Unionizing Non-Search Unemployment

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Abstract

This paper explores the effects of unionization in an island model of Lucas and Prescott (1974) with different union structures. When a model with competitive labor markets is set to match the empirical fact that a large number of unemployment spells ends with recalls, an introduction of a large labor union, that represents all workers and sets a common economy-wide minimum wage, increases unemployment substantially. Moreover, the whole increase is about non-search unemployment as search unemployment actually reduces marginally. If the same degree of unionization is generated by a continuum of small unions, the aggregate unemployment reaction is somewhat smaller. However, the increase in non-search unemployment is still considerable.

1 Introduction

The existence of powerful labor unions is a prominent feature of labor markets across a wide variety of countries and industries. Typically, these unions have an influence over a large group of firms with varying conditions, an extreme example being the nationwide cooperation over the whole economy sometimes applied, for example, in the Nordic countries. Quite often the unions seem to be unable or unwilling to take into account these varying local conditions potentially leading to increased unemployment. On the other hand, as some studies suggest, the increased coordination and better internalization of the adverse effects can lead to a preferable outcome compared with a set-up where many unions operate independently[1].

Somewhat surprisingly, studies that explore the issue in an equilibrium set-up, while modeling unemployment explicitly, are scarce. In this paper, I examine the workings of a large union by assuming that it sets a common minimum

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[1]For example, the study by Calmfors and Driffill (1988) suggest that cost of centralized wage setting systems are hump shaped, the extremes working the best.

wage over heterogeneous firms. Moreover, moving frictions between firms with different productivities generate search unemployment and prevent the instant reallocation of labor force over production units. In order to gain a better understanding of the potential advantages and disadvantages of a large union, I compare this with a case where there is a continuum of small unions that focus solely on their members and take the rest of the economy as given, but take the local conditions into account.

A major feature in the analysis is the fact that I allow unemployed workers to engage in non-search unemployment. Recent time diary studies have revealed that unemployed workers spend surprisingly little time looking for a job[2]. A potential explanation is that unemployed workers have a high probability of landing a job even without active search. In line with this, Fujita and Moscarini (2017) show that recalls are extremely common, widely exceeding the amount of temporarily laid off workers. However, the commonly used models of unemployment are based on an assumption of active search by the unemployed, a notable exception being Alvarez and Shimer (2011) who use an analytically tractable island search model and show that in order to explain the large wage differences between sectors, non-search unemployment has to be prominent. Additionally, Fujita and Moscarini (2017) and Fernandez-Blanco (2013) analyze non-search unemployment using the search and matching models à la Mortensen and Pissarides, while Shimer (2007) shows that many business cycle properties of unemployment can be generated with a model where non-search unemployment is the only form of unemployment.

Unions offer a powerful mechanism of generating non-search unemployment in a frictional labor market. When a union sets a minimum wage, it rations the job supply in firms where the productivity is low. However, as the upper tail of the wage distribution is unaffected, the returns of search do not change substantially. Given that non-search unemployment is less costly than search unemployment, an idea supported by the time diary evidence of Krueger and Mueller (2011), this should imply that a large part of the increased unemployment is non-search unemployment. The theoretical work of Alvarez and Shimer (2014) about the connections of non-search unemployment and unions suggests that this type of mechanism is indeed strong.

The cross-country comparison of Krueger and Mueller (2012) offers support for the idea that different labor market institutions and policies are important for unemployed search activity as they report large differences in the time devoted to search by unemployed workers. Interestingly for the mechanism outlined above, search intensities are relatively low in Europe where the labor unions are traditionally strong. For example, in the US and Canada, unemployed workers spend more than eight times more time on search than in the Nordic countries. Moreover, Krueger and Mueller (2012) also find that income variability is a strong predictor of search intensity. This, together with the empirical evidence of labor unions suppressing wage distributions[3], further suggests that

[2]See, e.g., Krueger and Mueller (2010)
[3]See Card, Lemieux and Riddell (2003)

the connection between unionization and non-search unemployment could be empirically relevant.

In order to explore the role of unionization, I formulate an equilibrium island model à Lucas and Prescott (1974) where firms and workers meet in locally competitive labor markets with varying conditions. In the economy with a large labor union, this union is assumed to set an archipelago-wide minimum wage.[4] In locations where this minimum wage is binding, jobs are rationed to a point where firms are willing to pay the minimum wage. Workers are attached to a certain local labor market. Moving between labor markets is possible but it takes time. Following Alvarez and Veracierto (1999), the search between islands is undirected. Moreover, instead of just working or searching, agents can also, as in Alvarez and Shimer (2011), stay inactive in their current labor market and enjoy increased leisure. Alvarez and Shimer (2011) call this type of unemployment rest unemployment. The objectives of the union and the workers differ in the sense that workers concentrate on their income maximization while the union looks at the consumption and the leisure of all workers. This means that the union has to take the workers incentives into account.

I also compare the case of a large union with a set up where there is a continuum of island specific unions. These unions are able to modify their policies according to local conditions and take the rest of the economy as given. Moreover, they only care about the workers that stay on the island. This, together with the assumption that rents are not shared equally between members, means that unions are not willing to restrict employment when the real wage is low, as some of their members might reallocate and become members of another union. Unions also find it optimal to allow all agents present to work when the wage is high enough.

When the model without a large union is made consistent with the empirical observation of Fujita and Moscarini (2017) that a large number of unemployment spells ends with recalls, the introduction of a large labor union representing all workers increases unemployment by 22.4%. The whole increase is non-search unemployment. This implies that unionization substantially drops unemployed workers search intensity. If the union is assumed to bargain over wages with a large union of firms, arguable a more empirically relevant scenario, the aggregate unemployment responses are not as severe, but non-search unemployment still increases substantially. For example, 50-50 Nash bargaining solution, yields to a unemployment rate that is "only" 4.4 percent higher than the unemployment rate in the laissez-faire economy.

The structure of unionization matters; the aggregate unemployment increases by about 17% as response to a continuum of small unions. Thus the unionization with a small unions is causing a smaller response in aggregate unemployment even though these unions do not internalize the aggregate effects of their actions. The key to this is unions desire to avoid losing members when the local labor market conditions are weak. Due to this reason unions find it

[4] As Krusell and Rudanko (2016) point out one can understand a large union set-up representing to the whole economy or think about it as an industry equilibrium where moving between industries is difficult.

optimal to restrict labor supply only in in a small range at the middle of the wage distribution. However, the whole increase in aggregate unemployment is still caused by non-search unemployment.

There are a few papers that study the effects of labor unions which model unemployment in an equilibrium framework. Alvarez and Veracierto (1999) explore, among other things, the effects of small labor unions in an island model. They look at the effects of unions when the gains of unionization are shared equally between all members, a coalition model, and when the monopoly rents are paid to a union boss. They find that while the coalition model leads to a strong increase in unemployment, the union boss model decreases unemployment.

In terms of concentrating on the connection between non-search unemployment and labor unions, my analysis is close to Alvarez and Shimer (2014). They explore the workings of unions in an island economy when unions apply strict seniority rules in hiring and firing decisions. They utilize a continuous time model where island specific productivities follow a geometric Brownian motion. This allows them to solve the model analytically. My work can be seen as complementary to theirs, as my focus is on the quantitative side of unionization and non-search unemployment, while also taking into account the large recall rate that implies that non-search unemployment has to be considerably less costly. Another difference is that while they explore the effects of small, the US style, unions, my focus is on the union structure more common in Europe where a large union is having an influence over a large group of varying firms.

There are also some studies that analyze the effects of a union in Mortensen-Pissarides models. Pissarides (1986) studies the effect of a union in a steady state of a canonical search and matching model, exploring conditions under which a large union internalizes the congestion externality, while Krusell and Rudanko (2016), explore the dynamic effects of a large union. Both of these papers, however, abstract away from firm heterogeneity, the main focus of this paper.

The rest of the paper is organized as follows. Section 2 represents the model with and without labor unions. Section 3 states the calibration of the model. While results are given in Section 4. Finally, Section 5 concludes.

2 Model

This section introduces the model used to explore the effects of unionization. The basic framework is essentially a standard island model in discrete time à la Lucas and Prescott (1974) and Alvarez and Veracierto (1999). Following Alvarez and Shimer (2011 and 2014), I allow non-search unemployment that is less costly than search unemployment in terms of flow values and allows workers to stay in touch with their current local labor market.

2.1 General environment

There is a mass one of infinitely lived workers distributed along a continuum of separate locations, islands, index by $i \in [0,1]$. On location i, there are $x_t(i)$ workers present at the beginning of period t. During the period, out of these agents $n_t(i)$ work, $r_t(i)$ are non-search unemployed and $x_t - n_t - r_t$ search for a new location. Agents who work or engage in non-search unemployment, start the next period in their current location, while searchers are randomly dropped on a new island at the beginning of the next period.

Each location produces identical goods and the production technology on each location is characterized by a production function of the form

$$y_t(i) = z_t(i)n_t(i)^{\alpha},$$

where $0 < \alpha < 1$ and the productivity shock, $z_t(i)$, is independent across locations. The logarithm of the productivity follows an AR(1) process

$$log(z_t(i)) = (1-\rho)a + \rho log(z_{t-1}(i)) + \varepsilon_t, \qquad \varepsilon_t \sim N(0,\sigma^2), \tag{1}$$

where $0 < \rho < 1$.

Each worker belongs to a large family that gives them a full insurance against idiosyncratic shocks. The family's utility function is given by additively separable balanced growth path consistent preferences as follows

$$\sum_{t=0}^{\infty} \beta^t (ln(C_H) + b_r U_r), \tag{2}$$

where C_H is the amount of market goods consumed and U_r is the amount of non-search unemployed workers, while b_r is the flow value of increased leisure that non-search unemployed can get and $\beta \in [0,1]$. I have dropped the time indices from the aggregate variables as I will focus on stationary equilibria. Following Alvarez and Shimer (2011), I assume that searching is more costly than non-search unemployment in the sense that the searchers are not able to enjoy increased leisure.

I assume that there is a mass one of capitalist who owns the firms and to whom the profits are paid. This implies that the household can only use wage income to finance its consumption, i.e.,

$$\int_0^1 w_t(i)n_t(i)di = C_H, \tag{3}$$

where $w_t(i)$ is the wage rate, to be specified in later subsections, in location i.

The amount of agents working and engaging in non-search unemployment is restricted by the mobility frictions and thus cannot be larger than the amount of workers present at location i at the beginning of the period, i.e.

$$n_t(i) + r_t(i) \leq x_t(i).$$

Given the insurance, each family member makes decisions about whether to work, stay on the island without working or search in a way that the discounted present value of flow payoffs is maximized.

The indirect search implies that the amount of workers present at the beginning of the next period will be

$$\mathbf{m}_{t+1}(i) = (m_{1,t+1}, m_{2,t+1}) = (n_t(i),\, r_t(i) + U_{s,t}), \tag{4}$$

where $U_{s,}$ is the amount of searchers in the economy. Given this, the beginning of period labor force in location i is

$$x_t(i) = \mathbf{m}_t(i) * \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

The aggregate amount of non-search unemployment is given by

$$U_r = \int r_t(i)di \tag{5}$$

and the aggregate employment rate is

$$N = \int_0^1 n_t(i)di \tag{6}$$

As I do not allow for the possibility of out of labor force, the amount of searchers is given by the aggregate feasibility condition

$$N + U_s + U_r = 1. \tag{7}$$

2.2 Competitive local labor markets

In this subsection, I set up the benchmark wage mechanism under which a large amount of workers and firms meet in competitive local labor markets in each location. Wages are then determined competitively. That is

$$w_t(x, z) = \alpha z_t n_t(x, z)^{\alpha-1}. \tag{8}$$

Since workers can costlessly move between non-search unemployment and work, the wage rate measured in units of marginal utility cannot be smaller than the flow value of non-search unemployment

$$b_r \leq w_t(x, z)\frac{1}{C}. \tag{9}$$

As in Alvarez and Shimer (2011), non-search unemployment is generated when the wage rate measured in units of utility would be lower than the flow value of leisure given that all workers that are willing to stay would work. In this case, the amount of agents working adjusts to a level that ensures that flow values work and non-search unemployment are equal and workers engaging in non-search unemployment and work are indifferent between the two activities.

The voluntary nature of non-search unemployment also means that it is not necessary to keep track of workers employment statuses. The relevant location specific state variables are the beginning of the period labor force $x_t(i)$ and productivity $z_t(i)$. An agent in location (x,z) has to decide whether to work, engage in non-search unemployment or search. The problem of an agent can be described with the following Bellman equation

$$\begin{aligned} V(x,z) \quad = \quad & max\{\omega(n(x,z)) + \beta \int V(x'(x,z),z')Q(z,dz') \\ & b_r + \beta \int V(x'(x,z),z')Q(z,dz'), \theta\} \end{aligned}$$

where $x'(x,z) = n(z,x)+r(x,z)+U_s$, $\omega(n(x,z))$ is the wage rate measured in the units of marginal utility, i.e., $\omega(x,z) = \frac{1}{C}w(x,z)$ and $Q(z,dz')$ is the transition function for the productivity shocks. Moreover, individuals take policies $n(x,z)$ and $r(x,z)$ as given.

At the equilibrium, policy functions have to be consistent with the individual decisions[5]

1. If $n(x,z) = x$ and $r(x,z) = 0$ then $V(x,z) > \theta$ and $\omega(n(x,z),z) > b_r$.
2. If $n(x,z)+r(x,z) = x$ and $n(x,z) < x$ then $V(x,z) > \theta$ and $\omega(n(x,z),z) = b_r$.
3. If $n(x,z) < x$ and $r(x,z) = 0$ then $v(x,z) = \theta$ and $\omega(n(x,z),z) > b_r$.
4. If $n(x,z)+r(x,z) < x$ and $r(x,z) > 0$ then $v(x,z) = \theta$ and $\omega(n(x,z),z) = b_r$.

The workers' policy rules together with the search technology and the law of motions for productivity, stated by condition (1), generate a stationary distribution of islands

$$\mu(X',Z') = \int_{\{(x,z):(n(x,z)+r(x,z)+U_s)\in X'\}} Q(z,Z')\mu(dx,dz), \tag{10}$$

for all sets of beginning of the next period labor forces, X', and productivities, Z'. Given the stationary measure, the value of search satisfies

$$\theta = \beta \int V(x,z)\mu(dx,dz). \tag{11}$$

The competitive stationary equilibrium, conditional on the general structure stated in the previous subsection[6], is such that workers' value functions satisfy the Bellman equations above and the island specific employment,$n(x,z)$, and non-search unemployment rules, $r(x,z)$, are consistent with conditions 1-4. Wages are defined by equations (8) and (9), the agents behavior together with the productivity process generate an invariant distribution that is consistent with equation (10) and the value of search is given by equation (11).

[5] As in this subsection the expected future values of non-search unemployment and work are equal, the decision between work and non-search is directly related to the flow values of both activities. Given this I use the flow values to describe the values of work and non-search unemployment.

[6] Especially, productivities follow condition (1) and aggregate conditions stated in equations (5)-(7) are satisfied.

2.3 A large union

This subsection introduces an equilibrium with a large labor union that represents all workers. The union has monopoly power over firms and it is fully aware of the general structure of the economy but it cannot observe time-varying local labor market conditions. Given this, the union sets an economy-wide minimum wage and forbids its members to work unless the wage offered meets the minimum requirement. When the minimum wage is not binding, competition on local markets determines the wage rate. This mimics the real life examples of the workings of unions that typically allow firms to pay more than the wage agreed. Ideally, the union would like to set a state-contingent policy for each locations based on the value of the best outside option, reallocation or non-search unemployment. However, due to the moving frictions this policy would still be a minimum wage policy.

I focus on the stationary minimum wage policy of the union. It is assumed that the union cares for the welfare of the representative household and thus it fully internalizes the unemployment effects caused by the minimum wage policy. However, the union cannot directly control reallocation or hiring decisions and thus has to take the objectives of workers and firms as given. Here, I assume that the rents of the union are shared only at the household level and each worker is, as before, maximizing her present and expected future earnings measured in units of marginal utility. The agents make decisions on working, searching and waiting for jobs in their current location.

Assuming that the union sets a minimum wage that is binding at least in some locations, i.e., $\omega_{min} > b_r$, the nature of non-search unemployment changes from voluntary to non-voluntary as now the non-search unemployed agents would rather work in their current location. Thus, the employment status becomes a state variable.

Given the local mass of workers at the beginning of the period m, productivity z, policies $n(m,z)$ and $r(m,z)$, the value of search θ, aggregate consumption C_H and the amount of searchers U_r, the problems of agents can be described with the help of the following Bellman equations

$$\begin{aligned} V_{job}(m,z;\omega_{min}) &= max\{\omega(n(m,z;\omega_{min}) \\ &\quad +\beta \int Q(z,dz')[p_{job}(m',z')V_{job}(m',z';\omega_{min}) \\ &\quad +(1-p_{job}(m',z'))V_{nojob}(m',z';\omega_{min})],\theta\} \\ V_{nojob}(m,z;\omega_{min}) &= max\{b_r+\beta \int Q(z,dz')[p_{nojob}(m',z')V_{job}(m',z;\omega_{min}) \\ &\quad +(1-p_{nojob}(m',z'))V_{nojob}(m',z';\omega_{min})],\theta\} \end{aligned}$$

where the evolution of m is defined based on equation (3). While, $p_{job}(m',z')$ and $p_{nojob}(m',z')$ are probabilities of being offered a job at the beginning of the next period, conditional on the current job market status, the amount of workers m' and productivity z'.

With the minimum wage $w_{min} = C_H * \omega_{min}$ and productivity z, the maximum amount of workers that can be offered a job is given by

$$e(z;\omega_{min}) = (\frac{w_{min}}{\alpha z})^{\frac{1}{\alpha-1}}$$

If $x \leq e(z, \omega_{min})$, all agents are offered a job, i.e., $p_{job}(m,z) = p_{nojob}(m,z) = 1$ and the wage rate is determined by equation (7). If $e(z;\omega_{min}) < x$ only $e(z;\omega_{min})$ workers get a job offer. I assume that the agents that worked in the last period are given a preferred position. That is, given the amount of agents who worked in the last period m_1 and agents who where waiting m_2,

$$p_{job} = min\{\frac{e}{m_1}, 1\}.$$

and

$$p_{nojob} = max\{\frac{e - m_1}{m_2}, 0\},$$

when $m_2 > 0$.

At the equilibrium the workers' behavior has to be consistent with the Bellman equations above. That is

1. If $x \leq e(z;\omega_{min})$
   (a) If $n(m,z;\omega_{min}) = x$ and $r(m,z;\omega_{min}) = 0$ then $V_{job}(m,z;\omega_{min}) > \theta$.
   (b) If $n(m,z;\omega_{min}) < x$ and $r(m,z;\omega_{min}) = 0$ then $V_{job}(m,z;\omega_{min}) = \theta$
2. If $x \geq e(z;\omega_{min})$
   (a) if $n(m,z;\omega_{min}) = e$ and $r(m,z;\omega_{min}) = x - e$ then $V_{nojob}(m,z;\omega_{min}) > \theta$
   (b) if $n(m,z;\omega_{min}) = e$ and $0 < r(m,z;\omega_{min}) < x - e$ then $V_{nojob}(m,z;\omega_{min}) = \theta$
   (c) If $n(m,z;\omega_{min}) < e$ and $r(m,z;\omega_{min}) = 0$ then $V_{job}(m,z;\omega_{min}) = \theta$

The workers' policies together with the productivity process generates a stationary distribution of islands

$$\mu(M', Z') = \int_{\{(m,z):((n(x,z),r(x,z)+U_s))\in M'\}} Q(z, Z')\mu(dm, dz), \qquad (12)$$

for all sets of beginning of the period labor forces, M', and productivities, Z'. The value of search is given by

$$\begin{aligned} \theta \quad = \quad & \beta \int [p_{nojob}(m,z)V_{job}(m,z;\omega_{min}) \\ & +(1 - p_{nojob}(m,z))V_{nojob}(m,z;\omega_{min}]\mu(dx,dz). \end{aligned} \qquad (13)$$

The labor union takes into account the workers' and the firms' behavior and the general structure of the economy and chooses the minimum wage, ω_{min}, such that the stationary utility of the representative household is maximized. That is, the union's problem is given by

$$\max_{\omega_{min}} ln(C_H) + b_r U_r$$

$$st\, C_H = \int w(m,z)n(m,z)\mu(dm,dz)$$

$$U_r = \int r(m,z)\mu(dm,dz)$$

where, for a given minimum wage, the variables $w(m,z)$, $n(m,z)$ and $r(m,z)$ are determined by the workers' and firms' behavior, as stated above.

The equilibrium is such that the workers' value functions are consistent with the Bellman equations stated above, the state dependent policies are in line with conditions 1 a-b and 2 a-c, the wages are defined by equation (8) or the minimum wage, the stationary distribution of islands is given by equation (12), the value of search is given by equation (13). Finally, the minimum wage is set by the labor union.

2.4 Bargaining

In countries where large labor unions are common, e.g. in continental Europe, employers have also typically set up employer's organizations to bargain with the labor unions. In order to explore this type of set-up, I assume that rents from the fixed factor are paid to a continuum of capitalists who have diversified their ownings over the whole economy. Moreover, these capitalists have formed a coalition that negotiates with the labor union.

The aim of this coalition is to maximize the utility of a representative capitalist when the periodic utility function takes the following form

$$U(C_{C,t}) = ln(C_{C,t})$$

The capitalist is only able to use profits from the fixed factor to finance her consumption, i.e.,

$$C_{C,t} = \int \pi(m,z)\mu(dm,dz) = \int (zn(m,z)^{\alpha} - w(m,z)n(m,z))\mu(dm,dz). \quad (14)$$

The labor union and the coalition of firm owners negotiate over the minimum wage in the economy. The union's objective function and restrictions are as in the previous subsection. Moreover, for a given minimum wage the workers behave as before. I also assume that the coalition of firms is not able to prevent firms from competing against each other in local markets. That is, in markets where the minimum wage constraint is not binding, wages are set according to equation (8).

The minimum wage rate is determined via Nash bargaining over the stationary equilibria. That is,

$$arg\underset{\omega_{min}}{max}(ln(C_H) + b_r U_r - b_r)^{\gamma} * (ln(C_C)^{1-\gamma}, \quad (15)$$

where γ is the bargaining power of the labor union. The outside option is assumed to be the one where no one is producing market goods and all workers are rest unemployed.

The equilibrium is similar to the one in last subsection, the only difference being that now the bargaining solution determines the minimum wage.

2.5 Many small unions

To contrast the results related to a large union with a more traditional analysis of many small unions (see, e.g., Alvarez and Veraciero, 1999 and Alvarez and Shimer, 2014), I set up an economy with a continuum of unions that takes the rest of the world as given. As in previous subsections, I assume universal coverage ,i.e., all workers belong to some union. To be more precise, I assume that there is a union on every island.

The union on island (x,z) maximizes the expected present discounted value of earnings of its current members, measured in units of marginal utility. I assume that when an agent enters the island, she becomes a member of the union. The membership ends when the agent reallocates. As before, each agent gets her own income and makes her own reallocation decisions. The future employment statuses are allocated randomly. The union chooses the amount of workers allowed to work, taking into account how its decisions affect non-search unemployment. As the union is small, it takes the aggregate consumption, the value of search and the amount of incoming new workers as given.

The value function of a union satisfies the following Bellman equation

$$V_U(x,z) = \max_{n,r} \frac{1}{C} wn + b_r r + \beta \frac{x}{x'} EV_U(x',z')$$

$$s.t.\, x' = n + r + U_s$$

$$0 \leq x - n - r$$

$$0 \leq r$$

$$w = z\alpha n^{\alpha-1},$$

Moreover, as the union cannot force agents to stay on the island, it has to be the case that the amounts of workers and non-search unemployed agents are consistent with the value functions of agents. Due to the insurance given by the family and the fact that the next period jobs are allocated randomly, we can write these constraints with the help of the union's value function. This happens because the next period continuation value for a worker is equal to the continuation value of the union divided by the amount of workers present in the next period.

$$0 \leq r(b_r + \beta \frac{1}{x'} EV_U(x',z') - \theta)$$

and

$$\theta \leq w + \beta \frac{1}{x'} EV_U(x',z')$$

Given the policy of the union and the workers' behavior, there are four possibilities

1. All agents stay and work
2. All agents stay and some are non-search unemployed

3. Some agents go, while some are non-search unemployed and others work

4. Some agents go while those who stay, work

If case 1 is observed on island (x,z), the union finds it optimal not to restrict labor supply. This can happen when the competitive wage rate is high enough. As the union does not care about the workers who reallocate, in case 4, the union also finds it optimal not to restrict labor supply. Finally, from the first order conditions it can be concluded that in cases where the union restricts labor force, i.e. cases 2 and 3, the union sets the amount of workers according to

$$n = (\frac{b_r}{\alpha^2 z} C)^{\frac{1}{\alpha - 1}} \tag{16}$$

This implies that the union chooses the following wage rate

$$w = \frac{b_r}{\alpha} C. \tag{17}$$

That is, when the union finds it optimal to restrict labor supply, it will generate non-search unemployment and set the wage rate in a way that equates it with the flow value of the outside option multiplied with a constant mark up.

To sum it up, the union's optimal policy at the stage (x,z) is either to allow wages to be determined competitively or set the wage on the island according to equation (17). The union chooses between these two actions in a way that solves the Bellman equation above.

Note that the union's problem in this section is simplified by the random allocation of the next period job opportunities. If, as in the previous subsection, employed workers would have been offered a preferred position, the next period continuation values would be present in the optimal wage policy. Moreover, the mapping between the union's value function and the workers' value functions would be more complicated. However, as the union prefers to keep all workers present on the island, the randomization of future jobs is in the interest of the union as it makes the values of non-search unemployment and work more similar. In addition to the randomization, other major difference is the fact that small unions do not internalize the effects of its actions on the aggregate consumption, the value of search and the amount of searchers.

The policy of the union resembles the union wage rule in Alvarez and Shimer (2014), who, at the top of an exogenous minimum wage, also consider the wage policy of a small union when it is maximizing over the flow values of utility. In their analysis, they explore a set up where the employment opportunities are decided based on a strict seniority rule. This implies that workers become search unemployed only through a period of rest unemployment. This means that the union's policy is a minimum wage policy where jobs are rationed when the competitive wage would be lower than the target rate of the union. In my case, the risk of losing members means that a union may also find it optimal not to ration labor supply when local labor market conditions are weak. That

is, unions are restricting labor force only in a small range at the middle of the wage distribution.

Finally, the stationary measure of islands is similar to the stationary measure of islands in the competitive economy (see equation (10)). Given this measure, the value of search can be expressed with the help of the union's value function

$$\theta = \beta \int \frac{1}{x} V_U(x, z) \mu(dx, dz).$$

3 Calibration

I utilize the method of simulated moments in order to calibrate the model. I first fix the values of certain parameters based on external evidence and then set the rest of the parameters in a way that the model without unions matches the stylized facts of the unemployment patterns in the US. To be more precise, I minimize the relative distance between simulated moments and moments calculated from the data using the identity matrix as a weighting matrix.

The model period is set to a month and the annual real interest rate is assumed to be 4%. Taken together these decisions imply that β is fixed to 0.9966. The curvature parameter of the production function, α, is set to 0.66, based on the labor share of output. I use Tauchen's method with 15 stages to approximate the AR(1) process of logged productivity. The unconditional mean of the productivity is normalized to 1.

The remaining parameters, i.e., the flow value of non-search unemployment and the parameters of the productivity process, the persistence, ρ, and the volatility of innovations, σ, are calibrated internally. These parameters determine unemployment and its decomposition. In order to take a conservative approach to non-search unemployment, I assume that only workers who return to their previous employer are non-search unemployed. This, as suggested by Fernandez-Blanco (2013), is one interpretation of Alvarez and Shimer's (2011) "rest unemployment".

When deciding on the empirical target for non-search unemployment, I rely on the empirical evidence of Fujita and Moscarini (2017). From the Survey of Income and Program Participation (SIPP), they conclude that a large share of jobless workers returns to their previous employer. Depending on the SIPP panel and the type of non-employment, the recall rates vary between 0.32 and 0.553. As I do not allow the out of labor force option, I focus on the recall rate related to workers who do not leave the labor force. My target for completed unemployment spells that end with recalls is 0.48175 and it is calculated as a non-weighted average from the SIPP panels of 1996 to 2008 (see Fujita and Moscarini, 2017). Given that this interpretation would imply that the non-search unemployed always return to their previous employer, this calibration strategy gives the lower bound for the non-search unemployment.

My next target is the average duration of completed unemployment spells for workers who stay in the labor force. This is set to 2.96 months. It is again from Fujita and Moscarini (2017) and calculated as an unweighted mean of the SIPP

Table 1: Parameter values

α	β	ρ	σ^2	b_r	a
0.66	0.9966	0.9571	0.051	0.0095	0

Table 2: Empirical targets and the model counterparts

	unemployment	recall rate	mean duration
Data	6	0.4818	2.96
Model	6.0152	0.4752	2.9826

panels. Note that the laissez-faire economy considered in Section 2.2 is silent about the duration of non-search unemployment due to the fact that agents are indifferent between work and non-search unemployment in those islands where part of them decide to "rest". When calculating the duration of unemployment spells, I assume, consistently with the analysis of the large union, that employed workers are always offered jobs first in the next period. My last empirical target is the aggregate unemployment rate, 6 per cent, calculated from the period covered by the SIPP panels from 1996 to 2008.

When calculating the simulated moments, I generate pseudo SIPP panels for a large number of individuals at the stationary equilibrium of the competitive economy. Table 1 presents the parameter values associated with the preferred calibration, while Table 2 recaps the empirical targets and summarizes the model counterparts.

Before moving on to the effects of different types of union structures, I first highlight some results related to the competitive economy that where not targeted. For any given period, 16% of the unemployed workers are search unemployed. Given that over 50% of completed unemployment spells involves periods of active search, this reflects the fact that a considerable fraction of those workers who switch locations also spend time being non-search unemployed. To compare this to the empirical evidence, Krueger and Mueller (2012) report, based on time diary evidence, that for a given day, 20% of the unemployed in the US searches for a job. However, the time they spent on search is less than half the time spent on work for employed workers (159.7 minutes vs 325 minutes). In the model, it is assumed that the time spent on search is the same that the time spent at work. Calculating the average search time per day in the model by multiplying the fraction of search unemployed by the average minutes spent on work for employed agents, reported in Krueger and Mueller (2012), gives 52 minutes. This is somewhat higher than the average search times in the data (32 minutes) but relatively close to the time that unemployed workers spend on search and work-like activities, 42 minutes, on average.

4 Results

This section quantitatively asses the effects of unionization with different union structures introduced in section 2. Instead of using simulated panels, the aggregate unemployment rate and its composition are calculated from the stationary distributions. In order to facilitate comparisons, the results related to wages, consumption and output are normalized to the competitive economy levels.

4.1 A large union

Table 3 reports the effects of the large union. The union sets a minimum wage that is almost 20 percent higher than the lowest wage paid in the laissez-faire economy. In fact, the minimum wage is 7.4 percent higher than the average wage paid in the competitive economy.

Due to the policy of the union, the average income of a worker goes up by 11%. This is consistent with the body of empirical evidence that suggests that union membership increases the wage rate. For example, Lewis (1986) reviews the empirical literature of the union wage differentials in the US and concludes that (the upper bound for) the union wage gap is around 14%.

Achieving the substantial increase in minimum wage rates requires unions to heavily restrict labor supply. This leads to a strong increase in unemployment which rises to 28.3 percent. All of this increase is non-search unemployment, which goes up to 27.6 percent. The search unemployment reduces marginally to 0.7 per cent. Now around 97.5% of the unemployed workers are not searching for a job in any given period. Repeating the back of the envelope calculation of average search times for unemployed workers implies that an unemployed worker spends on average 8.15 minutes per day on search. That is, the search intensity of an average unemployed worker drops substantially compared to 52 minutes in the competitive economy. Moreover, the search time is comparable with the average search times in Europe, reported by Krueger and Mueller (2012)[7].

Even though the increase in unemployment is strong, it is in terms of magnitudes broadly in line with other studies that explore unions in frictional labor markets. For example, in the coalition model of Alvarez and Veracierto (1999), the introduction of an 80% unionization increases unemployment from 5.3% to 16.3%. Since in their model less costly non-search unemployment is not possible, a milder increase in unemployment is to be expected, especially given the high flow value of non-search unemployment that is needed to achieve the high recall rate. In Krusell and Rudanko (2016), a large union causes unemployment to rise from 5% to 16%. Once again, the possibility of recall is likely to give unionization more power in my analysis, even though directly comparing the results is more difficult, as Krusell and Rudanko (2016) build their analysis on the search and matching framework.

The strong increase in the lowest wage paid in the economy, together with increased non-search unemployment, implies that the majority of firms are now

[7] According to Krueger and Mueller (2012), the average search time per day is 12 minutes in Western Europe and 11 minutes in Eastern Europe.

Table 3: Model with a large union

	Competitive economy	Large union
Search unemployment	0.94	0.71
Non-search unemployment	4.99	27.6
Total unemployment	5.93	28.3
Search/total unemployment %	15.9	2.51
Avg. duration	2.98	6.80
Avg wage	100	110.8
Std. of wages	100	70.3
Min. wage	100	119.5
Max. wage	100	103.9
Market output	100	84.5
Household's consumption	100	84.5
Capitalists's consumption	100	84.6
Household's welfare	100	104.7

paying the minimum wage; only 20% of the islands are paying more than the minimum wage. However, decreased search unemployment increases the highest wages paid in the economy. For example, the maximum wage in the economy goes up by 3.9%. Taken together, the suppression of the lower tail dominates the widening of the upper tail and so the standard deviation of wage distribution decreases by almost 30%. This is qualitatively consistent with the empirical evidence that unions reduce wage inequality (see Card et al, 2003).

To summarize, the model implies that the unionization decreases the search intensity of unemployed workers and suppresses the wage distribution. This is in line with Krueger and Mueller (2012), who by using a cross country data, show that the wage dispersion is a strong predictor of unemployed workers' search activity. Interestingly, they also find that the lowest search activities among the countries they examine are found in Scandinavian countries, where the centralized wage mechanisms are particularly popular.

Increased unemployment and reduced search activity also coexist with increased unemployment duration. The average duration of unemployment spells goes up from 2.98 months to 6.8 months.

The increasing unemployment causes a 15.5% reduction in the market output produced. In line with this, the workers' and the capitalists' consumption also go down, roughly equivalently. Finally, looking at the welfare of the workers, measured in units of consumption at the competitive economy, we can see that the welfare gain for workers from a large union is equivalent to a 4.7 percent increase in the representative household's consumption.

4.2 Bargaining

This section analyzes the model where the union is assumed to bargain over the minimum wage with the coalition of firms. The results for the bargaining solutions, when the bargaining power of the union takes the values of 0.5 and 0.75, are given in Table 4.

As one would expect, the bargaining results are more moderate than the results in the last subsection where the union decided the minimum wage unilaterally. Compared to the competitive economy, the minimum wage increases by around 9% when the union's bargaining power is equal to 0.75, while the 50/50 bargaining rule increases the minimum wage by only about 2%. The restrictions on labor supply increase the average wage in the economy to 4.9% or 1.8%, depending on the bargaining power.

It can be seen that the unemployment responses are considerably weaker when at least some bargaining power is given to the coalition of firms. When γ is set to 0.75, aggregate unemployment increases to 16%, while the bargaining model with $\gamma = 0.5$ is associated with aggregate unemployment around 10%. The whole increase is non-search unemployment, as in both cases search unemployment drops to 0.5%. Due to these effects, the relative amount of search unemployed agents increases as the bargaining power of the union decreases. The average search times for unemployed workers are 8.7 minutes and 13.3 minutes for $\gamma = 0.75$ and $\gamma = 0.5$, respectively. Consistently with smaller unemployment responses, also the increase in the average duration of unemployment spells is milder in comparison with the economy analyzed in the previous subsection.

Decreasing search unemployment increases the highest wages paid in the economy. However, for $\gamma = 0.75$, the increasing minimum wage dominates and wage inequality measured with the standard deviation of the wage distribution decreases by 8.3 percent. When the union's bargaining power is 0.5, wage inequality increases 4.7 percent, as the effects on the left tail are not strong enough to compensate for the increased inequality caused by the reduced search.

The market output reduces by 6.7 and 2.7 percent depending on the value of bargaining power. The workers' welfare increases is 3.6% compared with the competitive economy when the bargaining power is set to 0.75. When $\gamma = 0.5$, the welfare increases by less than 2%.

4.3 Many small unions

Table 5 assembles the results of the model where labor supply on each island is controlled by a local labor union. In order to keep as many workers as possible attached to their current locations, small unions do not restrict employment in locations where conditions are weak. Moreover, due to the moving frictions, restricting labor supply is not optimal when local conditions are good enough. At the equilibrium, 31% of all locations have an active labor union. Compared with the case of a large union, in which firms in almost 80% of the locations restricted labor supply, there is a major drop in the amount of local markets where unionization causes direct effects. This, in turn, implies that non-search unem-

Table 4: Bargaining model

	Competitive economy	Bargaining	
γ		75	50
Search unemployment	0.94	0.44	0.42
Non-search unemployment	4.99	16.0	9.86
Total unemployment	5.93	16.5	10.3
Search/total unemployment %	15.9	2.67	4.08
Avg. duration	2.98	5.29	4.38
Avg wage	100	104.9	101.8
Std. of wages	100	91.7	104.7
Min. wage	100	108.9	102.3
Max. wage	100	103.9	104.7
Market output	100	93.3	97.3
Household's consumption	100	93.3	97.3
Capitalists' consumption	100	93.3	97.3
Household's welfare	100	103.6	101.9

ployment does not increase as much. Though, the non-search unemployment still increases to 21.9% reflecting the fact that the active unions still represent a large group of labor force. Search unemployment is even lower than in the competitive economy. This shows that small unions are able to reduce mobility, especially with respect to the economy with a large union.

Aggregate unemployment goes up to 22.7 percent. That is, even though small unions do not take into account how their actions contribute to the aggregate variables, such as the amount of the search unemployed, the unionization with a continuum of small unions leads to five percent smaller increase in aggregate unemployment than in the case of a large union. The unions' desire to retain their members by not restricting labor supply in bad times creates a strong enough effect to counter for the negative consequences of non-existing coordination. Note that, the assumption of randomization of jobs is likely to increase the unions' use of monopoly power compared with what would be the case if previously employed workers were preferred . That is, the difference in unemployment between one large union versus many small unions could be even larger.

Decreasing search unemployment, together with increasing non-search unemployment, means that only 3.62% of the unemployed are searching for a job per period. Model consistent search time of an average worker is 11.8 minutes per day when the daily average working hours from Krueger and Mueller (2012) are used to measure search times in the model. This is close to the average search time for Western Europe, 12 minutes, in Krueger and Mueller (2012).

Since the unions let competitive markets determine the wage rate when local conditions are weak, the minimum wage is determined in a similar way as in the competitive model. Given that the aggregate consumption is lower than in the

Table 5: Many small unions

	Competitive economy	Continuum of unions
Search unemployment	0.94	0.82
Non-search unemployment	4.99	21.9
Total unemployment	5.93	22.7
Search/total unemployment %	15.9	3.62
Avg wage	100	106
Std. of wages	100	164
Min. wage	100	88.2
Max. wage	100	109
Market output	100	87.0
Household's consumption	100	87.0
Capitalists's consumption	100	87.0
Household's welfare	100	102.1

benchmark equilibrium, the minimum wage is actually 11.8% lower. Moreover, due to decreased search the highest wage paid in the economy increases by 9%. Taken together, the dispersion of wages increases, standard deviation being 64% higher. This raises the question of whether the assumption that unions are willing to allow competitive wage rates during bad times, is realistic. For example, the union boss model à Alvarez and Veracierto (1999) might lead to increased wage dispersion and higher unemployment.

The market output, the workers' and the capitalists' consumption all drop by 13%. These reactions are somewhat smaller than in the equilibrium with a large union. Workers' welfare goes up by 2.1 percent.

5 Conclusions

This paper explored the equilibrium effects of the unionization with different union structures. The main focus was on a union that affects a large group of heterogeneous firms by setting a common minimum wage. The results were also compared against a union structure of many small unions. A key element of the analysis was the fact that unemployed workers could engage in non-search unemployment that allowed the unemployed to enjoy increased leisure time. The model was calibrated based on the empirical evidence of recall unemployment in the US. Even though this can be seen as a natural lower bound of non-search unemployment, the resulting search intensity was broadly comparable to the search activity measures of time diary evidence.

The quantitative results of a large union suggest that the steady state unemployment increases strongly, by around 22%, as a response to the introduction of a minimum wage set by the union. The whole increase is non-search unemployment, as search unemployment actually decreases a bit. Taken together,

the search intensity of unemployed agents decreases strongly. This is qualitatively consistent with the empirical observation of Krueger and Mueller (2012) that in Europe the unemployed workers search substantially less than in North America. The union also decreases wage inequality in the economy. When it is assumed that the union negotiates over wages with an employer's organization, the increase in aggregate unemployment is much more subdued. For example, the Nash bargaining solution, when the bargaining power of the union is set to 0.5, generates unemployment increase by 4.4 percent. However, the non-search unemployment still increases and the search unemployment decreases.

The unionization with a continuum of small unions leads to an increase in aggregate unemployment that is about 17%. That is, even though small unions do not properly internalize their actions as they take the aggregate variables as given, the increase in unemployment is less severe than with the large union. The important factors behind this are the assumptions that the union membership is determined based on the workers' current location and that the unions care only about workers who stay put. These assumptions imply that unions are not willing to restrict employment in times when the wage rate is low. However, this set-up also leads to an increase in wage inequality which is at the odds with the empirical evidence and so casts some doubts on whether small unions truly react to weak local conditions.

Overall, the results highlight the fact that unions offer a powerful channel for generating non-search unemployment. To be more precise, the natural level of non-search unemployment is complementary with the union generated non-search unemployment, as the possibility of an additional, less costly form of unemployment, allows the union(s) to push minimum wages higher.

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