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

José Ramón García
Universitat de València

Valeri Sorolla *
Universitat Autònoma de Barcelona and Barcelona GSE

September 7, 2015

Abstract

With the standard Diamond-Mortensen-Pissarides labor market with frictions we analyze when there is more employment with individual wage setting compared to collective wage setting, using a wage equation generated by the standard total surplus sharing rule. Using a Cobb-Douglas production function (AL^{α}, $\alpha < 1$) we 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 the opposite is also true. When the individual worker and the union have the same bargaining power, if the cost of open a vacancy is high enough, there is more unemployment with individual wage setting. Finally, for a constant marginal product of labor production function AL, when the individual worker and the union have the same bargaining power, individual bargaining produces more unemployment.

Keywords: Matching Frictions, Unemployment, Individual and Collective Wage Setting.

JEL number: E24, O41.

---

*Corresponding author. Departament d'Economia i d'Història Econòmica, Universitat Autònoma de Barcelona, Edifici B - Campus UAB, 08193 Bellaterra, Spain; tel.: +34-93.581.27.28; fax: +34-93.581.20.12; e-mail: valeri.sorolla@uab.cat. I'm grateful for financial aid to the Spanish Ministry of Economy and Competitiveness through grant ECO2012-32392 and to Generalitat of Catalonia through grant 2014 SGR 803.

1 Introduction

In this paper we analyze which bargaining system: individual or collective generates more unemployment, in a Diamond, Mortensen and Pissarides (DMP) labor 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 only few papers analyze collective bargaining. Pissarides (1986) and Bauer and Lingens (2013) analyze under which conditions 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 stable institution. De la Croix (2006), in a model with imperfect competition in the goods market, the effect of different collective wage setting systems on employment. García and Sorolla (2013) in a model with matching frictions where matches last for one period which wage setting system generates frictional unemployment and Ranjan (2013) the role of labor market institutions on offshoring. Nevertheless none of the papers compares the same wage setting structure for both systems of wage setting, in this paper we compare individual and collective wage setting when both wages and employment are set at the same time or without commitment. The novelty of the paper is to derive the collective wage setting equation applying Ranjan (2013) approach to case where wages and employment are set simultaneously and wages are negotiated and compare the equilibrium with the one obtained with standard wage setting equation obtained with individual bargaining in Pissarides (2000). The difference with the collective wage equation obtained in Ranjan (2013) is that he considers the union monopoly model when a union sets unilaterally the wage before employment is decided.

Our results say that for a Cobb-Douglas production function, AL^{α}, $\alpha < 1$, if the bargaining power of the individual is high enough compared to the one of the union there is more unemployment at the individual level and the opposite is also true. When the individual and the union have the same bargaining power with respect to the firm, if the cost of open a vacancy is high enough there is more unemployment when wages are set individually. Finally, for a constant marginal product of labor production function AL, when the individual worker and the union have the same bargaining power individual bargaining produces more unemployment.

The rest of the paper is organized as follows. In the next section we present the standard pieces of the DMP model that one can find in any exposition of the model (for example Pissarides (2000) or Cahuc et al. (2014)) and that will be used later: the equilibrium labor market flows equation, the employment equation, and the value functions in the steady state. In section 3 we derive the individual wage equation and in section 4 the collective wage equation. The final section compares both equilibria and states the main results.

2 The Market Economy

2.1 Labor Market Flows

We assume matching frictions in the labor market where the matching function is $X(t) = m(V(t), U(t))$ where X are matches[1], V vacancies and U the amount of unemployment. Then $U = (N - L)$ where N is the total size of the work force that is constant and L is employment. We assume that m has constant returns to scale and $m_V > 0$ and $m_U > 0$. Then we define $\frac{X}{V} = m(1, \frac{1}{\frac{V}{U}}) \equiv q(\theta)$ where $\theta \equiv \frac{V}{U}$ is the degree of the labor market tightness, and one can show that $q' < 0$. Also we define $\frac{X}{U} = \frac{V}{U}\frac{X}{V} = \theta q(\theta)$ where one can show that $\frac{d(\theta q(\theta))}{d\theta} > 0$. Assuming that a proportion $0 < \lambda < 1$ of employed people loose the 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 labor markets flows equation (the Beveridge curve) is:

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

where an increase in θ increases employment.

2.2 The Multiple-Worker (Large) Firm

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

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

where ω is the real wage, r the real interest rate, γ_0 the cost of open a vacancy, subject to the employment flow equation given by (1), that is, the firm maximizes:

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

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

[1] t is a continuos variable and omitted when not necessary.

$$F_L(L) = \omega + \gamma_0 \frac{r+\lambda}{q(\theta)}. \tag{4}$$

that says that the benefits of employing an additional unit of labor (a match) $\frac{F_L - \omega}{r+\lambda}$ is equal to its cost $\frac{\gamma_0}{q(\theta)}$[2]. We assume that γ_0 is proportional to the wage that is $\gamma_0 = \gamma\omega$[3].

and then the employment equation is:

$$F_L(L) = \left[1 + \gamma \frac{(r+\lambda)}{q(\theta)}\right] \omega \tag{5}$$

where an increase in ω and θ reduce employment.

2.3 Value Functions in the Steady State

We denote the value function of an employed worker, that is, his expected discounted labor income along life that takes into account that he can change from employment to unemployment with the constant probability λ as V_E. Then, as usual, the following asset value equation holds (see for example Cahuc et al. (2014) equation (10.6) or Pissarides (2000) equation (1.11)):

$$rV_E = \omega + \lambda(V_U - V_E). \tag{6}$$

We denote the value function of an unemployed worker as V_U and if θ is constant, that is, in an steady state, the following asset value equation holds[4]:

$$rV_U = b_0 + \theta q(\theta)(V_E - V_U). \tag{7}$$

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

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

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

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

Then the value asset equation implies

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

[2] See equation (3.7) in Pissarides (2000) or equation (9.46) in Cahuc et al. (2014).
[3] This assumption is standard in the literature, see the discussion on Pissarides (2000), P. 10 or P.74.
[4] Pissarides (2000), equation 1.10 and Cahuc et al. (2014) equation 9.14.

that is,

$$V_F = \frac{\left[F(L) - \omega L - \gamma\omega\frac{\lambda L}{q(\theta)}\right]}{r}. \tag{8}$$

Finally we need to know the value function of a firm of hiring an extra worker V_F' at the steady state, that is[5]

$$rV_F' = [F_L - \omega] - \lambda V_F'$$

or:

$$V_F' = \frac{F_L - \omega}{r + \lambda}. \tag{9}$$

3 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 the wage with the firm. Then, when deciding the wage the function to maximize is

$$(V_E - V_U)^{\beta_I} (V_F')^{1-\beta_I} \tag{10}$$

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.

This is the usual surplus sharing rule for individual wage setting, used normally in models with matching frictions. Then with individual wage setting the wage is chosen in order to maximize (10) subject to (6) and (9), then the function to maximize is:

$$\left(\frac{\omega - rV_U}{r+\lambda}\right)^{\beta_I} \left(\frac{F_L(L) - \omega}{r+\lambda}\right)^{1-\beta_I} \tag{11}$$

that gives as a first order condition[6]:

$$\omega = (1 - \beta_I)rV_U + \beta_I F_L(L).$$

One can also show that the first order condition imply that total surplus $(V_E - V_U + V_F')$ is divided in such a way that:

$$(V_E - V_U) = \beta_I(V_E - V_U + V_F'),$$

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

[6] Pissarides (2000) equation 1.18.

that is

$$(1-\beta_I)(V_E - V_U) = \beta_I V_F'. \tag{12}$$

Note that the wage setting rule says that the wage depends positively on the marginal product of labor. 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 P.16. 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 (7) we get

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

Note that the wage setting rule says that the wage depends positively on the unemployment benefit. Using (12) and (9) one gets

$$\omega = (1-\beta_I)b_0 + \beta_I \theta q(\theta) V_F' + \beta_I F_L(L) = (1-\beta_I)b_0 + \beta_I \theta q(\theta) \left[\frac{F_L(L) - \omega}{r+\lambda}\right] + \beta_I F_L(L).$$

and finally using (5)[7]

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

Assuming that $b_0 = b\omega$ such that $b < 1$then the individual wage equation is given by

$$\omega_I = m_I F_L = \frac{\beta_I}{1-(1-\beta_I)b - \beta_I\gamma\theta} F_L(L), \tag{13}$$

that is the wage is a proportion $m_I = \frac{\beta_I}{1-(1-\beta_I)b-\beta_I\gamma\theta}$ of the marginal product of labor that depends on θ, having that an increase in θ increases the wage.

4 Collective Wage Setting

When there is collective wage setting we assume that a union that represents both employed and unemployed workers bargains the wage with the firm[8]. In this case the function to maximize is[9]

$$\left\{\left[\left(\frac{L}{N}V_E + \frac{(N-L)}{N}V_U\right) - V_U\right] N\right\}^{\beta_C} (S_F)^{1-\beta_C} \tag{14}$$

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

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

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

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 one may consider that in the collective bargaining system a union that represents only employed workers (insiders) bargains the wage with the firm, in this case the function to maximize is[10]

$$[(V_E - V_U)\,L]^{\beta_C}\,(S_F)^{1-\beta_C} \tag{15}$$

Note that operating (14) gives also (15). 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. We assume, as Ebell and Haefke (2006), that in the event of disagreement the firm is dissolved but, different from them, he must pay the costs of open vacancies because, by symmetry to the individual wage setting, they have been predetermined in advance[11], in which case $S_F = \frac{[F(L)-\omega L]}{r}$. Then with collective wage setting the wage is chosen in order to maximize:

$$[(V_E - V_U)\,L]^{\beta_C}\left(\frac{[F(L)-\omega L]}{r}\right)^{1-\beta_C} \tag{16}$$

subject to (6) and (7).

Substituting $V_E - V_U$ from (6) and (7) as in Ranjan (2013)[12] we obtain $V_E - V_U = \frac{\omega - b_0}{r+\lambda+\theta q(\theta)}$and then the objective function is:

$$\left[\left(\frac{(1-\tau_w)\omega - b_0}{r+\lambda+\theta q(\theta)}\right)L\right]^{\beta_C}\left(\frac{[F(L)-\omega L]}{r}\right)^{1-\beta_C} \tag{17}$$

that gives the wage equation:

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

where in this case the wage depends on the average product of labor or labor productivity[13].

[10] 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 sets unilaterally 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.

[11] Ebell and Haefcke (2006) assume that if the firm is disolved he has not to pay the cost of open 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 is separated from its current employees and time is continuous he can start producing in the next instant with new employees in which case: $S_F = V_F - \left[V_F - \gamma\omega\frac{\lambda L}{q(\theta)}\right] = \gamma\omega\frac{\lambda L}{q(\theta)}$.

[12] The difference with the case in which the union cares only about employed workers (insiders) is that in this case one computes $V_E - V_U$ only using (6) that is the usual assumption in the literature.

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

Assuming also that $b_0 = b\omega$ the wage equation becomes:

$$\omega_C = m_C \frac{F(L)}{L} = \frac{\beta_c}{[1-(1-\beta_c)b]} \left[\frac{F(L)}{L}\right], \tag{18}$$

where now the wage is a proportion $m_C = \frac{\beta_c}{[1-(1-\beta_c)b]}$ of the average product of labor.

5 Equilibrium

As we said, the employment equation is given by:

$$F_L(L) = \omega \left[1 + \gamma \frac{(r+\lambda)}{q(\theta)}\right] \tag{19}$$

and substituting the individual wage equation (13) in the employment equation (19) one gets the equilibrium labor market equation that gives θ:

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

and, simplifying, with individual wage setting θ_I is given by:

$$\frac{1-b}{\beta_I} + b - \gamma \theta_I = \left[1 + \gamma \frac{(r+\lambda)}{q(\theta_I)}\right]. \tag{20}$$

Substituting the collective wage equation (18) in the employment equation (19) one gets

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

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

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

and, simplifying, with collective wage setting θ_C is given by[14]:

$$\alpha \left[\frac{1-b}{\beta_C} + b\right] = \left[1 + \gamma \frac{(r+\lambda)}{q(\theta_C)}\right]. \tag{21}$$

Then, comparing both equilibria given by (20) and (21), one obtains the following propositions:

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

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

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 (20) and (21) is identical[15], equal to one when $\theta = 0$ and increasing in θ because $q' < 0$. The left hand side of equation (21) is constant, that is, is a constant straight line, and if $\alpha\left[\frac{1-b}{\beta_C} + b\right] > 1$ and equilibrium with collective wage setting exists. The left hand side of equation (20) is equal to $\frac{1-b}{\beta_I} + b$ when $\theta = 0$ and decreases with θ, that is, is a straight line with negative slope λ, then, for a positive β_I $\left[\frac{1-b}{\beta_I} + b\right] > 1$ and an 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 $\alpha\left[\frac{1-b}{\beta_C} + b\right]$ and the straight line with negative slope crosses to the right hand side curve below the crossing of the constant straight line and the right hand side curve, then $\theta_I < \theta_C$ and, using the equilibrium labor market flows equation, $L_I < L_C$. The opposite occurs when β_C is high enough because $\alpha\left[\frac{1-b}{\beta_C} + b\right]$ is low enough with respect $\left[\frac{1-b}{\beta_I} + b\right]$ and the constant straight line crosses to the right hand side curve below the crossing of the straight line with negative slope and the right hand side curve, then $\theta c < \theta_I$ and, using the equilibrium labor market flows equation, $L_C < L_I$.

When $\beta_I = \beta_C = \beta$ one 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: In this case the value of the straight line is $\alpha\left[\frac{1-b}{\beta} + b\right]$ and the intercept of the straight line with negative slope λ 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 side curve below the crossing of the constant straight line and the right hand side curve, then $\theta_I < \theta_C$ and, using the equilibrium labor market flows equation, $L_I < L_C$.

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: in this case the constant straight line corresponds to $\frac{1-b}{\beta} + b$ and the intercept of the straight line with negative slope is also $\frac{1-b}{\beta} + b$ which means 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 labor market flows equation, $L_I < L_C$.

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

The general intuition for the results is the following: The wage setting system that generates more unemployment is the one that sets the higher wage, because the wage in the individual wage setting system depends basically on the bargaining power of the individual (β_I) and the cost of open a vacancy (γ) and, in the collective wage setting system, on the bargaining power of the union (β_C) and the parameter of the production function (α, where $F(L) = AL^{\alpha}$) one plays with these parameters for achieving the results.

6 References

Bauer, C. and Lingens, J. (2013). "Does Collective Wage Bargaining Restore Efficiency in a Search Model with Large Firms?", *The Economic Journal*, 53: 1-20.

Cahuc, P. Carcillo, S. and Zylberberg, A. (2014); Labor Economics (second edition), *The MIT Press.*

De la Croix, A. (2006). "A multisectorial matching model of unions", *Journal of Monetary Economics*, 53: 573-596.

Ebell, M. and Haefke, C. (2006); "Product Market Regulation and Endogenous Union Formation", *IZA Discussion Paper 2222.*

García, J.R. and Sorolla, V. (2013); "Frictional and Non Frictional Unemployment in Models with Matching Frictions", *IVIE Working Papers serieAD* n^o 2013-02.

Pissarides, C.A. (2000); Equilibrium Unemployment Theory (second edition), *The MIT Press.*

Pissarides, C.A. (1986); "Trade Unions and the Efficiency of the Natural Rate of Unemployment", *Journal of Labor Economics* 4(4): 582-595.

Ranjan, P. (2013);"Offshoring, unemployment, and wages: The role of labor market institutions", *Journal of International Economics*, 89: 172-186.