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When is there more employment, with individual or collective wage bargaining?

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Abstract

In a standard Diamond-Mortensen-Pissarides labour market with frictions, the authors seek to determine when there is more employment with individual wage bargaining than with collective wage bargaining, using a wage equation generated by the standard total surplus sharing rule. Using a Cobb-Douglas production function, they find that if the bargaining power of the individual is high compared to the bargaining power of the union, there is more unemployment with individual wage setting and vice versa. When the individual worker and the union have the same bargaining power, if the cost of opening a vacancy is sufficiently high, there is more unemployment with individual wage setting. Finally, for a constant marginal product of labour production function *AL*, when the individual worker and the union have the same bargaining power, individual bargaining produces more unemployment.

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1 Introduction

Compared to Anglo-Saxon countries (i.e. the US and the UK), European labour markets are generally characterized by higher unemployment, more stringent employment protection legislation, more tightly regulated legislation and a large proportion of wages decided by collective agreements. The recent global financial and economic crisis of 2008-2009 led to a sharp increase in the unemployment rate, especially in the Mediterranean countries. For example, Spain reached a 26.23% harmonized unemployment rate during the second quarter of 2013, Portugal reached 17.37% during the first quarter of 2013, Greece reached 27.83% during the third quarter of 2013 and Italy reached 12.70% during the fourth quarter of 2014. This large increase in the unemployment rate has led to a renewed emphasis on the need to carry out structural labour market reforms, particularly in the Mediterranean countries, as the key to boosting employment, productivity and GDP growth.[1] Most of these structural reforms call for deregulation in employment protection legislation and an acceleration of the decentralization of collective bargaining leaving much more room for firm-level bargaining on wages.

Support for these policy recommendations can be found in a large body of literature that points to the institutional aspects of the labour market, such as employment protection legislation, unemployment benefits and the wage bargaining system, as the source of the observed high unemployment rate.[2] In this paper, we focus on one particular structural reform: to have individual or collective wage bargaining. The rate of collective bargaining coverage is really different across countries: in 2013 the average for OCDE is 33% being for example 77% in Spain, 12% in the US and 89% in Sweden.[3] With individual wage bargaining each worker bargains the wage unilaterally with firm whereas with collective bargaining all workers, generally represented by a union, bargain together with the firm. The objective of this paper is to analyze which bargaining system -individual or collective- generates more unemployment, in a Diamond, Mortensen and Pissarides (DMP) labour market using a wage equation derived from the usual surplus-sharing rule in both systems. In general, models with frictional unemployment assume individual wage bargaining and few papers analyze collective bargaining. For example, Pissarides (1986) and Bauer and Lingens (2013) analyze the conditions under which collective wage bargaining is efficient. Ebell and Haefke (2006), in a model with imperfect competition in the goods market, study which bargaining regime emerges as the more stable institution. Delacroix (2006), in a model with imperfect competition in the goods market, analyses the effect of different collective wage setting systems on employment. García and Sorolla (2017) evaluate, in a model with matching frictions, which collective wage setting system generates a higher frictional unemployment rate. Ranjan (2013) analyses the role of labour market institutions in offshoring, Moen (1997) retains the basic DMP framework but assumes that wages are no longer bargained over but rather fixed by employers at the time when

[1] Substantial structural labour market reforms to employment protection legislation (EPL) and bargaining decentralization were approved over the period 2010-2012 in Spain, Greece, Italy, Portugal and France. For more details, see page 40 of the OECD (2013) report.

[2] See, for example OECD (1994) Jobs Study, Scarpetta (1996), Siebert (1997), Belot and Van Ours (2004) and Bassanini and Duval (2006), among others.

[3] Collective bargaining coverage rate corresponds to the ratio of employees covered by collective agreements, divided by all wage earners with right to bargaining. Concretely, this data are available in OECD (2017) page 137.

they open up vacant jobs. More recently, Krusell and Rudanko (2016) and Morin (2017) develop dynamic search and matching models of the labour market that introduce trade unions into the Mortensen and Pissarides framework. Krusell and Rudanko (2016) focus on the welfare effect of a monopoly union, while Morin (2017) studies how trade unions affect the cyclical properties of wages, labour market tightness and employment. Most of the papers afore mentioned assume a linear production function AL and none of them, however, compares the same wage-setting structure for the two wage-bargaining systems, whereas Jimeno and Thomas (2013) or Cai et al. (2014) do so with a single worker (constant marginal product) and heterogeneous firms, comparing individual/firm-level wage setting and sector/collective wage setting, where the same wage is set for all firms.

In this paper, we compare individual and collective wage setting when both wages and employment are set at the same time or without commitment in a search model framework with large firm. In our model, we assume that the firm does not have a first-mover advantage because the employment level is determined after the union has bargained over the wage. With this assumption on timing there is no over-employment as is the case with Smith (1999), Cahuc and Wasmer (2001) or Cahuc et. al (2008).

The novelty of the present paper is to derive the collective wage setting equation applying the Ranjan (2013) approach to a case where wages and employment are set simultaneously. Moreover, the wages are negotiated taking into account a production function with decreasing marginal product of labour. Finally, we compare our equilibrium outcome to the standard wage setting equation obtained with individual bargaining in Pissarides (2000). The difference with the collective wage equation presented by Ranjan (2013) is that he considers the union monopoly model, where a union unilaterally sets the wage before employment is decided. Compared with the papers of Jimeno and Thomas (2013) and Cai et al. (2014) the main difference is that we have a multiple worker firm whereas they assume a single worker firm which allows us to have different objective functions for individual and collective wage bargaining whereas for them is the same. Furthermore, we use a single firm model having no room for heterogeneity, as they have, and our production function has decreasing marginal product whereas they use one with constant marginal product. With Jimeno and Thomas (2013) set up they obtain that unemployment is lower with firm-level bargaining whereas Cai et al. (2014) get that the most efficient system depends on worker bargaining power and the relative efficiency of job search.

Our main findings, using a Cobb-Douglas production function $F(L) = AL^{\alpha}$, where $\alpha < 1$, are that with individual wage setting, wages are set proportional to the marginal product of labour, while with collective wage setting they are set proportional to the average product of labour. As is well known, in this case, the average product is higher than the marginal product of labour. On the other hand, with collective wage setting, the value function of unemployed workers is internalized by the union when negotiating the wage, producing wage moderation. Depending on the weight of these two opposing forces, lower wage and more employment might be more likely obtained with collective than with individual bargaining.

The rest of the paper is organized as follows. In the next section, we present the standard components that can be found in any exposition of the DMP model (for example Pissarides (2000) or Cahuc et al. (2014)) and that will be used later: the equilibrium labour market flows equation, the employment equation, and the steady-state value functions. In Section 3, we derive the two wage equations: the individual and the collective. Section 4 compares the two equilibria and states the main results. In Section 5, we discuss when the social planner's solution can be reached under individual and collective wage bargaining. In Section 6, we discuss and compare the results with a numerical example. Finally, Section 7 concludes.

2 The Market Economy

2.1 Labour Market Flows

In our framework, there are matching frictions in the labour market when firms recruit formalized by the matching function $X(t) = m(V(t), U(t))$. Following standard assumptions, let X be the total number of contracts between the mass of vacancies, denoted by V, and the total of unemployed workers U. We define $U = (N - L)$, where the total size of the work force N is constant, and L measures the employment level.[4] We assume that the function m has constant returns to scale, increasing and concave in each argument. Let us define the parameter $\theta \equiv \frac{V}{U}$ as the degree of the labour market tightness. The probability of filling a vacant job slot per unit of time is given by $\frac{X}{V} = m(1, \frac{1}{\frac{V}{U}}) \equiv q(\theta)$ with $q(\theta)' < 0$ and $q(0) = +\infty$. Similarly, the probability of an unemployed worker being employed by a firm is defined as $\frac{X}{U} = \frac{V}{U}\frac{X}{V} = \theta q(\theta)$, where it can be shown that $\frac{d(\theta q(\theta))}{d\theta} > 0$.

Assuming that a proportion $0 < \lambda < 1$ of employed people lose their job, then employment flows are given by the differential equation

$$\dot{L} = X - \lambda L = q(\theta)V - \lambda L = q(\theta)\frac{V}{U}U - \lambda L = q(\theta)\theta(N - L) - \lambda L. \tag{1}$$

When the labor market flows are in equilibrium $\dot{L} = 0$, the equilibrium labour markets flows equation is given by (the Beveridge curve):

$$L = \left[\frac{1}{1 + \frac{\lambda}{\theta q(\theta)}} N \right] \tag{2}$$

This linkage describes a relationship, which is strictly increasing, between employment level and θ.

2.2 The Multiple-Worker (Large) Firm

We assume a production function $Y = F(L)$ with $F' > 0$ and $F'' < 0$. The firm simultaneously chooses L and V (vacancies) in order to maximize its value function V_F, that is, the sum of discounted profits over a lifetime,

$$V_F = \int_0^\infty e^{-rt} \left[F(L) - \omega L - \gamma_0 V \right] dt, \tag{3}$$

[4] To simplify notation, we will omit the letter t, which indicates a continuous variable, when it is not necessary.

subject to the employment flow equation given by (1). Where ω denotes the real wage, r is the exogenous real interest rate and γ_0 the cost of opening a vacancy per unit of time and per vacancy posted. From (1) we obtain $V = \frac{\dot{L}+\lambda L}{q(\theta)}$, and substituting it into a firm's objective yields a maximization problem in terms of L, that is, the firm maximizes:

$$V_F = \int_0^{\infty} e^{-rt}\left[F(L) - \omega L - \gamma_0 \frac{\dot{L}+\lambda L}{q(\theta)}\right] dt \tag{4}$$

if we assume that θ is exogenous and constant (steady state), the first-order condition gives the standard employment equation:

$$F_L(L) = \omega + \gamma_0 \frac{r+\lambda}{q(\theta)}. \tag{5}$$

This expression provides an equality relationship between the benefits of employing an additional unit of labour (a match) $\frac{F_L-\omega}{r+\lambda}$ with its cost $\frac{\gamma_0}{q(\theta)}$.[5] We assume that, in a steady-state path, γ_0 is proportional to the wage that is $\gamma_0 = \gamma\omega$.[6]

Thus, we write the employment equation as:

$$F_L(L) = \left[1 + \gamma \frac{(r+\lambda)}{q(\theta)}\right] \omega \tag{6}$$

where an increase in ω, γ and θ reduce employment.

2.3 Steady State Value Functions

We denote the value function of an employed worker, that is, his expected discounted labour income over a life time taking into account the fact that the worker can change from employment to unemployment with the constant probability λ as V_E. Then, as usual, the following asset value equation holds at steady-state (see for example Cahuc et al. (2014) equation (10.6) or Pissarides (2000) equation (1.11)):

$$rV_E = \omega + \lambda(V_U - V_E) VFE \tag{7}$$

We denote the value function of an unemployed worker as V_U and if θ is constant, that is, in a steady state, the following asset value equation holds:[7]

$$rV_U = b_0 + \theta q(\theta)(V_E - V_U) VFU \tag{8}$$

[5] See equation (3.7) in Pissarides (2000) or equation (9.46) in Cahuc et al. (2014).

[6] This assumption is standard in the literature, see the discussion in Pissarides (2000), page 10 or page 74.

[7] Pissarides (2000), equation 1.10 and Cahuc et. al. (2014) equation 9.14.

We know that the value function of the firm, its expected discounted profits, is given by

$$V_F = \int_0^\infty e^{-rt} \left[F(L) - \omega L - \gamma\omega V\right] dt = \int_0^\infty e^{-rt} \left[F(L) - \omega L - \gamma\omega \frac{\dot{L} + \lambda L}{q(\theta)}\right] dt. \tag{9}$$

In a steady state, where $\dot{L} = 0$, we get

$$V_F = \int_0^\infty e^{-rt} \left[F(L) - \omega L - \gamma\omega \frac{\lambda L}{q(\theta)}\right] dt. \tag{10}$$

Then the value asset equation implies

$$rV_F = \left[F(L) - \omega L - \gamma\omega \frac{\lambda L}{q(\theta)}\right], \tag{11}$$

which is equivalent to

$$V_F = \frac{\left[F(L) - \omega L - \gamma\omega \frac{\lambda L}{q(\theta)}\right]}{r}. \tag{12}$$

Finally, we need to know the firm's steady-state value function for hiring an extra worker V_F', that is[8]

$$rV_F' = [F_L - \omega] - \lambda V_F' \tag{13}$$

which is rewritten as

$$V_F' = \frac{F_L - \omega}{r + \lambda}. \tag{14}$$

3 The Wage Setting Systems

3.1 Individual Wage Setting

We consider the Nash situation where L and ω are set at the same time or without commitment. When there is individual wage setting, each individual worker bargains with the firm over the wage. Then, when deciding the wage, the function to maximize is

$$(V_E - V_U)^{\beta_I} \left(V_F'\right)^{1-\beta_I} \tag{15}$$

[8] Pissarides (2000) equation 1.14 and Cahuc et al. (2014) equation 9.10.

where $(V_E - V_U)$ is the surplus that a worker gets if hired, V_F' is the surplus that the firm gets if it hires an extra worker and β_I is the bargaining power of the individual worker.[9]

This is the usual surplus-sharing rule for individual wage setting, normally used in models with matching frictions. With individual wage setting, the wage is chosen in order to maximize (15) subject to (7) and (14), and taking V_U as given, then the function to maximize is:

$$\left(\frac{\omega - rV_U}{r+\lambda}\right)^{\beta_I}\left(\frac{F_L(L)-\omega}{r+\lambda}\right)^{1-\beta_I} \tag{16}$$

The first-order condition yields the following expression for wages:[10]

$$\omega = (1-\beta_I)rV_U + \beta_I F_L(L). \tag{17}$$

It can also be shown that the first-order condition implies that total surplus $(V_E - V_U + V_F')$ is divided in such a way that:

$$(V_E - V_U) = \beta_I(V_E - V_U + V_F'), \tag{18}$$

or equivalently

$$(1-\beta_I)(V_E - V_U) = \beta_I V_F'. \tag{19}$$

Note that the wage setting rule states that the wage depends positively on the marginal product of labour and that an increase in expected income over a life of an unemployed worker V_U increases the wage. It is important to note that, because the wage is bargained between an employed worker and the firm, we substitute $V_E - V_U$ using only the asset value equation of an employed worker, as Pissarides (2000) does on page 16. This produces that the wage equation when there is individual bargaining depends on V_U. In the collective wage setting case when a union represents both employed and unemployed workers, we will use the asset value equations of an employed and an employed worker to substitute $V_E - V_U$.

Using the asset value condition (8) we can rewrite (17) as the following wage equation:

$$\omega = (1-\beta_I)b_0 + (1-\beta_I)\theta q(\theta)(V_E - V_U) + \beta_I F_L(L) \tag{20}$$

Note that the wage setting rule states that the wage depends positively on the unemployment benefit. Now substituting (19) and (14) into the above expression leads to

$$\begin{aligned}\omega &= (1-\beta_I)b_0 + \beta_I\theta q(\theta)V_F' + \beta_I F_L(L) \\ &= (1-\beta_I)b_0 + \beta_I\theta q(\theta)\left[\frac{F_L(L)-\omega}{r+\lambda}\right] + \beta_I F_L(L)\end{aligned} \tag{21}$$

[9] Note that in all the expressions shown in this paper the subscripts I and C refers to the individual and collective wage setting, respectively.

[10] Pissarides (2000) equation 1.18.

and finally, using the employment equation (6), yields the wage curve[11]

$$\omega = (1-\beta_I)b_0 + \gamma\beta_I\theta\omega + \beta_I F_L(L). \tag{22}$$

The wage equation with individual wage setting depends positively on the unemployment benefit, the marginal product of labour, labour market tightness and the cost of open a vacancy. The intuition for the last results is that, an increase in θ, increases the probability of an unemployed worker being employed in the future and then of its life income, implying an increase in the wage as stated by the expression (17). An increase in γ produces an increase in the marginal product of labour in employment equation (6), and then an increase in the value of the firm of hiring an extra worker expressed by (14). Finally because of the surplus sharing rule is given by (19), an increase on the life income of an unemployed worker and on the wage set.

Assuming that, on the steady state path, $b_0 = b\ \omega$ such that $b < 1$, then the individual wage equation can be reduced to

$$\omega_I = m_I F_L = \frac{\beta_I}{1-(1-\beta_I)b-\beta_I\gamma\theta} F_L(L), \tag{23}$$

that is, the wage is a proportion of the marginal product of labour, $m_I = \frac{\beta_I}{1-(1-\beta_I)b-\beta_I\gamma\theta} > 0$, that depends on θ. This expression also indicates that an increase in λ and θ increase the wage.

3.2 Collective Wage Setting

When there is collective wage setting we assume that a union that represents both employed and unemployed workers bargains with the firm over the wage.[12] In this case, the function to maximize is[13]

$$\left\{\left[\left(\frac{L}{N}V_E + \frac{(N-L)}{N}V_U\right) - V_U\right]N\right\}^{\beta_C} (S_F)^{1-\beta_C} \tag{24}$$

where $\left(\frac{L}{N}V_E + \frac{(N-L)}{N}V_U\right)$ is the expected value function of a worker, and then $\left(\frac{L}{N}V_E + \frac{(N-L)}{N}V_U\right) - V_U$ is the expected surplus of a worker. On the other hand, S_F is the surplus that the firm gets when employing L workers. Finally, β_C is the bargaining power of the union. Alternatively, it may be the case that in the collective bargaining system, the union bargaining with the firm represents only employed workers (insiders), in which case the union's objective to maximize is given by the following expression:[14]

$$[(V_E - V_U)L]^{\beta_C} (S_F)^{1-\beta_C} \tag{25}$$

[11] This is Pissarides (2000) equation 1.20 when $\gamma_0 = \gamma\omega$, that is $\omega = (1-\beta_I)b_0 + \beta_I[F_L(L) + \gamma_0\theta]$.

[12] Pissarides (1986) and Ranjan (2013) assume that the union unilaterally sets the wage.

[13] This is the extension of the function proposed by Ranjan (2013) when the wage is negotiated.

[14] This is the objective function proposed by Ebell and Haefke (2006) and Bauer and Lingens (2013). As we said, Ranjan (2013) and Pissarides (1986) consider the case where the union unilaterally sets the wage, maximizing $\left[\left(\frac{L}{N}V_E + \frac{(N-L)}{N}V_U\right) - V_U\right]N = [(V_E - V_U)L]$ and $V_E^{\beta_C} V_U^{(1-\beta_C)}$ respectively.

Note that rearranging the terms in (24), the function to maximize is equal to (25). There are many options for defining the surplus of the firm, S_F, when there is agreement in the bargaining process and it employs L workers. Like Ebell and Haefke (2006), we assume that in the event of disagreement, the firm is dissolved but, unlike those authors, we assume that the firm must pay the costs of opening vacancies because, as in individual wage setting, they have been determined in advance, [15] in which case $S_F = \frac{[F(L)-\omega L]}{r}$. Then, with collective wage setting the wage is chosen in order to maximize:

$$[(V_E - V_U)L]^{\beta_C} \left(\frac{[F(L) - \omega L]}{r} \right)^{1-\beta_C} \tag{26}$$

subject to (7) and (8).

Substituting $V_E - V_U$ from (7) and (8) as in Ranjan (2013),[16] we obtain $V_E - V_U = \frac{\omega - b_0}{r+\lambda+\theta q(\theta)}$, and can rewrite the objective function as:

$$\left[\left(\frac{\omega - b_0}{r+\lambda+\theta q(\theta)} \right) L \right]^{\beta_C} \left(\frac{[F(L) - \omega L]}{r} \right)^{1-\beta_C} \tag{27}$$

yielding the first order condition:

$$\omega = (1-\beta_C)b_0 + \beta_C \left[\frac{F(L)}{L} \right], \tag{28}$$

where, in this case, the wage depends on bargaining power, the unemployment benefit and the average product of labor or labor productivity. [17] With collective wage setting the wage does not depend on θ, because when maximizing the union internalizes how both V_E and V_U are computed, using (7) and (8), and then changes in θ affect in the same way both value functions and the optimal wage does not change.

Assuming also, that on the steady state path, $b_0 = b\ \omega$, the wage equation simplifies as:

$$\omega_C = m_C \frac{F(L)}{L} = \frac{\beta_c}{[1-(1-\beta_c)b]} \left[\frac{F(L)}{L} \right], \tag{29}$$

where now the wage is a proportion, $m_C = \frac{\beta_c}{[1-(1-\beta_c)b]} > 0$, of the average product of labour. Comparing both wage equations (22) and (28) or (23) and (29) we see that, apart from bargaining

[15] Ebell and Haefcke (2006) assume that if the firm is dissolved it does not have to pay the cost of opening vacancies in which case $S_F = V_F$. All the results derived below are also true for this case. On the other hand, Bauer and Lingens (2013) assume that if the firm separates from its current employees and time is continuous, it can start producing in the next instant with new employees, in which case: $S_F = V_F - \left[V_F - \gamma\omega \frac{\lambda L}{q(\theta)} \right] = \gamma\omega \frac{\lambda L}{q(\theta)}$.

[16] The difference with the case in which the union negotiates only on behalf of employed workers (insiders) is that, in this case, $V_E - V_U$ is computed using only (7), which is the usual assumption in the literature.

[17] Considering the Ebell and Haefke (2006) case where $S_F = V_F$ the wage equation is

$\omega = (1-\beta_C)b_0 + \beta_C \left[\frac{F(L)}{L} \frac{1}{\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right]} \right]$, which is similar to the wage equation WS that appears in Bauer and Lingens (2013).

power and the unemployment benefit, the wage with individual wage setting depends positively on γ, θ and F_L and only on $\frac{F(L)}{L}$ with collective wage setting. If the production function presents decreasing marginal product, then $F_L < \frac{F(L)}{L}$, which means that without anything else, there is wage moderation with individual wage setting. However, this moderation can be inverted with a sufficiently high value of γ or θ, because individual wage setting depends on these parameters and collective wage setting does not.

4 Equilibrium

Let us now describe the equilibrium of the search and matching model with both types of wage bargaining system. In this context, we can obtain a solution for labour market tightness and employment. These solutions, depend on the properties of the production function (constant or decreasing returns to labour), on the bargaining power and, finally on the hiring cost.

As mentioned above, the employment equation, whether for individual or collective bargaining, is given by:

$$F_L(L) = \omega\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right] \tag{30}$$

Substituting the individual wage equation from (23) in the employment equation (30) one gets the equilibrium labour market equation that gives an implicit expression for θ:

$$F_L(L) = \frac{\beta_I}{1-(1-\beta_I)b-\beta_I\gamma\theta}F_L(L)\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right] \tag{31}$$

after rearranging and simplifying terms, we get the expression that characterizes labour market tightness for individual wage bargaining, θ_I, as:

$$\frac{1-b}{\beta_I}+b-\gamma\theta_I = \left[1+\gamma\frac{(r+\lambda)}{q(\theta_I)}\right] \tag{32}$$

Applying the same procedure, we substitute the collective wage equation (29) in the employment equation (30):

$$F_L(L) = \frac{\beta_c}{[1-(1-\beta_C)b]}\left[\frac{F(L)}{L}\right]\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right] \tag{33}$$

If the production function is Cobb-Douglas, $F(L) = AL^{\alpha}$, this implies that $\frac{F(L)}{L} = \frac{1}{\alpha}F_L(L)$, and one obtains:

$$F_L(L) = \frac{\beta_c}{[1-(1-\beta_C)b]}\frac{1}{\alpha}F_L(L)\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right] \tag{34}$$

simplifying, we arrive at the implicit expression that characterizes the labour market tightness for collective wage bargaining,[18] θ_C, as:

$$\alpha\left[\frac{1-b}{\beta_C}+b\right]=\left[1+\gamma\frac{(r+\lambda)}{q(\theta_C)}\right] \tag{35}$$

Then, comparing the two equilibria given by (32) and (35), one obtains the following propositions:

Proposition 1 *If β_I is high enough $\theta_I < \theta_C$ and then $L_I < L_C$. If β_C is high enough $\theta_C < \theta_I$ and then $L_C < L_I$.*

Proof: The right-hand side of equations (32) and (35) are identical. Moreover, both expression are equal to 1 when $\theta = 0$ (notice that $q(0) = +\infty$), and increasing in θ because $q(\theta)' < 0$.[19] The left-hand side of equation (35) is a constant straight line, and thus if $\alpha\left[\frac{1-b}{\beta_C}+b\right] > 1+\frac{\gamma(r+\lambda)}{q(\theta)}$, a unique equilibrium with collective wage setting exists. The left-hand side of equation (32) is equal to $\frac{1-b}{\beta_I}+b$, when $\theta = 0$ and decreases with θ, that is, it is a straight line with negative slope λ, then, for a positive β_I $\left[\frac{1-b}{\beta_I}+b\right] > 1+\frac{\gamma(r+\lambda)}{q(\theta)}$ a unique equilibrium with individual wage setting exists.

If β_I is high enough, then $\left[\frac{1-b}{\beta_I}+b\right]$ is low enough with respect to $\alpha\left[\frac{1-b}{\beta_C}+b\right]$. In this case, the right straight line $1+\frac{\gamma(r+\lambda)}{q(\theta)}$ crosses to the left-hand side curve (32) below the left-hand side curve (35) and, therefore, $\theta_I < \theta_C$. Using the equilibrium labour market flows equation (2), it is easy to demonstrate that $L_I < L_C$. The determination of the equilibrium is illustrated in Figure 1, which gives the right and left value of expressions (32) and (35) on the vertical axis and the labour market tightness on the horizontal axis.

The opposite occurs when β_C is high enough, because $\alpha\left[\frac{1-b}{\beta_C}+b\right]$ is low enough with respect to $\left[\frac{1-b}{\beta_I}+b\right]$. In this case, the right straight line $1+\frac{\gamma(r+\lambda)}{q(\theta)}$ crosses to the left-hand side curve (32) above the left-hand side curve (35) and, therefore $\theta_C < \theta_I$, which implies the opposite outcome $L_C < L_I$. In Figure 2 we graph this solution.

Another interesting result from this model can be obtained when $\beta_I = \beta_C = \beta$. In this case we can prove the following.

Proposition 2 *If $\beta_I = \beta_C = \beta$ and γ is high enough then there is more unemployment with individual wage setting.*

Proof: This is a specific demonstration of the above proposition. In this particular case, the value of the straight line of the left-hand side curve (35) is equal to $\alpha\left[\frac{1-b}{\beta}+b\right]$, and the intercept of the straight line with negative slope λ of the left-hand side curve (32) is $\left[\frac{1-b}{\beta}+b\right]$. Then, if λ is big enough, the straight line with negative slope is really steeper crossing to the right hand

[18] If $S_F = V_F$ equilibrium with collective wage setting gives $\alpha\left[\frac{1-b}{\beta_C}+b\right]=\left[1+\frac{\gamma r}{q(\theta_C)+\gamma\lambda}\right]$.

[19] When $S_F = V_F$ the one corresponding to collective bargaining, for a positive θ, is below the one corresponding to individual bargaining.

Figure 1: Demonstration of proposition 1

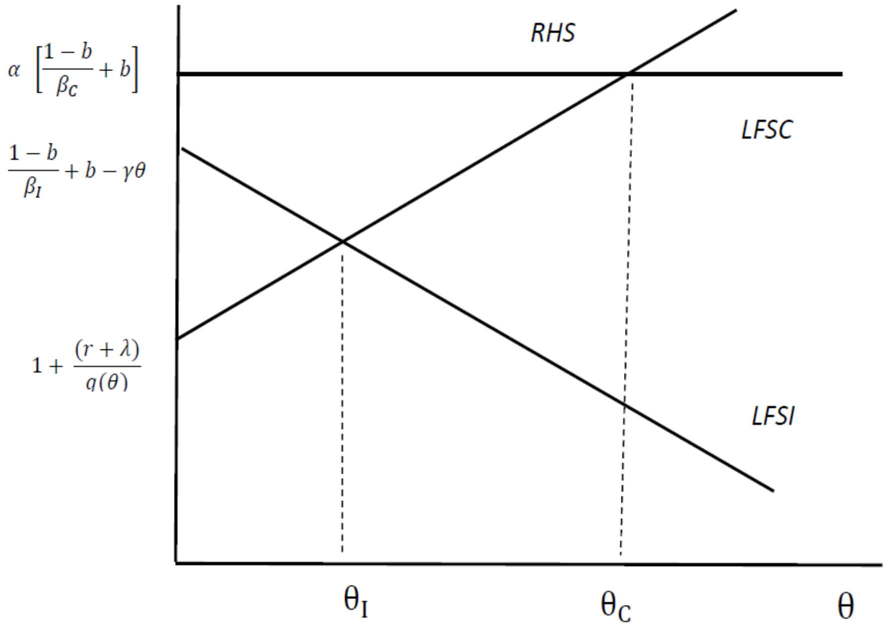
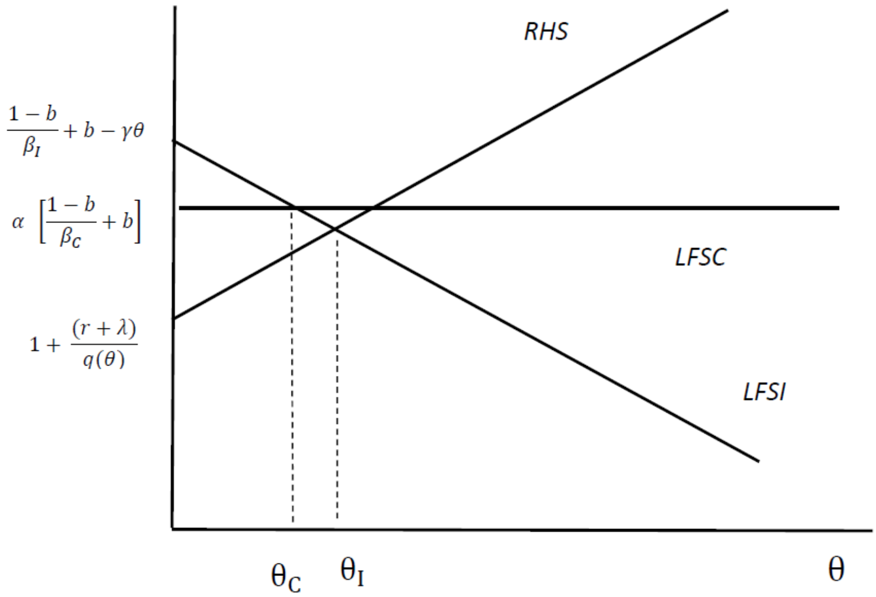
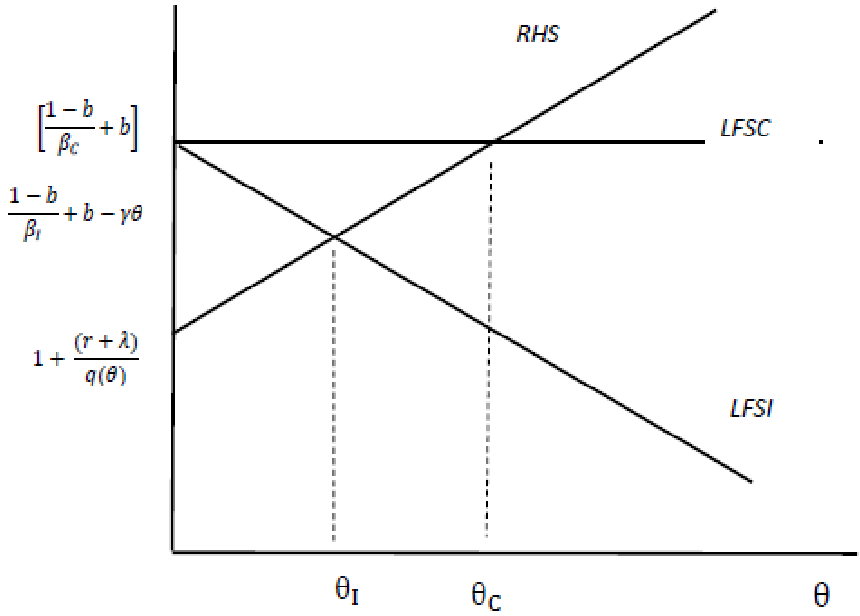


Figure 2: Demonstration of proposition 1



side curve $1+\frac{\gamma(r+\lambda)}{q(\theta)}$ below the crossing of the constant straight line $\alpha\left[\frac{1-b}{\beta}+b\right]$ and, therefore, $\theta_I < \theta_C$. Using the equilibrium labour market flows equation (2), it is easy to prove that $L_I < L_C$. In Figure 3 we graph this case.

Figure 3: Demonstration of proposition 3

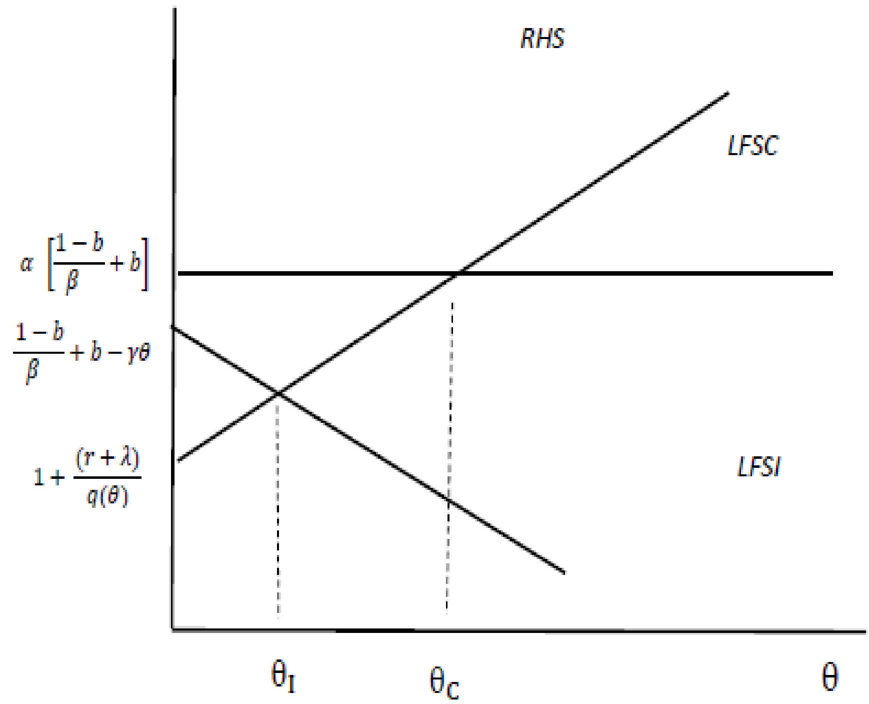


Finally, if the production function is $F(L) = AL$, that is $\alpha = 1$, then the following proposition holds:

Proposition 3 *If $\alpha = 1$ and $\beta_I = \beta_C = \beta$ then there is more unemployment with individual wage setting.*

Proof: This is a more specific demonstration of the above proposition. In this specific case, the constant straight line of the left-hand side curve (35) corresponds to $\frac{1-b}{\beta} + b$, and the intercept of the left-hand side curve (32) is the same. This implies that when θ is positive, the straight line with negative slope is below the constant straight line and intersects the right hand side curve for a lower θ, then $\theta_I < \theta_C$ and, using the equilibrium labour market flows equation (2), it is easy to check that, $L_I < L_C$. Figure 4 illustrated this solution. The general intuition, behind the results, is as follows: The wage setting system that generates more unemployment is the one that sets the higher wage. As we saw in the previous section, where both wage equations are compared, the wage in the individual wage setting system depends, basically, on the bargaining power of the individual (β_I), the cost of opening a vacancy (γ) and the marginal product of labour F_L $(\alpha AL^{\alpha-1}$, when $F(L) = AL^{\alpha})$. Nonetheless, in the collective wage setting system, the wage depends on the bargaining power of the union (β_C) and the average product of labor $\frac{F(L)}{L}$ $(AL^{\alpha-1}$, when $F(L) = AL^{\alpha})$. With the same bargaining power and anything else marginal product is less than average product and there is wage moderation with individual wage setting, but this moderation can be inverted for a higher γ because the wage with individual wage setting also depends on the cost of opening a vacancy.

Figure 4: Demonstration of proposition 2



5 Social Planner's Problem

In this section, we first analyze the problem of a social planner whose objective is to maximize social surplus, while being constrained by the link between the degree of the labour market tightness and the labour market flows. Then, we discuss how the social solution can be decentralized through individual and collective negotiation.

The planner's problem takes the standard form shown in Pissarides' (2000) equations (7.13) and (7.14). That is, the planner chooses a sequence of vacancies that maximize the present-discounted value of profits taking into account the Beveridge curve.

The efficient condition for tightness, in the steady state, is given by the following expression[20]

$$\frac{1-b}{\eta(\theta)}+b-\gamma\theta=\left[1+\gamma\frac{(r+\lambda)}{q(\theta)}\right] \tag{36}$$

where $\eta(\theta)$ denotes the elasticity of the expected duration of a vacancy.

As we have seen, the decentralized solution under individual and collective bargaining, respectively, is given by (37) and (38):

$$\frac{1-b}{\beta_I}+b-\gamma\theta_I=\left[1+\gamma\frac{(r+\lambda)}{q(\theta_I)}\right] \tag{37}$$

[20] See expression 8.55 of Pissarides (2000).

$$\alpha\left[\frac{1-b}{\beta_C}+b\right]=\left[1+\gamma\frac{(r+\lambda)}{q(\theta_C)}\right] \tag{38}$$

Comparing the social condition (36) with the decentralized individual wage bargaining system (37), we find that the two are identical if, and only if, $\beta_I = \eta(\theta)$. This is the standard Hosios (1990) condition: If $\beta_I = \eta(\theta)$, decentralized markets with individual wage setting internalize the search externalities that arise through the frictional matching process. However, when we compare the decentralized collective solution with the socially efficient outcome we obtain the following expression:

$$\frac{1-b}{\eta(\theta)}+b-\gamma\theta=\alpha\left[\frac{1-b}{\beta_C}+b\right] \tag{39}$$

rewriting the above expression yields

$$\beta_C=\frac{\eta(\theta)\alpha(1-b)}{(1-b)+\eta(\theta)b(1-\alpha)-\eta(\theta)\gamma\theta} \tag{40}$$

Only when β_C is given by the previous equation, collective wage setting is efficient and, thus, the standard Hosios condition does not internalize the externality associated with the collective wage bargaining system and it may, therefore, result in either over-employment or under-employment relative to the social optimum.

6 An Illustrative Simulation

We now investigate and evaluate the properties of a simulated version of our model for the US and Spanish labour markets. These countries are fairly representative of individual and collective wage bargaining systems, respectively. Most of the parameters are common to both calibrations. We calibrate the individual wage bargaining model to match the US unemployment rate and apply these calibrated parameter values to the collective wage bargaining model for this country. In a similar exercise, we also calibrate the collective wage bargaining model to replicate the Spanish unemployment rate and apply these calibrated parameters to the individual wage bargaining model. This procedure allows us to analyze two aspects. On the one hand, we can analyze the effect of changes in the value of one parameter on the unemployment rate under different wage bargaining systems. On the other hand, we can answer the following question: what would be the effect on unemployment if, *ceteris paribus*, the US adopted the Spanish wage bargaining system or, naturally, vice versa. All these counterfactual comparative statics exercises are presented graphically.

The matching function is assumed to be Cobb-Douglas with constant returns to scale $X = E * U^{1-\varphi}V^{\varphi}$, where E denotes the matching efficiency and φ is the elasticity of the matching function with respect to vacancies. We normalize the level of matching efficiency E to unity.

6.1 Calibration for the US

In this section, we follow the calibration of Shimer (2005). The time period is one quarter. Therefore, the real interest rate is $r = (0.05)^{1/4} - 1$, which corresponds to an annual real interest rate of 5%, reflecting the fact that the annual real interest rate has in fact been around 5%. We set the cost of vacancy equal to $\gamma = 0.213$, the separation rate λ =0.10 and the value of leisure b=0.4, following Shimer (2005). Furthermore, we set the labour share parameter in the Cobb-Douglas production function $\alpha = 0.65$ taking into account the average annual data from the US for the period 1950-2014.

We assume an elasticity φ equal to 0.5, following Petrongolo and Pissarides (2001), and set the value of workers' bargaining power equal to 0.5 to satisfy the Hosios condition. Therefore, under these idealized conditions, we replicate an efficient decentralized equilibrium with the individual wage bargaining model.

Given these parameter values, we can compute the labour market tightness for the US labour market using the expression (32). In this case, we obtain $\theta = 2.6351$, which implies that the job finding rate X/U= $\theta^{\varphi} = 1.6233$. Finally, analysing the steady-state Beveridge curve, we obtain the following unemployment rate $u = \frac{s}{s+\theta^{\varphi}} = \frac{0.1}{0.1+1.6233} = 0.05802$. This outcome replicates the average US unemployment rate in the period 1948-2017, which has been around 5.8%.[21] Table 1 summarizes the parameter values for the benchmark case.

Table 1

Calibrated parameter, United States

Description	Parameter	Value
Real interest rate	r	0.012
Leisure value	b	0.4
Separation rate	λ	0.1
Labour share	α	0.65
Vacancy posting cost	γ	0.213
Workers' bargaining power	β	0.5
Elasticity of X with respect to vacancies	φ	0.5

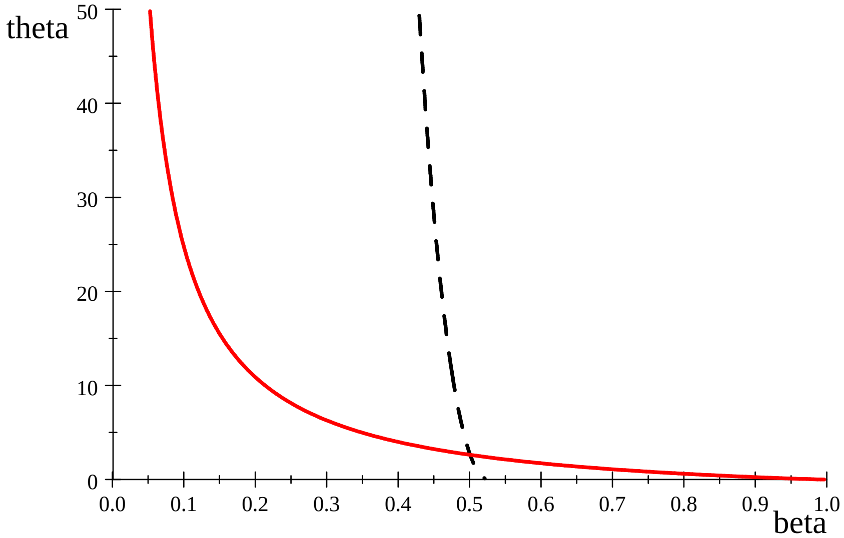
When does individual wage setting perform better than centralized wage setting?

Next, we compare the labour market tightness outcome under two different wage setting regimes: individual and collective. We will focus on four parameters: the workers' bargaining power β, leisure value b, real interest rate r, and the vacancy posting cost γ.

Figure 5 plots the equilibrium values of labour market tightness θ,under the individual wage regime for different values of workers' bargaining power together with their counterfactual collective wage solution taking into account the same parameter values. The dashed curve represents the solution for collective wage negotiation while the solid line shows the individual wage solution. It can be easily seen that when workers' bargaining power is too high this leads to insufficient vacancy creation and excessive unemployment in both wage negotiation systems.

[21] See Bureau of Labor Statistics Data for US labor market.

Figure 5: Changes of labour market tightness with respect to β: US



Both curves are intersected at point $\theta = 2.625\,, \beta = 0.50$, which implies an unemployment rate equal to 5.81% .This point is where the private bargaining power of workers coincides with the system that achieves the most efficient allocations and the tightness of centralized and decentralized wage bargaining. It should be noted that smaller values for workers' bargaining power imply that collective wage setting offers a higher tightness value and, therefore, a lower equilibrium unemployment rate.[22] In this case, we move away from the Hosios (1990) efficient solution.

Using exactly the same procedure we analyze another parameter of interest: leisure value b. Figure 6 depicts how the leisure value affects labour market tightness for both wage negotiation systems. In this case the value of β returns to its benchmark value of $\beta = 0.50$, which implies that, given an elasticity value of $\varphi = 0.5$, the individual and the efficient solution coincide. An increase in b rapidly lowers θ under centralized wage negotiation, but this occurs more slowly if the negotiation is individual. The two curves cross at point $\theta = 2.625\,, b = 0.40$, which implies an unemployment rate of 5.81%.Therefore, when the parameter b<0.4, we find a lower unemployment rate under a centralized wage negotiation system.

The effects of the real interest rate on θ can be seen in Figure 7. The graph highlights the stability of θ under individual wage negotiation against changes in the real interest rate. This suggests that the value of this parameter is not relevant when carrying out the simulations. Nevertheless, in the case of collective wage negotiation we observe a greater influence on θ, and thus, on the unemployment rate. Note that when the interest rate tends to zero the best option is centralized wage negotiation. Finally, we analyze the effect of vacancy posting costs on the labour market tightness. Figure 8 shows both curves with negative slopes, crossing at the point $\theta = 2.45, \gamma = 0.227$. In this case, when $\gamma < 0.227$, the pattern shown above is repeated and a lower rate of unemployment is obtained with the centralized wage negotiation. However, we observe that

[22] Note that the wage bargaining curve is defined for a very small β range.

Figure 6: Changes of labour market tightness with respect to leisure value: US

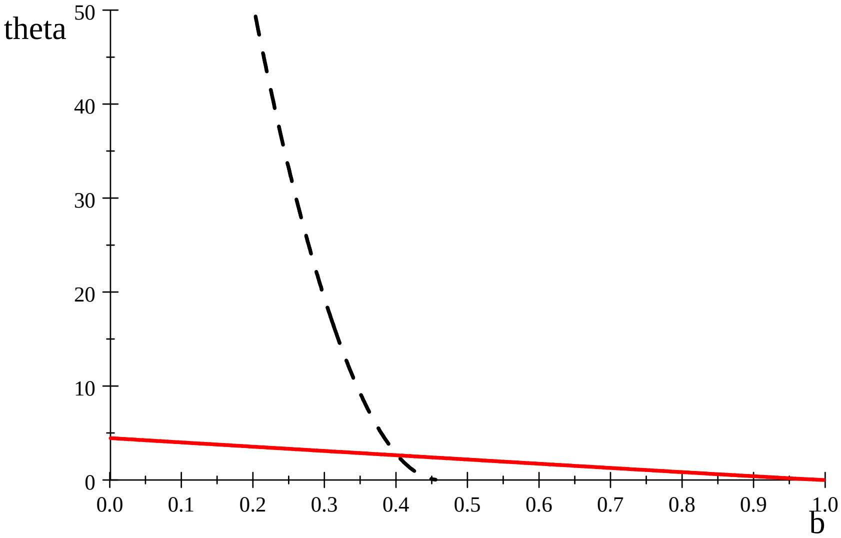
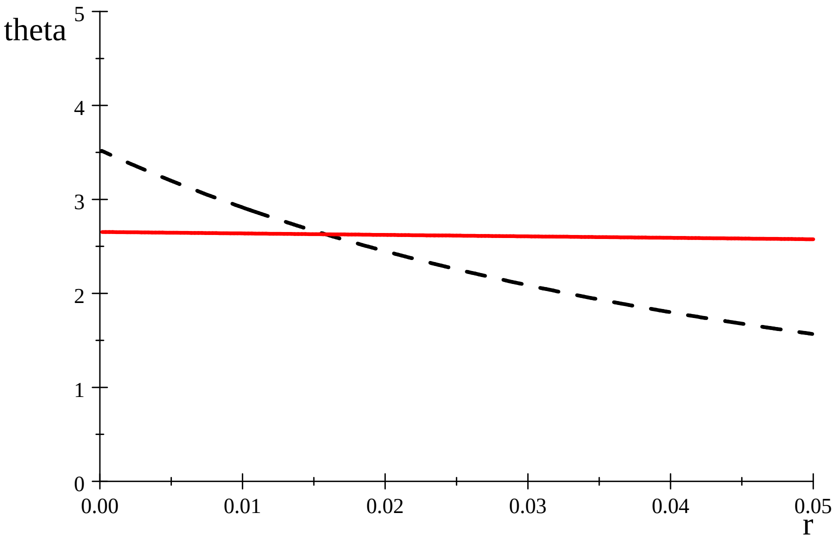


Figure 7: Changes of labour market tightness with respect to the real interest rate: US



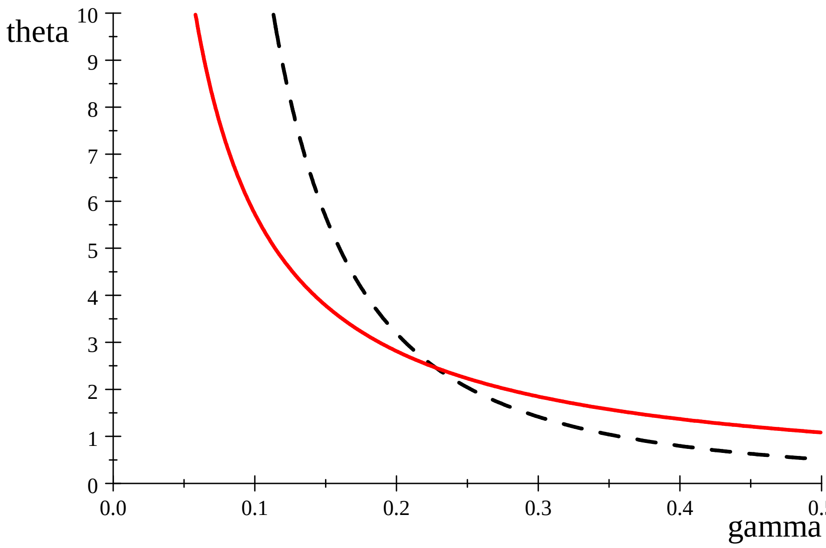
when γ increases, individual bargaining produces a lower unemployment rate. This outcome will be a numeric example of Proposition 2 demonstrated above.

6.2 Calibration for Spain

This model is also calibrated on a quarterly basis, so the real interest rate is r=0.012.

For the Spanish case, we decided to take the calibrated parameter value of a DGE model built for the Spanish economy, specifically the REMS (a Rational Expectations Model for the Spanish Economy). Thus, following Boscá et. al (2010) we choose a value for the vacancy posting

Figure 8: Changes of labour market tightness with respect to vacancy posting cost: US



cost of $\gamma = 0.183$, a value for the labour share of $\alpha = 0.6$ and a value for the matching elasticity with respect to vacancies of 0.57. In line with the efficiency condition in Hosios (1990), we also assume that the workers' bargaining power is equal to $1 - \varphi$. The exogenous separation rate, λ, is taken from empirical data and set to 0.06.[23] Finally, we calibrate the leisure value to match the empirical data on the steady-state unemployment rate with the solution from the expression (35) for labour market tightness. Finally, evaluating the steady-state Beveridge curve, we obtain the following unemployment rate $u = \frac{s}{s+\theta^{\varphi}} = \frac{0.06}{0.06+0.32969} = 0.1539$. This result is in line with the structural unemployment rate of around 15% estimated by Andrés and Doménech (2015), and the average unemployment rate of 15.9% observed for the period 1980-2017.[24] Table 2 summarizes the benchmark parameter values.

Table 2

Calibrated parameter, Spain		
Description	Parameter	Value
Real interest rate	r	0.012
Leisure value	b	0.489
Separation rate	λ	0.06
Labour share	α	0.60
Vacancy posting cost	γ	0.183
Workers' bargaining power	β	0.43
Elasticity of X with respect to vacancies	φ	0.57

[23] The separation rate was calculated as average job destruction divided by the labour force, according to data provided by the Spanish National Statistics Institute (INE) for the period 2005-2016. See Boscá et. al (2017).
[24] This data comes from the BDREMS database, which is used to estimate and calibrate the REMS model.

When does individual wage setting perform better than centralized wage setting?

Next, we show graphically the solution of (35) taking into account the parameter calibrated for Spain. Moreover, we consider an alternative setup involving individual wage negotiation, in other words, where both scenarios share the calibrated parameters from Table 2, but with different wage negotiation approaches. The results of these counterfactual exercises are also presented graphically. The vertical curve represents the parameter value calibrated for Spain. The important question here is whether the patterns found in the US case can also found in this case.

Figure 9: Changes of labour market tightness with respect to β: Spain

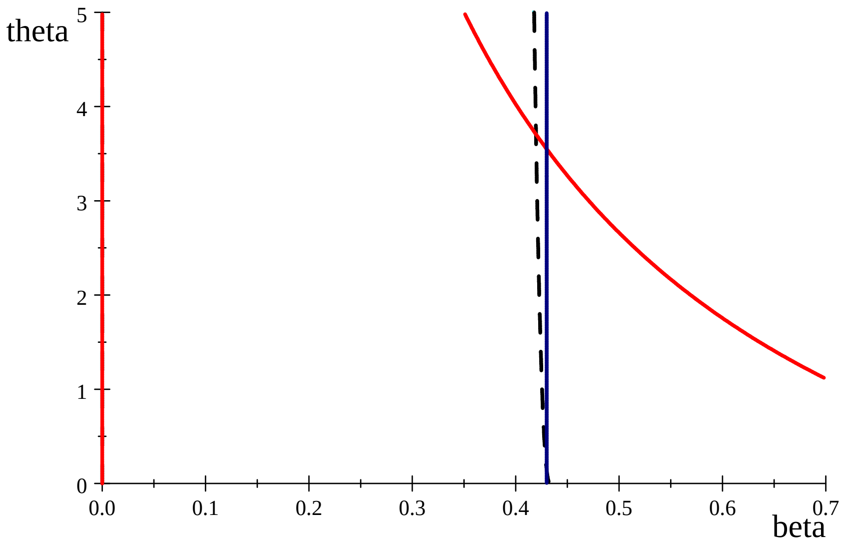
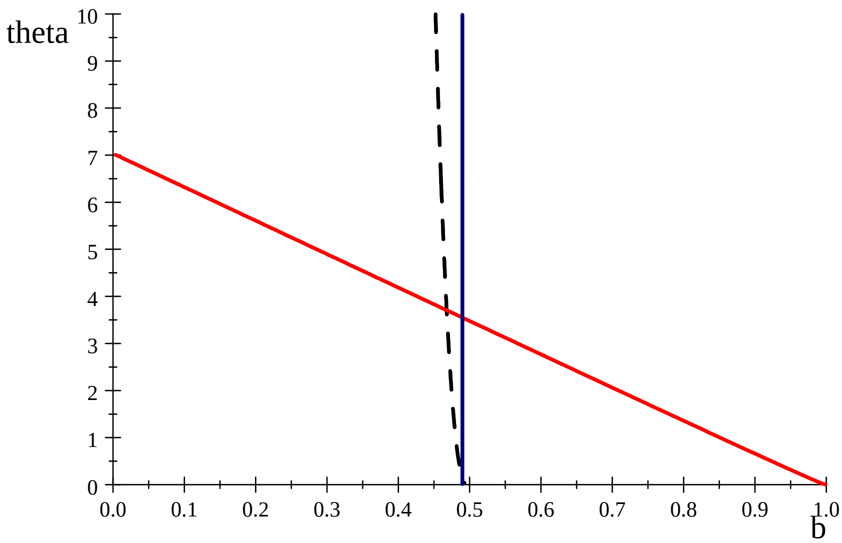


Figure 10: Changes of labour market tightness with respect to leisure value: Spain



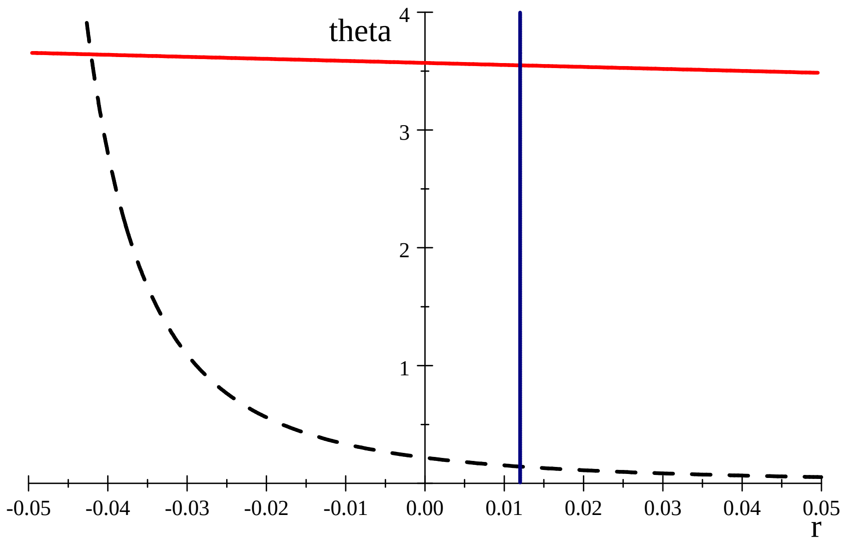
Figures 9 and 10 present the results obtained when the workers' bargaining power β and the leisure value b, respectively, are changed.

In this case, both the position of the curves and their slope are the same as those obtained in Figures 5 and 6. However, it is important to note that the change in bargaining system, *ceteris paribus*, considerably increases the labour market tightness, and therefore, reduces the unemployment rate substantially. In terms of the magnitudes, these results must be viewed with caution for two reasons: first, we have performed a very simple -albeit illustrative- counterfactual exercise. Second, we only consider the equilibrium in the labour market. However, it is worth emphasizing that, qualitatively, our results on the unemployment rate are in line with those of Jimeno and Thomas (2013).[25]

Figures 11 and 12 illustrate the effects of the real interest rate and vacancy posting cost, respectively, on θ for both wage bargaining systems. We find that, from the point of view of unemployment, the best option is clearly to switch to an individual wage bargaining system.

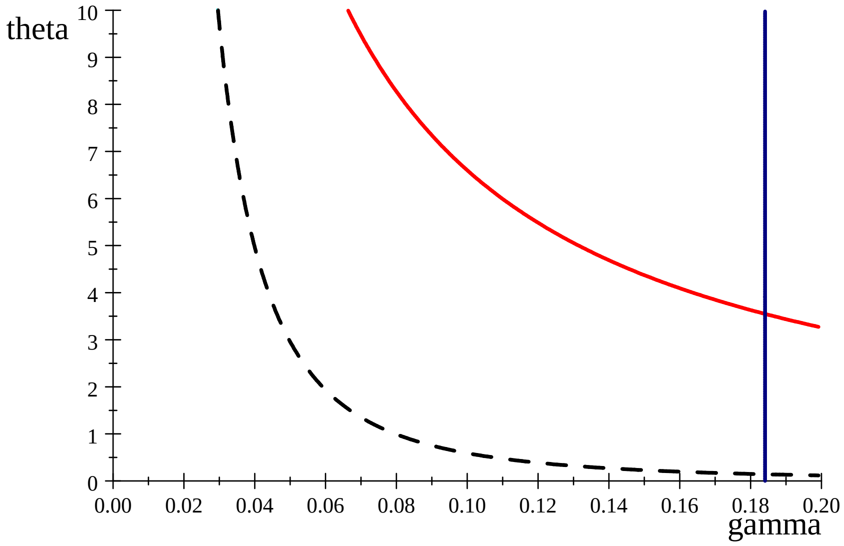
In general, therefore, it seems that in the Spanish labour market, the individual wage system is better than the collective one.

Figure 11: Changes of labour market tightness with respect to the real interest rate: US



[25] Jimeno and Thomas (2013) use a simulation exercise to compare labour market outcomes for an archetypal continental European economy under firm-level and sector-level bargaining, reporting a fall in the unemployment rate from 9.09% to 5.87%, respectively.

Figure 12: Changes of labour market tightness with respect to vacancy posting cost: Spain



7 Conclusions

In this paper, we analyze the situation in which the individual wage-setting system produces more unemployment than collective wage setting in a labour market with matching frictions. Our main findings are summarized as follows. First, if the bargaining power of the individual worker (union) is high enough, there is more unemployment with individual (collective) wage setting. Second, when we assume that the individual worker and the union exercise the same bargaining power and the cost of opening a vacancy is sufficiently high, there is more unemployment with individual wage setting. Finally, when the individual worker and the union exercise the same bargaining power and the production function is linear (AL), there is more unemployment with individual wage setting.

An intuitive explanation for the results is as follows: With individual wage setting, wages are set proportional to the marginal product of labour, while with collective wage setting they are set proportional to the average product of labour. Using a Cobb-Douglas production function specification, with decreasing marginal product of labour, we find that the average is higher than the marginal product. On the other hand, with collective wage setting, the value function of unemployed workers is internalized by the union when negotiating the wage, producing wage moderation. Depending on the weight of these two opposing forces, lower wage and more employment might be obtained with collective bargaining.

Moreover, we calibrate the model so that its steady-state solution can reflect the unemployment rate of US and Spain in a model with search and matching frictions. This allows us to graphically examine the results obtained as well as the effect on unemployment of exchanging one wage bargaining system with the other.

As a result, our counterfactual analysis indicates that the high unemployment rate in Spain could be reduced if the wage bargaining system was changed to individual wage negotiation. In this regard, the Spanish government's 2012 labour market reform attempted to reduce the degree of decentralization. Five years on, we may be able to see the real effect of the reform and to analyze the positive impact on the labour market, the increase in wage inequality and high rates of temporary employment. In the US case, the potential improvement entailed by switching from one negotiation system to another is not so clear. However, it must be borne in mind that the counterfactual exercises are very simple and it is difficult to draw very robust conclusions from them.

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