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A multisectorial matching model of unions ☆

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Abstract

We develop an equilibrium matching model where unions have an important institutional presence. Monopolistic competition characterizes the goods market, where only some sectors are unionized. Thus, the model can vary the coverage of collective bargaining. It can vary the degree of coordination between unions, and alternatively consider "national" and "sectorial" unions. Calibration to the union premium implies a workers' rent extraction parameter much lower than assumed in the matching literature. We introduce unemployment insurance to study the interactions of policies with unions and find that unions only push for more generous benefits if this does not entail higher payroll taxes.

JEL classification: E24; J41; J51; J65

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1. Introduction

The contrast between American and European labor markets has been the object of an extensive literature. European markets are generally characterized by higher

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unemployment and more generous government mandated policies. The matching literature, initiated by Pissarides (2000) and Mortensen and Pissarides (1994), has focused primarily on incorporating labor market policies into a matching framework (Millard and Mortensen, 1997), but less attention has been devoted to *institutional* differences, such as the fact that union presence is much more prevalent in Europe than in the U.S. This is problematic, however, given that collective bargaining covers an average of 80% of workers among Western European countries. Thus, the wage determination mechanism assumed in the matching literature actually only applies to a small portion of the labor force. Therefore, a complete model of a European style labor market should include a large union presence, yet also account for the fact that collective bargaining does not govern all employer-employee relationships. In addition, the impact of unions does not only depend on the extent of unionization, but also on other institutional characteristics, such as union coordination and the level at which collective negotiations are conducted. We develop a model which incorporates all these characteristics to properly reflect the impact of unions on European labor markets.

We calibrate the model to replicate the union wage premium and unemployment as observed in Europe. In fact, the union premium is used to pin down the rent extraction parameter for workers engaged in individual negotiations in the non-unionized sectors. We find a workers' rent extraction parameter[2] to be much lower than assumed in the matching literature, although consistent with a number of estimated values of workers' ability to extract rents. Since quantitative work using the Mortensen and Pissarides matching framework is clearly sensitive to how surpluses are split between workers and firms, this is an important first step in better assessing workers' bargaining power.

The model is used to study the implications of union structure on unemployment. The model can vary the extent of collective bargaining, as well as the degree of union coordination. This is done by having both unionized and non-unionized sectors, and by varying the number of unions representing workers. Unions are also alternatively considered as "national" and "sectorial" unions to study the impact of centralization of collective bargaining. The model can replicate stylized "union facts"—unemployment increases with collective bargaining coverage and decreases with centralization/coordination. Finally, the model delivers a number of predictions not only on unemployment and wages, but also on price–wage markups within a sector, relative prices across sectors, firm sizes, and number of firms per sector.

Having thus set up a model of unions with the important institutional characteristics, we then introduce unemployment insurance (UI) to study the interactions of unions with policies. European economies are characterized by both a high degree of unionization and generous unemployment benefits. Political economy considerations are generally put forth when attempting to explain why more generous benefits are sustained in Europe than in the U.S. The model can be used to consider a different approach. With the level of bargaining coverage characterizing European economies, would powerful unions support generous unemployment benefits? This is answered by investigating whether unionized workers benefit or not from generous policies, given that unions have the ability to adjust their wage demands to the policies in place. Thus, the union members' welfare is compared under various levels of unemployment benefits and different UI financing schemes. Different union objective functions—maximizing ex ante welfare of union members or

[2]That is the bargaining power to the worker in terms of the Nash bargaining solution.

welfare of employed members only—are used. The conclusion is that unions would only push for more generous benefits if this does not entail higher payroll taxes as well. This result is robust to changes in the institutional characteristics.

To build a model with partial unionization, a monopolistic competition model of the goods market in the spirit of Ebell and Haefke (2004) is developed. The labor market is composed of several sectors, some—but not all—being unionized. Each sector specializes in the production of a particular good. Wage determination varies across sectors. Since the labor market is characterized by matching frictions, the nature of wage determination affects firms' incentive to post costly vacancies and therefore is central to the relative unemployment performance in the different sectors. In non-unionized sectors, wages are negotiated individually between firms and workers. In unionized sectors, unions make wage demands and firms react to these demands by posting vacancies to find workers. As described in Ebell and Haefke, in a non-unionized sector, several effects are at play. First, monopoly power in each sector gives firms an incentive to restrict output and thus employment. Second, since firms have multiple workers, each worker is treated as marginal during individual negotiations (Stole and Zwiebel, 1996a, b). With monopoly power, the workers' marginal revenue product is decreasing, giving firms an incentive to over-hire. In this model, these two opposite effects are at play in the non-unionized sectors. However, in unionized sectors the second effect is absent as firms take the required union wage as given regardless of their number of employees. This only leaves the first negative effect on employment. Also, unions are the ones who set wages for their members, by maximizing their ex ante welfare, anticipating the effect of their demands on vacancy posting by firms and thus employment. In an economy with two types of goods—union goods and non-union goods—any variation in employment also implies variation in the relative price of the two goods, a type of "terms of trade" effect. Ultimately, the quantitative effect of union presence must be simulated, which is done in Section 6.

Section 2 briefly reviews the literature on unions and labor market policies. The model is developed by looking at the goods market (Section 3) and the labor market (Section 4), then by defining equilibrium (Section 5). In Section 6, the model is calibrated and its implications checked. Finally, the question of whether strong union presence can explain generous UI in Europe is considered in Section 7. Section 8 concludes and considers possible extensions.

2. Literature

Before introducing the model, a brief review of the literature on unions and UI is necessary. Relatively little attention has been devoted to the theoretical study of unions in a matching framework. Pissarides (1986), in a model with exogenous dissolution of matches, considers how a monopoly union, unilaterally setting wages, affects firms' search decision. In Mortensen and Pissarides (1999), unions set the workers' share of the surplus and firms respond by determining employment. In both cases, the focus is the condition under which collective bargaining can generate an efficient outcome. The focus of this paper is different. It is primarily interested in studying the effect of unions on the labor market and their interaction with policies, such as UI. To replicate common bargaining practice (sometimes referred to as "right to manage"), unions make wage demands and firms react by posting vacancies, as in Pissarides. It differs in one fundamental way from Pissarides, however, in that the product market is characterized by monopolistic competition, with some goods produced in unionized sectors and other goods produced in non-unionized sectors.

In order to assess empirically how unions affect unemployment, Nickell (1997), and Nickell and Layard (1999) focus on four main characteristics. Union density is the proportion of the workforce belonging to a union. This alone, however, may be misleading, since some countries have low union density, but high bargaining coverage, if union agreements are extended to non-union members. Thus bargaining coverage, or the proportion of workers covered by collective agreements, is a better measure of the prevalence of unions. The extent of centralization (whether negotiations take place at the national, industry or plant level) and coordination (the degree of consensus between the collective bargaining partners) is also important. Nickell (1997), Nickell and Layard (1999) and OECD (1997) find that union density and bargaining coverage are much higher in Europe than in the U.S., and that union activity is more centralized *and* more coordinated in Europe. In conclusion, these authors find that unemployment is positively correlated with union density and bargaining coverage and negatively correlated with union coordination and centralization. It is to be noted though that coordination and centralization are subjective notions, which are quite difficult to disentangle in practice. Consequently, the analysis of Nickell and Layard (1999) is based on combining both union *and* employer coordination,[3] while the results from OECD (1997) combine the notions of coordination and centralization into a single index.

Looking at the effect of collective bargaining on wages, Blau and Kahn (1999) find a positive union wage premium, although one has to be mindful of the fact that union coverage may be much higher than union density. In particular, they find that the U.S. has a much larger union wage premium (22%) than other OECD countries. Their evidence is based on Blanchflower and Freeman (1992), who find a union premium that varies between 4% and 10% in Australia, Austria, Switzerland, the United Kingdom and West Germany. This model is calibrated to the type of union wage premia and unemployment levels observed in Europe and its implications on the effect of bargaining coverage, union coordination and centralization checked against the empirical predictions.

Theoretically, UI is found to increase unemployment in a non-unionized labor market, due to the fact that it increases workers' search value and thus individually negotiated wages. However, no theoretical results have been established when wages are determined through collective bargaining. Empirically, Nickell (1997) finds that more generous unemployment benefits, as measured by a higher replacement rate, unambiguously increases unemployment. This model adds to the literature by introducing UI in a union setup and studying under which conditions can a strong union presence explain generous UI benefits in Europe.

Finally, this paper adds to the recent literature that introduces monopolistic competition in the goods market into traditional matching models of the labor market. The two main contributions are Blanchard and Giavazzi (2003) and Ebell and Haefke (2004). The former looks at the interaction between product and labor market deregulations, while the latter studies the effect of product market reform on the labor market in a fully dynamic

[3]As this model assumes that firms determine vacancies after unions' wage demands are made, the focus is on union coordination only. The authors also find that in presence of the coordination variable, there is no role for the centralization variable. For a discussion of that result, see Section 6.2.

matching model. This model uses the Ebell and Haefke framework, but instead introduces heterogeneity between unionized and non-unionized sectors.

3. The goods market

Households are participating both in the goods and the labor markets. Describing the goods market first, consumers have preferences over g differentiated goods

$$\left(\sum_{j=1}^{g} \alpha_j^{1/\sigma} c_{j,n}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)},$$

where j denotes the good (sector) and n the household. The term σ is the elasticity of substitution across varieties. Their problem is to

$$\max_{\{c_{j,n}\}} \left(\sum_{j=1}^{g} \alpha_j^{1/\sigma} c_{j,n}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)},$$

$$\text{s.t.} \sum_{j=1}^{g} p_j \cdot c_{j,n} = P \cdot I_n,$$

where p_j is the price of good j, P the price index and I_n the real income of household n. For reasons of symmetry, assume that $\alpha_j = 1/g$ for all j. Solving that problem generates an aggregate demand for good j

$$Y_j^{\mathrm{D}} = \frac{1}{g}\left(\frac{p_j}{P}\right)^{-\sigma} \cdot I, \tag{1}$$

where I is aggregate real income and the composite price index is[4]

$$P \equiv \left(\sum_{j=1}^{g} \frac{1}{g} p_j^{1-\sigma}\right)^{1/(1-\sigma)}. \tag{2}$$

There are N_j firms competing in sector j. Firms are assumed to play a Cournot game. Restricting attention to symmetric equilibria within sectors and using (1), firm k in industry j faces a demand given by

$$\frac{p_j}{P} = \left(g\frac{Y_{j,k} + (N_j - 1)\widehat{Y}_{j,-k}}{I}\right)^{-1/\sigma}, \tag{3}$$

where $Y_{j,k}$ is firm k's output and $\widehat{Y}_{j,-k}$ is the output of every other firm in the sector, taken as given. Of course, in equilibrium $Y_{j,k} = \widehat{Y}_{j,-k}$. Symmetric Cournot competition implies an elasticity of demand $\varepsilon_{j,k}$ faced by firm k which is the same for all firms in the sector and depends only on the elasticity of substitution in the consumption aggregator and the number of firms in the sector

$$\varepsilon_{j,k} = \varepsilon_j = \sigma \cdot N_j. \tag{4}$$

[4] Or $P \equiv \prod_{j=1}^{g} p_j^{1/g}$, when $\sigma = 1$.

The number of firms N_j is thus crucial in determining the level of competition in the sector and is endogenized by imposing a "firm free entry condition",

$$c_{e,j} = \frac{1+r}{r+\delta_e} \cdot \frac{\pi_j}{P}, \tag{5}$$

where $c_{e,j}$ represents the real cost of setting a firm in sector j, π_j/P the real firm profits in sector j, r the discount rate and δ_e the probability of firm exit (through death). Eq. (5) states that firms enter the sector until the discounted flow of profits (taking into account the match impermanence) just covers the cost of setting the firm up.

4. The labor market

Skills are sector-specific. Thus, workers can only work in one sector, making the labor market segmented across sectors. Informational frictions render a match between a worker and a firm a time-consuming process. Hence, firms have to post costly vacancies to hire workers, at a cost κ per vacancy each period. Specifically, in each period a stock of U unemployed workers and V vacancies produce $M(U,V)$ matches. Since matches are random, the probability p_w (p_f) that an unemployed worker (a vacant firm) matches in the current period is equal to $M(U,V)/U$ ($M(U,V)/V$). Assuming constant return to scale for the function M is standard implies that the matching probabilities in the sector are only functions of the market tightness $\theta_j = V_j/U_j$. Outflows are due to match breakdowns at rate δ. A match can be terminated either because it is not productive any longer and the firm and individual worker are separating—with probability δ_s, or because the firm itself exits—with probability δ_e—so that $\delta = \delta_e + (1-\delta_e)\delta_s$.

In steady state, flows in employment are equal to flows out. Hence, the unemployment rate in sector j is given by

$$u_j = \frac{\delta}{\delta + p_w(\theta_j)}. \tag{6}$$

Normalizing the total labor force to 1, each sector is of size $1/g$. Total sectorial employment is equal both to firm-level employment L_j times the number of firms in the sector and to the sectorial employment rate times the labor force. Thus,

$$N_j L_j = \frac{1}{g} \frac{p_w(\theta_j)}{\delta + p_w(\theta_j)}. \tag{7}$$

Finally, from Eq. (1), the aggregate demand for good j is given by $Y_j^D = 1/g(p_j/P)^{-\sigma} I = N_j L_j y$, where y is (linear) output per employee. This implies that

$$\frac{p_w(\theta_j)}{\delta + p_w(\theta_j)} \cdot \left(\frac{p_j}{P}\right)^{\sigma} = \Omega, \tag{8}$$

where Ω is a constant across sectors, determined in equilibrium.

4.1. Unions

The economy is composed of both non-unionized and unionized firms. Suppose that a given sector is either entirely non-unionized (m sectors) or entirely unionized ($g-m$ sectors). Thus, the unionization rate—or equivalently the extent of bargaining coverage—is given by $1-m/g$. In a non-unionized sector, wages are determined by individual negotiations between workers and firms, whereas in a unionized sector wages are set by unions. The focus is on the case where all unionized (non-unionized) sectors are identical and thus one only needs to consider two representative sectors, $j=u$ and $j=nu$.

In a unionized sector, union membership may be divided over several unions. Denote by $\mathcal{U}$ the number of unions in the representative unionized sector. Thus, varying the number of unions *per sector* $\mathcal{U}$ is equivalent to varying the degree of coordination among unions during the negotiations. To study the impact of centralization on unemployment, we consider two scenarios. In the *base case*, unions are treated as "national" unions. In that case, a given union represents workers in every unionized sector and its wage demands apply to members across *all* unionized sectors. Each union represents a proportion $1/\mathcal{U}$ of every unionized sector and thus a proportion $1/\mathcal{U}\cdot(1-m/g)$ of the total labor force. In effect, one can consider that there are a total of $\mathcal{U}$ different unions in the economy. A second case is also considered where unions are treated as "sectorial" unions. In that case, a given union represents workers in only one sector and its wage demands only apply to members in that sector. Under that scenario, a union only represents a proportion $1/\mathcal{U}$ of its sector and thus a proportion $1/\mathcal{U}\cdot 1/g$ of the total labor force. In effect, one can consider that there are a total of $(g-m)\cdot\mathcal{U}$ different unions in that economy. In both cases, however, the aggregate unionization rate and the number of unions per sector is the same.

Firms in unionized sectors are taking wage demands as given and must decide how many vacancies v_u to post. Firms in non-unionized sectors also have to make a vacancy posting decision v_{nu}, but negotiate wages individually with workers. To solve for the equilibrium of this economy, one first needs to model how individual union wage demands affect these decisions in each sector type, characterizing a *labor market equilibrium* conditional on a set of union wage demands. This is the object of Sections 4.2–4.4. This is done for a given number of firms N_j in each sector, $j\in\{u,nu\}$, hence a given level of competition within sector as implied by (4). One then needs to allow for free entry of firms to endogenize N_j thus characterizing a *labor market equilibrium with entry*, still conditional on a set of union wage demands. Unions anticipate the relationship between their individual demands and this labor market equilibrium with entry. Taking wage demands $\{\widetilde{w}_{u,-i}\}$ by other unions as given, union U_i chooses $w_{u,i}$ to maximize the ex ante welfare of its members.

4.2. Workers' value functions

Let us first look at the value functions resulting from workers' optimal behavior.[5] Denote by S_j^{w} (M_j^{w}) the worker's value of search (matching) in sector j. In flow terms,

$$rS_j^{\mathrm{w}} = bP + p_{\mathrm{w}}(\theta_j)[M_j^{\mathrm{w}} - S_j^{\mathrm{w}}], \tag{9}$$

$$rM_j^{\mathrm{w}} = w_j + \delta[S_j^{\mathrm{w}} - M_j^{\mathrm{w}}], \tag{10}$$

where w_j is the nominal wage and b the real unemployment income—which may include home production. Eqs. (9)–(10) have the usual interpretation. Unemployed workers enjoy income bP while searching, and with probability $p_{\mathrm{w}}(\theta_j)$ may realize a capital gain $M_j^{\mathrm{w}} - S_j^{\mathrm{w}}$, if they find employment in the period. Employed workers receive a wage w_j, but

[5]Without loss of generality, one can assume that a worker always accepts a match. It cannot be optimal for unions to set the wage so high that their members always remain unemployed.

their employment may end every period with probability δ, in which case they suffer a capital loss $S_j^{\mathrm{w}} - M_j^{\mathrm{w}}$.

4.3. Firms' problem in a non-unionized sector

Consider now the firms' problem. As the economy is characterized by monopolistic competition, firms strategically choose their production level and can have multiple workers, as opposed to the traditional Mortensen and Pissarides (1994) or Pissarides (2000) frameworks. Since wage determination differs across sectors, the problems of unionized and non-unionized firms are considered separately.

For simplicity, a large number approximation is made and the change in employment at the firm level is assumed to be non-stochastic. Denote by L the number of employees a firm starts the period with. Nominal output by a representative firm employing L workers in sector $j = nu$ is given by $\rho_{nu}(L) = Y_{nu}(L) \cdot p_{nu}(L)$. Firms maximize discounted profits. Thus, their value functions are given by

$$V_{nu}^{\mathrm{F}}(L) = \max_{v,L'} \frac{1}{1+r}\{\rho_{nu}(L) - w_{nu}L - \kappa P v + (1-\delta_{\mathrm{e}})V_{nu}^{\mathrm{F}}(L')\},$$

where

$$\begin{cases} Y_{nu}(L) = y \cdot L & \text{linear production function,} \\ \frac{p_{nu}}{P} = \left(g\frac{Y_{nu}+(N_{nu}-1)\widehat{Y}_{nu}}{I}\right)^{-1/\sigma} & \text{demand function,} \\ w_{nu} = w_{nu}(L) & \text{wage function,} \\ L' = p_{\mathrm{f}}(\theta_{nu}) \cdot v + (1-\delta_{\mathrm{s}})L & \text{transition function.} \end{cases}$$

The first-order condition with respect to vacancies is

$$\frac{\kappa P}{p_{\mathrm{f}}(\theta_{nu})} = (1-\delta_{\mathrm{e}})\frac{\partial V_{nu}^{\mathrm{F}}(L')}{\partial L}. \tag{11}$$

Eq. (11) states that firms post vacancies until expected search costs are equal to the marginal contribution of an additional worker to firm value. Denote net nominal revenues as $NR_{nu}(L) \equiv \rho_{nu}(L) - w_{nu}L$. The envelope condition with respect to L is given by $\partial V_{nu}^{\mathrm{F}}(L)/\partial L = 1/(1+r)\{\partial NR_{nu}(L)/\partial L + (1-\delta_{\mathrm{s}})(1-\delta_{\mathrm{e}})(\partial V_{nu}^{\mathrm{F}}(L')/\partial L)\}$. Combining the first order condition with the (steady-state) envelope condition,

$$\frac{\kappa P}{p_{\mathrm{f}}(\theta_{nu})} = \frac{1-\delta_{\mathrm{e}}}{r+\delta}\frac{\partial NR_{nu}(L)}{\partial L}. \tag{12}$$

Using the demand function for good nu and the definition of the elasticity of demand ε_{nu}, a relationship between the workers' marginal contribution to nominal revenues, the price level and the elasticity is established, $\partial\rho_{nu}(L)/\partial L = yp_{nu}((\varepsilon_{nu}-1)/\varepsilon_{nu})$. It is then convenient and intuitive to express (12) as

$$\frac{p_{nu}}{P} = \frac{\varepsilon_{nu}}{\varepsilon_{nu}-1}\frac{1}{y}\left[\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}\frac{r+\delta}{1-\delta_{\mathrm{e}}} + \frac{\partial[w_{nu}(L)/P]L}{\partial L}\right], \tag{13}$$

where $\varepsilon_{nu}/(\varepsilon_{nu}-1)$ can be interpreted as the markup over *total* marginal cost, inclusive of vacancy posting costs and changes in the firm's real wage bill.

Turning to wage determination in the non-unionized sector and following a number of authors,[6] each worker is treated as the marginal worker. Hence, equating the weighted surpluses

$$\phi \frac{\partial V^{\mathrm{F}}_{nu}(L)}{\partial L} = (1-\phi)(M^{\mathrm{w}}_{nu} - S^{\mathrm{w}}_{nu}), \tag{14}$$

where ϕ is the worker's bargaining power. After some algebra, Eq. (14) produces a differential equation in $w_{nu}(L)$ to solve, which can be rewritten as

$$\phi L \frac{\partial w_{nu}}{\partial L} + w_{nu} - \left[\phi y \frac{\varepsilon_{nu}-1}{\varepsilon_{nu}} p_{nu}(L) + (1-\phi) r S^{\mathrm{w}}_{nu}\right] = 0. \tag{15}$$

In canonical form, this is an equation of the form $y' + f(x)y + h(x) = 0$ for which general solutions are available (see Appendix A for details of the derivation). Thus, Eq. (15) can be solved for the equilibrium real wage and relative price

$$\frac{w_{nu}(L_{nu})}{P} = b + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}\phi[r+\delta+p_{\mathrm{w}}(\theta_{nu})], \tag{16}$$

$$\frac{p_{nu}(L_{nu})}{P} = \frac{\varepsilon_{nu}-\phi}{\varepsilon_{nu}-1}\frac{1}{y}\left\{b + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}[r+\delta+\phi p_{\mathrm{w}}(\theta_{nu})]\right\}. \tag{17}$$

4.4. Firms' problem in a unionized sector

Firms in sector u take the union wage demands $\{\widetilde{w}_{u,i}\}, i = 1, \ldots, \mathscr{U}$ as given. The firm's state variables are the number of workers it currently employs (and the distribution of wages it has to pay them, which depends on which union they belong to). It is assumed that this distribution reflects the distribution of union membership in the sector and remains constant over time. Thus,

$$V^{\mathrm{F}}_{u}(L) = \max_{L',v} \frac{1}{1+r}\{\rho_u(L) - \frac{1}{\mathscr{U}}\sum_{i=1}^{\mathscr{U}} \widetilde{w}_{u,i} L - \kappa P v + (1-\delta_{\mathrm{e}})V^{\mathrm{F}}_{u}(L')\},$$

$$\text{s.t.} \begin{cases} Y_u(L) = y \cdot L, \\ \frac{p_u}{P} = \left(g\,\frac{Y_u + (N_u-1)\widehat{Y}_u}{I}\right)^{-1/\sigma}, \\ L' = p_{\mathrm{f}}(\theta_u)\cdot v + (1-\delta_{\mathrm{s}})L. \end{cases}$$

Proceeding as in Section 4.3, the first-order condition is

$$\frac{p_u(L_u)}{P} = \frac{\varepsilon_u}{\varepsilon_u - 1}\frac{1}{y}\left[\frac{\kappa}{p_{\mathrm{f}}(\theta_u)}\frac{r+\delta}{1-\delta_{\mathrm{e}}} + \frac{1}{\mathscr{U}}\sum_{i=1}^{\mathscr{U}}\frac{\widetilde{w}_{u,i}}{P}\right]. \tag{18}$$

Eq. (18) states how much individual firms produce, taking the union wage demands and market tightness as given. Eq. (18) is similar to (13). The only difference is that in a unionized sector hiring an additional worker only changes the wage bill by an amount

[6] Cahuc and Wasmer (2001), Ebell and Haefke (2004), and Smith (1999).

equal to the expected wage to be paid to that worker. In a non-unionized sector, hiring an additional worker affects the wage paid to all workers in the firm.

5. Equilibrium

Let us look for an equilibrium symmetric within sectors of the same type. Two cases, national or sectorial unions, are considered. The former is the base case for the numerical analysis as it is more closely associated with European unions which is the focus of Section 7.

5.1. Equilibrium with national unions

Let $w_{u,i}/P$ be union U_i's real wage demand and $\widehat{w}_u/P$ the (symmetric) wage demands of all other unions. When a union makes a particular wage demand, it applies to its members across all unionized sectors. Denote by N_{nu} and N_u the number of firms in the two type of sectors. An equilibrium is defined as follows:

1. Taking wage demands $(\widehat{w}_u, w_{u,i})$ and the numbers of firms (N_{nu}, N_u) as given, a *labor market equilibrium* is an octuple $\{(\theta_j, p_j/P, L_j)_{j\in\{u,nu\}}, w_{nu}/P, \Omega\}$ satisfying (2), (7)–(8) for $j \in \{u, nu\}$, and (16)–(18).
2. A *labor market equilibrium with entry* requires that N_{nu} and N_u be given by (5) for $j \in \{u, nu\}$.
3. Anticipating the relationship between its individual wage demand $w_{u,i}$, other unions' demands $\widehat{w}_u$ and the labor market equilibrium with entry, union U_i chooses $w_{u,i}$ to maximize the ex ante welfare of its members $u_u \cdot S^{\mathrm{w}}_{u,i} + (1-u_u)\cdot M^{\mathrm{w}}_{u,i}$. Using (9)–(10), it is easy to show that the wage maximizes[7,8]
$$\frac{\delta b + p_{\mathrm{w}}(\theta_u)(w_{u,i}/P)}{\delta + p_{\mathrm{w}}(\theta_u)}.$$
4. A symmetric equilibrium requires that $w_{u,i} = \widehat{w}_u$.

5.2. Equilibrium with sectorial unions

Under this scenario, when union U_i makes a wage demand it only applies to its members in the sector it is operating in. Let $w_{u,i}/P$ be union U_i's demand. Let $\widehat{w}_u/P$ the demand of unions in other unionized sectors, as well as the demand of other unions in that sector. One thus need to differentiate between three kinds of sectors: (i) the unionized sector that union U_i is operating in, (ii) the other unionized sectors, and (iii) the non-unionized sectors. An equilibrium is then defined in a manner essentially similar as above, except that a labor market equilibrium in step 1 is given by market tightnesses, relative prices and firm sizes in

[7]The object to maximize is the weighted average of the search and match values, with the weights equal to the unemployment and employment rates, respectively. It can be rewritten as the convex combination of unemployment and employment incomes, the weights being proportional to the transition rates into these states.

[8]In the objective function, the unemployment rate is not restricted to be independent of union U_i's wage demand. In fact, one can see from (6) that u_u depends on θ_u.

the three kinds of sectors, and that in step 2, free entry of firms is required in the three sectors. The requirements in steps 3–4 are unchanged.

6. How do unions affect the labor market?

In this section, the model is calibrated to reproduce a ‘‘typical’’ European labor market and simulated to check that it replicates the main stylized facts mentioned in Section 2.

6.1. Calibration

The values of all parameters are reported in Table 1. The time period is one month. Starting with the technology and preference parameters, the linear production technology is characterized by the output per worker y which is normalized to 1. The discount rate r is set to correspond to an annual real interest rate of 4%. Consistent with Chistiano et al. (2001) and Rotemberg and Woodford (1992, 1995), the elasticity of substitution is set at $\sigma = 5$.[9] The matching technology is characterized by three parameters. The vacancy posting cost κ is set at 30% of output as in Millard and Mortensen (1997). The matching function is assumed to be Cobb–Douglas with an elasticity of the matching function with respect to vacancies equal to η and an intercept term s. Petrongolo and Pissarides (2001) report estimates of η between 0.3 and 0.5. The parameter η is set equal to 0.5. The term s is chosen to reproduce an unemployment rate of around 11%, which is the European average (OECD, 1996). The two parameters governing the stability of employer–employee relationships, namely δ_e and δ_s, have been chosen to match a median job tenure of 7 years across European countries (OECD, 1997), as well as a seven-year firm survival probability of 40% as reported in Scarpetta et al. (2002).

Two parameters are critical for wage determination, the real unemployment income b and the workers' bargaining power ϕ. The unemployment income b is set equal to 0.6. This value is chosen to reflect a value of home production set at 30% of market output and an UI replacement rate of 0.3, which is the average across OECD countries (OECD Database on Unemployment Benefit Entitlements and Replacement Rates). The bargaining power ϕ represents the ability of individual workers to retain the rent created by matching frictions, and thus is determinant in the union premium, defined as the relative difference between union and non-union wages. The value of $\phi = 0.045$ is chosen to replicate a 7% union premium, based on Blanchflower and Freeman (1992), who find a union premium that varies between 4% and 10% in Australia, Austria, Switzerland, the United Kingdom and West Germany.[10] It is worth noticing that this value of ϕ is somewhat smaller than the values typically used in the literature, which are generally chosen between 0.3 and 0.5. For example, due to a lack of empirical evidence, Mortensen (1994a) and Mortensen and Pissarides (1994) suggest the choice of $\phi = 0.5$, for reasons of symmetry. Millard and Mortensen (1997) choose $\phi = 0.3$.[11] However, actual estimates of rent splitting parameters are much lower than that, as evidenced in Blanchflower et al. (1996), Christofides and

[9]Another reason for choosing a high enough value for the elasticity of substitution σ becomes apparent once the model is simulated (see footnote 12).

[10]In a slightly different setup, Delacroix (2004) also finds a very low value of ϕ whether assuming that the union maximizes the ex ante welfare of the representative worker or of the representative employed worker.

[11]This is not without consequence, however. For example, Mortensen (1994b) acknowledges that the magnitude of the effects of the labor market policies he considers is sensitive to the choice of ϕ.

Table 1
Calibrated parameters

Production technology: $y = 1$	Matching technology: $s = .17$, $\eta = .5$, $\kappa = .3$	Preference parameters: $\sigma = 5$, $b = .6$, $r = .0033$
Breakdown rates: $\delta_e = .0108$, $\delta_s = .0011$	Individual wage determination: $\phi = .045$	Unions: $\mathscr{U} = 3$, $m/g = .2$
	Entry costs: $f = .21$	

Oswald (1992), and Hildreth and Oswald (1997), who find profit-per-employee elasticity of wages ranging from 0.01 to 0.08. To take into account the possible simultaneity of profits and pay, these authors use a combination of specifications (instrumental variables or regressing pay on past profits per employee). It is to be noted that Abowd and Lemieux (1993) and Van Reenen (1996), using IV estimates find higher values (around 0.2). Their data sets, however, do not allow them to control for workers' characteristics, which Blanchflower et al. can do. In any case, even these estimates are smaller than the values generally calibrated in the matching literature. In fact, using the union premium to pin ϕ down validates the choice of the rent-splitting parameter.

A further robustness test for the value of ϕ is carried out. The two key parameters for the simultaneous determination of the unemployment rate and the wage premium are s and ϕ. This model is designed to replicate a European labor market and these two parameters were chosen to replicate a "typical" European economy. The test is to check whether these two values would also generate predictions on unemployment and the wage premium consistent with the U.S. market. Although unionism in the U.S. presents a complex picture, an important feature of American unions that is absent in Europe is more bargaining at the firm level with a single union (Blau and Kahn, 1999). Although not structured with that purpose in mind, the model can be used to "approximate" an American labor market by assuming that (i) unions are sectorial in nature, that (ii) there is a very large number of sectors (i.e. equating a sector with an individual firm) and that the relative number of unionized sectors corresponds to the U.S. unionization rate ($m = 700, g = 800$), and (iii) that each sector is characterized by one union ($\mathscr{U} = 1$). Because a firm is associated with a sector, $N = 1$ and the firm free entry condition does not apply. The only other parameters that were changed are (δ_e, δ_s, b) to reflect a seven-year firm survival probability of 45%, a median job tenure of 4.2 years and a UI replacement rate of 0.11 (OECD Database on Unemployment Benefit Entitlements and Replacement Rates). Then keeping the values of ϕ and s as calibrated for the synthetic European economy, the model predicts an unemployment rate of 4.3% and a wage premium of 23%. To obtain a wage premium of 22% as in Blanchflower and Freeman (1992), one just has to set $\phi = 0.0485$. All these considerations validate the choice of a lower rent extraction parameter than is done in the literature. This choice is dictated by the size of the union premium for both European type and American labor markets.

The only type of policies considered in this section are entry regulations for new firms. Following a number of authors, Djankov et al. (2002) and Fonseca et al. (2001), two types of entry costs are considered, pecuniary opportunity costs and fees. In particular, Djankov et al. combine these two types of costs and report entry costs as a percentage of annual per capita GDP. Thus, total entry costs are modeled as

$$c_{\mathrm{e}} = f \cdot GDP,$$

where f is measured as percentage of individual GDP. Using Djankov et al. figures for the countries for which Blanchflower and Freeman (1992) report union premia, $f = 0.21$.

Finally, unions are described along two dimensions. First, the degree of unionization in the economy depends on both union density—the proportion of the labor force belonging to a union—and the extent of bargaining coverage—the proportion covered by a union wage agreement. As mentioned in Section 2, these two measures of the extent of unionization can be very different in a single country. Bargaining coverage is the notion that corresponds to the structure of the model. Since it averages 80% in Europe, m/g is set equal to 0.2. The other parameter is the number of unions per sector $\mathcal{U}$ representing workers (the base case assumes national unions). The European Trade Union Confederation reports 77 members over 35 countries, anywhere from 1 to 5 members per country. Only considering medium to large-size Western European countries, the average number of unions per country is approximately 2.5. As the mode of that distribution is equal to three, $\mathcal{U}$ is set equal to 3.

6.2. Simulations

Simulations are conducted to verify whether the model can replicate stylized union facts. In particular, the focus is on determining how the degree of union density/bargaining coverage $(1 - m/g)$ and union coordination ($\mathcal{U}$) affect unemployment. Although the base case looks at "national" unions, the model can also be used to investigate whether "national" or "sectorial" unions result in higher unemployment to verify the model's predictions with regards to centralization of collective bargaining. The model is also rich enough that it can generate predictions not only on union and non-union wages as well as unemployment, but also on price–wage markups within a sector, relative prices across sectors, firm sizes, and number of firms per sector. The results are reported in Tables 2–4. A description of the numerical method is provided in Appendix B.

When bargaining coverage decreases from 80% to 60% to 40%—which is a lower bound for European countries, the aggregate unemployment rate decreases from 11.1% to 10.4% to 9.5%. Hence, lower unionization leads to less unemployment, as expected. However, this aggregate result hides some sectorial effects. While overall unemployment does decrease, non-union unemployment stays relatively constant, and union unemployment actually increases. Because non-union sectors are now a larger part of the economy, aggregate unemployment decreases. When making their wage demands, unions take into consideration that high demands will increase the price of their goods relative to the non-union goods and restrict employment in their own sector. Unions trade off higher wages against lower employment. When they represent a smaller portion of the economy, they have a greater incentive to raise their wage demands.[12] This tends to mitigate the decrease in the overall unemployment rate expected from the fact that the low unemployment

[12]Unions have more of an incentive to push for high wage demands when it does not reduce employment as much, i.e. when firms can respond by increase p_u without reducing output too much. From (1), one can see that the ratio of real incomes between union- and non-union sectors is equal to $(p_u/p_{nu})^{1-\sigma}$. In the calibration, the substitution effect dominates ($\sigma > 1$). Thus, there is more incentive to be "aggressive" , when the relative price changes little. This happens when non-union sectors as a whole form a bigger portion of the economy (higher m).

Table 2

	$m/g = .2$	$m/g = .4$	$m/g = .6$
Unemployment (agg.) (%)	11.1	10.4	9.5
Unemployment (u) (%)	13.4	16.1	20.5
Unemployment (nu) (%)	2.1	2.1	2.1
w_u	.807	.812	.819
w_{nu}	.754	.755	.756
Union premium (%)	7.0	7.5	8.3
Unemployment duration (u)	13.0m.	16.1m.	21.7m.
Unemployment duration (nu)	1.8m.	1.8m.	1.8m.
Markup (p_u/w_u) (%)	24.5	24.8	25.4
Markup (p_{nu}/w_{nu}) (%)	30.1	30.1	30.3
Firm size (u)[a] (%)	0	−1.0	−3.1
Firm size (nu) (%)	−10.1	−9.9	−9.4
Number firms (u)[b]	1.08	1.06	1.02
Number firms (nu)	1.36	1.36	1.35
$\ln(p_u/p_{nu})$ (%)	+2.45	+3.08	+4.16

[a]Since firm size depends on the size of the labor force, the results have been normalized.
[b]Or equivalently, multiply by $\sigma = 5$ to get the elasticity of demand faced by the individual firm. Decreasing σ would increase firm size correspondingly.

Table 3

	$\mathscr{U} = 1$	$\mathscr{U} = 2$	$\mathscr{U} = 3$	$\mathscr{U} = 4$
Unemployment (agg.) (%)	6.3	8.9	11.1	13.3
Unemployment (u) (%)	7.4	10.5	13.4	16.1
Unemployment (nu) (%)	2.1	2.1	2.1	2.1
w_u	.800	.804	.807	.809
w_{nu}	.758	.756	.754	.752
Union premium (%)	5.4	6.4	7.0	7.6
Unemployment duration (u)	6.7m.	9.9m.	13.0m.	16.1m.
Unemployment duration (nu)	1.8m.	1.8m.	1.8m.	1.8m.
Markup (p_u/w_u) (%)	25.3	24.8	24.5	24.4
Markup (p_{nu}/w_{nu}) (%)	30.7	30.4	30.1	29.8
Firm size (u) (%)	0	−1.3	−3.1	−5.4
Firm size (nu) (%)	−10.8	−11.8	−12.9	−13.9
Number firms (u)	1.12	1.10	1.08	1.07
Number firms (nu)	1.33	1.34	1.36	1.38
$\ln(p_u/p_{nu})$ (%)	+1.12	+1.80	+2.45	+3.08

Table 4

	National	Sectorial
Unemployment (agg.) (%)	11.1	17.8
Unemployment (u) (%)	13.4	21.7
Unemployment (nu) (%)	2.1	2.2
w_u	.807	.812
w_{nu}	.754	.748
Union premium (%)	7.0	8.5
Unemployment duration (u) (%)	13.0m.	23.3m.
Unemployment duration (nu) (%)	1.8m.	1.9m.
Markup (p_u/w_u) (%)	24.5	24.4
Markup (p_{nu}/w_{nu}) (%)	30.1	29.1
Firm size (u) (%)	0	−7.4
Firm size (nu) (%)	−10.1	−13.6
Number firms (u)	1.08	1.06
Number firms (nu)	1.36	1.41
$\ln(p_u/p_{nu})$ (%)	+2.45	+4.46

sectors are now more prevalent.[13] Nonetheless, the increase in equilibrium wage demands is a moderate 1.4%, as monopolist unions anticipate how their demands affect vacancy posting decisions.

Let us contrast two economies, one where unions operate at the national level with one where unions operate at the sectorial level. National unions generate less unemployment (11.1% vs. 17.8%). The reason is similar to the above explanation: wage demands of sectorial unions affect a smaller portion of the economy than those of national unions.

Finally, when the level of union coordination is decreased (i.e. the number of unions per sector $\mathscr{U}$ increases from 1 to 4, considering national unions), aggregate unemployment increases from 6.3% to 13.3%. This again is due primarily to an increase in union unemployment. Less coordination implies that unions consider that their own wage demands have less of an effect on aggregate market tightness. If all unions respond by making higher wage demands though, it results in greater unemployment.

In conclusion, the model was able to generate a positive relationship between bargaining coverage and unemployment. As noted in Section 2, the empirical literature does not draw a sharp distinction between the notions of coordination and centralization, either combining union and employer coordination indices as in Nickel and Layard (1999) or

(*footnote continued*)
Then union goods are a smaller part of the consumption basket. A given increase in the price of union goods has less of an effect on the price index and is associated with a smaller increase in the relative price p_u/p_{nu} (see Eq. (2)).

[13]Unreported simulations find that when σ is smaller ($\sigma = 2$), the incentive to take advantage of terms of trade effects is stronger and aggregate unemployment can in fact increase.

combining coordination and centralization indices as in OECD (1997). Both studies find a negative relationship between unemployment and the indices thus defined. Nickell and Layard also find that in presence of the coordination variable, there is no statistically significant role for the centralization variable. By contrast, the model finds that more coordination and more centralization as we defined them are associated with less unemployment. In fairness, the complexity and diversity of actual collective bargaining institutions across European countries prevent a sharp distinction between the two notions. On the other hand, theoretical modelization makes it easier to come up with precise definitions for the two concepts. Thus, the proxy for centralization used in the Nickell and Layard regression is not fully comparable to the notion used in the model. Their index is derived from a ranking by Calmfors and Drifill (1988) which incorporates both (i) the *levels* of coordination within unions and employer organizations (national, industry, firm) and (ii) the number of existing unions and the extent of their cooperation. Thus, the index they use incorporates some elements of coordination and centralization, as defined in the model. However, several other authors define centralization as the level at which bargaining takes place and this is the simpler definition we used, allowing a clear distinction between the two notions.

In the next section, UI is introduced to study the interactions between UI and unions' interests. In particular, with the level of bargaining coverage characterizing European economies, would powerful European unions support generous unemployment benefits? The endogenous determination of labor market policies is generally thought of as a political economy process (Hassler and Rodriguez Mora, 1999; Saint-Paul, 2000; Pallage and Zimmermann, 2001). Instead of using this approach, we are examining in the next section the possibility that unions are " behind" the generous European policies, given their wage setting power and the fact that collective bargaining agreements extend to a majority of workers in Europe. One way to investigate that question is to see whether unionized workers benefit or not from generous policies, given that unions have the ability to adjust their wage demands to the policies in place.[14]

7. Unions and unemployment insurance

Real unemployment benefits are given by b' so that the unemployed worker's period utility is given by $(b+b')P$, inclusive of home production and benefits. Wage payments are subject to a payroll tax τ, imposed symmetrically on the worker and the firm. The derivation of equilibrium is very similar to Section 4. Only detailed here is how the introduction of policies alters the workers' and firms' problems. The workers' value functions in sector j are given by

$$\begin{aligned} rS_j^{\mathrm{w}} &= \left(b+b'\right)P + p_{\mathrm{w}}(\theta_j)[M_j^{\mathrm{w}} - S_j^{\mathrm{w}}], \\ rM_j^{\mathrm{w}} &= (1-\tau)w_j + \delta[S_j^{\mathrm{w}} - M_j^{\mathrm{w}}]. \end{aligned}$$

[14]Of course, with risk neutral workers, this abstracts from the insurance role of unemployment benefits. With risk aversion, the support for UI might depend on whether unionized sectors are more likely to be hit by sectorial shocks for example. This is left for future research.

Firms in either sector are facing the same constraints as in Section 4, but are now maximizing the following value function

$$V_j^{\mathrm{F}}(L) = \max_{v,L'} \frac{1}{1+r}\{\rho_j(L) - (1+\tau)w_j L - \kappa P v + (1-\delta_{\mathrm{e}})V_j^{\mathrm{F}}(L')\}. \tag{19}$$

The derivation of equilibrium is the same as in Section 4 and values for p_j/P and w_j/P are reported in Appendix C.

This framework is used to investigate how the (ex ante) welfare of union members is affected by the level of UI. When it comes to UI, the financing of these benefits is a very relevant issue. Rocheteau (1999) showed that in matching models of this sort, imposing budget balance with UI financed through payroll taxes only, leads to the possibility of multiple equilibria. When fixed benefits are financed by an endogenously determined payroll tax rate, market tightness is not uniquely determined. How many vacancies are posted depends on the expected tax rate. If firms expect a high (low) tax rate, they post few (many) vacancies. This results in high (low) unemployment and thus high (low) payroll taxes to balance the budget. Thus to avoid this problem, it is instead assumed that the payroll tax rate is proportional to the level of UI benefits, without requiring budget balance. Practically, it is assumed that $\tau = \gamma b'$ with a fixed γ.[15] For comparison purposes, the case where changes in benefits do not affect payroll taxes is also investigated. The tax rate τ is set at 0.1, an average across European countries based on OECD (1995). The model is then recalibrated, still based on "national" unions. The UI benefits are maintained at 0.3 (OECD Database on Unemployment Benefit Entitlements and Replacement Rates), implying that $\gamma = \frac{1}{3}$. Only the values of $b = 0.18$ and $s = 0.16$ are changed to maintain the unemployment rate and union premium.

In Tables 5 and 6, UI b' varies between 0 and 0.4 and changes in union members' welfare are reported. The unions are forward looking and realize that their wage demands affect the firms' incentive to post vacancies. They must balance the welfare of their employed and unemployed members, endogenously putting more weight on the employed ones. In non-unionized sectors, UI affects the workers' value of search and hence the matching surplus and equilibrium wages. In the unionized sectors, however, the income received while searching has no direct effect on wage determination, as what governs unions' demands is the trade-off anticipated between vacancy posting and wages (see Eq. (22). Of course, higher UI makes unemployed union members better off, but does not affect wage demands directly. What affects union members' welfare is how UI is financed. When higher UI is achieved through higher payroll taxes (Table 5), one observes higher unemployment and lower member welfare. When payroll taxes are kept constant (Table 6), unemployment is still higher, but union members do benefit. In fact, in the case where taxes increase with benefits, unions realize that firm incur some of the costs of higher benefits and reduce their demands, while with fixed taxes the demands are essentially unchanged.[16] Also notice that the same results would be reached, assuming that unions care about their employed

[15]In fact, with an *actual* budget constraint, as b' increases, unemployment would increase and thus τ would increase more than proportionately. Of course, all the results would still hold, taking into account that τ increases faster than b'.

[16]Notice that there is potential for UI to indirectly affect the unionized sector. UI influences wage determination in the small non-unionized sector, and therefore output as well. Quantitatively though, the terms of trade are not much affected.

Table 5

Varying τ	$b' = 0$	$b' = .1$	$b' = .2$	$b' = .3$	$b' = .4$
w_u	.798	.775	.753	.733	.715
Union premium (%)	13.8	11.8	9.3	6.8	3.2
Unemployment (agg.) (%)	6.1	7.3	8.5	11.4	17.8
Unemployment (u) (%)	7.3	8.8	10.1	13.7	20.7
Unemployment (nu) (%)	1.2	1.4	1.7	2.4	6.1
M_u^{w}	.7533	.7089	.6707	.6361	.6118
EAW_u[a]	.7524	.7080	.6698	.6352	.6113

[a]EAW_u: Ex ante welfare of a union member.

Table 6

Constant τ	$b' = 0$	$b' = .1$	$b' = .2$	$b' = .3$	$b' = .4$
w_u	.727	.728	.730	.733	.737
Union premium (%)	11.7	10.1	8.5	6.8	5.3
Unemployment (agg.) (%)	6.7	7.4	8.8	11.4	18.4
Unemployment (u) (%)	8.0	8.9	10.5	13.7	22.0
Unemployment (nu) (%)	1.4	1.6	1.9	2.4	3.9
M_u^{w}	.6170	.6228	.6290	.6361	.6464
EAW_u	.6162	.6220	.6282	.6352	.6453

Table 7

Monolithic union	$b' = 0$	$b' = .1$	$b' = .2$	$b' = .3$	$b' = .4$
w_u	.766	.745	.726	.710	.699
Unemployment (agg.) (%)	5.9	6.5	7.7	10.0	22.2
M_u^{w}	.7317	.6914	.6550	.6233	.6006
EAW_u	.7312	.6909	.6546	.6228	.6002

Payroll taxes vary with benefits.

members only. In conclusion, unions are in favor of generous UI only if the increase in benefits is not financed through payroll taxes.

A natural question is how union structure affects the lack of support for unemployment benefits when payroll taxes are allowed to vary. In other words, does the answer depend on institutional characteristics, such as coordination or the extent of bargaining coverage? We start by considering a single "monolithic" union covering all (employed and unemployed) workers.[17] Such a union could completely "internalize" the effect of a higher payroll tax and choose its wage demand so that the effective cost to the firm of hiring a worker is unchanged. What would that union choose to do? This is considered in Table 7 which shows that such a union would not want to push for higher benefits.[18] As expected,

[17]This is equivalent to setting $\mathcal{U} = 1$ and $m = 0$.

[18]To produce Table 7, we consider a fixed number of firms per sector. Otherwise, this monolithic union would basically have the possibility to "pick" the demand elasticity in all sectors.

Table 8

Coverage and support	$b' = 0$	$b' = .1$	$b' = .2$	$b' = .3$	$b' = .4$
$m/g = .2$ ($\mathscr{U} = 3$)					
w_u	.798	.775	.753	.733	.715
M_u^{w}	.7533	.7089	.6707	.6361	.6118
EAW_u	.7524	.7080	.6698	.6352	.6113
$m/g = .4$					
w_u	.801	.777	.755	.737	.721
M_u^{w}	.7517	.7090	.6701	.6352	.6138
EAW_u	.7506	.7080	.6690	.6339	.6130
$m/g = .6$					
w_u	.803	.779	.758	.743	.725
M_u^{w}	.7511	.7087	.6704	.6331	.6162
EAW_u	.7499	.7075	.6692	.6311	.6154

Based on the "national" union case. Payroll taxes vary with benefits.

Table 9

Coordination and support	$b' = 0$	$b' = .1$	$b' = .2$	$b' = .3$	$b' = .4$
$\mathscr{U} = 1$ ($m/g = .2$)					
w_u	.787	.764	.744	.726	.713
M_u^{w}	.7597	.7160	.6760	.6403	.6118
EAW_u	.7594	.7157	.6757	.6400	.6115
$\mathscr{U} = 2$					
w_u	.795	.771	.750	.731	.715
M_u^{w}	.7566	.7136	.6742	.6389	.6118
EAW_u	.7559	.7130	.6737	.6383	.6113
$\mathscr{U} = 3$					
w_u	.798	.775	.753	.733	.715
M_u^{w}	.7533	.7089	.6707	.6361	.6118
EAW_u	.7524	.7080	.6698	.6352	.6113

Based on the "national" union case. Payroll taxes vary with benefits.

in reaction to higher benefits and payroll taxes, the union moderates its wage demand. This increases the current income of their unemployed members—who carry an even slightly higher mass—but the largest component of their membership (the employed) is made worse off and so the union cannot favor it (this is true even though the payroll burden is spread over a large mass of employed relative to unemployed). In addition, we also look in Tables 8 and 9 at how the support for UI is affected by the extent of bargaining coverage and coordination. Again, in all cases unions would not push for generous benefits. The reason is the same, the majority of their membership would be negatively affected.

8. Conclusion

Real world labor markets are characterized by both individual and collective wage formation. It is therefore important to build models that have that feature. This paper was such an attempt. It was able to replicate the established facts about the effect of unions on unemployment with regards to bargaining coverage, and coordination and centralization of negotiations—while being consistent with the range of union premia observed in Europe. Using a monopolistic competition model of the goods market also allowed for interactions between unionized and non-unionized sectors, a kind of "terms of trade" effect.

We established that a small bargaining power to the individual worker is needed to match the union wage premium observed in Europe. Although it is consistent with some estimations, it is much smaller than the values typically used in the matching literature. However, quantitative analysis of labor market policies in a matching framework depends very much on that parameter. Thus, more work is needed in that area.

By introducing unemployment insurance, one can look at the interactions between unions and labor market policies. In particular, one can study how unions affect the response of unemployment to the benefits level. One can also ask whether unions would be favorable to generous benefits as observed in Europe. The model was able to determine under which conditions unions would push for high levels of unemployment insurance. The answer is robust to the institutional characteristics.

We established that the strong European unions could not be behind the generous UI observed in Europe, if this also translated into higher payroll taxes. This raises the question of how to explain the fact that Europe tends to be characterized by high replacement rates, while the opposite holds in the U.S. One possibility is that unions are able to obtain such benefits without increasing payroll taxes to neither workers nor firms—putting all the financing burden on employers would negatively affect vacancy posting by firms and thus would not be to the benefit of union members. Another possibility is the political-economy process. But this raises some issues. An explanation based on multiple equilibria would not be satisfactory. Also, simulations indicate that, in the non-unionized sector as well, generous UI benefits have a negative enough effect on vacancy posting to decrease employed workers' welfare. Thus, generous policies cannot be the result of a political economy process in this model. Hence, one has to look for some other fundamental difference between the U.S. and Europe. Since ϕ represents the *individual* worker's ability to extract rent, it is not clear why this parameter should vary significantly between the U.S. and Europe. Then, one must be looking for another institution that differs in the two economies and which interacts with the political-economy determination of UI. This is left for future research.

Other extensions of this model can also be considered. First, one could analyze other types of policies, such as firing costs for example. Second, one could endogenize the separation rate between the individual worker and firm. Third, when comparing welfare under different policies, it may be important to consider transitions as well, to incorporate the welfare of current workers. These last two extensions may be more relevant when analyzing firing costs. Finally, the question really addressed by the model is: Could unions be behind the generous European policies? But of course, the question of how would unions affect policies has not been addressed. This is left for future research.

Appendix A. Solving the differential equation (15)

For notational simplicity, omit the "*nu*" index from this appendix. Rewrite (15) as

$$\frac{\partial w(L)}{\partial L} + F(L)w(L) + G(L) = 0,$$

where $F(L) = 1/\phi L$ and $G(L) = -[\phi y((\varepsilon - 1)/\varepsilon)p(L) + (1-\phi)rS^{\mathrm{w}}]/\phi L$. A solution is of the form (Hill, 1992)

$$w(L) = \left(a - \int_0^L \frac{G(z)}{H(z)}\,\mathrm{d}z\right)H(L),$$

where H is solution to the homogeneous equation $\mathrm{d}H(L)/\mathrm{d}L + F(L)H(L) = 0$. The latter can be solved readily and

$$H(L) = L^{-1/\phi}.$$

To keep the wage rule bounded at $L = 0$, it must be that $a = 0$. Thus,

$$w(L) = L^{-1/\phi} \cdot \int_0^L z^{1/\phi}\left(\frac{[\phi y((\varepsilon-1)/\varepsilon)p(z) + (1-\phi)rS^{\mathrm{w}}]}{\phi z}\right)\mathrm{d}z.$$

This implies that

$$w(L) = \frac{1}{\phi}L^{-1/\phi} \cdot \int_0^L z^{1/\phi - 1}[\phi y\frac{\varepsilon-1}{\varepsilon}p(z) + (1-\phi)rS^{\mathrm{w}}]\,\mathrm{d}z.$$

Thus,

$$w(L) = (1-\phi)rS^{\mathrm{w}} + y\frac{\varepsilon-1}{\varepsilon}L^{-1/\phi}\int_0^L z^{1/\phi-1}p(z)\,\mathrm{d}z.$$

The integral on the right-hand side can be integrated by parts. By definition, $\mathrm{d}p(z)/\mathrm{d}z = -p(z)/z\varepsilon$ so that the integral equals $(\varepsilon\phi/(\varepsilon-\phi))L^{1/\phi}p(L)$. Thus, after simplifications

$$w(L) = (1-\phi)rS^{\mathrm{w}} + \phi\frac{\varepsilon-1}{\varepsilon-\phi}yp(L).$$

Notice that

$$\frac{\partial w(L)}{\partial L} = -\frac{\phi}{\varepsilon-\phi}\frac{\varepsilon-1}{\varepsilon}y\frac{p(L)}{L}.$$

Thus, Eq. (15) can be solved and

$$\frac{w_{nu}(L)}{P} = \phi\frac{p_{nu}(L)}{P}\frac{\varepsilon_{nu}-1}{\varepsilon_{nu}-\phi}y + (1-\phi)(rS^{\mathrm{w}}_{nu}/P). \tag{20}$$

Using (20) to compute $\partial w_{nu}(L)/\partial L$ and inserting it into (13), one gets

$$\frac{w_{nu}(L)}{P} = \frac{p_{nu}(L)}{P}\frac{\varepsilon_{nu}-1}{\varepsilon_{nu}-\phi}y - \frac{r+\delta}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}. \tag{21}$$

Using (9), the steady state version of (11), and (14), one finds that[19]

$$\frac{rS^{\mathrm{w}}_{nu}}{P} = b + \frac{\phi}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\kappa\theta_{nu}.$$

Finally, combine (20)–(21) and the above expression to obtain the equilibrium real wage and relative price

$$\frac{w_{nu}(L_{nu})}{P} = b + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}\phi[r+\delta+p_{\mathrm{w}}(\theta_{nu})],$$

$$\frac{p_{nu}(L_{nu})}{P} = \frac{\varepsilon_{nu}-\phi}{\varepsilon_{nu}-1}\frac{1}{y}\left\{b + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}[r+\delta+\phi p_{\mathrm{w}}(\theta_{nu})]\right\}.$$

Appendix B. Solving numerically

The algorithm is looking for a symmetric equilibrium. Let wages belong to a grid $\mathscr{W} = \{w_l\}_{l=1,\dots,W}$. Consider the case of national unions first. Denote by $w_i \in \mathscr{W}$ the wage demand of all other unions and by w_j the wage demand of the individual union in consideration. As assumed in Section 4.4, a firm in a unionized sector expects to pay a wage equal to $\overline{w}_{ij} = (1-1/\mathscr{U})w_i + (1/\mathscr{U})w_j$.

- Loop on $(i,j) \in \{1,\dots,W\} \times \{1,\dots,W\}$, each time defining $\overline{w}_{ij}$.
  - For that $\overline{w}_{ij}$, solve for the *labor market equilibrium with entry* as defined in Section 5.
  - Set (N_{nu}, N_u).
    - — For that pair, solve for the *labor market equilibrium* as defined in Section 5.
    - — Set θ_{nu}.
    - — Use Eq. (17) to compute p_{nu}/P and Eq. (8) to compute Ω.
    - — Use Eqs. (8) and (18) to solve for θ_u.
    - — Use Eq. (18) to compute p_u/P.
    - — Compute the price index as in Eq. (2). Obtain a residual.
    - — Update θ_{nu}, if necessary, using the Newton–Raphson method.
  - Use Eq. (16) to compute w_{nu}/P.
  - Compute real firm profits in both sectors and real GDP.
  - Compute entry costs in both sectors as defined in Section 6.1. Obtain two residuals from Eq. (5) applied to each type of sectors.
  - Update (N_{nu}, N_u), if necessary. This is done by choosing new values of (N_{nu}, N_u) which, combined with the previously determined prices, satisfy the firm free entry conditions.
- For each $(i,j) \in \{1,\dots,W\} \times \{1,\dots,W\}$, use Eq. (6) to compute the union sector unemployment rate. Compute the (individual) union objective function as defined in Section 5. For each wage demand by all other unions in the grid $\mathscr{W}$, obtain the (optimal) wage demand by the individual union which maximizes the ex ante welfare of the union members. A symmetric equilibrium requires that the two wages coincide.

[19] Since matching is random, $p_{\mathrm{w}}(\theta)/p_{\mathrm{f}}(\theta) = \theta$.

Solving for the case of sectorial unions is very similar. The difference is that one now needs to keep track of three types of sectors: a non-unionized sector, a generic unionized sector, and the one unionized sector where the individual union wage demands only apply. The structure of the algorithm is the same, except for the fact that (i) it loops on three values (N_{nu}, N_u^1, N_u^2) for the *labor market equilibrium with entry*, and (ii) solves for two values (θ_u^1, θ_u^2) for the *labor market equilibrium*. Other straightforward modifications follow from these two adjustments.

Appendix C. Equilibrium with unemployment insurance

Following the same methodology as is Section 4.3 and Appendix A,

$$\frac{w_{nu}}{P} = \frac{1}{1-\tau}\left\{b + b' + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}\phi[r+\delta+p_{\mathrm{w}}(\theta_{nu})]\right\},$$
$$\frac{p_{nu}}{P} = \frac{\varepsilon_{nu}\Lambda-\phi}{\varepsilon_{nu}-1}\frac{1}{\Lambda}\frac{1+\tau}{1-\tau}\frac{1}{y}\left\{b + b' + \frac{1}{1-\phi}\frac{1}{1-\delta_{\mathrm{e}}}\frac{\kappa}{p_{\mathrm{f}}(\theta_{nu})}[(r+\delta)\Lambda+\phi p_{\mathrm{w}}(\theta_{nu})]\right\},$$

where $\Lambda \equiv (1-\tau+2\tau\phi)/(1+\tau)$. A derivation similar to the one in Section 4.4 gives an expression for the price of the union good

$$\frac{p_u}{P} = \frac{\varepsilon_u}{\varepsilon_u-1}\frac{1}{y}\left[\frac{\kappa}{p_{\mathrm{f}}(\theta_u)}\frac{r+\delta}{1-\delta_{\mathrm{e}}} + (1+\tau)\frac{1}{\mathscr{U}}\sum_{i=1}^{\mathscr{U}}\frac{\widetilde{w}_{u,i}}{P}\right]. \tag{22}$$

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