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The Role of Migration in Unemployment: Search, Matching & Structural Differences

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Abstract

Search models have been used extensively to explain differences in employment rates and unemployment rate volatility, and are often used to compare the US and European labor markets in the post-war world. 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. In particular, treating Europe as one completely integrated labor market glosses over variation at the national level in both policies and outcomes. 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 search 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 perhaps the most important factor in generating migration and differential unemployment rates under costless migration is in fact productivity differentials within the EU, not the lack of labor mobility as is often thought. I find that migration between European countries is not sufficient to equalize labor market conditions despite the legislative unification of many labor market characteristics.

1 Introduction

Despite decades of efforts from European Union (EU) legislative bodies, labor market conditions across member states remain disparate.[1] Differences range from the role of unions and workers' bargaining power to productivity and permanent or temporary workers' shares in employment. This results in large differences in unemployment rates across countries especially when compared to the United States, seen in Figure 1. Factors that have been synchronized are unemployment benefits minimum requirements and the elimination of border controls for EU nationals.[2] Holmlund (2014) documents the changes in such laws and their applications for EU member states, and shows that, while policies are in general becoming more similar, significant differences persist.

(Figure 1 here.)

At the same time as labor market structures and policies have converged, there has been a convergence in the movements and levels of macroeconomic indicators such as GDP, inflation, relative prices, current account as a proportion of GDP, consumption, and investment documented by Perri and Quadrini (2011) and Estrada et al. (2013). Figure 1 shows that unemployment rates displayed a similar trend leading into the financial crisis, but diverged slightly post-crisis and during the subsequent recovery. Unemployment rates across EU member states maintained a much higher variation than between US states, and display a similar pattern to a group of OECD countries without EU states included, despite pre-Great Recession convergence

Labor migration within the US is held to be much more fluid than in the EU, but EU labor migration has increased consistently since the creation of the euro as seen in Figure 2. While a majority of respondents to the special Eurobarometer survey on labor mobility in the EU (2009) think that labor mobility and a single labor market at the EU level are good, only 10% have ever lived and worked abroad. Though this is a small number, especially compared

[1]The euro zone is made up of the 19 countries in the European Union that use the euro as their currency. They share a central bank and monetary policy, but not fiscal policy. A full list of member states can be found in Appendix A.

[2]Despite much press to the contrary during the ongoing refugee crisis and Brexit vote, European borders remain fully open to EU nationals.

with mobility in the US, more people move abroad for work every year. Almost twice as many (17%) anticipated working abroad in the future. Increasing migration over time makes understanding this process more important.

(Figure 2 here)

Most Europeans prefer to work abroad for long periods of time, and would rather live abroad than commute across borders for work. Fully 70% of ever-movers in the EU have moved more than once, with 17.5% choosing to move upwards of 4 times. Movement back and forth, as well as permanent moves are common among workers willing to move across borders for work. I will capture this flexibility of location in the model below.

While workers move for a variety of reasons, respondents report that unemployment at home is the single most influential factor in deciding to move abroad for work. Fully 28% of people would move regardless of how the expected wage abroad compared to expected wages at home, and only 39% required at least a matched salary to move abroad. The perception of the probability of finding a job abroad varies by country, and is strongly linked with moving intention, with those viewing the probability highest also having the most serious intentions to move as measured by preparations taken for such a move.

Sending and receiving countries are not uniformly distributed. Bonin et al. (2008) report that Cyprus, Malta, Romania, Bulgaria, Slovakia, and Belgium have the most out-migration into other EU countries with 2.6% to 13.3% of the sending country population living and working abroad in 2007/8.[3] The most popular destination countries from 2000 to 2009 were Germany, the United Kingdom, Spain, Austria, Italy, and the Netherlands due to expected wages, smaller language barriers and a higher perceived probability of finding a job according to the Eurobarometer survey.

In the theoretical model presented here I emphasize the role that even small differences in productivity, job posting and maintenance costs to firms, unemployment benefits, and workers' bargaining power play in determining variation in unemployment across countries. I will incorporate workers' willingness to move more than once, the role unemployment plays in encouraging a move, and the legislative similarities across countries. Using two competitive

[3]Based on a labor force survey conducted from 2007-2008 in the EU.

equilibrium cases and a planner's problem, I distinguish between two types of firm behavior, and the first-best outcome to compare model predictions under the three characterizations as well as with data from the EU.

I find that productivity, job posting costs, and worker's bargaining power differentials can be more important in driving the differences in labor market conditions than previous work has found.[4] One reason I observe a larger impact is the ability to observe each workers' movements where other models focus on market tightness, which in some cases changes less than unemployment and worker allocation across countries due to the concurrent changes in vacancies posted by firms. This can be seen in the comparative statics exercises in Sections 2.1.3, 2.2.3, and 2.4.2 below. There are also large differences in which nationality of workers is impacted from these structural differences in terms of the impact on migrant and native unemployment rates. 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 labor market structures and the effects of different labor market characteristics on unemployment, but I am unaware of any that utilizes labor market differences to explore unemployment in the context of labor search 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

[4]See Nickell (1997, 2006).

European models focusing primarily on within-country and between-country comparisons miss the millions of EU citizens moving across European borders each year.[5]

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 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.

[5]For examples of within-country, European studies see Postel-Vinay and Robin (2002), Gautier (2002), Scarpetta (1996), Jolivet et al. (2006), Nickell (2006), Ridder and Berg (2003), Brücker et al. (2014), Bonthuis et al. (2015), or Hatton and Tani (2005).

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.[6] Empirical studies typically must differentiate across workers' skills in order to estimate any 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.

The search theoretic model with migration in this paper thus joins 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 employment and wage effects on both natives and migrants.

2 Model

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, δ.[7] 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, β_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. To fix ideas, we can think of

[6] For selected others, see Butcher and Card (1991), Gerfin et al. (2010), and Ottaviano and Peri (2012).

[7] 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 δ country- or match-specific.

the foreign country as the most common sending countries (i.e. Cyprus, Malta, Romania, Bulgaria, Slovakia, and Belgium), and the home country as the most common receiving countries (i.e. Germany, the United Kingdom, Spain, Austria, Italy, and the Netherlands), as regional aggregates. 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. Each period, a fixed proportion of matches, δ, are 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 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. Figure 3 shows this from both the workers' and firms' sides. 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 Figure 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.

(Figure 3 here)

I separately examine two competitive equilibrium models: one of "discrimination", and one of "non-discrimination" on the part of employers. 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.

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.[8] 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:

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

where $\theta_k = v_k/u_k$. Market tightness, θ, 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. The segmented markets in the discrimination case make the relevant market tightness defined by worker country of origin, worker unemployment location, and firm location:

$$q_k(\theta_{ij}^k) = (1 + (\theta_{ij}^k)^{Z_k})^{-1/Z_k} \tag{2}$$

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 workers' unemployment location, and k indicates the job matching location. In the least restrictive specification (from the firm's perspective), market tightness, θ, depends on worker origin and current location, i and j, as well as firm location, k. In the more restrictive specification without discrimination it depends only on firm location, k.

2.1 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).

[8]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.

Separate markets mean that the market tightness in each sub-market, θ_{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.[9]

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, rU, 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:

$$rU_{ij} = b_j + \max_k \{\theta_{ij}^k q_{ij}^k(\theta_{ij}^k)(N_{ij}^k - U_{ij}^k)\} \tag{3}$$

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

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

[9] 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.

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, rV, in country k for a worker from country i living in country j:

$$rV_{ij}^k = -c_k + q_{ij}^k(\theta_{ij}^k)(J_{ij}^k - V_{ij}^k) \tag{5}$$

The flow value of a filled vacancy, rJ, 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, $\delta(V - J)$:

$$rJ_{ij}^k = y_k - w_{ij}^k - c_k + \delta(V_{ij}^k - J_{ij}^k) \tag{6}$$

Wages are bargained based on production surplus for the type of match, S, bargaining power, β, 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 the EU in particular, and allows differences in outside options to migration to be reflected in wages through unemployment values. Workers employed in country k always receive share β_k of the match surplus, S_{ij}^k, where $S_{ij}^k = J_{ij}^k + N_{ij}^k - U_{ij} - V_{ij}^k$:

$$w_{ij}^k = \beta_k S_{ij}^k = \beta_k(y_k - c_k) + (1 - \beta_k)rU_{ij} = y_k - c_k - \frac{c_k}{q_k(\theta_{ij}^k)} \tag{7}$$

Firms in country k receive share $(1 - \beta_k)$ of the match surplus:

$$(1 - \beta_k)S_{ij}^k \tag{8}$$

2.1.1 Equilibrium

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. Equilibrium population distribution across countries

is examined in the comparative statics below. The stationary equilibrium can be described in terms of market tightness determined by the labor market bargaining for wages and the free-entry zero-profit condition for firms, $rV = 0$.

Wages can now be characterized by:

$$w_{ij}^k = \beta_k(y_k - c_k) + (1 - \beta_k)rU_{ij} = y_k - c_k - \frac{c_k}{q_k(\theta_{ij}^k)} \tag{9}$$

where the first equality is from the worker's optimization, and the second equality is from the firm's zero-profit condition. After substituting for rU, wages are pinned down by parameters and market tightness.

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:

$$\theta_{FF}^F = \frac{v_{FF}^F}{u_{FF}} \tag{10}$$

$$\theta_{FF}^H = \frac{v_{FF}^H}{u_{FF}} \tag{11}$$

$$\theta_{FH}^F = \frac{v_{FH}^F}{u_{FH}} \tag{12}$$

$$\theta_{FH}^H = \frac{v_{FH}^H}{u_{FH}} \tag{13}$$

$$\theta_{HH}^H = \frac{v_{HH}^H}{u_{HH}} \tag{14}$$

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

$$P_o^F = u_{FF} + u_{FH} + n_{FF}^F + n_{FH}^F + n_{FF}^H + n_{FH}^H \tag{15}$$

$$P_o^H = u_{HH} + n_{HH}^H \tag{16}$$

Job creation and destruction conditions ensure that the total stock of employed and unemployed in each submarket remains constant in equilibrium. For example, Equation (17)

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. The right hand side is the number of foreign workers employed in the foreign country who lose their job. Equations (17) through (21) ensure that every market is in equilibrium:

$$\theta_{FF}^{F} q_{FF}^{F}(\theta_{FF}^{F}) u_{FF} = \delta n_{FF}^{F} \tag{17}$$

$$\theta_{FF}^{H} q_{FF}^{H}(\theta_{FF}^{H}) u_{FF} = \delta n_{FF}^{H} \tag{18}$$

$$\theta_{FH}^{F} q_{FH}^{F}(\theta_{FH}^{F}) u_{FH} = \delta n_{FH}^{F} \tag{19}$$

$$\theta_{FH}^{H} q_{FH}^{H}(\theta_{FH}^{H}) u_{FH} = \delta n_{FH}^{H} \tag{20}$$

$$\theta_{HH}^{H} q_{HH}^{H}(\theta_{HH}^{H}) u_{HH} = \delta n_{HH}^{H} \tag{21}$$

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.

$$\theta_{FH}^{F} q_{FH}^{F}(\theta_{FH}^{F}) u_{FH} = \theta_{FF}^{H} q_{FF}^{H}(\theta_{FF}^{H}) u_{FF} \tag{22}$$

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.

2.1.2 Parameterization

Once the equilibrium conditions are met, it is possible to evaluate the model. While an analytical solution does not exist, a numerical examination is possible. 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, β, 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, δ, 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 1.[10]

(Table 1 here.)

In the baseline calibration, the parameters are chosen to correlate with data values, or with common usage in the literature. Under this, some parameters are restricted in the values they may take in order to ensure an equilibrium with reasonable values for variables exists. Some restrictions may be placed on variables analytically, but most restrictions are due to the particular parameterization choices from the baseline. These cases are given below.

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: $c < y - b$ or 0.335, whichever is smaller, and is kept to positive values.[11]

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.

2.1.3 Comparative Statics

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. The home (usually receiving) country is always at the baseline calibration outlined above, and

[10] Bounds and values were found using a multiple complementarity solver in GAMS.

[11] Negative cost parameters could be used to identify government subsidies to firms wishing to stimulate job growth, but is left out of this paper.

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.[12] Changing the parameters in this way allows for clearer interpretations of the impacts on migration from changes in structural labor market characteristics. Figures 4-18 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 1.

Figure 4 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 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 target-

[12]Values in the home country could also be toggled. Results vary due to the asymmetry of the migration restriction on home workers.

ing 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 7. 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 10 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 13). 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 16 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 overcrowd 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.

2.2 Non-Discrimination

In the discrimination regime, firms hire only one type of worker. Under non-discrimination, firms are only able to 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. The interdependence of the two labor markets 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. Firms in the home country can no longer guarantee that the worker they match with will have a particular outside option as under discrimination.

There are now only two labor markets: one in each country. The interdependence of markets without discrimination continues to generate different unemployment rates given the search frictions.

As under discrimination, 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:

$$rU_{ij} = b_j + \max_k \{\theta^k q^k(\theta^k)(N_{ij}^k - U_{ij}^k)\} \tag{23}$$

The flow value of employment to the worker, rN, remains the discounted value of the wage less the value of moving into unemployment:

$$rN_{ij}^k = w_{ij}^k + \delta(U_{ij} - N_{ij}^k) \tag{24}$$

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:

$$rV_i = -c_i + \frac{q^i(\theta^i)}{(u_{ii} + u_{ij})}[u_{ii}(J_{ii}^i - V_i) + u_{ij}(J_{ij}^i - V_i)] \tag{25}$$

in country i, and

$$rV_j = -c_j + \frac{q^j(\theta^j)}{(u_{ii} + u_{ij} + u_{jj})}[u_{ii}(J_{ii}^j - V_j) + u_{ij}(J_{ij}^j - V_j) + u_{jj}(J_{jj}^j - V_j)] \tag{26}$$

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:

$$rJ_{ij}^k = y_k - w_{ij}^k - c_k + \delta(V_k - J_{ij}^k) \tag{27}$$

Wages are determined exactly as in the discrimination model from Equation (7). Firms in country k receive $(1 - \beta_k)$ of the match surplus as in the discrimination model from Equation (8).

The consolidated markets in the non-discrimination case means that the relevant market tightness and matching are indexed by firm location only:

$$q_k(\theta_k) = (1 + (\theta_k)^{Z_k})^{-1/Z_k} \tag{28}$$

With $\partial q_i/\partial \theta_i < 0$ and $\partial q_i/\partial \theta_j < 0$. Job matching location is indicated by k, where $Z_k > 0$ can be symmetric, or allowed to vary by country of firm location, k.

2.2.1 Equilibrium

Equilibrium in the non-discrimination model is determined as in the discrimination model. Market tightness is defined for each country as:

$$\theta_F = \frac{v_F}{u_{FF} + u_{FH}} \tag{29}$$

$$\theta_H = \frac{v_H}{u_{FF} + u_{FH} + u_H} \tag{30}$$

It is now explicit that the market tightnesses depend on overlapping subsets of the unemployment pool rather than segmented pools as under discrimination.

Equality of job creation and destruction at the country-level is given by:

$$\theta_F q^F(\theta_F)(u_{FF} + u_{FH}) = \delta n_F \tag{31}$$

$$\theta_H q^H(\theta_H)(u_{FF} + u_{FH} + u_H) = \delta n_H \tag{32}$$

The number of migrants into each country must equal the number of migrants out to keep population constant in equilibrium:[13]

$$\theta_F q^F(\theta_F) u_{FH} = \theta_H q^H(\theta_H) u_{FF} \tag{33}$$

[13]This does not imply that populations must be equal.

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:

$$P_o^F = u_{FF} + u_{FH} + n_F + \frac{\theta_H q^H(\theta_H)(u_{FF} + u_{FH})}{\delta} \tag{34}$$

$$P_o^H = u_H + \frac{\theta_H q^H(\theta_H) u_{HH}}{\delta} \tag{35}$$

Given the overlap of the markets, it is now more difficult to track workers' movements and employment status. Workers employed in the home country now must be divided into the two origin groups by inference rather than explicitly counted as before.

2.2.2 Parameterization

The same baseline parameter values are used to evaluate the non-discrimination characterization as were used in the the discrimination characterization (Table 1).

Worker productivity, posting and maintenance costs, and unemployment benefits retain the same analytical and numerical boundaries as in the full discrimination model. The restrictions on the discount rate, and the initial populations, are also unchanged.

Workers' bargaining power is now more restricted and must lie between 0.335 and 0.86. Bargaining between firms and workers breaks down because of workers at share values for workers below 33.5% while firms cause the breakdown when share values for workers are larger than 86%.

Matching elasticity now must be strictly positive rather than larger than 0.33, and the job destruction rate is unbounded outside of definitional bounds.

2.2.3 Comparative Statics

The home country is set to the baseline parameterization as in the full discrimination model, 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 has the same impact on equilibrium

population, market tightness, and unemployment as in the full discrimination characterization (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. As under discrimination, 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 8 illustrates the impact on the non-discrimination characterization from an increase in productivity in the foreign country from parity with the home country to quadruple that of the home country. Qualitative results are similar to the full discrimination equilibrium with some important differences. The first panel shows that despite the same increase in productivity as under full discrimination, more workers move to the home country under non-discrimination. 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.

A similar pattern between discrimination and non-discrimination can also be seen for changes to posting and maintenance costs of vacancies. 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 11). 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 14. 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 17). 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 very little relatively 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. They are no longer insulated by firms' targeting behaviors. 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. Again, more workers are migrating to the home country on average than is observed in the data.[14] The

[14]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.

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 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.

2.3 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 4 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 4 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 7 and 8 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 10 and 11. 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, po-

tentially 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 13 and 14 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 home country without risking matching with foreign migrants demanding higher wages from their outsize bargaining power in the foreign country. Figures 16 and 17 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.

2.4 Efficient Allocations

Finally, 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.[15] 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 possible to reach the equivalent condition for each market individually due to market and worker heterogeneity, and worker ability to change type.[16]

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:

$$\int_0^\infty e^{-rt}[(y_F - c_F)n_{FF} + (y_H - c_H)(n_{FH} + n_{HH}) + b_F u_{FF} + b_H(u_{FF} + u_{FH}) \\ -c_F\theta_F(u_{FF} + u_{FH}) - c_H\theta_H(u_{FF} + u_{FH} + u_{HH})] \tag{36}$$

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.

[15] See Hosios (1990).

[16] 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 is subject to the laws of motion for unemployment:

$$\dot{u}_{FF} = \delta n_F - \theta_F q_F u_{FF} \tag{37}$$

$$\dot{u}_{FH} = \delta n_{FH} - \theta_F q_F u_{FH} - \theta_H q_H u_{FH} \tag{38}$$

$$\dot{u}_{HH} = \delta n_{HH} - \theta_H q_H u_{HH} \tag{39}$$

$$\dot{n}_{FF} = \theta_F q_F (u_{FF} + u_{FH}) - \delta n_{FF} \tag{40}$$

$$\dot{n}_{FH} = \theta_H q_H (u_{FF} + u_{FH}) - \delta n_{FH} \tag{41}$$

$$\dot{n}_{HH} = \theta_H q_H u_{HH} - \delta n_{HH} \tag{42}$$

These six constraints represent the same evolution of employment and unemployment as in the competitive equilibrium. The planner is also subject to the equilibrium conditions as under non-discrimination on population, market tightness definitions, and migration which ensure a stationary equilibrium Equations (29), (30), (31), (32), (33), (34) and (35).

Wages are determined exactly as in the competitive equilibrium models shown in equation (7), with firms and workers sharing the surplus of the match according to worker's bargaining productivity, β_k while firms in country k receive $(1 - \beta_k)$ of the match surplus, although the planner is indifferent to the sharing rule.

2.4.1 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. Bounds on productivity, posting and maintenance costs, unemployment benefits, and population are unchanged from the competitive equilibria. Matching elasticity must now be larger than 0.2. The discount and job destruction rates are unbounded aside from definitional restrictions between zero and one. Additionally, there is no role for workers' bargaining power. The planner is unconcerned with how the surplus is distributed between workers and firms.

2.4.2 Comparative Statics

Allocation of equilibrium population between countries is the same under the planner as in the competitive equilibria 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 9 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 12. 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 15). 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 18 shows that the planner does not react to changes in workers' bargaining 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. Populations, market tightness, and unemployment do not vary with bargaining power under the planner.

2.5 Planner vs Non-Discrimination

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 8 and 9), 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 9 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 11 and 12 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 14 and 15. 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 14 and 15 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 market, 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 17 and 18 show that while the planner chooses a 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.

3 Approximating the Data

In order to assess the power of the model in predicting the patterns seen in the data, I assign the most common sending and receiving countries for within EU migration to be the foreign and home countries. I then average the parameter values within each group taken from data and the literature. Parameter values are taken as the most recent available from Eurostat,

the OECD, Campolmi and Faia (2011), and Nickell and Nunziata (2000). The home group values are normalized when appropriate to ease comparison interpretations.

The countries sending the most workers to other EU countries are Cyprus, Malta, Romania, Bulgaria and Slovakia according to Bonin et al. (2008). The most common destination countries for all intra-EU migrants are Germany, the United Kingdom, Spain, Austria, Italy and the Netherlands. While the typical sending country group displays a tendency to concentrate in the eastern part of the EU and the receiving cluster in the western part of the EU, these are not the only migration patterns, as seen in Figure 2.

Actual populations in the data are used for initial populations in the home country, while the foreign country is augmented to be approximately the current population plus the approximately 10% who have migrated from the Eurobarometer survey. Population is then normalized to 1 in the receiving group of countries, with sending countries' populations relative to the receiving ones.

I estimate productivity as the normalized real labor production per hour worked from the Eurostat database, 2013. The foreign value is set to approximately one third the value of that in the home country based on group averages. There is a large difference in measured productivity between the most common sending and receiving countries in the EU. This differential likely generates much of the migration from the foreign country in the model. While the baseline calibrations above do not highlight the region where the home country productivity is three times that of the foreign country, Table 3 shows the results of such a large imbalance, and the difference is included in Figures 7, 8, and 9 from the baseline parameterization.

Unemployment benefits are taken from Campolmi and Faia (2011), and Nickell and Nunziata (2000). Variation in jobless benefits is fairly large across EU countries, despite EU legislative requirements pushing for unification. The differences within groups impact overall flows of migrants in the data, but unfortunately, the group averages used here do not reflect this variation well.

Vacancy costs are assigned the baseline value of the parameterizations above in line with Albrecht and Vroman (2002). I set these as symmetric values due to the high convergence

documented in restrictions on firms at the national level documented in Bonin et al. (2008). While differences between permanent and temporary workers, as well as variation in practice certainly persist in practice, these are difficult to estimate with accuracy in this framework.

Workers' bargaining power is taken as the labor cost as a proportion of total costs of production from Eurostat. This is an important structural characteristic in the model, but varies only slightly across EU countries as measured here. Labor unions and worker's rights have a large impact on the expected income of both natives and migrants, and play a large role in determining where migrants choose to locate. A recent ruling by the European Court of Justice eliminated the use of temporary migrant contracts by firms in an effort to pay migrant workers below the market rate when those workers are contracted from their home country. This use of "posted" workers was argued to edge out local workers since they were required to pay local union wages rather than the lower wage contracted through the process of posting. Poles, Hungarians, and other central and eastern Europeans were the largest group of posted workers seen as being exploited by the practice.

The elimination of posting makes local union bargaining power that much more important in determining where migrants choose to search for work. The higher value of bargaining power in the sending countries results in higher unemployment there, making the lower bargaining power in receiving countries more attractive due to the lower unemployment and higher probability of finding a job upon migration. This potentially counter-intuitive result is reflected in the results in this exercise as well as in the baseline parameterizations of the three regimes above.

Wages are taken as the group average of median annual earnings of full-time workers divided by GDP per capita in 2014 from Eurostat. The normalized home country wage is then 1.255, while the foreign country wage is 1.041. The group wages for the home country in the data are much more similar across countries than for the foreign country. There are no obvious outliers between Germany, the United Kingdom, Spain, Austria, Italy and the Netherlands. Cyprus and Malta look more like the home country than like Romania, Bulgaria, and Slovakia. Data are unavailable by immigrant status within the Eurostat database at this time, so country-level averages are the most disaggregate data available.

Matching elasticity, the discount rate, and the destruction rate are the same in both countries since EU countries share monetary policy, and overall labor market structures are similar. It is not unrealistic to think the job destruction rate might vary across countries, but the model does not allow for this. Matching might also vary at the country-level, but it is unclear whether or how this would differ systematically across sending and receiving countries, particularly for the groups shown here. Table 2 shows the parameter values chosen for each group of countries.

(Table 2 here)

I limit this section to comparing the non-discrimination and planner's outcomes with the data given that non-discrimination is expected to more accurately reflect legal restrictions on firm recruiting behaviors as well as the interest in examining the difference between actual outcomes and optimal outcomes from the benevolent planner.

Table 2 supports evidence from Bonin et al. (2008) that many labor market structures are quite similar across the sending and receiving countries, at least in aggregate. Bargaining power does not vary significantly within group. Unemployment benefits vary more, but legislation mandates that existing differences converge over time, and so should decrease without further action. The productivity differential in aggregate is large, but does not vary within the groups as much as between them.

Table 3 shows equilibrium outcomes of market tightness, unemployment rates, and equilibrium population under non-discrimination and the planner. Both versions of the model predict that no workers will choose to stay in the foreign country. This results in no open vacancies maintained, and therefore zeroes for market tightness, unemployment rate and population in the foreign country. The productivity differential in reality is too great for the model to allocate any workers in the foreign country regardless of restrictions on firm behavior. Market tightness is also overestimated in the home country compared to the data. The model anticipates that firms will maintain more open vacancies than they actually do. Unemployment rates in the home country are overestimated by non-discrimination and under estimated by the planner. This is one indication that perhaps European labor markets are closer to optimal allocation than the non-discrimination model outlined in this paper.

(Table 3 here)

The driving force for the inequality of worker distribution for this parameterization in the model is the productivity differential. However, even if foreign productivity were to increase to only half as large as in the home country, the model would still allocate all workers in the home country. When workers face no explicit costs to movement, and implicit costs are externalities associated with migration as in the search framework here, foreign productivity would need to be at least 60% as large under non-discrimination, and at least 85% as large under the planner, as home productivity in order for either characterization of the model to allocate any workers in the foreign country, given the other parameters.

Wages for workers vary significantly within and between countries. Workers in the home country always receive a higher wage- owing largely to the productivity differential. Workers in the foreign country receive a higher wage if they never migrate than if they leave and subsequently return. Compared to the data, the model prediction for within-country average wages are too low in the foreign country, and too high in the home country.

This points to one avenue of policy that countries can employ to keep workers at home: increasing productivity both decreases out migration, lowers unemployment for those who stay, 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[17] from other countries could provide FDI in common sending countries that works toward improving productivity abroad. Aside from efforts to improve productivity in common sending countries, the EU could also work to decrease labor market frictions for matching, and to open up all markets to be more flexible. 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.[18]

[17]Many would argue that the Brexit vote was driven by anti-immigrant sympathies among lower skilled Brits.

[18]Further exercises on how changes in parameters away from the approximations shown here support the above policy analysis, and are available from the author upon request.

4 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 EU states. Even with costless migration, and symmetric labor markets, unemployment rates across countries and regions remain highly dependent on labor market structural characteristics. When the model is parameterized to match structural values from the data, the model generates movement of labor larger than that observed in the data, but fails to match any equilibrium values we observe. The numerical example shows large differences in unemployment even when limited migration is allowed.

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 allows 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. Fostering a healthy business environment may have played a larger role in unemployment equalization in the US than previously recognized in the literature. 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.

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5 Figures & Tables

Figure 1: Global Unemployment Rates and Variation

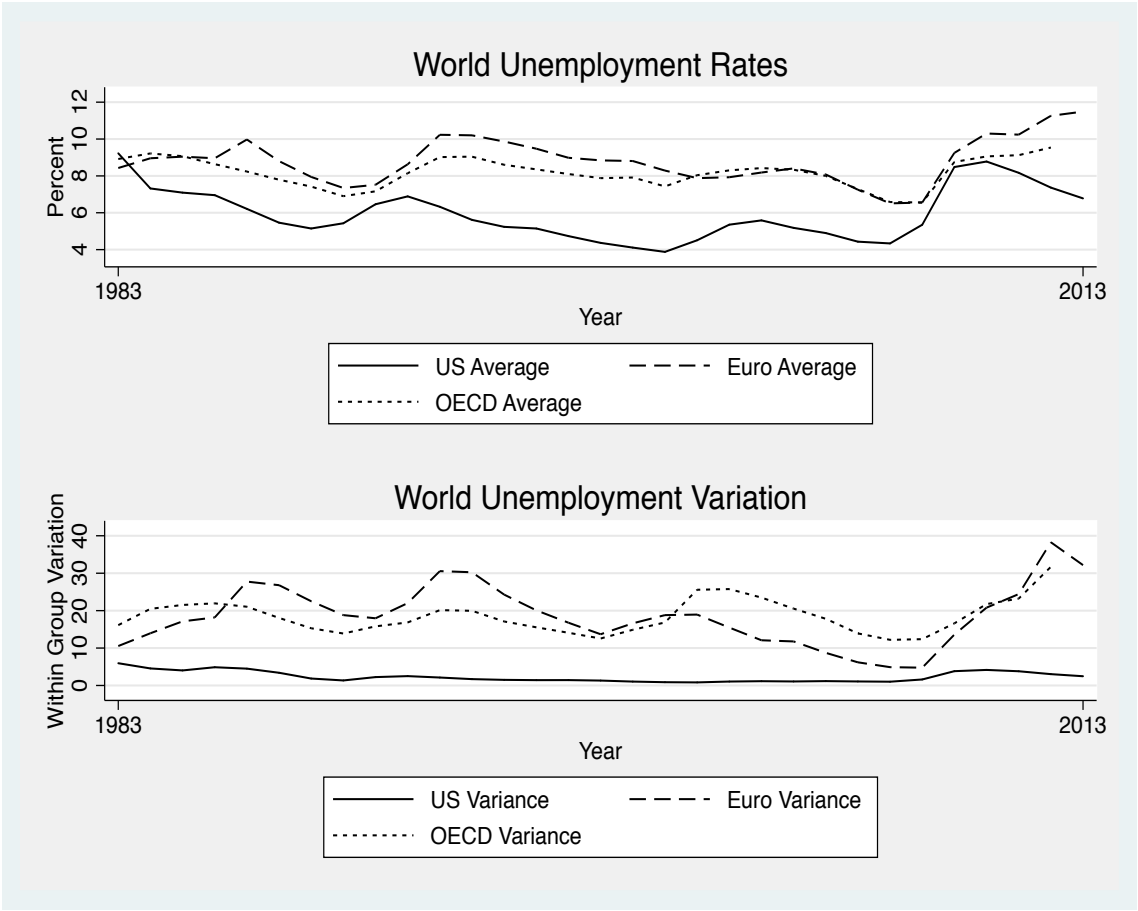


Figure 2: Intra-EU Labor Migration by Region

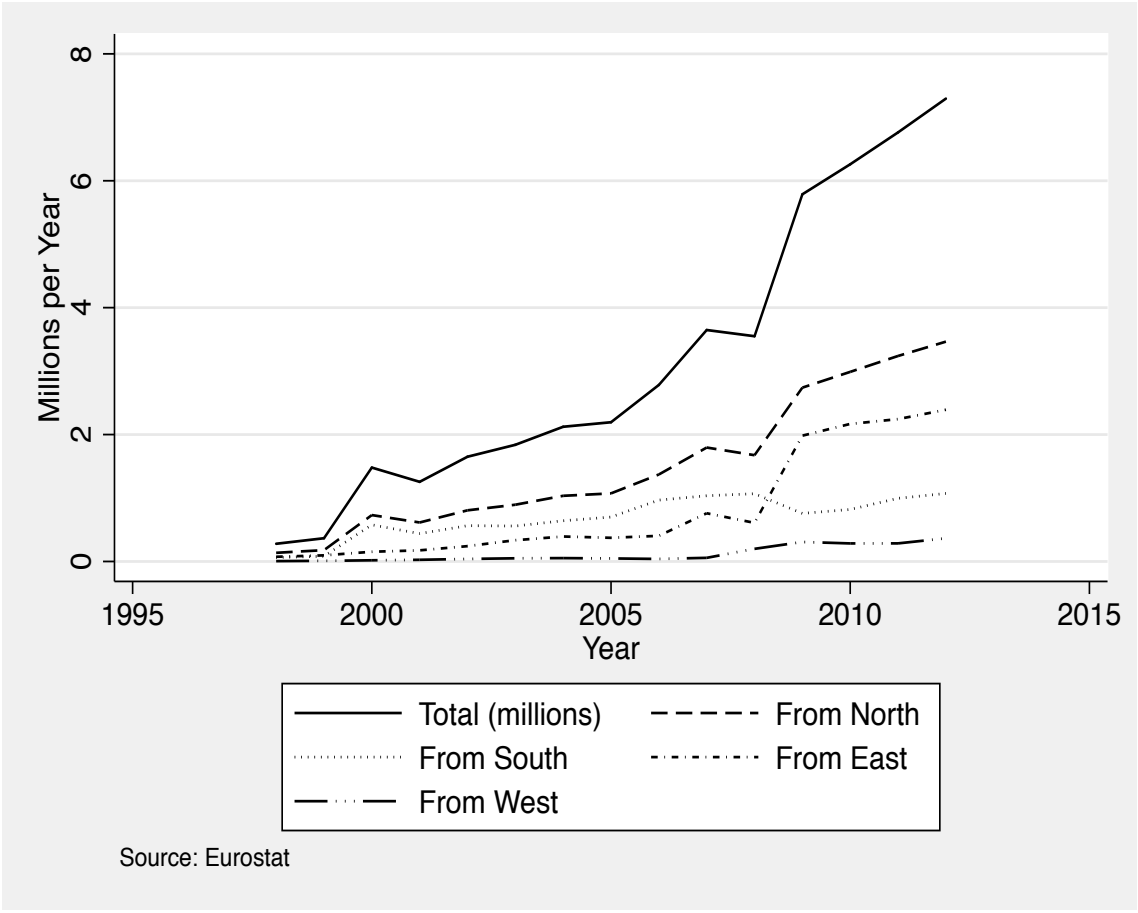
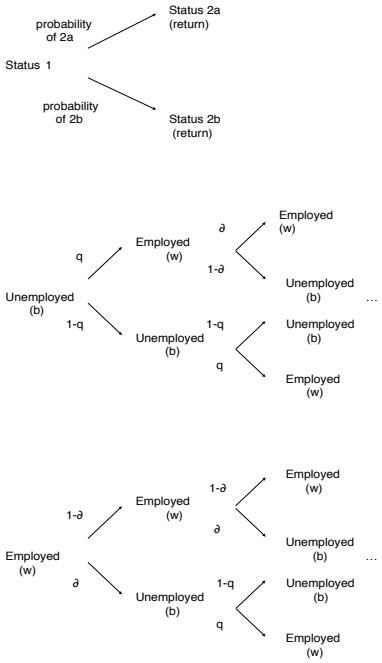


Figure 3: Timing in the Model



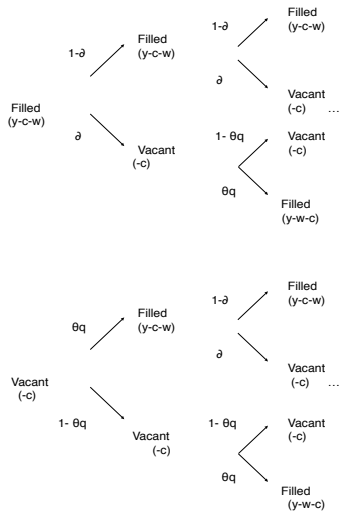


Figure 4: Full Discrimination Changing Initial Population

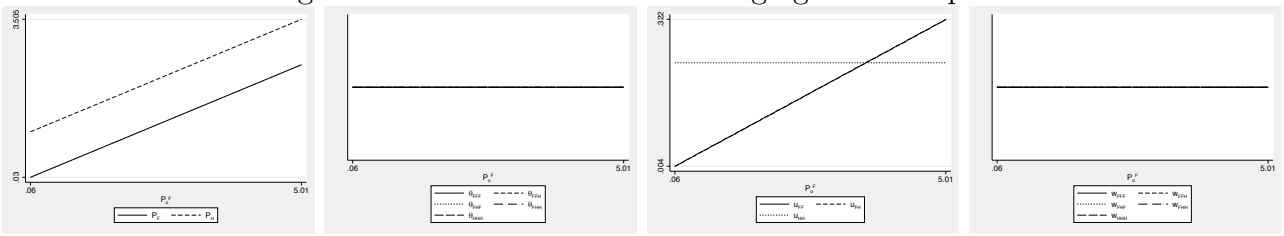


Figure 5: Non-Discrimination Changing Initial Population

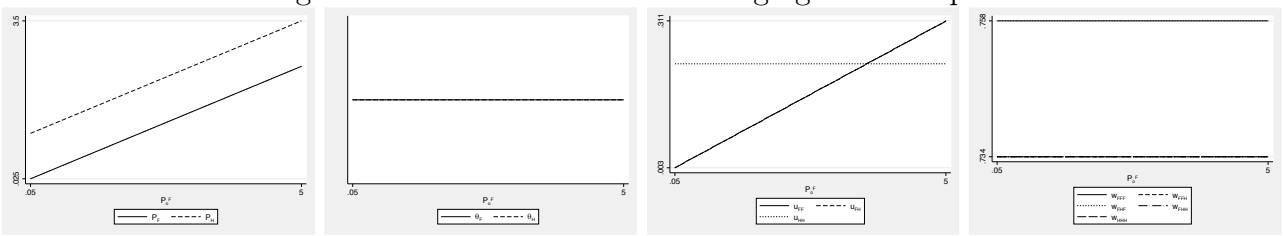


Figure 6: Planner Changing Initial Population

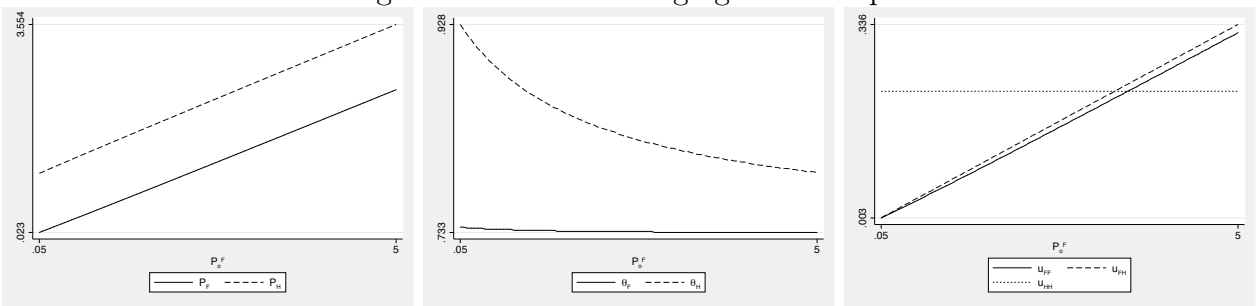


Figure 7: Full Discrimination Changing Productivity

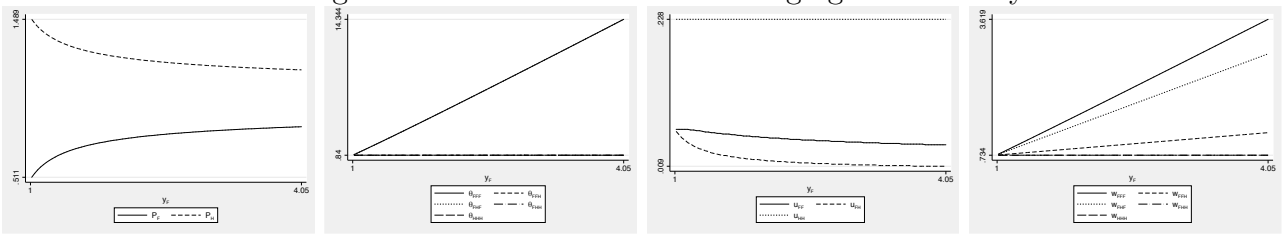


Figure 8: Non-Discrimination Changing Productivity

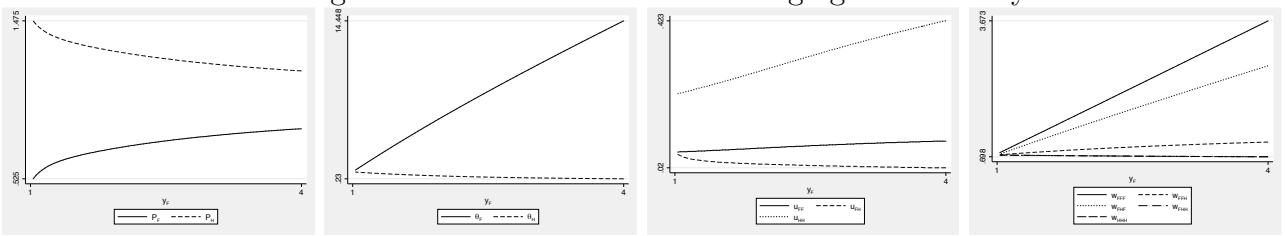


Figure 9: Planner Changing Productivity

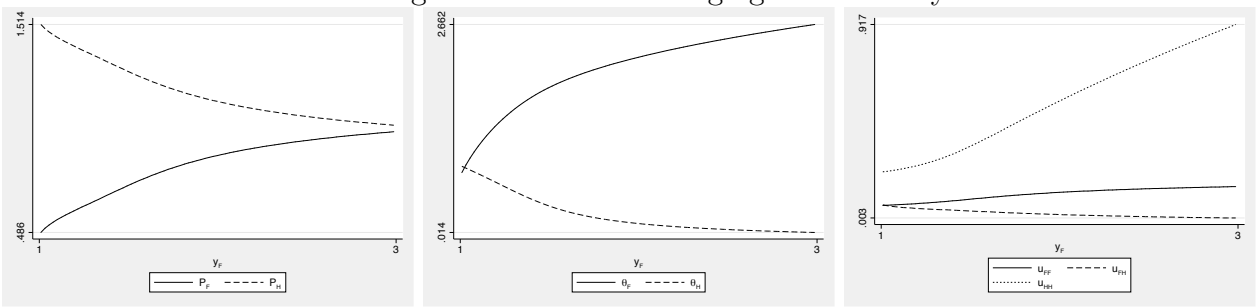


Figure 10: Full Discrimination Posting and Maintenance Costs Changing

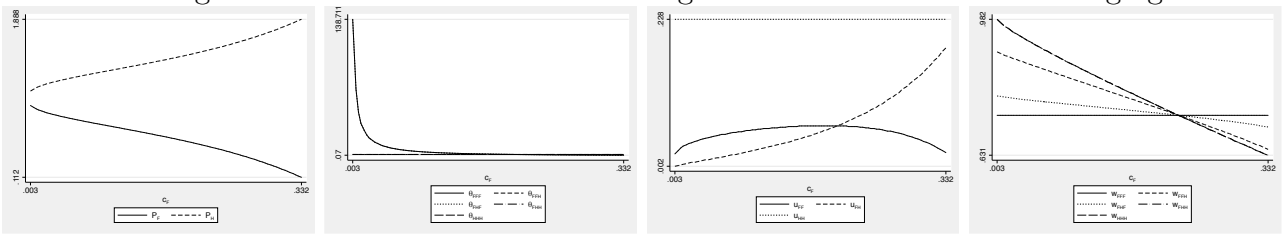


Figure 11: Non-Discrimination Posting and Maintenance Costs Changing

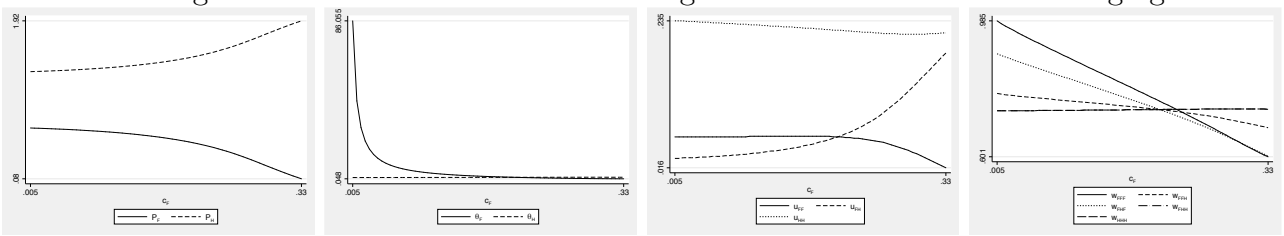


Figure 12: Planner Posting and Maintenance Costs Changing

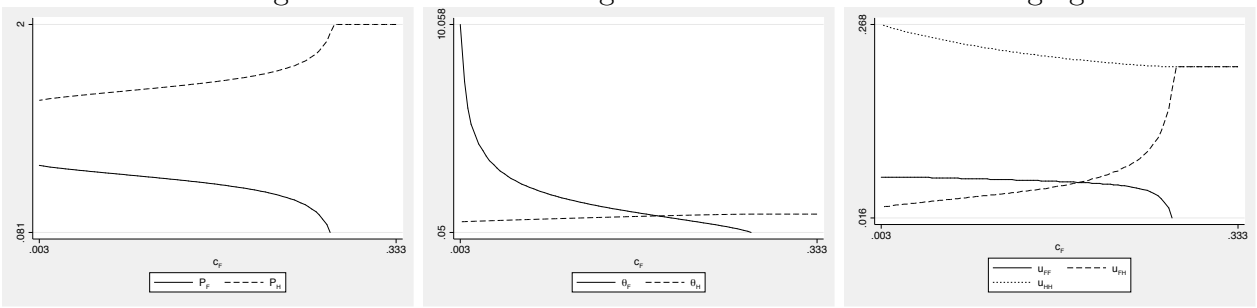


Figure 13: Full Discrimination Changing Unemployment Benefits

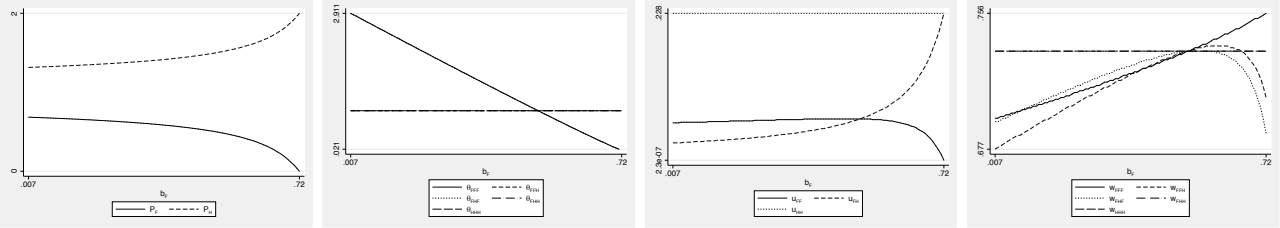


Figure 14: Non-Discrimination Changing Unemployment Benefits

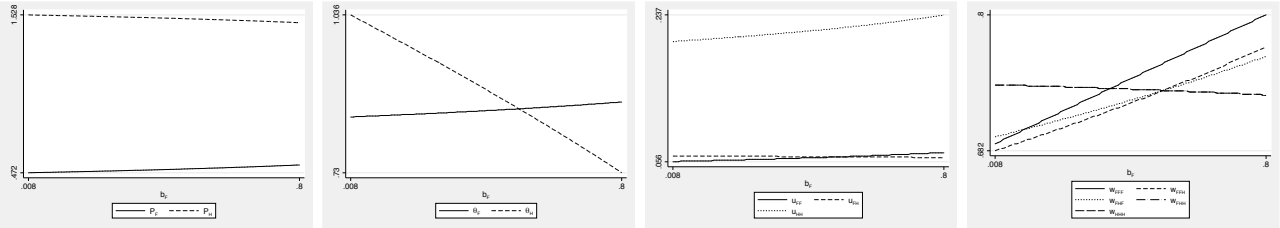


Figure 15: Planner Changing Unemployment Benefits

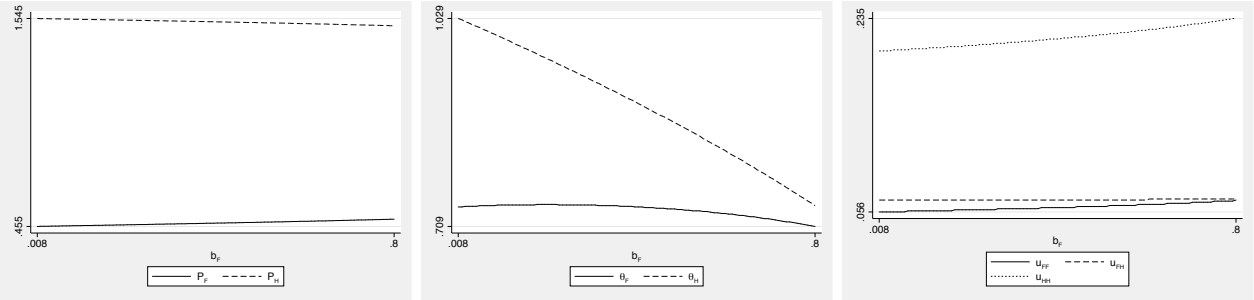


Figure 16: Full Discrimination Changing Bargaining Power

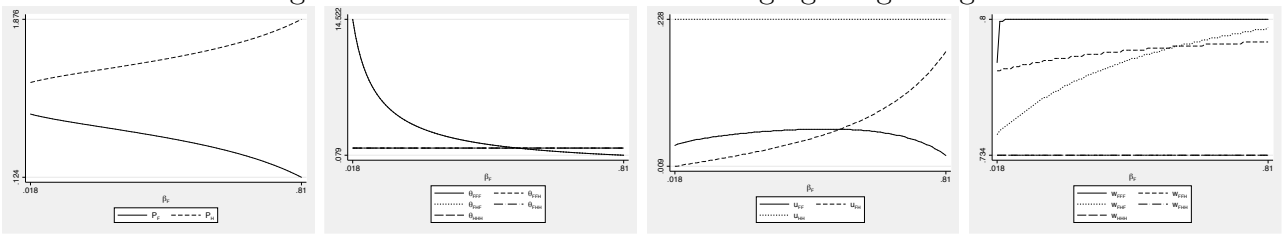


Figure 17: Non-Discrimination Changing Bargaining Power

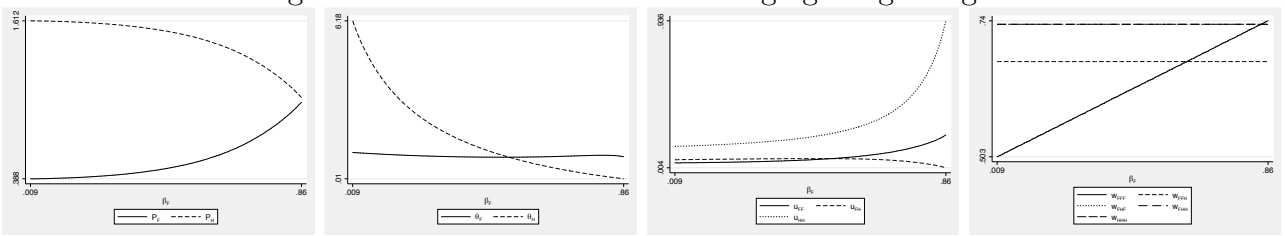


Figure 18: Planner Changing Bargaining Power

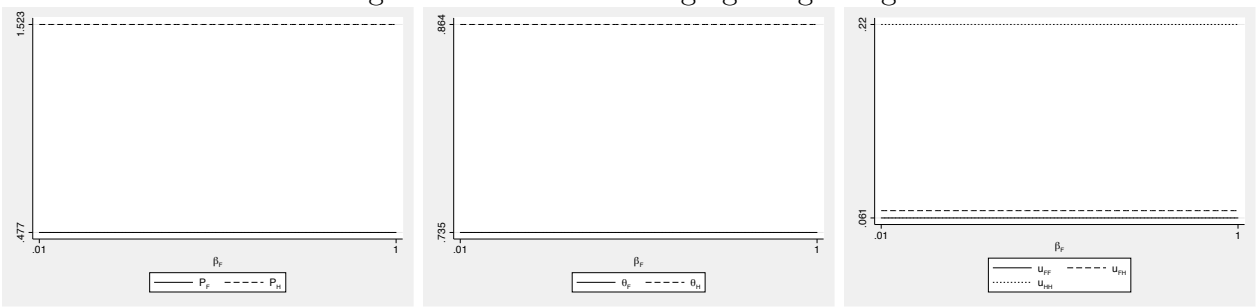


Table 1: Baseline Parameterization

Parameter	Value H, F
y	1
b	0.5
c	0.2
β	0.5
Z	1.25
r	0.05
δ	0.15
P	1

Table 2: Approximation of Data Parameterization

Parameter	Value H, F
y	2, 0.7
b	0.5, 0.4
c	0.2
β	0.75, 0.82
Z	1.25
r	0.05
δ	0.15
P	1, 0.16

Table 3: Approximation of Data Equilibrium Values

Model	θ_F	θ_H	u_F	u_H	P_F	P_H
ND	0.0	1.567	0.0	0.176	0	1.16
PP	0.0	1.993	0.0	0.023	0	1.16
Data	0.0607	0.181	0.0882	0.0906	0.14	1

Table 4: Approximation of Data Equilibrium Wages

Model	w_{FFF}	w_{FFH}	w_{FHF}	w_{FHH}	w_{HHH}	avg. w_F	avg. w_H
ND	0.5	1.517	0.482	1.713	1.713	0.491	1.648
Data						1.041	1.255

Appendix A

Country Classifications

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

OECD: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

OECD not EU or US: Australia, Canada, Chile, Iceland, Israel, Japan, Korea, Mexico, New Zealand, Switzerland, Turkey

OECD close partners: Brazil, China, India, Indonesia and South Africa (included in OECD unemployment data as they are expected to join in the near future and constitute a significant portion of the world economy).