemployment for foreign stayers. Changes to unemployment for foreign migrants similarly depends on whether the effect of market tightness for returning migrants is larger than that
of newly leaving migrants. If this is the case, unemployment for foreign workers living in the home country will decrease. Home workers see no change in unemployment from changes in foreign productivity or posting and maintenance costs.

When home productivity increases or home posting and maintenance costs decrease, it is similarly unclear what happens to unemployment for workers. Foreign stayers’ unemployment levels will decrease is the effect from prior foreign migrants and new migrants outweighs the effect from returning migrants. Foreign migrants’ unemployment will decrease if the effect from prior migrants and returning migrants outweighs the effect from new migrants. Home workers see a decrease in unemployment levels from the increase in home productivity or the decrease in home posting and maintenance costs.

Increasing foreign unemployment benefits decreases unemployment levels for foreign stayers, and has no impact on any workers in the home country. Increasing home unemployment benefits has an indeterminate effect on unemployment for foreign workers in both countries. For foreign stayers, unemployment will increase if the effect of returning migrants outweighs the effect of prior and newly leaving migrants. For foreign workers living in the home country, unemployment will increase if the effect of new migrants outweighs the effect of returning migrants and prior migrants. Home workers experience an increase in unemployment when home unemployment benefits increase. Changes in bargaining power in either country have an indeterminate effect on unemployment for all workers.

Given the frequently unclear effects from changes in parameters on unemployment in either country, I pursue a numerical experiment to evaluate in a more concrete way what happens to workers in either country when parameters change.

C.4 A Numerical Experiment

In order to give a clear example of how the parameter choices impact the equilibrium, I employ a numerical comparative statics exercise for each characterization of the model. This captures the general equilibrium impacts on labor markets not captured in the comparative statics on wage and market tightness conditions from labor supply and demand, and on employment conditions from changes in market tightness alone. The home (usually receiving) country is always at the baseline calibration outlined above, and parameters for the foreign (usually sending) country are varied one at a time. This allows us to study the impact of policy changes in the sending country on the destination country.

Changing the parameters in this way allows for clearer interpretations of the impacts on migration from changes in structural labor market characteristics. Figures 20-14 show the impact from changing parameters one at time with equilibrium outcomes plotted as the parameter of interest increases on the horizontal axis moving right to left from the lower to upper bound of allowable values given the baseline parameterization. In all figures, home values and all but the parameter of interest in the foreign country are kept at the baseline calibration in Table 3.

Figure 20 shows the effect of increasing the initial population of foreign workers from zero to five times the value in the home country. Increasing the initial foreign population increases the final population in both countries, maintaining the absolute difference between the two countries (first panel). Since all other parameters are the same across countries, this population differential is constant with absolute levels increasing proportionately according to the additional workers in the economy. The home country is always more populated due to

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17Values in the home country could also be toggled. Results vary due to the asymmetry of the migration restriction on home workers.
the equalization of unemployment rates for foreign workers at home (in the foreign country) and abroad (in the home country). Foreign workers’ migration decisions equalize their unemployment in either country since other parameters are symmetric, making equal populations across markets the only way workers equalize the expected value of search across markets. Market tightness is unchanged as the initial population is increased since structurally the two countries are identical (second panel), and firm trade-offs haven’t changed in the structural dimension. This also means wages are unaffected by changes in initial population. Unemployment for home workers remains unchanged while foreign workers experience increased unemployment (third panel) as their scarcity decreases. Home workers also experience higher unemployment until foreign population is about three times as large as the home population. Foreign workers are disproportionately impacted from the population increase since it is their country getting more crowded. Vacancies for home natives are not affected due to the targeting of particular worker types by firms. Changing the initial population value in the foreign country has the expected effect of increasing unemployment for foreign workers, increasing populations in both countries, and has relatively minimal effects on home workers.

Increases in foreign country productivity are shown in Figure 21. Starting from parity, the figure shows the impact from the foreign country becoming increasingly more productive until it is four times as productive in the foreign country as in the home country. Fewer workers choose to migrate as the foreign country becomes more and more productive relative to the home country (first panel). Regardless of how much more productive the foreign country becomes; however, the population is never evenly split between the two countries when all other parameters are equal. This is due to the crowding out in the foreign country of too many workers seeking too few jobs. Foreign workers do not anticipate their impact on the origin and destination markets from an individual migration decision, and so foreign workers remain in the home country even when the foreign country is much more productive. Their probability of finding a job increases when productivity increases, though the effect is larger in the foreign country. Home workers experience no change in unemployment from the productivity change in the foreign country since the markets for each worker type are segmented. Foreign workers, regardless of location, see a decrease in unemployment when their home country gains productivity (third panel). Home workers always face higher unemployment than any foreign workers. Firms in the foreign country open more vacancies since each filled vacancy is more productive. Wages for all workers in the foreign country increase, with never-movers seeing the largest gain from the gain in productivity. Newly arrived foreign workers in the home country also see a small increase in wages since their outside option of unemployment in their home country has increased. Workers who have previously moved and remained in the home country along with home workers see no change in wages with increased foreign productivity.

When foreign firms face an increase in vacancy posting and maintenance costs, the size of the total surplus from any given match is decreased. Figure 22 shows the outcome from rising costs in the foreign country, beginning with costless posting and ending with costs taking up around a third of all production value at approximately 50% larger than in the home country. When posting is costless in the foreign country, very few foreign workers migrate to the home country (where costs are larger than zero), and unemployment for foreign workers at home and abroad is near zero. As costs in the foreign country increase, more workers move to the home country seeking the larger surplus values there. Market tightness for all positions in the home country is unaffected, while those in the foreign country see a large decrease. More costly posting means fewer vacancies posted. Home workers see no change in unemployment,
while foreign workers who stay in the foreign country first see an increase due to the higher cost of vacancies to firms, and then a decrease in unemployment as more workers leave and those remaining become relatively scarce. Unemployment is always larger for home workers. On the other hand, migrant workers experience increased unemployment as their continual migration increases the available worker pool in the home country for firms while profitability remains constant in the home country. At the point where posting and maintenance costs are equal between the two countries, all wages are equal. When costs are lower in the foreign country, wages are higher for all workers except foreign stayers, who see no change in wages regardless of changes in costs to firms. When costs are higher in the foreign country, wages everywhere drop. In the foreign country this is due to the lower surplus of matches due to the high costs while in the home country, firms no longer have to pay high wages to entice workers to search in the home country.

Making unemployment benefits more generous in the foreign country has qualitatively similar effects on population, market tightness, and unemployment as increases in posting costs (Figure 23). As the foreign country becomes more generous, so few jobs are posted in the foreign country that eventually all workers migrate to the home country. This is reflected in the market tightness decreasing to zero as the number of open vacancies maintained is zero when benefits are as large as is allowable for this parameterization. Unemployment increases slightly for foreign stayers as benefits become more generous, and then tends to zero as workers vacate the foreign country in favor of the higher probability of job finding rates in the home country. Foreign migrants see their unemployment rates converge up to those for home workers as the entire population moves into the home country seeking employment. The less restrictive environment for firms from the relatively lower unemployment benefit there leads them to post more vacancies and increases the probability that workers will match with a firm. Wages for foreign workers in the home country who moved prior to the most recent unemployment spell and home workers are unaffected by changes in unemployment benefits in the foreign country. Wages for workers in the foreign country and new migrants in the home country increase as unemployment benefits increase to compensate for the higher value of unemployment. As benefits in the foreign country increase beyond the level in the home country, wages drop for new migrants in both countries, coinciding with the movement of the entire population moving into the home country, and their crowding of the home market for foreign workers.

Changes in the bargaining power of workers in the foreign country again has qualitatively similar effects as posting costs and unemployment benefits. Each of these three parameters impacts the size and/or division of the match surplus, and incentivizes workers and/or firms to try to increase the probability of a match from the other side of the market. Figure 24 illustrates the impact when workers have very little bargaining power through the opposite extreme of having almost all the bargaining power in wage negotiations. Equilibrium population is most evenly split across the two countries when the foreign country’s workers have no bargaining power. Then, as worker’s share of the match surplus increases in the foreign country, more workers migrate until only 12% of the original workforce remains when their share is as large as possible. Market tightness in the foreign country also decreases in tandem with the increase in worker’s bargaining power as firms find it less attractive to offer vacancies when their share of the surplus is low. Home workers again see no change in their unemployment levels from the changes in the foreign country, but migrants face increasing unemployment as they over crowd the home market. Again, home workers always face higher unemployment. Foreign stayers, on the other hand, first see an increase in unemployment.
as firms open fewer vacancies, but then benefit from the exodus of workers into the home market, thereby lowering foreign country unemployment levels. Changes in productivity have relatively small effects on unemployment compared to posting costs, unemployment benefits, and bargaining power, but large differences in unemployment persist across all parameter variations. Wages for foreign stayers as well as new migrants in both countries see wages increase with the increase in bargaining power. The rise is most dramatic for foreign stayers. Home workers, and foreign workers who moved prior to their last unemployment spell see no change in wages with changes in foreign bargaining power.

Under discriminating behavior of firms, home workers’ unemployment doesn’t change even when foreign workers move in and out of the home country. They are relatively insulated from foreign worker’s impacts on market tightness and population levels through the targeting of particular workers by firms. More workers migrate under discrimination conditions, typically around 50%, than in the data, close to around 10%. If firms were to behave as they do under discrimination, there would be no support for the argument that immigrants hurt native workers’ job prospects through competition for jobs. Given that most firms are unlikely to behave this way, we must examine what happens not only to home workers, but to all workers under more realistic firm hiring conditions. Wages are positively related with changes in market tightness for changes in initial populations, productivity, and posting costs, but negatively related with market tightness for changes in unemployment benefits and bargaining power.

C.5 Discrimination vs Non-Discrimination

I now compare how the two firm restrictions result in different equilibrium outcomes. Firm behavior, migration patterns, and unemployment values vary across parameter changes depending on the restrictions imposed on vacancy posting. The discrimination and non-discrimination characterizations are qualitatively similar for most of the comparative statics exercises. Both market equilibria provide important insights into the effects of changes in the structural characteristics of labor markets, while differences highlight ways in which labor markets may not work as expected when migration is limited to one nationality, but not for another.

When the initial population in the foreign country size is varied, the equilibrium distribution of workers is the same. Foreign workers are split evenly between the two countries (Figures 20 and 5). Firms under the two regimes behave differently: firms allowed to discriminate between worker types maintain slightly fewer unfilled vacancies than firms not allowed to discriminate. The second panels of Figures 20 and 5 show that discriminating firms post fewer vacancies per unemployed worker likely because their postings can be more targeted, but the third panels show that unemployment for home workers is higher as a result while foreign workers’ unemployment in both countries are unaffected by the differing firm behavior. Wages for all workers are the same under both firm behaviors except for foreign stayers without discrimination. In that case, foreign stayers benefit from the inability of firms to discriminate by targeting those workers who are not moving.

Figures 21 and 7 show how the discrimination and non-discrimination outcomes vary for changes in productivity in the foreign country. The population is less evenly distributed between countries for all values of productivity under discrimination. Firms recruit less equally when allowed to discriminate. Vacancies per unemployed worker increase in the foreign country under both firm behaviors, but home firms are not required to alter behavior under discrimination as the foreign productivity varies in order to retain an acceptable workforce. Under non-discrimination, firms begin to offer fewer vacancies as the foreign country becomes
more productive, since those firms must compete with foreign firms to attract workers. Foreign workers who migrate experience the same unemployment under either firm behavior, but workers choosing to stay in the foreign country and home workers have very different unemployment conditions. Home workers are not affected under discrimination, but their competition for jobs without discrimination means they suffer disproportionately from the decrease in vacancies in the home country, and have large increases in unemployment as the foreign country becomes more productive. Foreign stayers benefit from the increase in vacancies under discrimination, but suffer from the increase in population (due to a decrease in migration) following the increase in productivity. When the countries are symmetric, all workers receive higher wages with discrimination. As the foreign country becomes more productive, foreign stayers more than overcome the initial lower wages under non-discrimination, and receive higher wages when firms cannot target particular workers. All other workers always receive higher wages when firms can discriminate.

When posting costs in the foreign country approach zero, almost no workers migrate to the home country under discrimination, but without firm discrimination, foreign workers continue to migrate at a rate of about 33% of the original population, shown in Figures 22 and 9. When firms cannot target particular workers, workers choose to search in the home country despite the larger surplus from remaining in the foreign country. As costs to firms in the foreign country increase, more workers leave the foreign country until no one lives there under both discrimination and non-discrimination. Given the more equal distribution initially under discrimination, this transition occurs more quickly with the cost increase than under non-discrimination. Overall market tightness is lower under non-discrimination for all workers given firms’ inability to target workers in the same way as when they are permitted to discriminate, but changes as foreign posting costs increase is qualitatively similar across the two scenarios (second panel). Home tightness increases slightly as firms open more vacancies, potentially in response to their relative advantage in a higher surplus once foreign costs surpass home costs. This increase in the home country benefits all workers under non-discrimination by decreasing unemployment despite the increase in population, but the decrease in unemployment benefits only foreign migrant workers under discrimination since home firms need not increase postings for home workers who are trapped there. Foreign workers experience decreased unemployment as fewer workers remain in the home country, but the overall foreign unemployment rate increases as eventually no jobs are filled, and all workers are unemployed when costs are highest. Foreign stayers and returning migrants receive higher wages under non-discrimination when costs are lower in the foreign country, but receive lower wages when costs are higher in the foreign country. New migrants to the home country, home workers and migrants who spent their most recent period of unemployment in the home country receive higher wages under discrimination when costs are lower in the foreign country, but lower wages when costs are higher.

Population distributions across discrimination and non-discrimination vary dramatically when unemployment benefits vary in the foreign country. Figures 23 and 11 show that discriminating firms result in workers always being less equally distributed, beginning with almost 70% of the original foreign population in the home country when there are almost no benefits in the foreign country, and inequality increasing as the foreign country becomes so generous that no match surplus remains after accounting for the opportunity cost to employment in the foreign country. This contrasts with the case in which firms cannot discriminate where population distribution changes relatively little when benefits increase in the foreign country, and results in a more equal (though not close to equal) distribution when benefits are very
generous in the foreign country. Market tightness also displays large differences from firm behavior under the two regimes: the second panels show tightness increasing slightly in the home country under discrimination and the foreign country under non-discrimination while tightness decreases in the foreign country under discrimination and in the home country under non-discrimination. I attribute this to the complete erosion of surplus under discrimination resulting in a marked decrease in vacancies by firms. When firms cannot discriminate, they decrease all postings in the home country due to the high opportunity cost of hiring a foreign migrant and being forced to pay those workers higher wages under equal bargaining rules due to foreign workers’ higher opportunity cost of employment. This is reflected in the differences in unemployment patterns. Under discrimination, home workers are unaffected by the changes in foreign unemployment benefits while foreign migrants face increasing unemployment due to their increased migration and cost to the home country. Without discrimination, foreign workers in either country face little change in unemployment due to firms’ inability to choose their worker pool. Home workers experience higher unemployment since firms unable to choose to hire home workers post fewer vacancies to avoid the higher wages foreign workers demand. Wages are higher without discrimination for newly leaving and returning migrants. Wages are higher without discrimination for home workers and migrants who spent their most recent period of unemployment in the home country when foreign unemployment benefits are low, but lower for those workers when foreign benefits are at their maximum allowable level. Wages are higher with discrimination for foreign stayers when foreign benefits are low, but higher when foreign benefits are high.

Changes in workers’ bargaining power in the foreign country have markedly different effects across discrimination and non-discrimination. This is likely due to the differential impact on firms of decreasing the surplus they receive from matching when they are able to target home workers under discrimination in the home country without risking matching with foreign migrants demanding higher wages from their outsize bargaining power in the foreign country. Figures 24 and 13 show the effects from increasing workers’ bargaining power from very small shares to very large shares of surplus. When firms are allowed to discriminate, the population is initially more equally distributed between the countries since firms are better able to target workers. Under discrimination, workers increasingly begin to locate in the home country as bargaining power in the foreign country increases. Without discrimination, foreign workers cease to migrate as the foreign country employment becomes more attractive. Firms have opposing incentives for maintaining open vacancies depending on their ability to discriminate. Discriminating firms in the home country maintain a fairly constant market tightness even as the foreign workers become less attractive, while foreign firms maintain fewer open vacancies as the foreign worker absorbs more of the match surplus. Home tightness is lower under discrimination than without discrimination until foreign workers absorb more than 80% of the match surplus. Foreign tightness is lower without discrimination until foreign workers’ receive more than 46% of the match surplus. Workers also face very different unemployment conditions under the two regimes. When firms can discriminate, home workers are unaffected by changes in foreign bargaining power, and have lower unemployment rates than when firms cannot discriminate except when foreign workers receive less than half of the match surplus. Foreign migrants are worse off (in terms of unemployment) when foreign bargaining is low and firms cannot discriminate, but are better off when firms can discriminate and their bargaining power is high; this is partially attributable to the high value of employment in their native country, and the falling rates of migration as bargaining power increases. Foreign stayers always have higher unemployment when firms cannot discriminate: Foreign firms know the
only workers available to match are foreign workers, and always know the unemployment pool’s uniformity. As firms receive less of the match surplus, they hire fewer workers despite the increasing demand for foreign employment. Foreign stayers, new migrants, and returning migrants receive higher wages when firms discriminate. Home workers and migrants who spent their most recent period of unemployment in the home country receive the same wages regardless of changes in bargaining power under both types of firm behavior.

Firms in the home country offer slightly more vacancies as the population increases, and there are always more vacancies in the home country when firms cannot discriminate. This makes home workers better off in the sense of experiencing in lower unemployment when firms cannot discriminate, and this decreases as more foreign workers join them in the unemployment pool in the home country. Wages vary significantly across firm behaviors, and depending on parameter values. Workers’ wages are not systematically higher or lower under either regime.

Restrictions on firm recruiting behavior matters for equilibrium population allocations, unemployment, wages, and other labor market conditions more broadly.

C.6 Discrimination Figures

Figure 20: Full Discrimination Changing Initial Population

Figure 21: Full Discrimination Changing Productivity

Figure 22: Full Discrimination Posting and Maintenance Costs Changing

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Figure 23: Full Discrimination Changing Unemployment Benefits

Figure 24: Full Discrimination Changing Bargaining Power
D  Equilibrium Values

Wages

Discrimination (Labor Supply)

\[ w_{11}^1 = \frac{\beta_1(y_1 - c_1)(r + \delta + \theta_1^1 q_1^1(\theta_1^1)) + (1 - \beta_1) q_1}{r + \delta + \beta_1 \theta_1^1 q_1^1(\theta_1^1)} \]

\[ w_{12}^2 = \frac{\beta_2(y_2 - c_2)(r + \delta + \theta_2^2 q_2^2(\theta_2^2)) + (1 - \beta_2) q_2}{r + \delta + \beta_2 \theta_2^2 q_2^2(\theta_2^2)} \]

\[ w_{22}^2 = \frac{\beta_2(y_2 - c_2)(r + \delta + \theta_2^2 q_2^2(\theta_2^2)) + (1 - \beta_2) q_2}{r + \delta + \beta_2 \theta_2^2 q_2^2(\theta_2^2)} \]

Non-Discrimination (Labor Supply)

\[ w_{11}^1 = \frac{(c_2 - y_2) \beta_2(r + \delta)(r(r + \delta) + q_1^1 \theta_1^1 q_1^1(\theta_1^1)) + q_1^1 (c_2 - y_2) \beta_2(r + \delta)^2 + q_1^1 (r - y_2) \beta_2 - (y_2) \beta_2 + \beta_1(-c_1 + y_1 + (c_1 - y_1 + y_2) \beta_2) \delta + c_2 \beta_2 (\delta + \beta_1 (r + \delta)) \theta_1^1 q_1^1(\theta_1^1)}{r + \delta + \beta_1 \theta_1^1 q_1^1(\theta_1^1)} \]

Non-Discrimination (Labor Demand)

\[ w_{ij}^k = y_k - c_k - \frac{\gamma_k (r + \delta)}{\theta_k} \]

Non-Discrimination (Labor Demand)

\[ w_{ij}^k = y_k - c_k - \frac{\gamma_k (r + \delta)}{\theta_k} \]
Equilibrium Values

Discrimination

\[ u_{FF} = (P_o^F q_{FF}^F \delta_{FF})/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ u_{FH} = (P_o^F q_{FF}^H \theta_{FF}^H)/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ u_{HH} = (P_o^H \delta)/(\delta + q_H \theta_{HH}^H) \]
\[ v_{FF} = (P_o^F \delta q_{FF}^F \theta_{FF}^F)/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ v_{FH} = (P_o^F \delta q_{FF}^H \theta_{FF}^H)/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ v_{HH} = (P_o^H \delta)/(\delta + q_H \theta_{HH}^H) \]
\[ n_{FF} = (P_o^F q_{FF}^F q_{FH}^F \theta_{FF}^F \theta_{FH}^F)/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ n_{FH} = (P_o^F q_{FF}^H q_{FH}^F \theta_{FF}^H \theta_{FH}^F)/(q_{FH}^F (\delta + q_{FF}^F \theta_{FF}) + q_{FH}^F \theta_{FF}^F (\delta + 2q_{FH}^F \theta_{FF}^F + q_{FH}^F \theta_{HH}^F)) \]
\[ n_{HH} = (P_o^H q_{HH}^H \theta_{HH}^H)/(\delta + q_H \theta_{HH}^H) \]

Non-Discrimination

\[ u_{FF} = (P_o^F q_{FF}^F \delta \theta_{FF})/(q_{FH}^F \theta_{FF} + q_{HH} \theta_{HH})(\delta + q_{FF} \theta_{FF} + q_{HH} \theta_{HH}) \]
\[ u_{FH} = (P_o^F q_{FH}^H \delta \theta_{FH})/(q_{FF}^F \theta_{FF} + q_{HH} \theta_{HH})(\delta + q_{FF} \theta_{FF} + q_{HH} \theta_{HH}) \]
\[ u_{HH} = (P_o^H \delta)/(\delta + q_H \theta_{HH}) \]
\[ n_{FF} = (P_o^F q_{FF}^F \delta \theta_{FF})/(\delta + q_{FF} \theta_{FF} + q_{HH} \theta_{HH}) \]
\[ n_{FH} = (P_o^F q_{FH}^H \delta \theta_{FH})/(\delta + q_{FF} \theta_{FF} + q_{HH} \theta_{HH}) \]
\[ n_{HH} = (P_o^H \delta)/(\delta + q_H \theta_{HH}) \]