ISAE Istituto di Studi e Analisi Economica

WAGE SETTERS, CENTRAL BANK CONSERVATISM AND ECONOMIC PERFORMANCE

by

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ABSTRACT

This work analyses the relationship among wage setters, Central Bank conservatism and economic performance. The main findings are that we can not confirm the so called *Calmfors-Driffill* effect. Key parameter is the elasticity of substitution between labor types, or σ, which affects the unions' market power. It emerges that with high values of σ decentralized economies, rather than centralized ones, face lower levels of inflation and unemployment. The opposite occurs with low values of σ.
Dealing with the conservatism of the Central Bank, the paper shows that an ultra conservative central banker, rather than a populist one is able to maximize the welfare of a society.

JEL Classification: E5, J5

Key Words: Non Atomistic Agents, Conservatism, Wage Bargaining

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NON TECHNICAL ABSTRACT

Aim of this article is to analyze how central bank's policies affect economic performance in countries characterized by different levels of centralization of wage bargaining. We consider an economy where there are *n* different unions, which set nominal wages, *k* different firms, which set prices, and finally a central bank that fixes the amount of nominal money, trying to minimize its loss function whose arguments are inflation and unemployment. Even if this structure of the model is quite complicated, we believe that it can be very useful for understanding the channel through which central bank's preferences affect real economy; moreover we manage to make a step towards reality. As it emerges from the literature, a lot of models consider an economy where there is only a representative firm, which behaves as price taker. The advantage of modeling many goods is the following: under a decreasing return to scale technology, the firm labor demand is function of real money balances; therefore, the existence of a more conservative central bank reduces the amount of money in the economy, affecting real economy.

Solving the model we obtain that the central bank's conservatism always reduces inflation and unemployment. This is due to the higher costs in terms of unemployment that unions have to face whenever the central bank is more conservative. In this case, real money balances will be smaller, as well as the labor demand of every firm. Therefore, to reduce the unemployment costs, unions find optimal to reduce their wage claims.

Moving towards decentralized economies, (that is, dealing with higher numbers of unions) we can obtain increasing or decreasing levels of unemployment. This result is related with the value of a technological parameter that enters in the production function. This parameter is the elasticity of substitution between labor types, which gives unions the possibility to fix nominal wages. Firms, in fact, have to use all different kinds of labor input, given the imperfect substitutability between labor types. It emerges that the higher this elasticity is, the lower the unions' market power is. Notice that, in decentralized economies, unions have a lower perception of how much they can contribute to aggregate variables as inflation and aggregate nominal wages. Increasing the number of unions, the gains in real wages, as consequence of higher wage claims, are higher, causing an increase in inflation and unemployment. Anyway this is not always the case. If the elasticity of substitution between labor types is high, it means that firms can quite easily substitute one labor type with another. In this case, the gains in terms of higher real wages are overcome by the costs in terms of unemployment, inducing the unions themselves, to reduce their wage demand.

SINDACATI, CONSERVATORISMO DELLA BANCA CENTRALE E PERFORMANCE ECONOMICHE

SINTESI

Con questo lavoro, si è cercato di evidenziare quali siano gli effetti della politica monetaria in paesi caratterizzati da differenti livelli di centralizzazione delle negoziazioni salariali. Elemento chiave del modello è l'elasticità di sostituzione tra i diversi tipi di lavoro, evidenziata dal parametro σ, il quale influenza il potere di mercato dei sindacati. Dal modello emerge che per alti valori di σ, economie decentralizzate hanno tassi d'inflazione e disoccupazione più bassi rispetto ad economie centralizzate. L'opposto si verifica per bassi valori di σ.
Per quanto concerne gli effetti delle preferenze della banca centrale, il lavoro mostra che un banchiere centrale ultra conservatore, rispetto ad uno *populista,* massimizza il benessere della società

Classificazione JEL: E5, J5

Parole chiave: Agenti non atomistici, conservatorismo, contrattazione salariale

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1. INTRODUCTION

With this work I want to analyze how the existence of non atomistic wage setters, the unions themselves, with the power to set wages, affect countries' economic performance, and how monetary institutions affect the unions' decisions and through this, economic performance.

Dealing with the relationship between wage bargaining and economic performance, the main work in the literature is the one of Calmfors and Driffill (1988) who found an inverted U relation between centralization of wage bargaining (CWB) and unemployment. Countries can be classified according to the centralization of wage bargaining; in particular we say that one country is more centralized if the wage bargaining occurs at national level; an intermediate case is that of sectorial level and the decentralized case is referred to firm level. They say that economies characterized by either few large unions (centralized economies) or many small unions (decentralized economies) obtain low levels of unemployment. They claim that the presence of unions causes some negative externalities (as prices' increases and unemployment's increases). If the bargaining takes place at national level, then the few large unions internalize these negative effects; on the contrary, at firm level, it is natural to assume that the competition among products of the same sector is quite high. Therefore firms can not increase too much prices as the labor costs increase; otherwise they start to make negative profits. Hence unions, knowing this, start to reduce their wage demand. They conclude that economies characterized by intermediate levels of CWB are the ones that face higher levels of inflation and unemployment. They assume that the elasticity of labor demand towards every union goes to infinity once the number of unions increases, that is, when we move towards decentralized economies. Therefore unions reduce their wage demand once we deal with economies highly decentralized. Notice that unions always evaluate higher gains in real terms against losses in unemployment. In particular they can demand higher values of nominal wages (their control variable) until the losses in unemployment are lower than the gains in real wages. Obviously this can happen when the elasticity of labor demand is quite low. This elasticity can be considered as a measure of the unions' market power (see Guzzo and Velasco (1999) and Lippi (2002)); therefore, in my opinion, it is not so innocuous making assumption on this point. If we are assuming how institutional factors affect this elasticity, implicitly we are also assuming how different degrees of centralization of wage bargaining affect countries' economic performance. Moreover notice that the *Calmfors-Driffill effect* recently, has also been chanlleged on the empirical side. In particular Blaney, using an index for cor-

poratism[1] rather than one of centralization of wage bargaining, finds a negative relation between economic performance and CWB. The OECD (1997), updating the study of Calmfors and Driffill (1988), can not find any significant relation between economic performance and CWB. They find that countries highly decentralized are the ones whose wages are more unequal. Recently, Cukierman and Lippi (1999), doing an empirical exercise, confirmed the Calmfors-Driffill effect. They claim that it is fundamental to consider the interaction between wage bargaining and conservatism of the Central Bank to fully understand the relationship between wage bargaining and economic performance.

Another important element that has to be used to explain economic performance of every country, in terms of unemployment and inflation, is given by the Central Bank's policy. As showed by Barro and Gordon (1983), when the market is characterized by some imperfections, the equilibrium output can be below its natural level, creating some incentives for the Central Bank to follow an expansionary policy. This is the classical *inflation-bias* problem. Rogoff (1985) proposed, as solution of the inflation-bias, the delegation of price control to an independent and more conservative authority. There is a general consensus on the negative relation between Central Bank conservatism (following the Rogoff's idea (1985)) and inflation. Something not so clear is how monetary institutions can have real effects. A sufficient set of assumptions under which the monetary rules have no effect on real variables are: *i)* rational expectations, *ii)* perfect competition *iii)* complete information *iv)* absence of nominal rigidities (see for instance Soskcie and Iversen (2000)). What happens if we modify assumption *ii)*? As showed by the seminal work of Blanchard and Kiyotaki (1987), money is still neutral when we introduce monopolistic competition in the labor and good markets. It is the so called Rogoff coefficient which can have real effects. Moreover Guzzo and Velasco (1999), in their work, show that the best economic performance for a country can be obtained by a *Populist Central Banker*, the one who does not care at all about inflation. Can we conclude that the Rogoff analysis is completely overcome? The answer is not. As noticed by Lippi (2002), they solve a game between n different unions and a Central Bank, where unions fix real wages instead of the nominal one. In this case they loss some important aspects of the bargaining. Moreover almost all the model present in the literature consider, as argument of the unions objective function, real wages, unemployment among the unions' members and inflation. Including an inflation target, as noticed by Berger, Haan and Eijffinger (2001) it is not so intuitive. If we consider centralized economies, with few large unions, able

[1] For a definition of corporatism, see Tarantelli (1986) or the OECD (1997).

to represent almost all the workers, then it makes sense, given that the society as a whole, can be considered as inflation adverse. When we deal with many small unions, it is quite hard to think that they care about interests concerning all the society. Moreover, we can show that using a simple game between only one union and a Central Bank, it is only the inflation target that generates real effects. Finally notice that so far economists did not reach an agreement on this point; in fact Sockice and Iversen (2000), as well as Coricelli Cukierman and Dalmazzo (2000), contrarily to Guzzo and Velasco (1999), find that a conservative Central Banker is able to maximize the welfare of an economy. Cukierman and Lippi (1999) found the classical trade-off between lower inflation and higher unemployment.

Hence, in economic literature there are some controversies on the effects of institutional factors, as different degrees of CWB and CBC on economic performance; as I have mentioned sometimes these effects are due to the assumptions used which are not always so innocuous and intuitive. Therefore for analyzing the relationship between wage bargaining, Central Bank's conservatism and economic performance, it is fundamental to develop a general model. I proceed in the following way: starting from the analysis of Barro and Gordon (1983), I develop a game between n different unions, which organize all the labor force, and a Central Bank. I introduce monopolistic agents in the labor market, (the unions themselves) using, as Blanchard and Kiyotaki (1987), a Constant Elasticity of Substitution (CES) production function and in the good market (firms), thanks to a total consumption index with an imperfect substitutability between goods. It is the imperfect substitutability between labor types which gives to unions their market power. Using a CES function it has been possible make endogenous the unions' market power. In fact we derive from the model the labor demand towards every union and the elasticity of labor demand to nominal wages. Therefore, we do not make any assumption on the elasticity of labor demand towards every union, which is, in my opinion, a key element of the model.

The time moving is the following: unions in the first step fix nominal wages; in the second one the Central Bank fixes the amount of money, and finally firms, moving along their demand curve, determine the quantity of labor demanded in the economy. Notice that introducing money, as Coricelli Cukierman and Dalmazzo (2000) is not only a complication of the model; it is allows us to develop a model closer to reality and to understand what is the channel through which monetary institutions cause real effects. Finally notice that in our model we do not include any inflation target in the unions' objective function, that, as I mentioned, it is not so intuitive and innocuous, as assumption.

With our model, we can not confirm the so called *Calmfors-Driffill effect*. Key parameter is the elasticity of substitution between labor types, or σ. This affects the unions' market power, measured by the elasticity of labor demand to nominal wages. According to the specific value of σ unions can have higher or lower market power when we move towards decentralized economies, whereas in Calmfors and Driffil (1988) model, unions are less powerful in a decentralized economies.

Dealing with the conservatism of the Central Bank, the model shows that the best solution is obtained by a conservative Central Banker rather than a populist one. In fact unions always evaluate higher gains in real terms against losses in unemployment. It emerges that the more conservative the central bank, the higher the costs in terms of unemployment; therefore unions, in this case reduce their wage demand.

Our model is close to the ones of Cukierman and Lippi (1999) and to the one of Coricelli Cukierman and Dalmazzo (2000). Anyway we do not introduce an inflation target in the unions' objective function, that, as we have seen, it is not so innocuous as assumption; moreover, notice that the specification of the technology used is a key element. We use a CES production function with an imperfect substitution between labor types, whereas Coricelli *et al*. (2000) use a production function where there is no substitutability between labor types. Cukierman and Lippi (1999), according to their specification of the labor demand towards every union, implicitly assume that the elasticity of labor demand with respect to nominal wage goes to infinity once we move towards decentralized economies. In our model, this is not always the case; it is related to the technological parameter σ, or the elasticity of substitution between labor types, the parameter from which unions derive their market power.

2. THE MODEL

2.1 The Underlying Economy

The basic elements of the model are the following: we develop a game among n different unions, which have the power to set wages, and a Central Bank, which sets money. We assume that there is a continuum of individuals belonging to the interval $[0, 1]$. The n unions organize all the labor force. Increasing the number of unions, it means that there are more agents involved in the bargaining; therefore, intuitively, we can think that we are moving towards decentralized economies. Unions have a market power thanks to the specification of the production function

used. As I will show later, there is an imperfect substitutability between labor types; thanks to this, unions can set wages, and try to minimize a loss function whose argument are real wages and unemployment among the unions' member. The Central Bank fixes the amount of money, minimizing a loss function whose argument are inflation and unemployment. Finally there is a continuum of firms which maximize profits; their control variable is the price of every good. Firms derive their market power form the specification of the total consumption index for every agent, given that there is an imperfect substitution between the different good types. Given the assumption of perfect information and rationality, we solve the game by backward induction, looking for a sub-game perfect equilibrium. Therefore we start from the households' problem, we move to the firms' problem, to the central bank's problem and finally to the unions' problem[2].

2.2 The Households

Following Blanchard and Kiyotaki (1987), we assume that every agent in the economy faces the following utility maximization problem:

$$\max_{C_k(i),M_i} U_i = \left(C_i^T\right)^{\gamma} \left(\frac{M_i}{P}\right)^{1-\gamma} \tag{1}$$

such that

$$\int_0^1 \left[P_k C_k(i)\right] dk + M_i = I_i \tag{2}$$

We assume that there is continuum of goods k belonging to the interval $[0,1]$. Notice that γ is a parameter between zero and one, C_i^T is the total consumption for every individual, M_i is the money demand for the individual i, P is the aggregate level of prices and I_i is a given wealth (see Blanchard and Kiyotaki (1987), Obstfeld and Rogoff (1996)) equal to

$$I_i = W_i N_i + V_i + M_i^0 \tag{3}$$

[2] Recently Jerger (2002) has modified this assumption solving a non-cooperative game where all agents move at the same time. He has been able to confirm that a populist Central Banker (the one who does not care at all about inflation) leads to a first best only in some special cases, confirming the analysis of the current literature in this field, contrarily to what found by Guzzo and Velasco (1999).

$W_i N_i$ is labor income, V_i indicates the total profits earned by every agent, and M_i^0 is the given amount of money initially held by every agent. Notice that, as Obstfeld and Rogoff (2000), in this model we do not introduce the interest rate, given that we develop a static game; we justify the presence of money in the utility function because we want to avoid the Say's law, where the supply of goods generates automatically its own demand. Here the presence of money gives the possibility to people to choose between consuming and holding money.

The total consumption for every individual i, C_i^T, is expressed by the following CES index:

$$C_i^T = \left[\int_0^1 \left[C_k(i)^{\frac{\theta-1}{\theta}} \right] dk \right]^{\frac{\theta}{\theta-1}} \tag{4}$$

where θ is the elasticity of substitution between goods (restricted to be > 1) and

$$P = \left[\int_0^1 [P_k]^{1-\theta} \, dk \right]^{\frac{1}{1-\theta}} \tag{5}$$

is the corresponding price index[3].

Solving the household's problem we obtain the individual demand for every good (see appendix A for details):

$$C_k(i) = \left(\frac{P_k}{P} \right)^{-\theta} C^T(i) \tag{6}$$

and

$$C^T(i) = \frac{\gamma}{1-\gamma} \frac{M_i}{P} \tag{7}$$

We are now in a position to compute the total demand for every good; in particular we have:

[3] Notice that the price index P is the minimum expenditure $I = \int_0^1 P_k C_k(i) dk$ such that $C_i^T = \left[\int_0^1 \left[C_k(i)^{\frac{\theta-1}{\theta}} \right] dk \right]^{\frac{\theta}{\theta-1}} = 1$ (see Obstfeld and Rogoff (1996)).

$$Y_k = \int_0^1 C_k(i)di \tag{8}$$

Using (6) and (7) we can rewrite (8) as:

$$Y_k = \left(\frac{P_k}{P}\right)^{-\theta} \left(\frac{\gamma}{1-\gamma}\right) \left[\frac{M}{P}\right] \tag{9}$$

where we have used also the aggregate conditions for money such that total money demand equals money supply. Notice from (9) that the higher the price of a particular good is, the lower its demand will be.

2.3 The Firms

In the economy there is a continuum of firms distributed along the interval $[0, 1]$. Following Blanchard and Kiyotaki (1987), every firm produces by using a CES production function, that is:

$$Y_k = \left[\int_0^1 \left[N_i^{\frac{\sigma-1}{\sigma}}\right] di\right]^{\frac{\sigma}{\sigma-1}\frac{1}{\alpha}} \tag{10}$$

σ is the parameter that measures the elasticity of substitution between different labor types, restricted to be >1 and α is the inverse of the returns to scale in production, restricted to be ≥ 1. All the labor force lies contiguously in the interval [0,1] (the range of the integral of (10)). Workers are organized in n different unions (which have equal size, $\frac{1}{n}$). We are not interested in group formations, but on different degrees of centralization of wage bargaining represented exactly by the n unions[4]. We assume that unions treat equally all their members, that is, every individual belonging to the same union obtains the same wage. Obviously if $n \to \infty$ we obtain an atomistic setup with as many unions as individuals. We assume that all the labor force is unionized; in this way if there are few unions, able to represent almost all the workers, we say that we are in a centralized economy. On the other case, in a decentralized economy, the number of agents that participate to the bargaining is high, and their representativeness is smaller.

[4] This idea was already developed by Tarantelli (1986). He was interested in analyzing how economies characterized by different degrees of *"corporatism"* (see also Cubitt (1995) and OECD (1997)) for a definition of corporatism) affect inflation. In our model we only consider one aspect of the definition of corporatism, that is, the centralization of wage bargaining.

Every firm maximizes profits solving the following problem:

$$\max_{P_k} V_k = P_k Y_k - \int_0^1 W_i N_i di \tag{11}$$

$$s.t.$$

$$\begin{aligned} \int_0^1 W_i N_i di &= W Y_k^{\alpha} \\ Y_k &= \left(\frac{P_k}{P}\right)^{-\theta} \left(\frac{\gamma}{1-\gamma}\right) \left[\frac{M}{P}\right] \end{aligned}$$

The second constraint, equation (9), comes from the consumer problem, once we have aggregated the demand of a particular good for every individual.

The first one (see appendix B for details) comes from the cost minimization problem of firms. Solving that problem we obtain

$$N_i = \left(\frac{W_i}{W}\right)^{-\sigma} Y_k^{\alpha} \tag{12}$$

where

$$W = \left[\int_0^1 [W_i]^{1-\sigma} di\right]^{\frac{1}{1-\sigma}} \tag{13}$$

Some important features come from (12). In fact we can see how labor demand is an inverse function of its own wage. Moreover, combining (12) with (9) we can see the relationship between real money balances and real economy. In particular notice that the lower real money balances, the lower the labor demand.

Solving (11) with respect to P_k we obtain, after some algebra:

$$\frac{P_k}{P} = \left[\left(\frac{\theta}{\theta-1}\right) \alpha \frac{W}{P} \left(\frac{\gamma}{1-\gamma}\right)^{\alpha-1} \left(\frac{M}{P}\right)^{\alpha-1}\right]^{\frac{1}{1+\theta(\alpha-1)}} \tag{14}$$

This is the firm price rule (Blanchard, Kiyotaki (1987)). Notice that the price of a particular good is positively related to aggregate wages and to real money balances. To keep the model simple, we did not use any rigidities in prices and in wages; as the one of Blanchard and Kiyotaki (1987), this model has the property of monetary neutrality.

From (14) we obtain the inflation rate. In fact plugging (14) into (5), we obtain the following expression for the prices' level

$$\log P = \frac{1}{\alpha}\log W + \frac{\alpha-1}{\alpha}\log M + Q \tag{15}$$

where $Q = \frac{1}{\alpha}\left[\log\left(\frac{\theta}{\theta-1}\right) + \log\alpha + (\alpha-1)\log\frac{\gamma}{1-\gamma}\right]$ is only a term collecting some constants. Now subtracting from both sides the level of prices of the previous period, we obtain the inflation rate:

$$\pi = \log P - \log P_{-1} = \frac{1}{\alpha}\log W + \frac{\alpha-1}{\alpha}\log(M) + Q - \log P_{-1} \tag{16}$$

2.4 The Problem of the Central Bank.

The Central Bank minimizes the following loss function[5]:

$$\Gamma = u^2 + A\pi^2 \tag{17}$$

whose arguments are u, or unemployment and π, or inflation. A is the key parameter representing the aversion to inflation of the Central Bank. The best solution for the Central Bank would be to set $\Gamma = 0$ but she does not have two instruments; only one, the quantity of money. The Central bank anticipates the firms' behavior, so she takes into account the price rule (equation (16)). Let's see how we can compute u; we can show (see appendix C) that

[5] This kind of function is quite popular in the economic literature; similar expressions can be found in Cukierman and Lippi (1999), (2001), in Coricelli Cukierman and Dalmazzo (2000a), (2000b); moreover Woodford (1999) shows that, taking a second order Taylor approximation of the consumer utility function, we obtain a function similar to (17).

$$N^T = \int_0^1 Y_k^{\alpha} dk \tag{18}$$

Equation (18) represents the total amount of labor demanded by all firms. After some algebra we obtain:

$$N^T = H^{\alpha} \left(\frac{W}{P}\right)^{\frac{-\theta\alpha}{1+\theta(\alpha-1)}} \left(\frac{M}{P}\right)^{\frac{\alpha}{1+\theta(\alpha-1)}} \tag{19}$$

where H is a term collecting parameters (see again appendix D for details). Let N^0 be the total labor supply in the economy. Therefore we derive a measure of unemployment, u, computing:

$$u = \frac{N^0 - N^T}{N^T} \simeq \log N^0 - \log N^T \tag{20}$$

Hence unemployment is a function of real wages and real money balances. The Central Bank's problem, taking into account inflation (equation (16)) and the expression for unemployment (equations (19) and (20)) can be written as:

$$\begin{aligned} \min_M \left[\log N^0 - \log\left(H^{\alpha} (W)^{\frac{-\theta}{1+\theta(\alpha-1)}} (P)^{\frac{\theta-1}{1+\theta(\alpha-1)}} (M)^{\frac{1}{1+\theta(\alpha-1)}}\right)\right]^2 + \\ + A\left[\tfrac{1}{\alpha}\log W + \tfrac{\alpha-1}{\alpha}\log M + Q - \log P_{-1}\right]^2 \end{aligned} \tag{21}$$

After some algebra we obtain the following reaction function of the Central Bank:

$$\log M = -F\frac{\alpha^2}{\alpha^2 + A(\alpha-1)^2} + \frac{\alpha^2 - A(\alpha-1)}{\alpha^2 + A(\alpha-1)^2}\log W \tag{22}$$

where F is a term collecting some parameters (see appendix E for details). From (22) we can see the trade-off faced by the Central Bank. If unions increase their wage demand, then the Central Bank can increase or decrease the quantity of money, according to her preferences. In particular if $A < \frac{\alpha^2}{(\alpha-1)}$ the Central Bank will follow an accommodating policy, increasing the amount of money after an increase of wages. On the other case, she will reduce money. If the Central Bank gives more weight to unemployment, then she will increase money; in the other case she will reduce the quantity of money.

This confirms the analysis made by Cukierman, Rodriguez and Webb (1998), who have studied how the monetary policy reacts to inflation increases. What they found is exactly that the higher the Central Bank independence, the stronger the reduction of money growth, as inflation increases.

2.5 The Unions' Problem.

The unions' problem is the last step to close the model. We assume that unions have the following loss function:

$$\Omega_j = -2\log\left(\frac{W_j}{P}\right) + Bu_j^2 \tag{23}$$

Intuitively unions care about real wages for their members and dislike higher levels of unemployment among their members. Hence they have sectorial interests. To be consistent, we express the first argument in logarithms, given that, as it will appear clear later, the unemployment rate is computed in logarithms. Moreover this makes easier the solution of the unions' problem. Equation (23) is a loss function; therefore real wages enter negatively in it. u_j is the unemployment rate among the members of union j; B is the weight that unions give to unemployment.

The control variable of every union is obviously the nominal wage. Similar expressions to (23) can be found, for instance, in Cukierman and Lippi (1999), (2001), in Coricelli *et al.* (2000a)[6].

Unions take into account the reaction function of the Central Bank and the inflation rate (which is derived from the firms' problem). To determine the unemployment rate among the union's members we proceed in the following way: we know the labor demand for every labor type; therefore taking (12) and summing over all the members of every union, we obtain:

$$N_j^{TU} = \int_{\frac{i}{n}}^{\frac{i+1}{n}} \left(\frac{W_i}{W}\right)^{-\sigma} Y_k^{\alpha} di \tag{24}$$

where the upper index TU stands for total labor demand towards every union; plugging (14) into (9) and then into (24) we obtain:

[6] Anyway, for I have mentioned in the introduction, I do not introduce an inflation target in the unions' objective function.

$$N_j^{TU} = H^{\alpha} \left(\frac{W}{P}\right)^{\frac{-\theta\alpha}{1+\theta(\alpha-1)}} \left(\frac{M}{P}\right)^{\frac{\alpha}{1+\theta(\alpha-1)}} \int_{\frac{i}{n}}^{\frac{i+1}{n}} \left(\frac{W_i}{W}\right)^{-\sigma} di \tag{25}$$

where H (see appendix C) collects some terms. Once more, notice the positive relationship between real money balances and labor demand.

Let N_j^{0U} be the total labor supply for the union j; we can derive the unemployment rate, u_j, among the members of union j as:

$$u_j = \frac{N_j^{0U} - N_j^{TU}}{N_j^{TU}} \simeq \log N_j^{0U} - \log N_j^{TU} \tag{26}$$

Now we can rewrite the union's problem in the following way:

$$\min_{W_j | W_{-j}} \Omega_j = -2(\log W_j - \log P) + B \left[u_j\right]^2 \tag{27}$$

$$\begin{aligned} & s.t. \\ u_j &= \log N_j^{0U} - \log N_j^{TU} \\ \pi &= \frac{1}{\alpha} \log W + \frac{\alpha - 1}{\alpha} \log M + Q - \log P_{-1} \\ \log M &= -F \frac{\alpha^2}{\alpha^2 + A\left(\alpha - 1\right)^2} + \frac{\alpha^2 - A\left(\alpha - 1\right)}{\alpha^2 + A\left(\alpha - 1\right)^2} \log W \end{aligned}$$

Every union, solving its problem, takes as given the nominal wage of the other unions, anticipates the reaction function of the Central Bank, the firms' price rule and the firms' labor demand. The first order condition gives us the following expression:

$$-\left(\frac{d \log W_j}{dW_j} - \frac{d \log P}{dW_j}\right) + B\left[u_j\right] \frac{du_j}{dW_j} = 0 \tag{28}$$

After some manipulations, this expression can be rewritten as:

$$-1+\left\{\frac{d\log P}{d\log W_j}\right\}+B\left[u_j\right]\left\{-\frac{d\log N_j^{TU}}{d\log W_j}\right\}=0 \tag{29}$$

where the first term in brackets can be interpreted as the elasticity of prices to union nominal wage, and the last term in brackets of (29) is the elasticity of labor demand towards union j to its own nominal wage. A more convenient way to write (29) (see appendix E for details) is:

$$-1+\left\{\varepsilon_{P;W_j}\right\}+B\left[u_j\right]\left\{\varepsilon_{N_j;W_j}\right\}=0 \tag{30}$$

where the terms in brackets are the elasticities just mentioned. Let's analyze the first one. Considering (15) and taking the derivative with respect to $\log W_j$ we obtain:

$$\frac{d\log P}{d\log W_j}=\left[\frac{\alpha^2}{\alpha^2+A\left(\alpha-1\right)^2}\right]\frac{1}{n}\equiv\varepsilon_{P;W_j}\left(n,A\right) \tag{31}$$

Here we have used the result, as showed in appendix E, that $\frac{d\log W}{d\log W_j}=\frac{1}{n}$. This expression is quite important for our analysis; in particular equation (31) gives us a measure of the unions' contribution to inflation. Equation (31) is what we call "*strategic effect*" (see Cukierman and Lippi (1999), (2001)). The smaller this effect is, the more aggressive unions are. As we can see, (31) is a decreasing function of n and A. The intuitions are the following:

i) increasing the number of unions, the contribution to aggregate variables of every union decreases (just considering equation (31) and computing the derivative $\frac{d\varepsilon_{P;W_j}}{dn}$). Moreover if we are dealing with a conservative Central Bank, the reduction of money supply, due to an increase of wage demand, will be smaller. This emerges considering the derivative $\frac{d\log M}{d\log W_j}$ (see equation (22)) where $\frac{d\log W}{d\log W_j}=\frac{1}{n}$. Therefore unions reduce the losses in terms of unemployment.

ii) Higher values of A make the Central Bank more conservative. Thanks to this, prices will not change too much as nominal wages increase; therefore unions can be more aggressive given that the negative effect of their behavior (the increase in prices) will be smaller. In this way, unions obtain higher gains in real terms.

It is worth analyzing the structure of the elasticity of labor demand to nominal

wage. We show (see again appendix E) that

$$\frac{du_j}{d\log W_j} = -\frac{d\log N_j^{TU}}{d\log W_j} \equiv \varepsilon_{N_j;W_j} \tag{32}$$

This expression, following Guzzo and Velasco (1999) and Lippi (2002), (2000), gives an idea of the "*unions' market power*". In fact, if the elasticity of labor demand is quite high, then unions can not be too much demanding, because the losses that they have to face in terms of unemployment are quite high. Substituting (25) into (32) we obtain:

$$\varepsilon_{N_j;W_j} = \sigma\frac{d\log\left(\frac{W_j}{W}\right)}{d\log W_j} + \left(\frac{\theta\alpha}{1+\theta\left(\alpha-1\right)}\right)\frac{d\log\left(\frac{W}{P}\right)}{d\log W_j} - \left(\frac{\alpha}{1+\theta\left(\alpha-1\right)}\right)\frac{d\log\left(\frac{M}{P}\right)}{d\log W_j} \tag{33}$$

As we can see[7] there are three effects: the relative wage effect, the aggregate real wage effect, and the real money balances effect. Once an union increases its wage demand, obviously its wage increases, but also the aggregate wages increase. Anyway, knowing that $\frac{d\log W}{d\log W_j} = \frac{1}{n}$, we can show that the first effect is always positive. It is worth analyzing the parameter σ. This parameter affects directly the unions' market power; the higher σ, the higher the elasticity of labor demand. In this case firms can easily substitute one labor type with another.

Considering the real wage effect, we can see that $\frac{d\log\left(\frac{W}{P}\right)}{d\log W_j} > 0$ given that $\frac{d\log W}{d\log W_j} = \frac{1}{n}$ and from (31) we have $\frac{d\log P}{d\log W_j} = \left[\frac{\alpha^2}{\alpha^2+A(\alpha-1)^2}\right]\frac{1}{n}$ where A is non negative and $\alpha \geq 1$ so $\left[\frac{\alpha^2}{\alpha^2+A(\alpha-1)^2}\right] < 1$. Therefore aggregate real wages go in the direction of a reduction of the unions' market power.

Real money balances can decrease for two reasons: first, because the level of prices increases, and second because M decreases if the Central Bank is conservative (see what we have said dealing with equation (22)). In this case $\frac{M}{P}$,

[7] Notice that equation (33) is obtained considering that all the members belonging to the same union obtain the same wage. In particular:

$$\frac{d\log\int_{\frac{i}{n}}^{\frac{i+1}{n}}\left(\frac{W_j}{W}\right)^{-\sigma}di}{d\log W_j} = \frac{d\log\left(\frac{1}{n}\right)\left(\frac{W_j}{W}\right)^{-\sigma}}{d\log W_j}$$

obviously, decreases, increasing the elasticity of labor demand and the level of unemployment. Anyway, if M increases, given a partial accommodating policy of the Central Bank, we can show that the aggregate effect is still negative: in fact, using (22) and $\frac{d\log W}{d\log W_j} = \left(\frac{1}{n}\right)$, we obtain $\frac{d\log M}{d\log W_j} = \left[\frac{\alpha^2 - A(\alpha-1)}{\alpha^2 + A(\alpha-1)^2}\right]\left(\frac{1}{n}\right) < \frac{d\log P}{d\log W_j} = \left(\frac{1}{n}\right)\left[\frac{\alpha^2}{\alpha^2 + A(\alpha-1)^2}\right]$.

Concluding all the elements of (33) reduce the unions' market power. From (33) emerges clearly the trade-off faced by every union between more wages and higher levels of unemployment.

Once we have clarified these effects, we can solve (27) obtaining (at the symmetric equilibrium as in Cukierman and Lippi (1999), or Guzzo and Velasco (1999)) the following equilibrium relation for wages

$$\log W = \left\{ -\overline{FF} + \frac{1}{B}\frac{\left(1 - \varepsilon_{P;W_j}\right)}{\varepsilon_{N;W_j}} \right\} \frac{\left[\alpha^2 + A\left(\alpha - 1\right)^2\right]}{\alpha\left(\alpha - 1\right)A} \tag{34}$$

where $\overline{FF}$ collects some terms (see appendix F). From (34) we can see that whenever unions are more concerned about the unemployment rate among their members (the coefficient B), then the equilibrium wage is smaller.

2.5.1 *The Behavior of the Elasticities*

From (31) we can see how the elasticity of prices to nominal wages is a decreasing function with respect to the number of unions, and with respect to the conservatism of the Central Bank; in the previous subsection we have already given an intuition for these effects. Let's see how the elasticity of labor demand to nominal wage changes with respect to different degrees of centralization of wage bargaining and with respect to different degrees of the Central Bank conservatism. Solving explicitly (33) we obtain:

$$-\frac{d\log N_j^{TU}}{d\log W_j} \equiv \varepsilon_{N;W_j} = \frac{A\left(\alpha - 1\right)\alpha}{\alpha^2 + A\left(\alpha - 1\right)^2}\frac{1}{n} + \sigma\left(1 - \frac{1}{n}\right) \tag{35}$$

As we can see (35) is a function of A, n and σ, the elasticity of substitution between different labor types. Differentiating (35) with respect to n we obtain:

$$\frac{d\varepsilon_{N;W_j}}{dn} > 0 \;\; if \;\; \sigma > \frac{A\left(\alpha-1\right)\alpha}{\alpha^2+A\left(\alpha-1\right)^2} \tag{36}$$

This means that increasing the number of unions, ceteris paribus, the unions' market power decreases. This is called, following Cukierman and Lippi (1999), Lippi (2002), (2000), "*competition effect*". Moving to a decentralized economy (higher values of n), where the bargaining takes place at firm level, unions know that an increase of the wage demand induces firms to reduce the labor demand[8]; as it emerges from (36), in this case the unions' market power decreases. Anyway this is not always the case; in fact, if the elasticity of substitution between labor types, σ, is smaller than $\frac{A(\alpha-1)\alpha}{\alpha^2+A(\alpha-1)^2}$, increasing values of n lead to an increase in the unions' market power. In this case unions know that firms can not easily substitute one labor type with another; therefore the competition effect and the strategic effect (see equation (31)) work in the same direction towards an increase of the wage demand.

Differentiating $\varepsilon_{N;W_j}$ with respect to A we can easily prove that:

$$\frac{d\varepsilon_{N;W_j}}{dA} > 0 \text{ always} \tag{37}$$

The more conservative the Central Bank is, the smaller the unions' market power is. Let's give an intuition of this result; for increasing values of A, prices will be more stable (see equation (31)). Therefore the gains in real terms for the unions will be higher. In this way, firms will face higher costs, and the labor demand will decrease as a consequence of an increase of real wages and a decrease of real money balances (see equation (33)). In fact, as we have seen, higher values of nominal wages lead to a reduction in real money balances and consequently to a reduction of labor demand. All these effects decrease the unions' market power (see again (33)), and they are stronger the higher A is, as it emerges from (37); concluding we can call this effect, "*fear of unemployment*".

Notice that unions always evaluate gains in real terms against losses in terms of unemployment. As it will emerge from the following sections, to understand how institutional factors, as centralization of wage bargaining and monetary institu-

[8] Remember that at firm level the competition takes place among firms of the same sector. In this case competition among firms is quite high and they can not increase too much prices as labor costs raise.

tions, affect countries' economic performance, we have to evaluate how they influence the unions' behavior and their assessments of the gains in real terms and of the losses in terms of unemployment.

3. DIFFERENT DEGREES OF THE CONSERVATISM OF THE CENTRAL BANK AND WAGE BARGAINING

Let's analyze how the equilibrium wage (equation (34)) changes for different degrees of centralization of wage bargaining and for different levels of Central Bank conservatism. Given that equation (34) is quite complicated to be analyzed we resort to a simulation of the results. The parameterization adopted is derived from Guzzo and Velasco (1999); α, the inverse of the return to scale in production, is equal to $\frac{4}{3}$; the elasticity of substitution between different labor types, σ, is equal to 2. γ, the fraction of a given income (Blanchard and Kiyotaki (1987)) spent on consumption or held as money, is equal to $\frac{1}{2}$. A and B, the Central Bank conservatism and the weight given by unions to unemployment are fixed in the first experiment and equal respectively to 5 and 4.

3.1 Increasing the Number of Unions.

The first experiment computed, has been to modify the number of unions; notice that with the parameterization adopted, we are in the case for which σ is quite low. Remember that in this case, ceteris paribus, the unions' market power is stronger. The results are summarized in the next proposition:

Proposition 1. *If σ is smaller than a particular threshold, then, ceteris paribus, the higher the number of unions, the higher the unions' wage demand. On the contrary, for high values of σ, increasing values of n reduce the unions' wage demand.*

Plotting (34) for different values of n we obtain, as it emerges from figure 1, that the higher the number of unions, the higher the equilibrium wage. In this particular case, for a given A[9] and B we can see how the *strategic effect* and the *competition effect* move in the same direction, towards an increase of the wage demand. In fact unions know that their contribution to inflation decreases (see equation (3.31)); moreover notice that, in this case, the unions' market power is higher the more decentralized the economy is, as it emerges from equation (3.36)

[9] Notice that, as it will appear clear analyzing section 3.4, this effect works for each value of A.

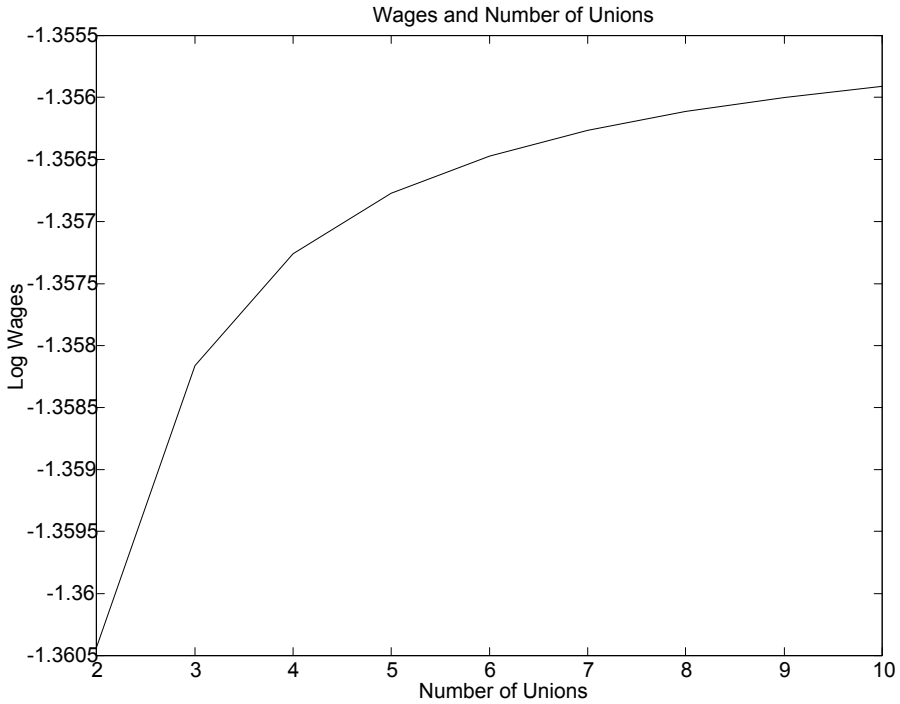

Figure 1

where we observe that $\frac{d\varepsilon_{N;W_j}}{dn} < 0$.

Increasing the value of σ, that is, making the substitution between labor types easier for Firms,

we obtain completely different results. In particular we can see how the wage demand is a decreasing function for an increasing number of unions. This emerges from Figure 2 where I set $\sigma = 8$ (see Guzzo and Velasco (1999)). The intuition is quite clear: given that Firms can easily substitute one labor type with another, in this case unions start to be less demanding and for higher levels of n, their market power decreases, showing that the competition effect dominates the strategic one. Notice that in this case, (36), $\frac{d\varepsilon_{N;W_j}}{dn} > 0$.

Our results are quite different from the ones reached in the literature. From what emerges in this section, we can not prove the existence of the so called *Calmfors-Driff.ill effect* (1988).

3.2 Increasing the Conservatism of the Central Bank.

Now we analyze how the Central Bank conservatism affects behavior of the unions.

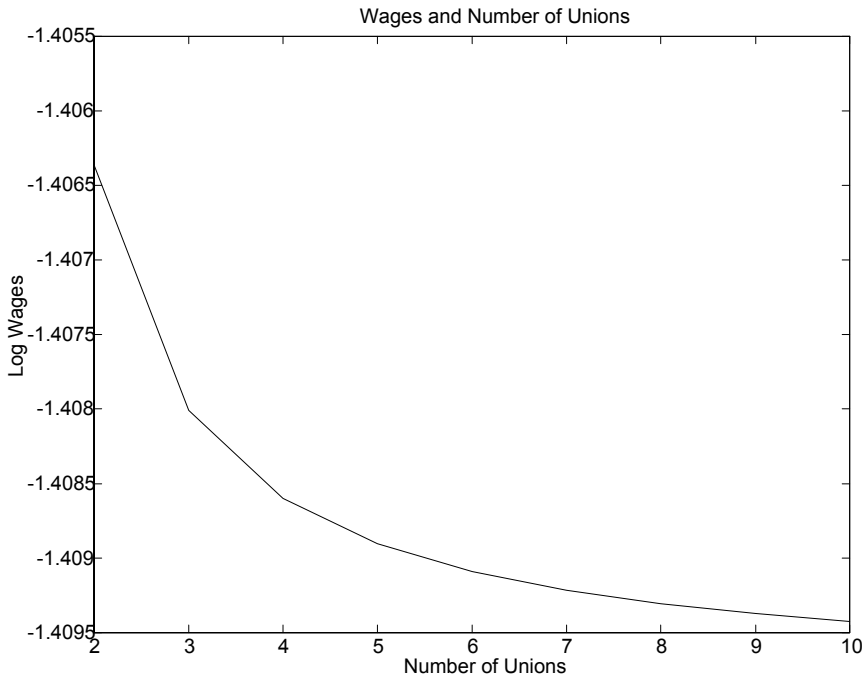

Figure 2

As in the previous case, we simulate how equation (34) changes with respect to different levels of A.

Proposition 2. *For a given number of unions, increasing values of Central Bank conservatism reduce the union wage demand.*

Fixing the number of unions to 5, we obtain:

We can see that the higher the Central Bank conservatism, the lower the union wage demand. The intuition is clear. Increasing values of A trigger two opposite effects:

i) From one side the strategic effect changes. It becomes stronger the higher A is (as we have seen from (31)).

ii) From the other side, the higher A, the higher the fear of unemployment effect (see equation (37)). Considering the elasticity of labor demand to nominal wages, we have seen how it is an increasing function of A. In this way the union market power decreases. Therefore the higher A is, the smaller the union wage demand is. Even if the gains in terms of real wage are higher for increasing values of A, unions evaluate also the negative effects of higher real wages and smaller real

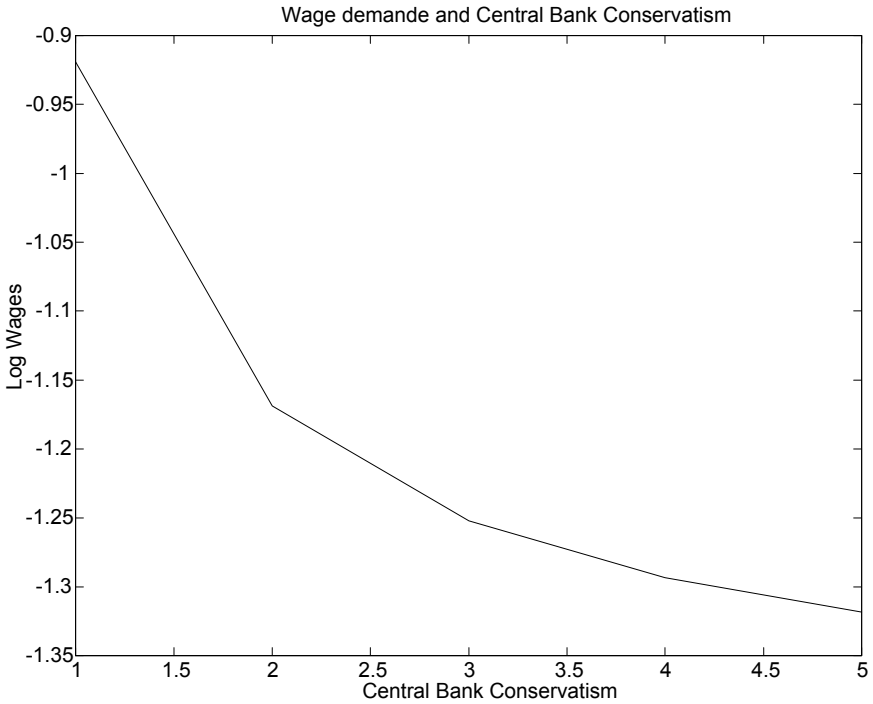

Figure 3

money balances on labor demand (see equation (33) and the analysis developed at that point). All the combinations of these effects lead to a reduction of the wage demand with respect to increasing values of A.

3.3 The Effects on Labor Demand.

We have seen how the wage demand changes when we increase the conservatism of the Central Bank. Using (18) and (9) we can see how the total demand depends on real money balances. In fact:

$$N^T = \int_0^1 Y_k^{\alpha} dk$$

$$Y_k = \left(\frac{P_k}{P}\right)^{-\theta} \left(\frac{\gamma}{1-\gamma}\right) \left(\frac{M}{P}\right)$$

and, as we have already shown, the labor demand can be expressed as (see also appendix D):

$$\log N^T = \alpha \log H - \frac{\theta\alpha}{1+\theta(\alpha-1)} \log\left(\frac{W}{P}\right) + \frac{\alpha}{1+\theta(\alpha-1)} \log\left(\frac{M}{P}\right) \quad (38)$$

The effects of Central Bank conservatism on labor demand can be summarized by the next proposition:

Proposition 3. *The higher the Central Bank conservatism (the parameter A), the higher the labor demand in the economy.*

To understand how the Central Bank conservatism affects the labor demand, we have to consider how the elasticity of labor demand to nominal wages varies with respect to increasing values of A. In particular we have shown (see equation (37)) that:

$$\frac{d\varepsilon_{N;W_j}}{dA} > 0$$

Hence the more conservative the Central Bank is, the smaller the unions' market power is. Considering (33) we can see that for higher nominal wage demands:

i) real money balances decrease;

ii) aggregate real wages increase.

If A is high, then prices will be more stable; therefore the incentive to demand higher values of nominal wages will be stronger. In this way the negative effects of real wages on labor demand will be even worse. When unions make their decisions, they consider these aspects. Therefore for increasing values of A, they decide to reduce the wage demand, causing an increase in labor demand[10].

Let's see now how the labor demand changes once we modify the number of unions:

Proposition 4. *For a given level of Central Bank conservatism and for σ quite small, an increasing number of unions reduces the labor demand in the economy. If the elasticity of substitution between labor types is high, then the labor demand*

[10] Figure 8 is obtained for $\sigma = 2$. Making the elasticity of substitution between labor types higher, then the positive effect on labor demand is going to be smaller and smaller. Intuitively, if unions do not have a lot of market power, their wage demand is low. Therefore the gains, deriving by a reduction of real wages are smaller and the effects on labor demand are very poor and small.

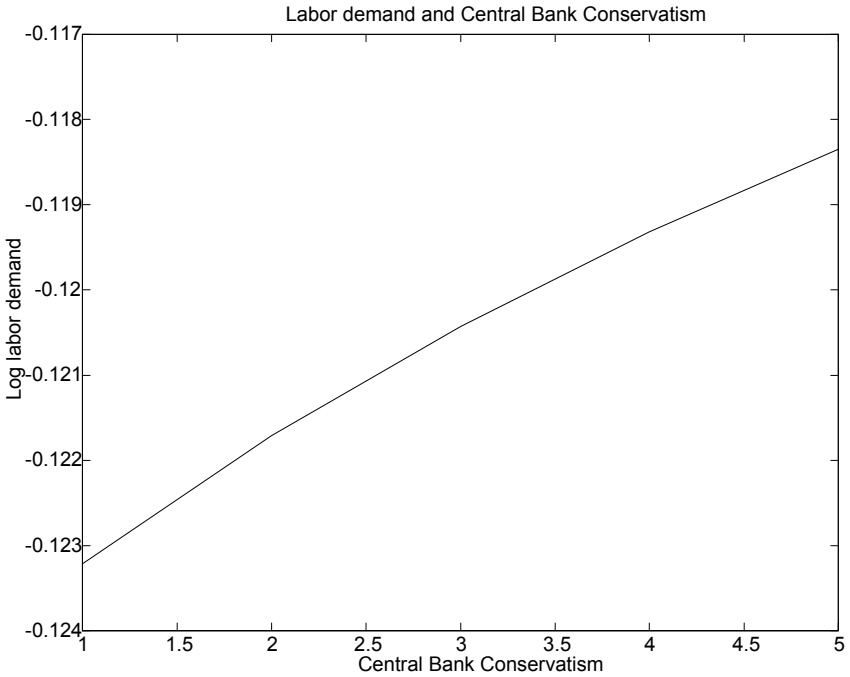

Figure 4

increases with respect to higher values of n.

In fact the wage demand, for σ quite low, is an increasing function of n. In this case the strategic effect and the competition effect work in the same direction towards an increase in the union wage demand. As it emerges from subsection 2.5.1, in this case the higher the number of unions, the higher their market power, making the unions themselves more aggressive. This behavior leads to a reduction of labor demand and consequently to an increase of unemployment, as it emerges from Figure 5. This is the trade-off faced by unions: higher wages at the price of higher unemployment.

In this case the perception of increases of prices (the strategic effect, see equation (31)) is lower, the higher n is. Therefore unions have a higher perception of how much their real wages can increase and a lower perception of how much real money balances can decrease as a consequence of higher wage demands. Remember that $\frac{d\log M}{d\log W_j} = \frac{\alpha^2 - A(\alpha-1)}{\alpha^2 + A(\alpha-1)^2} \cdot \frac{d\log W}{d\log W_j}$ (with $\frac{d\log W}{d\log W_j} = \frac{1}{n}$) is negative for a conservative Central Bank (see equation (22)), but, as we can see, this effect is smaller the higher the number of unions is. These are incentives to ask for higher nominal wages which lead to higher levels of unemployment.

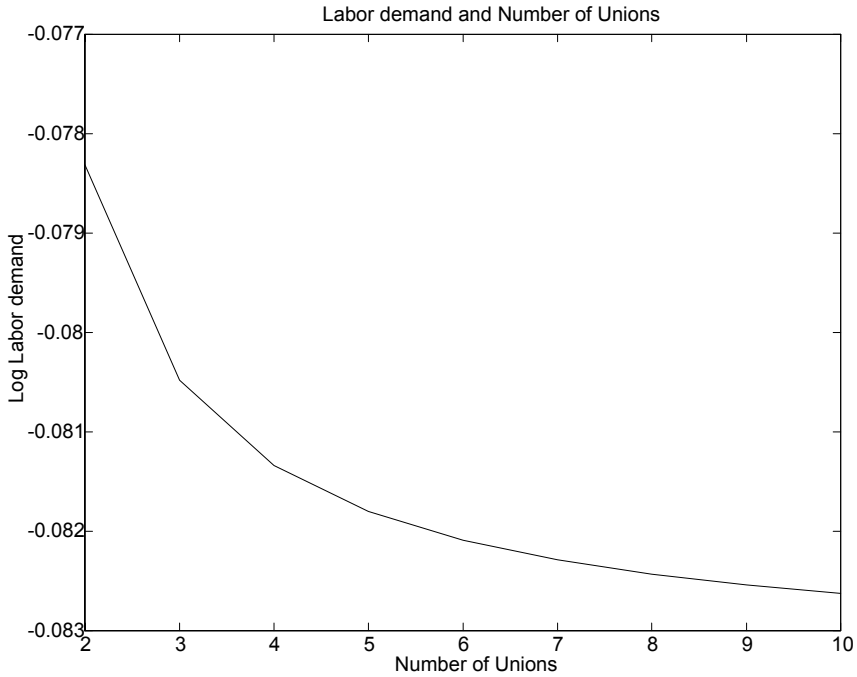

Figure 5

Notice that with high values of σ, if a union j increases its wage demand, then $\frac{d\varepsilon_{N;Wj}}{dn} > 0$, increasing the unemployment among the members of unions. In this setup, increasing values of n lead to a decrease of the market power of unions, inducing the unions themselves to moderate their wage demand. The competition effect dominates the strategic one. In this case, as we can see from Figure 6, the labor demand is an increasing function of the number of unions.

3.4 Real Effects: Ultra Liberal Versus Ultra Conservative Central Bank

From the last subsections we have obtained two important results:

i) the Rogoff parameter (in our case A) always reduces the level of prices.

ii) the monetary institutions have real effects.

With our model we show what suggested by Rogoff (1985) as solution of the classical inFlation-bias problem. Moreover we have seen how the higher A, the higher the labor demand in the economy. The mechanism underlying this result is the following: when an union j decides to increase its wage demand, three effects occur.

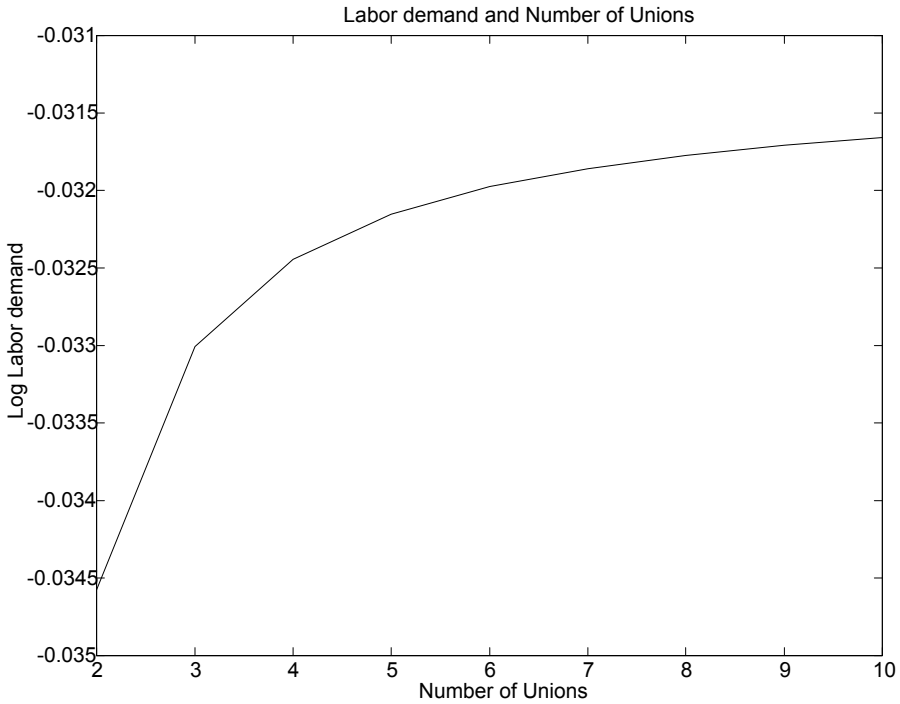

Figure 6

i) First, aggregate real wages $\left(\frac{W}{P}\right) \nearrow$ increase (see equation (33)).

ii) Second, the real wages of the other unions decrease, making all the other unions more competitive $\left(\frac{W_{-j}}{P}\right) \searrow$. In fact we have shown (see equation (31)) how the price level increases with respect to higher nominal wages and, solving the game for a given nominal wage of the other unions, then $\left(\frac{W_{-j}}{P}\right)$ decreases.

iii) Third, real money balances decrease for higher values of W_j, that is, $\left(\frac{M}{P}\right) \searrow$ (see again (33)).

When an union makes its decision, it evaluates the gains in real terms (highlighted by the strategic effect) against the losses in unemployment (highlighted by the fear of unemployment effect). In fact in equation (34) both the price elasticity and the labor demand elasticity to nominal wage appear.

What happens if we consider a stronger Central Bank? As suggested by Berger *et al*. (2001), to correctly evaluate the real effects and the advantages of an ultra liberal or ultra conservative Central Bank, we have to consider carefully how increases in wage demand affect the labor demand towards a particular union. When a union j increases its wage demand, then, as it emerges from (33), real wages in-

crease. This effect is higher the more conservative the Central Bank is (given that for higher values of A, prices will be more stable, see equation (31)). Moreover the losses in competition will be reduced given that $\left(\frac{W_{-j}}{P}\right)$ will decrease in a smaller way. This aspect suggests to the union j to increase its wage demand. Anyway the labor demand (equation (38)) is a decreasing function of real wages and an increasing function of real money balances. In particular notice that the higher A, the smaller $\left(\frac{M}{P}\right)$. In fact we can prove that $\frac{d\log\left(\frac{M}{P}\right)}{(d\log W_j)dA} < 0$[11]. Therefore the higher A, the smaller the labor demand and the higher the unemployment rate. We have shown how the unions' market power is always a decreasing function of A (see equation (37)); hence we can conclude that for higher values of A, unions give more weight to the losses in terms of labor demand (the *fear of unemployment*) than to the gains in real terms (the *strategic effect*).

We have found that the monetary institutions have real effects and moreover that an ultra conservative Central Bank is able to obtain the best economic performance as low inflation and high labor demand, confirming what found empirically by Soskice and Iversen (2000) and theoretically by Coricelli *et al*. (2000a). Notice that the introduction of money in this model has not been only a complication; on one side we have developed a model closer to reality; on the other side, we have had the possibility to understand and clarify the channel through which monetary institutions affect real economy[12] Thanks to the inclusion of money, we have seen how the losses in unemployment are so high for unions, that they decide to reduce the wage demand, something that does not emerge in Lippi (2000), or in Cukierman and Lippi (1999) where a conservative Central Bank reduces inflation to the price of higher unemployment. In this case our results diverge completely also from the work of Guzzo and Velasco (1999) where they found that an ultra liberal

[11] Considering equation (33) and the relative discussion, we can prove that $\frac{d\log\left(\frac{M}{P}\right)}{d\log W_j} = \left[\frac{-A(\alpha-1)}{\alpha^2+A(\alpha-1)^2}\right]$ that is negative given that $\alpha \geq 1$, and taking the cross derivative with respect to A we obtain: $\frac{d\log\left(\frac{M}{P}\right)}{d\log W_j dA} < 0$. Therefore the higher A is, the higher the reductions of real money balances are, as a consequence of an increase in the wage demand.

[12] Recently Lippi (2000) developing a model without money, found a non monotonic relation on how the elasticity of labor demand changes for different levels of Central Bank's conservatism. Unions evaluate the negative effects of higher real wages against the smaller losses in competition (the relative wages for the union j are smaller, the higher A is). In our case, using money, we have shown how the elasticity of labor demand is always a decreasing function of A (see equation (3.37)).

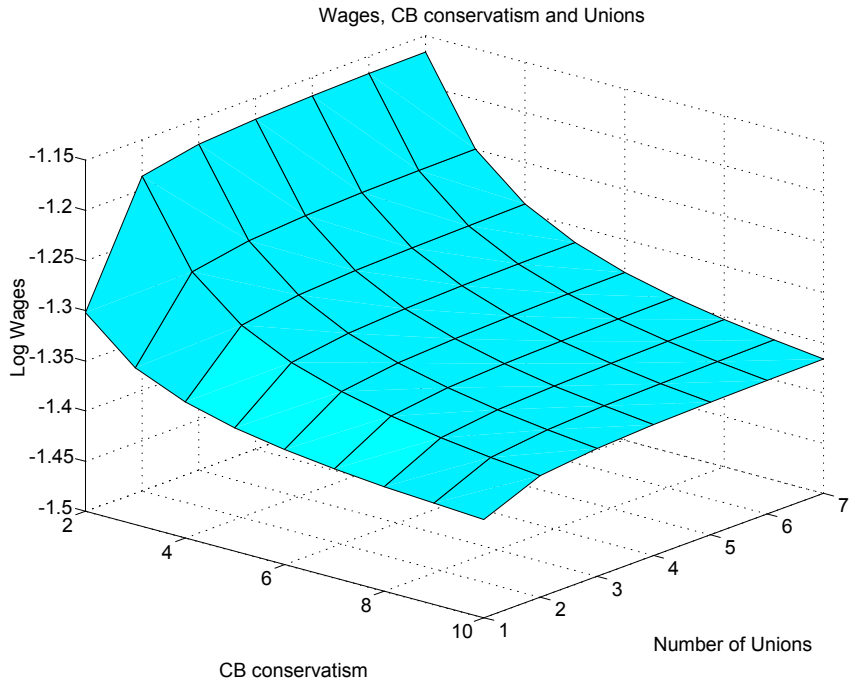

Figure 7

Central Bank is able to maximize the welfare of a society[13].

3.5 Joint Variations of the CB Conservatism and the Number of Unions.

We are now interested in analyzing contemporaneous changes of the Central Bank conservatism and of the number of unions:

Proposition 5. *If σ is small, then the best economic performance is obtained by a conservative Central Bank and by a high degree of centralization of wage bargaining. If σ is high, then the best result is obtained by a low level of Centralization of wage bargaining, associated with a conservative Central Bank.*

Figure 7 gives us the results for the First part of this proposition:

[13] Notice that the wage bargaining among n different unions is essential in our model to get real effects. In fact if we set $n = 1$ or $n \longrightarrow \infty$ we lose some important elements of the bargaining. In particular if there is just one union, then obviously the union can not affect the real wage of the other unions, and the same happens with an atomistic setup (see Lippi (2000)). So the decisions of unions are alterated, as well as their evaluations of how the preferences of the Central Bank can affect their decisions.

Computing a simulation of this result, it emerges exactly that for $n = 1$ or $n \to \infty$ the labor demand does not change with respect to the Central Bank conservatism.

Notice that, again contrarily to Guzzo and Velasco (1999), a stronger Central Bank is a good incentive to reduce the unions' wage demand. In fact for each level of centralization of wage bargaining, higher values of A lead to decreasing values of W and, through equation (16), to a reduction of inflation. On the other case, taking as given the Central Bank conservatism, and increasing the number of unions, we can see how increasing values of n lead to more aggressive unions' policies. The worst solution is obtained when the Central Bank's conservatism is very low and the economy is highly decentralized. In this way we confirm what Tarantelli (1986) said, that is, if a country is highly decentralized, then this country will face higher levels of inflation, because no union wants to pay for price stability by reducing its wage demand. Intuitively the higher is n the lower is the perception of how much inflation and aggregate nominal wages can increase as consequence of higher unions' wage demands (see equation (31)). In this way unions obtain higher real wages and can decrease the negative effect of higher unemployment rates due to lower levels of real money balances[14]. Only a strong conservative Central Bank in this case can be the instrument to reduce their inflationary behavior.

Notice that we have computed this experiment for σ quite small. In this case unions have a strong market power. Increasing $\sigma,$ or the elasticity of substitution between labor types, we confirm what found in the previous section; doing a simulation it is possible to show that for every level of A, increasing the number of unions, the wage demand and inflation decrease. Moreover it emerges that always the Centra Bank conservatism reduces the unions' wage demand.

[14] Remember that from equation (38), we know that $\frac{M}{P}$ affects directly the labor demand. Moreover notice that $\frac{d\log M}{d\log W} = \frac{\alpha^2 - A(\alpha-1)}{\alpha^2 + A(\alpha-1)^2} \cdot \frac{d\log W}{d\log W_j}$ and that $\frac{d\log W}{d\log W_j} = \frac{1}{n}$. Therefore the smaller the unions' contribution to aggregate variables, the smaller the reduction of money supply.

4. CONCLUSIONS

As shown by the OECD (1997), economic performance among countries has varied a lot during the last two decades. With our model we have tried to explain this fact focusing in particular on how wage bargaining and Central Bank conservatism affect economic performance. Our model starts from the seminal work of Barro and Gordon (1983) who have shown the incentives of a Central Bank to inflate when output is below its natural level (the classical *inflation-bias* problem). We have introduced, as market imperfections, the presence of monopolistic agents in the labor market (unions) and in the good market (firms) with the power to set wages and prices respectively. To reach this goal we have followed the idea of Blanchard and Kiyotaki (1987) who have introduced monopolistic competition in the labor market by using a Constant Elasticity of Substitution (CES) production function and monopolistic firms in the good market by using a CES index for consumption.

The presence of monopolistic agents in the labor market produce some negative externalities, as higher prices and higher unemployment rates. Calmfors and Driffill (1988) show that economies characterized by either few (centralized economies) or many (decentralized economies) unions, can reach low levels of unemployment. In fact few large unions, able to represent almost all the workers, internalize the negative externalities. On the other extreme case (decentralized economies) the bargaining takes place at firm level. In this case, it is logical to assume that the competition among firms of the same sector is quite high; therefore firms can not increase too much prices as labor costs increase. Therefore unions become less aggressive. They conclude that the worst condition is reached by an intermediate level of centralization of wage bargaining. In fact they found an inverted U relation between wage bargaining and economic performance. Implicitly they are assuming that the elasticity of labor demand goes to infinity when the number of unions increases. In our model this does not occur. We consider the elasticity of labor demand as a measure of the unions' market power (see among others Lippi (2002)); the higher this elasticity, the lower the unions' market power. Unions evaluate gains in real wages against losses in unemployment. Obviously they can be more aggressive when they can increase their wage demand without too many losses in unemployment, that is when the elasticity of labor demand is quite small. Hence, it seems quite strong to make assumption on this point. Using a CES production function, we derive from the model the labor demand towards every union and their market power. We show that the elasticity of labor demand is bounded. The key parameter is the elasticity of substitution between labor types,

σ. With small values of σ, unions know that firms can not easily substitute one labor type with another; moving to decentralized economies, each union knows that its contribution to aggregate wages and inflation is smaller. Hence they have a clear incentive to increase their wage demand given the higher gains in real wages. If σ is quite high, then firms can substitute quite easily one labor type with another. Hence, in this case, unions are less aggressive in a decentralized economy than in a centralized one. Using this mechanism we show that if σ is quite small, then decentralized economies face higher rates of unemployment and inflation. The opposite occurs with high values of the elasticity of substitution between labor types.

Rogoff (1985) proposed to delegate to an independent and more conservative authority the price control in order to reduce inflation. With our model we have confirmed this analysis. Moreover we have found that monetary institutions also have real effects. In fact we have proved that the more conservative the Central Bank is, the lower real money balances and labor demand will be. The mechanism can be explained in the following way: when we deal with a conservative Central Bank, prices are more stable. Unions know that they can obtain higher gains in real terms. We have called this effect *strategic* (see Cukierman and Lippi (1999) among others). The paper shows that an increase in nominal wages leads to higher raises in real wages. Moreover it emerges that, for increasing values of the Central Bank conservatism, the level of real money balances is smaller, making the level of the labor demand lower and that of unemployment higher. In this case we speak of *fear of unemployment effect*. We have proved how the fear of unemployment effect is always higher than the strategic effect, inducing unions to moderate their demand for increasing values of the Central Bank conservatism. Therefore we obtain that the Rogoff coefficient has real effects and moreover that the welfare of a society is maximized by an ultra conservative Central Bank. In this case our model reaches conclusions that are completely different from those of Guzzo and Velasco (1999) who claim that a populist Central Banker can reach the first best solution (zero inflation and the maximum amount of labor demand).

Finally, notice how the introduction of money has not been only a complication; in fact, from one side we have developed a model closer to reality and from the other we have clarified how the preferences of the Central Bank affect real economy. Recently Lippi (2000), developing a model closer to the one seen in this chapter but without money, finds a non monotonic relation between Central Bank conservatism and unemployment. Using money we have seen how the negative effects, produced by low levels of real money balances, are so high to induce unions to

moderate their wage demand. Therefore we can confirm what found empirically by Soskice and Iversen (2000) and theoretically by Coricelli Cukierman and Dalmazzo (2000a) that the best economic performance for a society is reached by an ultra conservative Central Bank.

5. APPENDIX

5.1 Appendix A: The Household Problem

Every agent maximizes his utility in order to choose the demand for every good, and to allocate a given wealth between consumption and holding money. We follow Blanchard and Kiyotaki (1987) considering the following utility function:

$$\max_{C_k, M_i} \left(C_i^T\right)^{\gamma} \left(\frac{M_i}{P}\right)^{1-\gamma} \tag{39}$$

with C_i^T, P defined by equations (4) and (5) in the text. The Lagrangian has the following expression:

$$\max_{C_k, M_i} L = \left[\int_0^1 \left[C_k(i)^{\frac{\theta-1}{\theta}}\right] dk\right]^{\frac{\theta\gamma}{\theta-1}} \left(\frac{M_i}{P}\right)^{1-\gamma} + \lambda \left[I_i - \int_0^1 \left[P_k C_k(i)\right] dk + M_i\right] \tag{40}$$

where the aggregate price level is given by equation (5). Taking the ratio of the two first order conditions (given that we have as many first order conditions as goods) we obtain;

$$P_k = C_k^{-\frac{1}{\theta}} \left(C_i^T\right)^{\frac{1-\theta}{\theta}} M_i \frac{\gamma}{1-\gamma} \tag{41}$$

and now plugging (41) into (5), we obtain:

$$PC_i^T = M_i \frac{\gamma}{1-\gamma} \tag{42}$$

Hence, combining the last two expressions, we obtain:

$$C_k = \left(\frac{P_k}{P}\right)^{-\theta} C_i^T \tag{43}$$

To obtain the total demand of a particular good we have to plug (42) into (43) and the resulting expressions into equation (8), using the aggregate condition for

money, that is

$$\int_0^1 M_i di = M \tag{44}$$

After some algebra we obtain the total demand of every good in the economy as function of money, as in (9).

5.2 Appendix B: The Firms' Problem

The monopolistic firms try to minimize their total costs. The problem they solve is the following

$$\min_{N_i} \int_0^1 W_i N_i di \tag{45}$$

subject to the technology (equation (10)):

The Lagrangian is

$$\min_{N_i} L = \int_0^1 W_i N_i di + \varphi \left[\left[\int_0^1 \left[N_i^{\frac{\sigma-1}{\sigma}} \right] di \right]^{\frac{\sigma}{\sigma-1}} - Y_k^{\alpha} \right] \tag{46}$$

The first order conditions are a system of equations, one for every different i, plus the derivative with respect to the Lagrange multiplier φ. Taking the ratio between two different i we obtain:

$$N_i = \left(\frac{W_i}{W_j} \right)^{-\sigma} N_j \tag{47}$$

Now plugging (47) into the constraint $\left[\int_0^1 \left[N_i^{\frac{\sigma-1}{\sigma}} \right] di \right]^{\frac{\sigma}{\sigma-1}} = Y_k^{\alpha}$, and using the aggregate relation for nominal wages:

$$W = \left[\int_0^1 [W_i]^{1-\sigma} di \right]^{\frac{1}{1-\sigma}} \tag{48}$$

we obtain:

$$N_i = \left(\frac{W_i}{W}\right)^{-\sigma} Y_k^{\alpha} \tag{49}$$

As we can see, the demand for every input is positively related to the total demand of a particular good, but it is negatively related to its wage. Moreover notice that using (45), (49), and again (48), we can compute the total cost for every firm:

$$\int_0^1 W_i N_i di = \int_0^1 W_i \left(\frac{W_i}{W}\right)^{-\sigma} Y_k^{\alpha} di = W Y_k^{\alpha} \tag{50}$$

5.3 Appendix C: Total Labor Demand

In this subsection we compute the total labor demand. Starting from (see Blanchard and Kiyotaki (1987))

$$N^T W \equiv \int_0^1 \left[\int_0^1 N_i W_i di\right] dk \tag{51}$$

and using the cost function for every firm, equation (50) we can rewrite (51) as

$$N^T W = \int_0^1 W Y_k^{\alpha} dk \tag{52}$$

so rearranging we obtain:

$$N^T = \int_0^1 Y_k^{\alpha} dk \tag{53}$$

Now using (53) and (9) we obtain:

$$N^T = H^{\alpha} \left(\frac{W}{P}\right)^{\frac{-\theta}{1+\theta(\alpha-1)}} \left(\frac{M}{P}\right)^{\frac{1}{1+\theta(\alpha-1)}} \tag{54}$$

where H collects only some terms and it is equal to:

$$H = \left(\frac{\gamma}{1-\gamma}\right)^{1+\frac{(1-\alpha)}{1+\theta(\alpha-1)}} \left(\frac{\theta}{\theta-1}\cdot\alpha\right)^{\frac{-\theta}{1+\theta(\alpha-1)}} \tag{55}$$

5.4 Appendix D: The Central Bank Problem

Solving the Central Bank problem (see equation (17) in the main text) we obtain after same tedious calculus:

$$\log M = -F\frac{\alpha^2}{\alpha^2 + A\left(\alpha-1\right)^2} + \frac{\alpha^2 - A\left(\alpha-1\right)}{\alpha^2 + A\left(\alpha-1\right)^2}\log W \tag{56}$$

where

$$\begin{aligned} F &= -\log N_c^0 + \alpha\log H + \phi\cdot Q \\ \phi &= \frac{\left(\theta-1\right)\alpha}{1+\theta\left(\alpha-1\right)} + A\frac{\left(\alpha-1\right)}{\alpha} \end{aligned} \tag{57}$$

5.5 Appendix E: The Problem of the Unions

The first order conditions of (27), in the main text, lead to the following expression:

$$-\left(\frac{d\log W_j}{dW_j} - \frac{d\log P}{dW_j}\right) + B\left[u_j\right]\frac{du_j}{dW_j} = 0 \tag{58}$$

that can be rewritten as:

$$-\frac{1}{W_j} + \frac{d\log P}{dW_j} - B\left[u_j\right]\frac{d\log N_j^{TU}}{dW_j} = 0 \tag{59}$$

Multiplying everything by W_j and rearranging we obtain:

$$-1 + \frac{dP}{dW_j}\frac{W_j}{P} - B\left[u_j\right]\frac{dN_j^{TU}}{dW_j}\frac{W_j}{N_j^{TU}} = 0 \tag{60}$$

Notice that

$$\begin{aligned} \frac{dP}{dW_j}\frac{W_j}{P} &= \frac{d\log P}{d\log W_j} = \varepsilon_{P;W_j} \\ -\frac{dN_j^{TU}}{dW_j}\frac{W_j}{N_j^{TU}} &= -\frac{d\log N_j^{TU}}{d\log W_j} = \varepsilon_{N_j;W_j} \end{aligned} \tag{61}$$

that are the expression in the main text.

To understand the contribution of every union to aggregate wages, consider the aggregate index for wages:

$$W = \left[\int_0^1 [W_i]^{1-\sigma}\, di\right]^{\frac{1}{1-\sigma}} \tag{62}$$

Now considering the derivative $\frac{dW}{dW_j}$ for a given nominal wage of the other unions:

$$\begin{aligned} \left(\frac{dW}{dW_j}\right)|_{W_{-j}} = \frac{1}{1-\sigma}\left[\int_{i\in j} W_j^{1-\sigma} di\right]^{\frac{1}{1-\sigma}-1} \cdot \\ \cdot\left\{\left[\int_{i\in j}(1-\sigma)\, W_j^{-\sigma}\left(\frac{dW_i}{dW_i}\right) di\right] + \left[\int_{i\notin j}(1-\sigma)\, W_{-j}^{-\sigma}\left(\frac{dW_{-i}}{dW_i}\right) di\right]\right\} \end{aligned} \tag{63}$$

Given that (63) is computed for a given nominal wage of the other unions, this expression can be rewritten as (using again (62)):

$$\frac{dW}{dW_j} = \left(\frac{W}{W_j}\right)^{-\sigma} \cdot \frac{1}{n} \tag{64}$$

and evaluating (64) at the symmetric equilibrium we obtain

$$\frac{dW}{dW_j} = \frac{1}{n} \tag{65}$$

as in the main text.

5.5.1 *Appendix F: Solution of the Unions' Problem*

Solving the union's problem (equation (27) in the main text) with respect to W_j we obtain, after some tedious algebra, equation (34) in the main text, where

$$\overline{FF} = \log N_j^{0U} - \alpha \log H + \frac{(1-\theta)\,\alpha}{1+\theta\,(\alpha-1)} Q + F \frac{\alpha^2}{\alpha^2 + A\,(\alpha-1)} + \log n \quad (66)$$

where H has been defined in appendix C, Q in the main text and F in appendix D.

REFERENCES

Barro R. J. and R. Gordon (1983), "A Positive Theory of Monetary Policy in a Natural Rate Model" in *Journal of Political Economy* 91, pp.589-610.

Berger H., Haan J. and S. Eijffinger (2001), "CentraI Bank Independence: An Update of Theory and Evidence" in *Journal of Economic Surveys* vol. 15, N. l.

Blanchard O. and N. Kiyotaki (1987), "Monopolistic Competition and Effects of Aggregate Demand" in *American Economic Review* vol. 77, pp. 647-666.

Blaney M. (1996), "CentraI Bank Independence, Wage-Bargaining Structure, and Macroeconomics Performance in OECD Countries" in *Oxford Economics Papers,* 48, pp. 20-38.

Boeri T., Brugiavini A. and L. Calmfors (Eds.) (2001), " *The Role of unions in the Twenty-First Century* " (Edit by) , Oxford University press. New York.

Calmfors L. and J. Driffill (1988), "Bargaining Structure, Corporatism and Macroeconomics Performance " in *Economic Policy* 6, pp. 14-61.

Clarida R., Gali J. and M. Gertler (1999), "The Science of Monetary Policy: A New Keynesian Perspective" in *Journal of Economics Literature* Vol.XXXVII December, pp. 1661-1707.

Coricelli F., Cukierman A. and A. Dalmazzo (2000a), "Monetary Institutions, Monopolistic Competition, Unionized Labor Market and Economic Performance" CEPR Discussion Paper N. 2407 March.

Coricelli F. Cukierman A. and A. Dalmazzo (2000b), "Economic Performance and Stabilization Policy in a Monetary Union with Imperfect Labor and Good" CES-t6ifo Discussion Paper, December.

Cubitt R. (1995), "Corporatism, Monetary Policy and Macroeconomics Performance: A Simple Game Theoretic Analysis " in *Scandinavian Journal of Economics* 97 (2), pp. 245-259.

Cukierman A., Webb S. and B. Neyapi (1992), "Measuring the Independence of CentraI Banks and its Effect on Policy Outcomes" in *The World Bank Economic Review* 6 N. 3, pp. 353-398.

Cukierman A. and F. Lippi (1999), "Central Bank Independence, Centralization of Wage Bargaining, Inflation and Unemployment -Theory and Some Evidence" in *European Economic Review* 43, pp. 1395-1434.

Cukierman A. and F. Lippi (2001), "Labor Market and Monetary Union: A Strategic Analysis" in *Economic Journal* 111, pp. 1-26.

Cukierman A., Rodriguez P. and S. Webb (1998), "Central Bank Autonomy and Exchange Rate Regime-Their Effects on Monetary Accomodation and Activism" in *Positive Political Economy-Theory and Evidence,* Cambridge University Press, Cambridge UK and NY.

Guzzo V. and A. Velasco (1999), "The Case for a Populistic Central Bank" in *European Economic Review* 43, pp. 1317-1344.

Galí J. (2002), "New Perspectives on Monetary Policy, Inflation and the Business Cycle" NBER Working paper N.8767, April.

Heiner R. A. (1983), "The Origin Of Predictable Behavior" *in American Economic Review* 4 vol. 73, pp. 560-595.

Holden S. (2000), "Monetary Regime and Co-ordination of Wage Setting" *mimeo*, University of Oslo.

Jerger J. (2002), "How Strong is the Case for a Populist Central Banker? A Note" in *European Economic Review* vol. 46, pp. 623-632.

Lippi F. (2002), "Revisiting the Case for a Populist Central Banker" in *European Economic Review* vol. 46, pp. 601-612.

Lippi F. (2000), "Strategic Monetary Policy with Non-Atomistic Wage-Setters", Manuscript Banca d'Italia Number 374, June. Forthcoming in *Review of Economic Studies.*

Obstfeld M. and K. Rogoff (1996), *Foundations of International Macroeconomic* Mit Press, Cambridge.

Obstfeld M. and K. Rogoff (2000), "New directions for stochastic Open Economy Models" in *Journal of International Economics* 50, pp. 117-153.

OECD (1997), "Economic Performance and the Structure of Collective Bargaining" in *Employment Outlook* July, Paris, pp. 63-92.

Redondo F. V (1999), *"Economics and Theory of Games* " *mimeo* Universitat Pompeu Fabra and Universidad de Alicante. Fortcoming, Cambridge University Press.

RogoffK (1985), "The Optimal Degree of Commitment to a Monetary Target" in *Quarterly Journal of Economics* 100, pp. 1169-1190.

Soskice D. and T. Iversen (2000), "The Non Neutrality of Monetary Policy with Large Price or Wage Setters" in *Quarterly Journal of Economics* 115, pp. 265-284.

Tarantelli E. (1986), " *Economia Politica del Lavoro"* Utet, Torino.

Walsh C. (1998), "*Monetary Theory and Policy"* MIT Press, Cambridge.

Woodford M. (1999), "Inflation Stabilization and Welfare" in *Interest and Prices*: *Foundations of a Theory of Monetary Policy,* chapter 6 *mimeo*, University of Princeton.