Monopolistic Competition and Different Wage Setting Systems.

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Abstract

In this paper we match the static disequilibrium unemployment model without labor market frictions and monopolistic competition with an infinite horizon model of growth. We compare the wages set at the firm, sector and national (centralized) levels, their unemployment rates and growth in economic variables, for the Cobb-Douglas production function, in order to see under which conditions the inverse U hypothesis between unemployment and the centralization of wage bargaining is confirmed. We also analyze the effect of an increase in monopoly power on employment and growth in the three wage setting systems.

Keywords: Disequilibrium Unemployment, Monopolistic Competition, Growth, Wage Setting Systems.

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1 Introduction

The financial and economic crisis that started in 2008 has generated strong growth in the unemployment rate in many countries of the OECD. More specifically, the average unemployment rate increased by 3 percentage points in OECD countries between 2007 and the first quarter of 2010. The increase in the unemployment rate has been dramatic in countries like Spain, where it rose from 8.3 % to 19 %.

These results have begun to encourage important debates at political and academic level on possible reforms of the labor market in the OECD countries most affected by this problem. It has been suggested to modify the system of wage negotiation in those countries characterized by wage bargaining at sector level to models of negotiation that generate higher wage moderation that can give rise to employment. These proposals are based on the seminal article by Calmfors and Driffill (1988), where the worst result, in terms of employment, was obtained in a model where the wage was negotiated at the sector level.

In this context, our article considers a wide range of variables at the moment of wage negotiation that do not appear in Calmfors and Driffill (1988), paying special attention to the role that market power has on producing higher unemployment when the wage is set at sector level. Moreover, we consider the effects that the unemployment rate has on long-term economic growth.

We match the static disequilibrium unemployment model without labor market frictions in a monopolistic competition set up (Arnsperger and De la Croix (1990), Layard, Nickell and Jackman (1991), Dutt and Sen (1997), Blanchard and Giavazzi (2003), Spector (2004)), with the infinite horizon model of growth (see Galí (1996) for the full employment version). We compare the wages set at the firm, sector and national (centralized) levels, their unemployment rates and growth in economic variables for the Cobb-Douglas production function in order to see under which conditions the inverse U hypothesis between the unemployment rate and the degree of centralization, postulated by Calmfors and Driffill (1988), holds for the unemployment rate and other variables.

We use the monopolistic competition set up because it is the natural framework for different labor demand elasticities with respect to the real wage when wages are set at the firm, sector and national (wage set for all sectors together) levels, the elasticity is greater at sector level than firm and centralized levels. This is because the effect of the wage on prices is only taken into account at sector level. This higher elasticity, combined with other variables, will normally produce higher wages and, ceteris paribus, a lower employment rate at the sector level.

The existence and consideration of product market power is the reason that usually produces the inverse U hypothesis in this paper. The idea that changing from sector to centralized level results in a decrease in labor demand elasticity appears in Layard, Nickell and Jackman (1991), but they also justify the existence of full employment when wages are set at the national level. We upgrade the Layard, Nickell and Jackman set up by adding firm level wage setting and, more importantly, by introducing other institutional characteristics that also affect wage determination, such as the size and structure of social expenditures, public sector inefficiencies, the degree of internalization of the contribution of labor income to the provision of social services and labor taxes. From a theoretical point of view, it is interesting to analyze under what circumstances these variables may change the inverse U effect, due to the different labor demand elasticities, and full employment at national level. Nevertheless, the important point is that, as we will see in the next section, the values of some of the institutional variables that we introduce in the model are really different across countries. This means that trying to check the inverse U hypothesis by looking only at the level of centralization, without controlling for all the other variables, may result in the inverse U hypothesis not appearing in the data. Finally, the introduction of growth allows us to check whether the inverse U hypothesis holds for other variables.

The market power explanation for the inverse U form is different from the original one given by Calmfors and Driffill because there is no market power in their model. The inverse U form arises because of the assumption that, as centralization increases, the goods produced by sectors whose unions set the wage together are closer substitutes.

There is another paper that combines monopolistic competition, (non frictional) unemployment and growth. Brauninger (2000) presents an OLG growth model with monopolistic competition, Cobb-Douglas production function, unemployment, wages set at sector level and a rule (constant replacement rate) that implies a constant employment rate. The paper analyzes how unemployment affects income per capita in the long run.

There are more papers that combine perfect competition, (non frictional) unemployment and growth: Daveri and Tabellini (2000) present an OLG growth model with perfect competition, Cobb-Douglas production function, unemployment, wages set at national level and the rule that implies a constant employment rate. They analyze how labor taxes affect employment and long run growth when there is an externality in production. Doménech and García (2008), using an IH growth model, introduce the institutional characteristics presented in this paper and analyze how they affect the employment rate.

All these papers make assumptions that imply a constant unemployment rate derived via the wage equation. The different assumptions used are discussed in Raurich and Sorolla (2008) and, because of the use of the wage equation, the constant unemployment rate is neutral with respect to changes in capital and total factor productivity. All these papers also use a Cobb-Douglas production function. Kaas and von Thadden (2003) present an OLG growth model with perfect competition, disequilibrium unemployment and a CES production function. The change of production function results in constant real wages and a capital labor ratio instead of a constant employment rate.

Our results show that a high degree of market power produces the inverse U form for unemployment postulated by Calmfors and Driffill (1988), but they also illustrate that an increase in employment is possible considering, alternatively, other types of reforms in the labor market. This is because the unemployment rate depends on a complex sample of variables, one of which corresponds to the system of wage negotiation.

The paper is structured as follows: In section 2 we present the stylized facts concerning some variables that appear in the model. Section 3 derives labor demand with monopolistic competition. Section 4 introduces the government budget constraint. Section 5 derives the wage set at the sector level and Section 6 the employment rate at the firm and sector levels. Section 7 computes the wage and employment at national level and section 8 includes the growth equations and results. The paper concludes with a summary of the main results.

2 The stylized facts for some OECD countries.

Many of the articles that have been written in the last few decades about unemployment focus on explaining the substantial differences in the level and evolution of the unemployment rate across OECD countries. The poor performance of the unemployment rate is explained by shocks and differences in institutions or the interaction of both[1]. It is important to note that the collective bargaining system appears as a key element in all these explanations . As pointed out by Calmfors and Driffill (1988), highly centralized (at national or multi-industry level) and decentralized (at the firm level) bargaining systems perform better than intermediate ones (at the sector/industry level) on wage demands. At firm level, the competitive pressure from other firms in the same industry (producing closer substitutes) provides strong incentives to moderate wage demands. At national level, the central union federation will internalize externalities that would be ignored by negotiators in decentralized bargaining structures. Consequently, it is predicted that more centralized collective bargaining arrangements will produce lower wage demands and unemployment rates.

This paper explores from a theoretical point of view the link between the unemployment and economic growth rates with the collective bargaining systems at the firm, industry and national levels. Nevertheless, our analysis is deeper because we add other institutional features, rigidities and macroeconomic parameters that also affect wage bargaining. We include the size and structure of social expenditures, public sector inefficiencies, the labor force participation rate, labor taxes and the degree of competition of the output market. We show that the employment rate depends on all these variables together, which means that empirical research based only on changes in one variable usually yields poor results. When one analyzes, for example, the influence of taxes on unemployment it seems that

[1] An excellent survey on these issues can be found in Blanchard (2006).

other elements must be taken into account in order to explain the data. The empirical evidence presented by Daveri and Tabellini (2000) supports the view that in more corporate and decentralized countries, labor taxes are less distortionary than in countries with an intermediate level of wage bargaining.

Taking into account a broader set of variables than the wage bargaining system offers an explanation for the lack of robustness of the hump-shaped curve predicted by Calforms and Driffill (1988)[2]. The group of countries that belong to a certain wage bargaining system may differ in the composition of labor taxes, the inefficiency of their governments, the degree of competition in the goods market, etc.. and all these variables also affect wage determination. However, as we will see, some characteristics are correlated, which sometimes implies good results without considering all variables.

Table 1 presents the classification of many OECD countries by their wage negotiation system in three groups that we have named ANGLO, EUCON and NORDIC. For this country classification we use the product of bargaining level, union density and bargaining coordination relative to the value for Finland[3].

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[2] See Aidt and Tzanatos (2008), for a excellent survey of these issues.

[3] Source: Database Nickell (2006).

Table 1

Some labour markets institutional indicators in OECD countries

	Bargaining level	Union Coverage	Coordination	Relative Product
ANGLO				
USA	1	0.2	1	0.02
Canada	1.1	0.37	1.3	0.04
Japan	1	0.23	4	0.08
UK	1.3	0.57	1.8	0.12
New Zealand	1.6	0.5	3	0.21
EUCON				
France	2	0.91	2	0.32
Switzerland	1.8	0.52	4	0.33
Greece	2	0.9	3	0.47
Australia	2	0.83	3.4	0.50
Italy	2.4	0.84	2.8	0.5
Denmark	2.3	0.72	4	0.58
Netherlands	2.1	0.8	4	0.59
Spain	2.5	0.75	3.7	0.61
Germany	2	0.87	4	0.61
Belgium	2	0.89	4	0.62
Portugal	2.5	0.75	3.8	0.63
Ireland	2.5	0.9	3.2	0.63
NORDIC				
Sweden	2.48	0.87	3.4	0.64
Norway	2.6	0.7	4.3	0.69
Austria	2	0.96	4.4	0.74
Finland	2.5	0.95	4.8	1

Source: Database Nickell (2006).

In Tables 2 and 3 we add an average value of different institutional indicators and rigidities for the period 1998-2008 . The theoretical study below investigates more closely the mechanism through which the variables that reflect the institutional framework affect the unemployment rate.

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The first variable presented in Table 2 is the harmonized unemployment rate from

OECD statistical (U). Column 2 shows the degree of efficiency of the public sector (GE)[4]. This variable was been constructed by Kaufmann et. al. (2009). These authors define government efficiency as an aggregate governance indicator that measures perceptions of the quality of public service provision, the quality of the bureaucracy and the competence of civil servants among other elements related to the government. This variable is relevant for wage determination when the government finances a given level of social expenditure. The more inefficient the government is the higher the tax rates necessary to finance a given government expenditure and, therefore, the greater the effects on employment.

Column 3 shows the degree of rigidity in the goods market (PMR)[5]. Many authors stress the relationship between rigidities in the goods markets and wage setting[6].When the price elasticity of goods' demand is high, firms have more market power and the elasticity of labor demand with respect to wages is also high and workers ask for a higher wage. Thus, although product market competition is assumed to not have a direct influence on union bargaining power, it does have an indirect impact through the elasticity of labor demand and thereby on the resulting wage rate.

Finally, Column 4 of Table 2 shows the average labor force participation rate elaborated by the OECD (LBPR) that we assume affects the amount of social services that an active worker receives.

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[4]See Doménech and García (2008) for an in-depth discussion of this variable.

[5]The indicator of product market regulations (PMR) is defined in Conway et. al. (2005). The source of the database is the webpage http:www.oecd.org/eco/pmr.

[6]For a more detailed discussion of these issues see, for instance, Nickell (1999), Boeri et.al (2000), Blanchard and Giavazzi (2003) and OECD (2002) chapter five.

Table 2

Rigidities and institutions

	U	GE	PMR	LBPR
ANGLO				
USA	4.98	1.74	1.04	78.78
Canada	7.05	2.01	1.13	78.59
Japan	4.57	1.27	1.57	78.69
UK	5.30	1.86	0.91	77.72
New Zealand	5.12	1.86	1.25	78.41
average	5.41	1.75	1.18	78.44
std desv	0.96	0.28	0.25	0.42
EUCON				
France	9.12	1.54	1.91	69.05
Switzerland	3.55	2.18	1.79	83.27
Greece	10.04	0.71	2.63	66.28
Australia	5.80	1.93	1.30	76.08
Italy	8.55	0.73	1.93	62.38
Denmark	4.55	2.17	1.28	80.98
Netherlands	3.44	2	1.13	76.21
Spain	10.84	1.42	1.75	69.20
Germany	8.74	1.72	1.66	73.65
Belgium	7.89	1.76	1.73	65.43
Portugal	6.11	1.05	1.77	76.89
Ireland	4.99	1.67	1.31	70.11
average	6.97	1.57	1.68	72.46
std desv	2.55	0.51	0.4	6.43
NORDIC				
Sweden	6.67	2.07	1.57	80.69
Norway	3.44	2.05	1.48	81.27
Austria.	4.29	1.83	1.85	72.94
Finland	8.79	2.09	1.52	75.48
average	*5.80*	*2.01*	*1.61*	*77.60*
std desv	*2.42*	*0.12*	*0.17*	*4.05*

Table 3, Column 1 shows social expenditures with respect to GDP (SE). These expenditures are basically financed by social security contributions paid by workers and employers. Imposition on labor revenues and other taxes play a minor role (See OECD

(2007))[7]. Thus, a very close relationship can be observed between the financing of social policy expenditure and the unemployment rate, through the social security contributions in the labour market. Columns 2 to 5 report average tax wedges (TW), income tax (IT) and employees' and employers' social contributions (WSC and ESC respectively). The tax wedge is computed as the sum of labor income tax, and social security contributions paid by workers and employers[8].

As can be seen from the Table 3, there are large differences in the composition of the tax wedge across OECD countries over the period 1988-2008. In general, countries with the highest labor tax are also those that tend to have the highest social contributions paid directly by employers.

The most striking results that emerge from the data for EUCON countries with respect to the rest of countries are the following. For financing social expenditures, we find that the social security contribution paid by employers (Table 3 ESC) in some countries is prominent (e.g. France, Italy and Spain). Another relevant fact is that, on average, they are the most inefficient (Table 2, GE average 1.57), have a more regulated goods market (Table 2, PMR average 1.68) and the lowest labor participation rate (Table 2, LBPR average 72.46). These three characteristics are important, since they interrelate with the imposition on the labor market and, therefore, with unemployment. Unfortunately, these series are relatively recent and it is not possible to obtain a longer sample period that allows regressions to be performed. These factors may explain the relatively good/poor empirical estimations found by different authors over time.

[7]Only Australia, Denmark and N. Zealand do not finance social policy expenditure with social security contributions.

[8]All the effective tax rates have been computed, as suggested in Boscá, García and Taguas (2005), using the methodology proposed by Mendoza et. al (1994).

Table 3

Social expenditure and the tax structure

	SE	TW	IT	WSC	ESC
ANGLO					
USA	15.36	0.25	0.13	0.06	0.06
Canada	16.91	0.30	0.20	0.04	0.06
Japan	17.28	0.24	0.07	0.08	0.09
UK	20.07	0.27	0.14	0.05	0.07
New Zealand	18.92	0.21	0.21	0.0	0.0
average	17.71	0.25	0.15	0.05	0.06
std desv	1.83	0.03	0.06	0.03	0.03
EUCON					
France	28.68	0.49	0.12	0.10	0.27
Switzerland	19.20	0.24	0.13	0.06	0.06
Greece	19.71	0.39	0.07	0.15	0.18
Australia	17.40	0.18	0.18	0.0	0.0
Italy	23.88	0.51	0.16	0.07	0.27
Denmark	26.81	0.40	0.38	0.02	0.0
Netherlands	20.61	0.34	0.10	0.15	0.1
Spain	20.62	0.38	0.11	0.05	0.22
Germany	26.59	0.41	0.12	0.14	0.15
Belgium	26.12	0.51	0.21	0.10	0.2
Portugal	20.41	0.33	0.09	0.08	0.16
Ireland	14.9	0.27	0.17	0.04	0.07
average	22.08	0.37	0.15	0.08	0.14
std desv	4.27	0.1	0.08	0.05	0.1
NORDIC					
Sweden	29.60	0.58	0.28	0.06	0.23
Norway	22.67	0.43	0.2	0.08	0.14
Austria.	26.93	0.45	0.15	0.14	0.16
Finland	25.42	0.55	0.27	0.06	0.23
average	26.23	0.5	0.23	0.08	0.19
std desv	2.78	0.07	0.06	0.04	0.05

The stylized facts presented above suggest that the Eucon countries have the institutional characteristics that can generate a higher unemployment rate than the rest of countries. Table 4 presents the simple correlation using cross-country data between all relevant variables over the period 1988-2008. Since a correlation does not imply in any sense causality, the existence of significant correlation suggests that the mechanism relating the variables to labor market performance is not so simple. Table 4 shows that the tax rates paid by employers seem to be positively related to the unemployment rate (0.663). At the same time, there is a positive correlation between government efficiency and the labor force participation rates in OECD countries (0.676). It is interesting to notice that there is a strong negative correlation between government efficiency and the product market regulation (-0.636). Finally, social expenditure and tax paid by employers are highly correlated (0.613). All these correlations led us to consider a theoretical framework, in the next sections, in which all these variables appear and determine the unemployment rate.

Table 4

Correlations between institutions and social expenditure

	GE	LBPR	PMR	SE	TW	ESC
U	-0.503*	-0.684**	0.546*	0.29	0.469*	0.663**
GE		0.676**	-0.636**	0.136	-0.065	-0.434*
LBPR			-0.561**	-0.168	-0.393	-0.601**
PMR				0.337	0.442*	0.613**
SE					0.860**	0.607**
TW						0.831**

** The correlation is significant at 0.01 level

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3 Labor demand in sector j with monopolistic competition in the goods market

We assume $J \in [0,1]$ sectors with one firm per sector that produces a different good, $Y_j(t)$, using the same production Cobb Douglas technology, that is:

$$Y_j(t) = AK_j(t)^{\alpha} L_j(t)^{1-\alpha}. \tag{1}$$

The demand function facing firm J is

$$Y_j(t) = \left(\frac{P_j(t)}{P(t)}\right)^{-\xi} \left(\bar{\mathbf{Y}}(t)\right), \tag{2}$$

where $\xi > 1$ is the constant elasticity of demand of product J with respect to its price, $\bar{\mathbf{Y}}(t) \equiv \frac{Y(t)}{P(t)}$ is total real expenditures on consumption and investment, $P_j(t)$ is price of product j, $P(t)$ is a price index with the habitual properties and $Y_j(t)$ is the corresponding quantity demanded of the consumption and investment good produced by firm j [9].

[9] For more details see Appendix A.

The firm in sector j maximizes the wealth of its shareholders subject to the demand function (2). Each firm pays a payroll tax, τ^f, in order to finance social services. The first order condition in terms of the real wage [10] is:

$$(1-\alpha)AK_j^{\alpha}L_j^{-\alpha}A^{-\frac{1}{\xi}}K_j^{-\frac{\alpha}{\xi}}L_j^{-\frac{1-\alpha}{-\xi}} = \frac{(1+\tau^f)m\omega_j}{\bar{\mathbf{Y}}(t)^{\frac{1}{\xi}}}, \tag{3}$$

where the parameter m represent the monopoly degree or the (price) markup $m \equiv \frac{1}{(1-\frac{1}{\xi})} \geqq 1$ and $\omega_j(t) \equiv \frac{W_j(t)}{P(t)}$ is the real wage in sector j.

The labor demand, in terms of the real wage, is, then:

$$L_j^d(t) = \tilde{L}_j^d(\omega_j(t)) = A^{\frac{\xi-1}{1+\alpha(\xi-1)}}K(t)^{\frac{\alpha(\xi-1)}{1+\alpha(\xi-1)}}\bar{\mathbf{Y}}(t)^{\frac{1}{1+\alpha(\xi-1)}}(m\frac{(1+\tau^f)}{(1-\alpha)}\omega_j(t))^{\frac{-\xi}{1+\alpha(\xi-1)}}, \tag{4}$$

where the elasticity of the labor demand with respect to the wage is constant and given by:

$$\varepsilon_{L_j^d,\omega_j} \equiv \frac{\partial \tilde{L}_j^d(\omega_j)}{\partial \omega_j}\frac{\omega_j}{\tilde{L}_j^d(\omega_j)} = \frac{-\xi}{1+\alpha(\xi-1)} = \frac{-1}{\alpha+\frac{(1-\alpha)}{\xi}}. \tag{5}$$

Note that the elasticity of labor demand depends positively on the product market elasticity ξ with the property that the greater the ξ the lower $\varepsilon_{L_j^d,\omega_j}$ and always $\varepsilon_{L_j^d,\omega_j} < -1$, meaning that an increase in the real wage always decreases the wage bill $\omega_j\tilde{L}_j^d(\omega_j)$. In the case of perfect competition we have $\xi = \infty$ and elasticity is equal to $-\frac{1}{\alpha}$[11].

4 Government budget constraint

Before describing wage bargaining, we need to introduce the government budget constraint. The government finances the unemployment benefits paid to unemployed workers and social services. To generate revenue, at each period t the government imposes a flat-rate tax. More specifically, τ^L denotes the tax rate paid by employees on wages. This tax includes income tax plus the social security contribution paid by employees.

We assume that given a level of taxes collected, more inefficient governments will produce a lower level of transfers and social services. It can be assumed that this level of inefficiency will be proportional to the administrative cost of managing tax revenues.

[10] This expression comes from equation (50) in the appendix.

[11] Alternatively, forcing the model because we assume only one firm per sector, we can consider the perfect competition situation the case where the firm takes $P_j(t)$ as given. Then, the first order condition in terms of $\frac{W_j(t)}{P_j(t)}$ is $F_L = \left(1+\tau^f\right)\frac{W_j(t)}{P_j(t)}$, labor demand is: $L_j^d = \tilde{L}_j^d(\frac{W_j}{P_j}) = \left(\frac{(1-\alpha)A}{(1+\tau^f)\frac{W_j}{P_j}}\right)^{\frac{1}{\alpha}}K_j$ and the elasticity with respect to $\frac{W_j(t)}{P_j(t)}$, $\varepsilon_{L_j^d,(\frac{W_j}{P_j})} = -\frac{1}{\alpha}$.

The parameter η stands for the level of inefficiency of the government to finance its public expenditure[12]. From all this, it follows that the government's flow budget constraint in real terms is:

$$(1+\eta)\left(S(t)+(N(t)-L(t))B(t)\right)=\left(\tau^L+\tau^f\right)\omega(t)L(t), \tag{6}$$

where $S(t)$ are social services in real terms, $B(t)$ the unemployment benefit in real terms and $N(t)$ the inelastic labor supply (active population).

We assume, that a part of the tax revenues is used to finance social services (such as education, social security system, pensions etc.) and another part is channelled to financing the unemployment benefits of unemployed workers in each period, so that the following equalities hold:

$$\begin{aligned}(1+\eta)S(t) &= \phi\left(\tau^L+\tau^f\right)\omega(t)L(t), && (7)\\ (1+\eta)B(t)(N(t)-L(t)) &= (1-\phi)\left(\tau^L+\tau^f\right)\omega(t)L(t), && (8)\end{aligned}$$

where the parameter ϕ captures the relative weight of the expense in social services decided by the government with respect to tax revenues. Rewriting the last two equations we get:

$$S(t)=\phi\frac{\left(\tau^L+\tau^f\right)\omega(t)L(t)}{(1+\eta)} \tag{9}$$

and

$$B(t)=(1-\phi)\frac{\left(\tau^L+\tau^f\right)\omega(t)L(t)}{(1+\eta)(N(t)-L(t))}. \tag{10}$$

Note that, because we assume $\tau^L$and τ^f are invariant, the last two equations imply that an increase in the wage always reduce $S(t)$and $B(t)$, when employment is given by labor demand, because its elasticity with respect to the real wage is less than 1.

We include the level of public services, $S(t)$, in the utility function of trade unions, reflecting the fact that the welfare of workers depends on the level of social services they receive[13]. If we add equation (9), we also assume that workers have perceptions about how changes in the wage affect the amount of public services.

[12] A similar assumption is made by Doménech and García (2008).

[13] For a more extensive discussion, see Mares (2004).

5 Wage setting at the sector level

We assume that the basic theoretical structure takes into account a three-stage game. In the first stage, the firms decide the level of capital stocks anticipating their effects on wage setting and labor demand. In stage two, the wage rate is determined through a process of bargaining between employers and trade unions. Finally, in stage three, the firm unilaterally determines the employment level once the conditions of the wage negotiations and investment decisions have been settled.[14]

It is assumed that the labor force is completely unionized. There are J unions (one for each industry) whose objective is to maximize the income of a worker working in the sector with respect to the alternative income of working outside the sector, $R_j(t)$, times employment. Additionally, we assume that the union takes into account that social services affect the welfare of workers and that the revenues obtained from the wage bill of the sector may contribute to finance social services[15]. The specification of the j th union utility function is given by

$$V_j = \left[(1-\tau^L)\omega_j(t) - R_j(t)\right] L_j^d(t) + \theta_s \phi \frac{(\tau^L + \tau^f)\omega_j(t) L_j^d(t)}{(1+\eta)}. \tag{11}$$

We introduce the parameter θ_s which measures the ability of the trade union in sector j to internalize the contribution of the wage bill in sector j, $\omega_j L_j^d$, to the provision of social services. It is reasonable to assume that this parameter is determined by two factors. The first is the degree of centralization of wage bargaining. There has been some consensus in recent literature on the importance of the degree of centralization of wage bargaining system on the unemployment rate. It is very usual in the literature to classify wage setting regimes by their degree of centralization into three types. Highly centralized systems, such as national level bargaining, intermediate levels of centralization, where the bargaining process is carried out at industry level and, finally, negotiation at the firm level. We assume that the degree of internalization θ is positively related with the level of centralization of wage bargaining. The second factor that will affect the value of parameter θ is the share of active labor force with respect to the inactive population in the economy. We suppose that the same level of social services is available to the labor force and the inactive population. Note that the social services for the non active population are financed by taxes levied on the active population. Therefore, if the unions care only about the social services of the active population, the higher the inactive population receiving social services, the lower the ability of trade unions to internalize the provision of services and the lower the value of parameter ${\theta_s}^{16}$. We also assume that the union considers no

[14] For a more details over this issue see, for example, Koskela et. al (2009)

[15] Details of these hypotheses are given in Mares (2004).

[16] In a more formalized way: our active population is $N(t)$ and total population $P(t) = (1+\lambda)N(t)$.

effect of the wage bill in sector j on alternative income because, although it is true that the wage will finance the unemployment benefit in this sector, the weight of the unemployment benefit on alternative income is small, because it is also comprises the wages of all the other sectors.

Turning to wage bargaining, we assume that employers negotiate the sector wage with the trade union taking into account that firms retain their right-to-manage power and determine employment (and capital) after the wage has been set. The outcome of wage bargaining is determined by the Nash-bargaining solution, which maximizes the Nash product $(V_j)^{\beta}\left(\Pi_j-\overline{\Pi_j}\right)^{1-\beta}$. Where β denotes the bargaining power of the trade union. The fall-back position for the firm is given by $\overline{\Pi_j}=-r_tK_j$.

For an interior solution, the maximization of the logarithm of the generalized Nash criterion gives the first order condition:

$$\beta\frac{V_{j\omega}}{V_j}+(1-\beta)\frac{\left(\Pi_j-\overline{\Pi_j}\right)_{\omega}}{\left(\Pi_j-\overline{\Pi_j}\right)}=0, \tag{12}$$

where

$$\frac{V_{j\omega}}{V_j}=\beta\left[L_j^d+\frac{\partial L_j^d}{\partial\omega_j}\omega_j\right]\left[(1-\tau^L)+\theta\phi\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]-\beta R_j\frac{\partial L_j^d}{\partial\omega_j} \tag{13}$$

and

$$(1-\beta)\frac{\left(\Pi_j-\overline{\Pi_j}\right)_{\omega}}{\left(\Pi_j-\overline{\Pi_j}\right)}=(1-\beta)\frac{1}{\omega_j\left(m(1-\alpha)-1\right)}. \tag{14}$$

Substituting expressions (13) and (14) into the first-order condition (12) yield, after some rearrangement, the following Nash bargaining solution for the wage rate set by union J

$$\omega_j(t)=\frac{\left[(1-\beta)+\beta\frac{m}{1-\alpha}\right]}{\left[(1-\tau^L)+\theta_s\phi\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}R_j(t). \tag{15}$$

Note that in this case an increase in market power increases the wage as emphasized by Layard, Nickell and Jackman (1991) (P. 27) and Spector (2004). Note also that an increase in θ, ϕ and τ^f produces wage moderation and an increase in $\tau^L$and η an increase in wage demands.

If the firm behaves competitively we have, on the one hand, $m=1$, which gives the labor demand elasticity $-\frac{1}{\alpha}$; on the other hand, we assume the internalization parameter θ to be zero because there are many firms and many sectors, the wage bill of one firm being negligible in regard to the total wage bill that finances social services. Then the wage is:

Then social services per person are $\frac{S(t)}{P(t)}$ and the social services of active population, the term that enters in utility function of the union, $\frac{S(t)}{P(t)}N(t)=\frac{S(t)}{(1+\lambda)}$.

$$\omega_f(t) = \frac{\left[(1-\beta) + \beta\frac{1}{1-\alpha}\right]}{(1-\tau^L)} R_j(t), \tag{16}$$

having that $\omega_f(t) < \omega_j(t)$ if m is high enough ($m > 1 + \left[(1-\beta) + \beta\frac{1}{1-\alpha}\right] \frac{(1-\alpha)}{\beta(1-\tau^L)} \theta_s \phi \frac{(\tau^L + \tau^f)}{(1+\eta)}$).

This is because the positive effect of the reduction in monopoly power will dominate the negative effect of the elimination of the internalization parameter and, then, there will be wage restraint. If we interpret the wage set in the competitive case as wage setting at firm level, because the union takes into account the labor demand of a small competitive firm[17], then we will have wage restraint at firm level.

6 The alternative income and the constant employment rate at the firm and sector level.

In the short run partial equilibrium presented above, the wage bargaining process takes the alternative income of working outside the sector (or the firm) as given. Nevertheless, in the short run general equilibrium, all sectors set the same price and wages in all firms and sectors are set in a similar way. As a result $R(t)$ becomes endogenous. In this model we assume that the alternative income a worker gets if he does not work in firm or sector j is given by[18]

$$R_j(t) = l(t)(1-\tau^L(t))\omega^e(t) + (1-l(t))B(t), \tag{17}$$

where $l(t)$ is the employment rate of the economy i.e. $l(t) \equiv \frac{L(t)}{N(t)}$, where $L(t) = \min(L^d(t), N(t))$ and $L^d(t) = \int_0^1 L_j^d(t)dj$, $\omega^e(t)$ is the alternative wage of working outside (firm) sector j and $B(t)$ is the unemployment benefit that an unemployed worker gets.

In a symmetric equilibrium $\omega_j(t) = \omega^e(t) = \omega(t)$. We assume that the unemployment benefit is financed by the employed workers' revenues and determined by the budget constraint of the government once it has decided the constant tax rates, then from (10), it is:

$$B(t) = \frac{(1-\phi)}{(1+\eta)} \frac{(\tau^L + \tau^f)\omega(t)l(t)}{(1-l(t))}, \tag{18}$$

taking into account that $\omega^e(t) = \omega(t)$ and combining equations (15), (17) and (18) we obtain:

[17] In this case the utility function of the union would be $V_{f,j} = \left[(1-\tau^L)\frac{W_j}{P} - R_j\right] \tilde{L}_j^d(\frac{W_j}{P_j})$ where the union chooses W_j, and, one can show that the solution is the above expression.

[18] In a similar way Romer (2006) p.454 assumes: $R_t = (1-bu_t)\omega_t$.

$$\omega(t) = \omega(t)l(t)\left[(1-\beta)+\beta\frac{m}{1-\alpha}\right]\frac{\left[(1-\tau^L)+(1-\phi)\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}{\left[(1-\tau^L)+\theta_s\phi\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}. \tag{19}$$

And the employment rate when wages are set at the sector level is:

$$l(t) = \frac{\left[(1-\tau^L)+\theta_s\phi\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}{\left[(1-\beta)+\beta\frac{m}{1-\alpha}\right]\left[(1-\tau^L)+(1-\phi)\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]} = l^*_{SL}. \tag{20}$$

This means that the wage equation plus the unemployment benefit budget constraint equation gives, for the Cobb-Douglas production function, a constant employment rate. We can find a similar expression for a constant employment rate derived via a wage equation plus an unemployment benefit budget constraint equation in a monopolistic competition set up with a Cobb-Douglas production function and where wages are set at national level (see next section) in Braüninger (2000). Layard, Nickell and Jackman (1991) P. 27 also derive a constant unemployment rate using a wage equation plus a constant exogenous replacement rate $\frac{B}{\omega}$. There are other ways of obtaining constant employment rates: with perfect competition and a Cobb-Douglas production function, Daveri and Tabellini (2000) assume $B(t) = \sigma\frac{Y(t)}{L(t)}$ and Doménech and García (2008) do the same. Raurich and Sorolla (2008) discuss different ways of obtaining a constant employment rate when the wage is a mark-up over the reservation wage. This constant unemployment rate depends crucially on the use of (10), which, as we said before, means that wage increases produce a reduction in the unemployment benefit[19]. Papers that assume a constant unemployment benefit are, for example, Pissarides (1998) but in our opinion this assumption in an economy with growth is worse that assuming constant taxes.

Looking at l^*_{SL} it is easy to see that there is unemployment when wages are set at the sector level m is high enough or $\theta_s\phi$ is low enough, that is, higher monopoly power or a lower proportion of social services or lower perceptions produce unemployment. Note $\frac{\partial l^*_s}{\partial m} < 0$ and that neither changes in capital K nor total factor productivity A affect employment, that is capital and productivity are neutral with respect to unemployment or growth does not affect employment. The reason is that with this wage setting rule an increase in Kor A decreases unemployment, but then the unemployment benefit increases and also the wage, completely crowding out the positive effect of Kor A on labor demand. Koskela, Stenbacka and Juselius (2009) with a particular production function obtain an employment rate that depends on capital. There is also empirical evidence that K affects employment on the short run (Karanassou et. al. (2008) and Driver and Muñoz-Bugarin (2009)).

[19] One may argue that real governments do not reduce the unemployment benefit when unemployment increases, but, as we said, a similar result is obtained using $B(t) = \sigma\frac{Y(t)}{L(t)}$.

We can explore the effect of the weight of social services ϕ, the imposition on the employee τ^L and τ^f on the employment rate. The differentiation of the employment rate (20) with respect to ϕ yields a positive relationship. The effect of the imposition on employment in both cases depends on the sign of the following expression $[\theta_s\phi - (1-\phi)]$. More specifically, $\frac{\partial l}{\partial \tau^L} > 0$ and $\frac{\partial l}{\partial \tau^f} > 0$ when $\theta_s > \frac{1-\phi}{\phi}$. Our findings concerning the determinants of unemployment, under short run general equilibrium, show the importance of the relationship between the parameters of the model.

When the wage is set at the firm level, the employment rate is equal to

$$l(t) = \frac{(1-\tau^L)}{\left[(1-\beta) + \beta\frac{1}{1-\alpha}\right]\left[(1-\tau^L) + (1-\phi)\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]} = l^*_{FL} < 1 \tag{21}$$

and there is always unemployment. Note that the employment rate does not depend on m. This may seem strange because from (16), it is the wage what does not depend on m. The explanation is that an increase in m does not initially change the wage and, via labor demand, increases unemployment, but, if unemployment increases, the unemployment benefit is reduced, implying, via a wage equation, a decrease in the wage in such a way that, finally, employment is not affected. Note finally that, as we argued before, if m is high enough, we will have a higher employment rate at firm level. This result gives the condition for the first part of the inverse U hypothesis to be true, if market power is high enough the unemployment rate will be higher if wages are set at the sector level than if they are set at the firm level. This fact is due to the higher wage set at sector level higher elasticity of the labor demand to take into account the output demand function.

7 Wage setting at national level

Following Layard, Nickell and Jackman (1991), P.51, in a symmetric equilibrium $P_j(t) = P(t)$ for all j and then the aggregate price index is also $P(t)$, thus the labor demand in sector j becomes[20]:

$$F_L(K_j(t), L_j(t)) = m(1+\tau^f)\frac{W_j(t)}{P(t)} = (1+\tau^f)m\omega_j(t),$$

moreover in this symmetric equilibrium $K_j(t) = K(t)$, $L_j(t) = L(t)$ and then the aggregate labor demand $\int_0^1 L_j(t)dj$ is also $L_j(t)$ and $\omega_j(t) = \omega(t)$. This means that aggregate labor demand is given by the equation:

[20] This assumption implies that product demand and then market power disappears from the program of the firm.

$$F_L(K(t), L(t)) = (1 + \tau^f)m\omega(t), \tag{22}$$

expression that implies the aggregate labor demand function $L^d(t) = \tilde{L}^d((1+\tau^f)m\omega(t), K(t))$ where $\tilde{L}_{(1+\tau^f)m\omega} < 0$ and $\tilde{L}_K > 0$. More specifically, for the Cobb-Douglas production function aggregate labor demand is:

$$L^d(t) = (1-\alpha)^{\frac{1}{\alpha}} A^{\frac{1}{\alpha}} ((1+\tau^f)m\omega(t))^{\frac{-1}{\alpha}} K(t),$$

with elasticity with respect to the wage equal to $-\frac{1}{\alpha} < -1$, that also does not depend on market power, m, as is the case when the firm acts competitively.

Now we assume that in a centralized wage setting system, the national union maximizes the utility function given by

$$V = (1-\tau^L)\omega(t)L(t) + (N(t) - L(t))B(t) + \theta_n \phi \frac{(\tau^L + \tau^f)\omega(t)L(t)}{(1+\eta)} \tag{23}$$

where

$$L(t) = \min(N(t), L^d(t)).$$

We assume, as argued before, that $\theta_n > \theta_s$. It is easy to check that the solution obtained from this program is the same as the one obtained if the national union also maximizes (11) considering that the alternative income $R(t)$ is the unemployment benefit $B(t)$, because there is no alternative sector. Then the wage set by the national union is

$$\omega_n(t) = \frac{\left[(1-\beta) + \beta\frac{1}{1-\alpha}\right]}{\left[(1-\tau^L) + \theta_n \phi \frac{(\tau^L+\tau^f)}{(1+\eta)}\right]} B(t). \tag{24}$$

Note now that the wage markup over the alternative income is lower at the national level than at the sector level because

$$\frac{\left[(1-\beta) + \beta\frac{1}{1-\alpha}\right]}{\left[(1-\tau^L) + \theta_n \phi \frac{(\tau^L+\tau^f)}{(1+\eta)}\right]} < \frac{\left[(1-\beta) + \beta\frac{m}{1-\alpha}\right]}{\left[(1-\tau^L) + \theta_s \phi \frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}$$

due to the presence of the price markup in the sector level wage setting system, moderation that is reinforced by the assumption that in the wage setting system the value of θ is higher.

Now considering (18) we have that the employment rate is:

$$l(t) = \frac{\left[(1-\tau^L) + \theta_n \phi \frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}{\left[(1-\tau^L) + \theta_n \phi \frac{(\tau^L+\tau^f)}{(1+\eta)}\right] + \left[(1-\beta) + \beta\frac{1}{1-\alpha}\right] \frac{(1-\phi)(\tau^L+\tau^f)}{(1+\eta)}} = l^*_{NL}. \tag{25}$$

Note that as long as $\phi < 1$ then $l^*_{NL} < 1$, that is there is always unemployment when wages are set in a centralized way. When $\phi = 1$ we have $l(t) = 1$, that is, if there are only social expenditures and not unemployment benefits the national union chooses the competitive wage. This is because in this case the utility function of the union becomes:

$$V = (1 - \tau^L)\omega(t)L(t) + \theta_n \phi \frac{(\tau^L + \tau^f)\omega(t)L(t)}{(1 + \eta)}, \tag{26}$$

and, as the elasticity of labor demand in this case is $-\frac{1}{\alpha} < -1$, an increase in the wage reduces $\omega(t)L(t)$ and the union chooses the competitive wage.

When $\phi = 0$, the employment rate is:

$$l(t) = \frac{(1 - \tau^L)}{(1 - \tau^L) + \left[(1 - \beta) + \beta \frac{1}{1-\alpha}\right] \frac{(\tau^L + \tau^f)}{(1+\eta)}} = l^*_{NL} < 1 \tag{27}$$

that means that when only unemployment benefits are paid we have unemployment when wages are set in a centralized way.

For having $l^*_{NL} > l^*_{SL}$ we need:

$$\begin{aligned} &\frac{\left[(1 - \tau^L) + \theta_n \phi \frac{(\tau^L + \tau^f)}{(1+\eta)}\right]}{\left[(1 - \tau^L) + \theta_n \phi \frac{(\tau^L + \tau^f)}{(1+\eta)}\right] + \left[(1 - \beta) + \beta \frac{1}{1-\alpha}\right] \frac{(1-\phi)(\tau^L + \tau^f)}{(1+\eta)}} \\ > \quad &\frac{\left[(1 - \tau^L) + \theta_s \phi \frac{(\tau^L + \tau^f)}{(1+\eta)}\right]}{\left[(1 - \beta) + \beta \frac{\mathbf{m}}{1-\alpha}\right] \left[(1 - \tau^L) + (1 - \phi) \frac{(\tau^L + \tau^f)}{(1+\eta)}\right]}. \end{aligned} \tag{28}$$

An educated look at this expression shows that the first term is always greater than the second one if m is high enough or θ_s low enough, assuming all the other parameters are equal. This means that for all the other parameters equal there is wage restraint at national level if market power is high enough or the degree of internalization of the sector union low enough. This may be surprising because we saw that the wage markup is always lower when wages are set in a centralized way, but the reason is that alternative income is different. Of course, when one considers different countries with different parameters it may be the case that even if the degree of market power is high enough or the degree of internalization of the sector union low enough there is more unemployment at national level.

One may alternatively consider that the national union also has perceptions about how the wage will affect the unemployment benefit in a similar way it considers it affects social expenditures. In this case, the national union believes that changing the wage, the wage bill and the amount of employment will change and then also the unemployment benefit according to the equation:

$$B(t) = \varphi \frac{(1-\phi)}{(1+\eta)} \frac{(\tau^L + \tau^f)\omega(t)L(t)}{(N(t) - L(t))} \tag{29}$$

with $0 < \varphi \leqq 1$[21]. With a Cobb-Douglas utility function, this means that the union now considers that an increase in the wage bill reduces the unemployment benefit because $\omega(t)L(t)$ decreases and $(N(t) - L(t))$ increases. Now the utility function of the union becomes:

$$V_B = (1 - \tau^L + \frac{[\varphi(1-\phi) + \theta_n \phi]\,(\tau^L + \tau^f)}{(1+\eta)})\omega(t)L(t) \tag{30}$$

and in this case it is obvious that it chooses the competitive wage because the elasticity with respect to the wage is equal to $-\frac{1}{\alpha}$and an increase in the wage always reduces the wage bill $\omega(t)L(t)$. In this case, therefore, there is full employment, that is, $l^*_{NL,S} = 1$ and $l^*_{NL,S} > l^*_S$ if m is high enough or $\theta_s \phi$ is low enough.

One may finally consider the opposite case: that in a centralized wage setting system the national union also has perceptions about the effect of wages on taxes. More specifically, it may think that if the wage increases then the unemployment benefit and the tax rate on employers will remain invariant and then the tax rate on employed workers is going to change. This means that, in this case, the national union now adds the following restriction to its program:

$$\tau^L = \left[\varphi \frac{(1+\eta)S(t)(N(t) - L(t))}{\omega(t)L(t)} - \tau^f\right]$$

where $0 < \varphi \leqq 1$ reflects the union's belief about how changes in the unemployment benefit are going to affect workers' taxes[22]. The case $\varphi = 0$, is the first one presented in this section and Layard, Nickell and Jackman (1991) on P. 130 consider the case $\varphi = \beta = 1$, $\eta = \theta = \tau^f = 0$[23]. Now the objective function of the union becomes:

$$V_{\tau^L} = (1 + \tau^f)\omega(t)L(t) + (1 - \varphi(1+\eta) + \varphi\theta\phi)S(t)(N(t) - L(t))$$

and for $0 < \varphi \leqq 1$ the wage is:

$$\omega_{n,\tau^L}(t) = \frac{\left[(1-\beta) + \beta \frac{(1-\varphi(1+\eta)+\varphi\theta\phi)}{1-\alpha}\right]}{(1+\tau^f)} B(t). \tag{31}$$

Then the employment rate is:

[21] This is the case when the union considers, in part, exactly what the government does.

[22] The alternative assumption is that the union thinks that if the wage increases, then the tax rate will remain invariant and, then, the unemployment benefit is going to change according to $s(t) = \frac{1}{\theta} \frac{\tau(t)\omega(t)L(t)}{(N(t)-L(t))}$. In this case the objective funcion of the union becomes $(1 + \left[\frac{1}{\theta} - \tau\right])\omega(t)L(t)$

[23] In this case, whatever the union considers is going to happen when employment changes, the objective function of the union is $\omega(t)L(t)$.

$$l(t) = \frac{(1+\tau^f)}{(1+\tau^f) + \left[(1-\beta) + \beta\frac{(1-\varphi(1+\eta)+\varphi\theta\phi)}{1-\alpha}\right]} = l^*_{NL,\tau^L}. \tag{32}$$

Note that in this case there is unemployment if the term $\varphi(1+\eta)$ is low enough and in the specific case consider by Layard, Nickell and Jackman (1991) we have full employment, $l(t) = 1$.

In order to have $l^*_{NL,\tau^L} > l^*_{SL}$ we need:

$$\frac{(1+\tau^f)}{(1+\tau^f) + \left[(1-\beta) + \beta\frac{(1-\varphi(1+\eta)+\varphi\theta\phi)}{1-\alpha}\right]} > \frac{\left[(1-\tau^L) + \theta_s\phi\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]}{\left[(1-\beta) + \beta\frac{\mathbf{m}}{1-\alpha}\right]\left[(1-\tau^L) + (1-\phi)\frac{(\tau^L+\tau^f)}{(1+\eta)}\right]} \tag{33}$$

and, again, $l^*_{NL,\tau^L} > l^*_S$ if m is high enough or θ_s is low enough.

Therefore, obtaining unemployment or full employment in the centralized wage setting system depends heavily on what the union assumes is going to happen when the wage it sets increases. If it thinks that neither the unemployment benefit nor taxes on employed workers will change, then there is unemployment. If it thinks that an increase in the wage will decrease the unemployment benefit then we have full employment. If it thinks that an increase in the wage will increase workers' taxes we have, in general, unemployment.

Note also that a higher degree of market power does not affect any of the employment rates obtained when wages are set at national level for the same reason as when they are set at firm level.

In all three cases we have a higher employment rate when wages are set at national level than when wages are set at sector level if m is high enough or θ_s is low enough. Hence, we should expect the inverse U relationship between unemployment and the degree of centralization of wage setting when the degree of market power in the product market is high enough. This is due to the higher labor demand elasticity at sector level because of considering market power at this level. This argument is similar to Calmfors and Driffil's assumption that the elasticity of labor demand decreases with the degree of centralization, but we have a strong argument for this assumption: the consideration of market power when wages are set at the sector level.

Note finally, that this relationship occurs when all the other parameters do not change. Therefore, it is not surprising that if one checks for the inverse U hypothesis without controlling for the other parameters that affect the employment rate, the relationship does not appear.

8 Households and equilibrium

In the IH model we have a representative family with $N(t)$ members growing at the constant rate n, with an inelastic labor supply equal to $N(t)$ that (see Galí (1996) section 2.1) chooses aggregate consumption per capita, $c(t) \equiv \int_0^1 c_j(t)dj$, where $c_j(t) \equiv \frac{C_j(t)}{N(t)}$, in order to maximize:

$$\int_{t=0}^{\infty} e^{-(\rho-n)t}\left[\frac{c(t)^{1-\theta}-1}{1-\theta}\right] \tag{34}$$

subject to:

$$\dot{a}(t)=(1-\tau)w(t)l(t)+s(t)(1-l(t))-e(t)+\int_0^1 (d_j(t)+\dot{q}_j(t))s_j(t)dj-na(t). \tag{35}$$

where $s_j(t)$ the number of shares per capita in firm j held at time t by the family. A share in firm j trades at price $q_j(t)$ and generates a dividend flow $d_j(t)$ at time t. Financial wealth of the family is thus given by $A(t)=\int_0^1 q_j(t))N(t)s_j(t)dj$ and then $a(t)\equiv\frac{A(t)}{N(t)}$.

Note that the revenues of this family accrue from total labor income because we assume the family is so big that it considers all workers, employed and unemployed, Daveri and Maffezzoli (2000), Eriksson (1997) and Raurich, Sala and Sorolla (2006) also make the big family assumption. If we have heterogeneous agents instead of a big family, the solution does not change as long as we assume complete competitive insurance markets for unemployment or that the union pursues a redistributive goal, acting as a substitute for the insurance markets (Maffezzoli (2001) and Benassy (1997)).

In market equilibrium we obtain (see Galí (1996)):

$$\frac{\dot{c}(t)}{c(t)}=\frac{1}{\theta}\left(\frac{1}{m}F_K(k(t),l(t))-(\rho+\delta)\right), \tag{36}$$

$$\dot{k}(t)=f(k(t),l(t))-c(t)-(n+\delta)k(t). \tag{37}$$

Where $k(t)$ is capital per capita and $F(k,l)$ is the production function per capita (see appendix). Assuming a constant employment rate $l_t=l^*$, that is what we obtain with a Cobb-Douglas production function plus the wage equations in the firm, sector and centralized wage setting systems, plus the assumption of the unemployment benefit budget constraint, these equations become:

$$\frac{\dot{c}(t)}{c(t)} = \frac{1}{\theta}\left(\frac{1}{m}F_K(k(t), l^*) - (\rho + \delta)\right), \tag{38}$$

$$\dot{k}(t) = F(k(t), l^*) - c_t - (n + \delta)k(t). \tag{39}$$

Because $l^* < 1$, it is clear from (39) that the rate of growth of capital per capita is lower for a given level of c and k in a model with unemployment, that is, employment affects growth in the short run. It is also clear, from (38) and (39), that consumption and capital per capita converge to a steady state with a zero rate of growth of capital per capita and consumption per capita. That means that there is no relationship between growth and unemployment in the long run: the constant rate of unemployment is given by l^* and the rate of growth in income per capita is zero, or x, if we introduce technological progress. It is also easy to see, drawing the phase diagram, that a decrease in l^* decreases the long run level of consumption, capital and income per capita, that is, there is a positive relationship between income, capital and consumption per capita and employment in the long run. In other words, all other parameters equal, economies with a higher employment rate will record higher income, capital and consumption per capita in the long run.

On the other hand, the level of capital per worker and income per worker in the long run does not depend on the employment rate because we can rewrite (38) as

$$\frac{\dot{c}(t)}{c(t)} = \frac{1}{\theta}\left(\frac{1}{m}f(\hat{k}(t)) - (\rho + \delta)\right), \tag{40}$$

where $\hat{k}$ is capital per unit of labor and $f(\hat{k})$ the production function in intensive form, and, hence, in the long run $\hat{k}$ is given by:

$$0 = \frac{1}{\theta}\left(\frac{1}{m}f(\hat{k}) - (\rho + \delta)\right). \tag{41}$$

Then, all the other parameters remaining equal, we also have a U relationship between long run income, capital and consumption per capita and the degree of centralization of wage setting when the degree of market power in the product market is high enough and there is no relationship between capital and income per worker and the degree of centralization of wage setting.

Finally, as we saw, an increase in market power increases unemployment when the wage is set at sector level, but has no effect when it is set at firm and national level. However, in all three systems it produces a decrease in long run income, capital and consumption per capita and in capital and income per worker.

9 Main Results

We the inverse U relationship between unemployment and the degree of centralization of wage setting is to be expected in an economy where the product market is non competitive when the degree of market power of this product market is high enough. This is due to the higher labor demand elasticity at sector level because of considering market power at this level. Note that this relationship occurs when all the other parameters do not change. As a result, it is not surprising that if one checks for the inverse U hypothesis without controlling for the other parameters that affect the employment rate, the relationship does not appear. We should also expect a U relationship between long run income, capital and consumption per capita and the degree of centralization of wage setting when the degree of market power in the product market is high enough and there is no relationship between capital and income per worker and the degree of centralization of wage setting.

Finally an increase in market power increases unemployment when the wage is set at sector level but has no effect when it is set at firm and national level. However, in all three systems it produces a decrease in long run income, capital and consumption per capita and in capital and income per worker.

This paper offers an explanation for the weak relationship between the wage bargaining system and the employment rate that has been explicitly tested in a large number of studies. As we saw in section 2, the empirical evidence reveals strong heterogeneity for the parameters that determine the rate of unemployment in the theoretical model of this paper for the sample of countries with a wage bargaining system at sector level. This causes, even inside this group, the results on the unemployment to be very heterogeneous.

Another implication of the results presented is that it may be particularly relevant for policy makers who plan to implement labor market reforms to reduce unemployment to analyze the specific characteristics for every country of the variables that determine the unemployment rate in the model, such as for example: social expenditure structure, government efficiency, etc.

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10.1 Appendix 1

We introduce the monopolistic competition set up in a growth model (Galí (1996)) having $j \in [0,1]$ sectors with one firm per sector that produces product $Y_j(t)$. Production functions at sector and firm level are characterized by function

$$Y_j(t) = F(K_j(t), L_j(t)), \tag{42}$$

with constant returns to scale with respect to K and L, $F_K > 0$, $F_L > 0$, $F_{KK} < 0$, $F_{LL} < 0$ and the Inada conditions: $Lim_{K\to 0}F_K = \infty$, $Lim_{K\to\infty}F_K = 0$, $Lim_{L\to 0}F_L = \infty$, $Lim_{L\to\infty}F_L = 0$. The production function in terms of output per worker or unit of labor, $\frac{Y_j(t)}{L_j(t)} \equiv \hat{y}_j(t)$, and capital per worker or the capital labor ratio, $\frac{K_j(t)}{L_{j(}(t)} \equiv \hat{k}_j(t)$, that is, in intensive form, is:

$$\hat{y}_j(t) = f(\hat{k}_j(t)), \tag{43}$$

where $f' > 0$ and $f'' < 0$.

Finally we also rewrite the production function in per capita terms $\frac{Y_j(t)}{N(t)} \equiv y_j(t)$, $\frac{K_j(t)}{N(t)} \equiv k_j(t)$, $\frac{L_j(t)}{N(t)} \equiv l_j(t)$, where $N(t)$ is population a time t. In this case, we have:

$$y_j(t) \equiv \frac{Y_j(t)}{N(t)} = F(\frac{K_j(t)}{N(t)}, \frac{L_j(t)}{N(t)}) \equiv F(k_j(t), l_j(t)), \tag{44}$$

with $F_k = F_K$ and $F_l = F_L$.

The stock of capital for firm j evolves according to the equation:

$$\dot{K}_j(t) = I_j(t) - \delta K_j(t), \tag{45}$$

where $I_j(t)$ is a composite of the flow of purchases by firm j of the good produced by firm h, $I_{j,h}(t)$[24].

The firm in sector j maximizes the wealth of its shareholders subject to the demand function. The demand function in sector j is the sum of the demands of consumers and firms (Galí (1996) equation (2.7)):

$$Y_j(t) = \left(\frac{P_j(t)}{P(t)}\right)^{-\sigma}\left(\frac{E(t)}{P(t)}\right) + \left(\frac{P_j(t)}{\Pi(t)}\right)^{-\eta}\left(\frac{Z(t)}{\Pi(t)}\right), \tag{46}$$

where $P(t)$ is the aggregate price index $P(t) \equiv \left(\int_0^1 P_j(t)^{1-\sigma}dj\right)^{\frac{1}{1-\sigma}}$, $E(t)$ is the flow of

[24] As defined below $I_j(t) \equiv \frac{Z_j(t)}{\Pi(t)}$.

expenditure in consumption goods $E(t) \equiv \int_0^1 P_j(t)C_j(t)dj$, $Z(t)$ is the flow of expenditure in investment goods, $Z(t) \equiv \int_0^1 Z_j(t)dj$, that is the sum for all sectors of expenditures in $I_j(t)$, $Z_j(t) \equiv \int_0^1 P_h(t)I_{j,h}(t)dh$, $\Pi(t)$ is the aggregate price index $\Pi(t) \equiv \left(\int_0^1 P_j(t)^{1-\eta}dj\right)^{\frac{1}{1-\eta}}$ and σ and η are the constant price elasticity of the consumer and firms demand functions. Finally, $\eta > 1$ denotes the (exogenously given) elasticity of substitution between different goods form the viewpoint of the firm which uses them as inputs (Galí (1996), P.255). Assuming that the price elasticity of the demands of consumers and firms is equal to ξ[25] , equation (46) becomes.

$$\begin{aligned} Y_j(t) &= \left(\frac{P_j(t)}{P(t)}\right)^{-\xi}\left(\frac{E(t)}{P(t)}\right) + \left(\frac{P_j(t)}{P(t)}\right)^{-\xi}\left(\frac{Z(t)}{P(t)}\right) = \left(\frac{P_j(t)}{P(t)}\right)^{-\xi}\left(\frac{E(t)+Z(t)}{P(t)}\right) \\ &= \left(\frac{P_j(t)}{P(t)}\right)^{-\xi}\left(\frac{Y(t)}{P(t)}\right) = \left(\frac{P_j(t)}{P(t)}\right)^{-\xi}(\bar{\mathbf{Y}}(t)) \end{aligned} \tag{47}$$

where $\bar{Y}(t) \equiv E(t) + Z(t)$ and $\bar{\mathbf{Y}}(t) \equiv \frac{Y(t)}{P(t)}$ is total real expenditures on consumption and investment. The aggregate price index is now $P(t) \equiv \left(\int_0^1 P_j(t)^{1-\xi}dj\right)^{\frac{1}{1-\xi}}$.

Defining $m \equiv \frac{1}{(1-\frac{1}{\xi})} > 1$, as the monopoly degree or the markup, from the solution to the program of the firm, we obtain the following first order condition for firm j (see again Galí (1996), equation 2.11) with the payroll taxes properly added:

$$F_L(K_j(t), L_j(t)) = (1+\tau^f)m\frac{W_j(t)}{P_j(t)}, \tag{48}$$

and then

$$\begin{aligned} F_L(K_j(t), L_j(t)) &= (1+\tau^f)m\frac{\frac{W_j(t)}{P(t)}}{\frac{P_j(t)}{P(t)}} = (1+\tau^f)m\omega_j(t)\frac{Y_j(t)^{\frac{1}{\xi}}}{\bar{\mathbf{Y}}(t)^{\frac{1}{\xi}}} \\ &= (1+\tau^f)m\omega_j(t)\frac{F(K_j(t), L_j(t))^{\frac{1}{\xi}}}{\bar{\mathbf{Y}}(t)^{\frac{1}{\xi}}} \end{aligned} \tag{49}$$

[25] The complication of the monopolistic competition set up in a growth model arises from the fact that both consumers and firms demand product i due to the demand of capital of each firm. On principle the price elasticity of both types of demand may be different, this is the point of Gali's paper, and this opens the door for multiplicity of equilibria. The assumption that ξ is constant is the $\sigma = \mu$ case in Gali´s paper.

where $\omega_j(t) \equiv \frac{W_j(t)}{P(t)}$ is the real wage in sector j. We can rewrite equation (49) as:

$$F_L(K_j(t), L_j(t))F(K_j(t), L_j(t))^{-\frac{1}{\xi}} = \frac{(1+\tau^f)m\omega_j(t)}{\bar{\mathbf{Y}}(t)^{\frac{1}{\xi}}} \tag{50}$$

and from the last equation[26] we get the"labor demand" function for sector j:

$$L_j^d(t) = \tilde{L}_j((1+\tau^f)m\omega_j(t), K_j(t), \bar{\mathbf{Y}}(t)), \tag{51}$$

where $\tilde{L}_{j,m\omega_j} < 0$ and $\tilde{L}_{j,\bar{\mathbf{Y}}} > 0$.

Because $F_L(K_j(t), L_j(t)) = f(\hat{k}_j(t)) - \hat{k}_j(t)f'(\hat{k}_j(t))$, equation (49) can also be rewritten in terms of the production function in intensive form as:

$$f(\hat{k}_j(t)) - \hat{k}_j(t)f'(\hat{k}_j(t)) = m\frac{W_j(t)}{P_j(t)}, \tag{52}$$

which gives the capital labor ratio function:

$$\hat{k}_j(t) = \tilde{k}\left(m\frac{W_j(t)}{P_j(t)}\right), \tag{53}$$

with $\tilde{k}' > 0$.

[26] We can also rewrite this condition in terms of the capital labor ratio as: $\left[f(\hat{k}_j) - \hat{k}_j f'(\hat{k}_j)\right] f(\hat{k}_j)^{-\frac{1}{\xi}} = \frac{m\omega_j}{(\frac{\bar{\mathbf{Y}}}{L})^{\frac{1}{\xi}}}$.