

Monetary Institutions, Monopolistic Competition, Unionized Labor Markets and Economic Performance

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Abstract

Recent literature on the strategic interaction between unionized labor markets and monetary policymaking institutions contains two opposing views about the real effects of central bank conservativeness (CBC). This paper develops a unified framework designed to evaluate the relative merit of those two views. The model features both supply and demand channels of transmission of monetary policy to the economy. A sample of conclusions follows: 1. The extent of real and nominal wage stickiness depends on CBC. 2. The sign of the effect of CBC on economic performance depends on the relative inflation-unemployment aversion of unions. 3. For plausible values of this relative aversion, macroeconomic performance is better under a conservative central bank. 4. A sufficiently conservative central bank responds to wage increases by contracting the money supply, which is consistent with the pre EMU behavior of the Bundesbank. 5. CBC exerts a stronger moderating impact on unemployment and wages the higher the degree of local monopoly power on product markets.

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1 Introduction

Does the structure of monetary institutions matter for real economic activity? Conventional wisdom maintains that, in the absence of shocks monetary institutions affect inflation but not the real economy. Recent literature challenges the conventional wisdom by showing that when the labor market is dominated by a small or moderate number of unions, the nature of monetary policymaking institutions affects real variables.¹ A central issue addressed by this burgeoning literature is whether a more conservative central bank encourages or discourages economic activity by deterring or by encouraging unions' real wage demands.

The recent literature contains two diametrically opposed views on this issue. One, based on the presumption that unions are averse to inflation, concludes that by alleviating the inflationary fears of unions more conservative central banks induce higher real wage demands and higher levels of unemployment. In the extreme case of a monopoly union this view implies that, (abstracting from stabilization policy) a populist or ultra liberal central bank (CB) that cares only about unemployment is best for a society that dislikes both inflation and unemployment (Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999, 2002), Lawler (2000) and Lippi (2002)). The other view is that less accommodating central banks moderate unions' wage demands more by raising the fear of unemployment among their members. This view implies that both inflation and unemployment are lower under less accommodative central banks (Soskice and Iversen (1998, 2000)). To date, evaluation of the relative merits of each of those views has not been possible because the models supporting each view differ in structure and do not nest **both** mechanisms. Thus, Soskice and Iversen abstract from unions' inflation aversion and postulate that the monetary authority affects the price level by controlling the money supply. They characterize the nature of the monetary authority by its tendency to accommodate wages. On the other hand, while recognizing the inflation aversion of unions, the papers by Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999) and Lawler (2000) assume that the CB controls inflation directly, thereby abstracting from the effects of monetary policy on the economy via demand.

¹A non exhaustive list includes Skott (1997), Jensen (1997), Gruner and Hefeker (1999), Cukierman and Lippi (1999, 2001), Guzzo and Velasco (1999), Soskice and Iversen (2000), Lawler (2000) and Holden (2001). A broad survey of the issues appears in Calmfors (2001).

This paper proposes a framework that nests the mechanisms leading to these different points of view within a **unified** framework making it possible to identify the conditions under which either one dominates. The main features of this framework follow. First, prices and wages are set, respectively, by monopolistically competitive firms and by labor unions with market power. Prices are fully flexible and wages are contractually fixed.² Second, the central bank (CB) affects the price level and inflation **indirectly** via its choice of money supply.³ This framework features two transmission mechanisms from monetary policy to employment. One is the traditional supply side channel in which expansionary monetary policy, by creating inflation, reduces real wages and stimulates employment. The other is an aggregate demand channel that works by stimulating the demand for goods and therefore the derived demand for labor.⁴ An important advantage of this formulation is that it makes it possible to identify the economic effects of the threefold interaction between CB conservativeness, centralization of wage-bargaining and product market imperfections. In particular, the impact of central bank's conservativeness on macroeconomic performance depends on the degree of imperfection in both labor and goods markets.

Besides being obviously more realistic, the assumption that the central bank controls the money supply rather than inflation permits a clear distinction between instruments and objectives of monetary policy and bridges, to some extent, the literature on strategic monetary policy with the literature on optimal monetary rules in non-strategic environments (see, for example, Taylor (1999), Clarida, Gali, Gertler (1999)). As a byproduct, the analysis provides an endogenous link between CB conservativeness and its accommodative tendencies making it possible to confront the two views presented above directly.⁵

This paper shares with some of the recent literature mentioned in footnote 1 the feature that the relative bargaining power of unions and of firms depends on the nature of monetary

²As in Blanchard and Kiyotaki (1987) each individual firm has some market power in the goods' market but no market power in the labor market. But labor supply and consumer demand for the differentiated products of firms are taken as primitives rather than derived from a Dixit-Stiglitz (1977) utility.

³A first step in this direction was made by Cubitt (1992). In his model, inflation is determined by a reduced form aggregate demand-supply model where the CB affects the price level through its choice of money supply and the (single) union chooses the nominal wage.

⁴Most of the literature which postulates that the CB directly controls inflation abstracts from this second channel which is a central aspect of New Keynesian thinking.

⁵Soskice and Iversen take the degree of accommodation as the primitive while the other papers take the level of (Rogoff (1985) type) CB conservativeness as the primitive.

institutions. A novel feature of our framework is that it clarifies how this relative bargaining power varies with the level of CB conservativeness when monetary policy affects the economy via **both** demand and supply channels. In particular, the paper uncovers the different channels through which the relative inflation-unemployment aversions of unions and of the CB affect real and nominal wages. A flash forward into the basic intuition underlying some of those effects follows. When an individual union raises the nominal wage of its members, it triggers an increase in the relative prices of the goods of the firms that use its labor. This action has two consequences. First, the derived demand for labor of the affected firms goes down, increasing unemployment among union's members. Second, inflation rises. The CB dislikes both higher unemployment and higher inflation. But it cannot fully offset both effects since it possesses only one instrument. Depending on its preferences, the CB decides whether to use monetary policy to counteract the impact of the wage increase on inflation, or on unemployment. If the CB is highly averse to inflation and the union relatively averse to unemployment, the union will be deterred from asking high wages since it anticipates that the policy reaction of the CB will raise unemployment by a lot. In this case, the more conservative the CB, the lower the bargaining power of unions. But if the union is relatively more averse to inflation the deterrent effect will be small since the union anticipates that the policy response of the, relatively conservative CB, will not raise inflation by much. In this case, the more conservative the CB, the **higher** the bargaining power of unions. Hence, a relatively **liberal** CB that inflates a lot in response to unemployment moderates the bargaining power of unions as in the 'populist CB' literature reviewed above.

In view of this literature an important result of the paper is that, when there is more than one union and unions care sufficiently more about unemployment among their members than about inflation, an **ultra conservative** CB that is concerned only about price stability reduces both inflation and unemployment to their minimal possible levels. This supports the view that the result on the social desirability of an ultra liberal or populist CB (Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999) (as corrected by Lippi (2002)) and Lawler (2000)) is a rather extreme special case.⁶

⁶But the result that an ultra liberal CB is socially optimal still obtains in the case of a **single monopoly** union. A broader discussion of this issue appears in section 2 of Calmfors (2001).

Besides making it possible to integrate and evaluate the relative merits of different existing approaches to the strategic interaction between unions and the CB the paper contains a number of additional novel results. In what follows we mention one of them that sheds light on the interaction between unions and the CB in Germany during the period over which the Bundesbank conducted monetary policy.⁷ Our analysis implies that a sufficiently conservative central bank finds it optimal to respond to a wage increase by **reducing** the money supply, and thus aggregate demand. Provided that wage bargaining is sufficiently centralized and unions sufficiently sensitive to unemployment this discourages excessive wage demands, leading to lower unemployment and inflation. As far as we know, this is the first time that this channel is modeled explicitly in a general equilibrium framework. Both casual and econometric evidence suggest that it has been operating in Germany where the Bundesbank often tightened monetary policy in response to "excessive" wage settlements.⁸ An important corollary is that the degrees of both nominal and real wage rigidity depend on the level of central bank conservativeness. This is an instance of the Lucas critique.

The paper is organized as follows. The model and the characterization of equilibrium are presented in section 2. The effects of central bank conservativeness, centralization of wage bargaining and the degree of product differentiation on inflation and unemployment are discussed in section 3. Section 4 presents new results concerning the socially optimal level of CB conservativeness. This is followed by concluding remarks that include a comparison to recent literature on unionized labor markets and monetary policy. Proofs are in the Appendix.

2 The model

The economy is composed of a continuum of monopolistically competitive firms and of n , equally sized, labor unions that organize the entire labor force. The firms are evenly distributed over the

⁷A more systematic review of the main results appears in the concluding section.

⁸Studies on industrial relations in Germany report that when it considered wage settlements to be excessively inflationary the Bundesbank often threatened to tighten monetary policy, thereby raising unions' fears from unemployment (Berghan and Detlev (1987), Hall (1994), Streek (1994) and Hall and Franzese Jr. (1998)). In addition estimates of the Bundesbank reaction to domestic wage inflation during the seventies and the eighties reveal that the Bundesbank has reduced the rate of high power money growth in response to increases in wage inflation (Cukierman, Rodriguez and Webb (1998), table 4.2, page 93).

unit interval and their mass is one. Thus, each union covers the labor force of a fraction $1/n$ of the firms. A quantity L_0 of workers, equal across firms, is attached to each firm but works only if the union in charge signs a labor contract with the firm. For convenience, and without loss of generality, the firms are indexed so that all firms whose labor force is represented by union i are located in the contiguous subinterval $(\frac{i}{n}, \frac{i+1}{n})$ of the unit interval, where $i = 0, 1, \dots, n - 1$. Each firm owns a production technology that exhibits decreasing returns to scale to labor input, and is given by

$$Y_{ij} = L_{ij}^\alpha, \quad \alpha < 1 \quad (1)$$

where Y_{ij} and L_{ij} are output supply and labor input of firm j . The index i means that the labor force of the firm belongs to union i . Each firm faces a demand for its output given by

$$Y_{ij}^d = \left(\frac{P_{ij}}{P} \right)^{-\eta} \frac{M}{P}, \quad \eta > 1 \quad (2)$$

where P_{ij} and P are respectively the price of the individual firm and the general price level, M is the aggregate nominal money supply, and η is the (absolute value of the) elasticity of demand facing the individual firm with respect to its relative price. Equation (2) states that the demand facing the individual firm is increasing in real money balances and decreasing in the relative price of its product.⁹ The general price level is defined as the integral, over the unit interval, of the (logarithms of) the prices of individual firms. It is convenient, for reasons that will become clearer later, to write it as

$$p = \frac{1}{n} \sum_{i=0}^{n-1} \left(\frac{\int_{\frac{i}{n}}^{\frac{i+1}{n}} p_{ij} dj}{\int_{\frac{i}{n}}^{\frac{i+1}{n}} dj} \right) = \sum_{i=0}^{n-1} \int_{\frac{i}{n}}^{\frac{i+1}{n}} p_{ij} dj = \int_0^1 p_{ij} dj. \quad (3)$$

⁹The demand function in equation (2) can be derived from a more basic formulation in which each individual chooses consumption so as to maximize his utility subject to his wealth constraint. Details appear in chapter 8 of Blanchard and Fischer (1989).

More broadly, as well as more realistically, the effect of real money balances on demand can be thought of as reflecting a whole variety of demand induced effects of real balances on demand. Those include the well known Keynes-Tobin effect of monetary expansion on demand via a lower interest rate, the Bernanke-Gertler credit channel as well as the narrow, Pigou-Patinkin, real balance effect. When real balances go up they generally stimulate demand through all those channels. We will therefore sometimes refer to the total impact of real balances on demand as a "generalized" real balance effect. A detailed discussion of these various channels appears in chapter 25 of Mishkin (2001). An overview appears in figure 1 of that chapter.

where p_{ij} is the logarithm of P_{ij} and p is the logarithm of P . It suffices to note at this stage that this way of expressing the general price level facilitates the identification of the firms that are affected by an increase in the nominal wage rate set by union i .

Monetary institutions are represented by a CB that dislikes both inflation and unemployment. The CB loss function is given by

$$\Gamma = u^2 + I\pi^2 \quad (4)$$

where u and $\pi \equiv p - p_{-1}$ are respectively the aggregate rate of unemployment and of price inflation. As in Rogoff (1985), the parameter I denotes the degree of CB conservativeness to which we shall occasionally refer as central bank independence (CBI).¹⁰ It measures the relative importance that the CB assigns to the objective of low inflation versus low unemployment. The policy instrument of the CB is the nominal money supply, M .

Each union likes a higher real wage, dislikes unemployment among its members, and possibly (but not necessarily) dislikes inflation. The individual union's loss function is given, as in Cukierman and Lippi (1999), by

$$\Omega_i = -2w_{ri} + Au_i^2 + B\pi^2 \quad (5)$$

where w_{ri} is the (logarithm) of the real wage of union's i members, u_i is the rate of unemployment among them, A is a positive parameter that measures the relative importance attributed to employment versus the real wage by the union's leadership, and B is a non negative parameter that characterizes the union's degree of inflation aversion. The first two arguments reflect the union's sectoral interest and are standard in the theory of trade unions' behavior.¹¹ The third reflects the union's aversion to inflation and appears rather often in the recent literature on the strategic interaction between unions and the CB.¹² Although the union cares about the real

¹⁰The rationale for this terminology is discussed in footnotes 8 and 12 of Cukierman and Lippi (1999).

¹¹See Oswald (1982) for example. The existence of a tradeoff between real wage and employment considerations in the union's objectives is consistent with political economy considerations of the type emphasized by Saint-Paul (2000) for example. In particular, since the majority of union members is employed the real wage-employment combination desired by the union management typically involves a positive levels of unemployment.

¹²Inflation averse unions have appeared *inter alia* in Cubitt (1992), Gylfason and Lindbeck (1994), Jensen (1997), Skott (1997), Cukierman and Lippi (1999, 2001), Guzzo and Velasco (1999) and Lawler (2000).

wage, it directly sets only the nominal wage.

To bring out the strategic interaction between unions and the monetary authority, as well as the effects of their behavior on the pricing strategies of firms, we postulate that monetary policy actions are more flexible than the decisions about the nominal wage made by the unions. To focus on the consequences of nominal wage stickiness we assume that product prices are flexible, in the sense that firms can immediately and costlessly adjust their prices to observed changes in monetary policy.¹³ These assumptions lead to the following, three-stage, sequence of events

In the first stage, each union chooses its nominal wage so as to minimize its loss function (5). In doing that, each union takes the **nominal wages** of other unions as given and anticipates the reactions of the monetary authority and of firms to its wage choice. The resulting nominal wages remain contractually fixed for the duration of the game.

In the second stage the monetary authority chooses the nominal stock of money so as to minimize its loss function (4). In doing that, the CB takes the preset nominal wages as given and anticipates the reaction of firms both to wages and to its choice of money supply.

In the third stage each firm takes the general price level as given and sets its own price so as to maximize its real profit. The resulting string of first order conditions, together with equation (3), simultaneously determine individual prices as well as the general price level.

General equilibrium is characterized by backward induction: we start by solving the firms' pricing problem, then the CB problem, and finally we solve for the unions' wage decisions.

2.1 Price setting by monopolistically competitive firms

Real profits of an individual firm are given by

¹³Wage stickiness is less controversial and undoubtedly better documented than price stickiness. The timing sequence we adopt abstracts from the incentive of the CB to expand output in order to overcome the welfare inefficiency caused by monopolistic competition stressed by Woodford (1999). This modeling strategy is adopted in order to highlight the incentive of the CB to expand employment above the level implied by unions' wage policy. Since there is no price stickiness the monopolistic competition distortion does not produce an inflation bias here. But the unions' distortion in conjunction with sticky wages does. We believe this is a more realistic story, at least for Europe.

$$\Pi_{ij} = \frac{P_{ij}}{P} Y_{ij}^d - \frac{W_i}{P} L_{ij} = \left(\frac{P_{ij}}{P} \right)^{1-\eta} \frac{M}{P} - \frac{W_i}{P} \left[\left(\frac{P_{ij}}{P} \right)^{-\eta} \frac{M}{P} \right]^{\frac{1}{\alpha}} \quad (6)$$

where the second equality is obtained by using (2), the demand facing the individual firm, and (1), the production function. In the third stage of the game, the firm takes P , M and the nominal wage, W_i , as given and chooses its own price, P_{ij} , so as to maximize real profits. Maximizing with respect to P_{ij} , taking logarithms and rearranging yields:

$$p_{ij} - p = \theta + \frac{1}{\alpha + \eta(1 - \alpha)} [\alpha(w_i - p) + (1 - \alpha)(m - p)] \quad (7)$$

where $\theta \equiv \left[\frac{\alpha}{\alpha + \eta(1 - \alpha)} \right] \log \left[\frac{\eta}{\alpha(\eta - 1)} \right]$ and lower case letters stand for the logarithms of the corresponding upper case letters. Equation (7) states that the optimal relative price of a typical monopolistically competitive firm is higher the higher the real wage it pays and the higher real money balances. The first element reflects the firm's reaction to labor costs and the second its reaction to the demand for its product. The firm's derived demand for labor can be obtained by equating the product demand (equation (2)) with the firm's supply (equation (1)). Taking logarithms and rearranging gives:

$$l_{ij}^d = \frac{1}{\alpha} [-\eta(p_{ij} - p) + (m - p)]. \quad (8)$$

Equation (8) states that the individual firm's derived demand for labor is an increasing function of real money balances and a decreasing function of its relative price. Using equation (7) in equation (8), we obtain an alternative form of the firm's demand for labor

$$l_{ij}^d = \kappa + \frac{1}{\alpha + \eta(1 - \alpha)} [-\eta(w_i - p) + (m - p)] \quad (9)$$

where $\kappa \equiv -\frac{\eta\theta}{\alpha}$. This form implies that when the union manages to raise the real wage, the firm's demand for labor goes down unless real money balances increase. This feature of the labor demand plays a crucial role in what follows.

2.2 Choice of money supply by the CB

The CB picks the money supply in the second stage so as to minimize its loss function (4), after observing nominal wages and anticipating the pricing and employment reaction of the firms to its own choice (as given by equations (7) through (9)). Averaging equation (7) over firms and rearranging, we obtain

$$(m - p) = \rho - \frac{\alpha}{(1 - \alpha)}(w - p) \quad (10)$$

where $\rho \equiv \frac{-\alpha}{(1-\alpha)} \log \left[\frac{\eta}{\alpha(\eta-1)} \right]$ and p and w are respectively the logarithms of the average price and the average nominal wage. Equation (10) states that, in the aggregate, there is an inverse **equilibrium** relation between the average real wage and real money balances. The equilibrium general price level can now be obtained by rearranging equation (10)

$$p = -(1 - \alpha)\rho + \alpha w + (1 - \alpha)m. \quad (11)$$

Thus, except for a constant that depends on the basic parameters of the economy, the equilibrium price level is a weighted average of nominal wages and of the nominal money supply. Correspondingly, the rate of inflation is given by

$$\pi = p - p_{-1} = -(1 - \alpha)\rho + \alpha w + (1 - \alpha)m - p_{-1}. \quad (12)$$

We now turn to a characterization of unemployment. Averaging equation (8) over firms yields the average employment per firm:

$$l^d = \frac{1}{\alpha}(m - p). \quad (13)$$

Since the total mass of firms is one, l^d also coincides with aggregate demand for labor. In contrast with "supply-side" models where the CB picks inflation directly, equation (13) reflects the "Keynesian" feature of our model, where monetary policy affects employment not only via supply but also through aggregate demand. Note that this Keynesian feature arises even though prices are completely flexible.

Let $l_0 \equiv \log [L_0]$ be the logarithm of labor supply per firm. The average rate of unemployment per firm, as well as the average economy-wide rate of unemployment, are given by

$$u = l_0 - \frac{1}{\alpha}(m - p). \quad (14)$$

Taking the average nominal wage w as given, the CB chooses the nominal stock of money m so as to minimize its loss function. Substituting the expressions for inflation and unemployment (equations (12) and (14)) into equation (4) and rearranging, the CB problem becomes

$$\min_{\{m\}} \left\{ \begin{array}{l} [l_0 - m + \frac{1}{\alpha}(-\rho(1-\alpha) + \alpha w)]^2 + \\ + I [(-\rho(1-\alpha) + \alpha w + (1-\alpha)m) - p_{-1}]^2 \end{array} \right\}. \quad (15)$$

This yields a reaction function for the CB in which the money supply is a linear function of the average nominal wage:

$$m = \mu + \frac{1 - \alpha(1 - \alpha)I}{1 + (1 - \alpha)^2 I} w. \quad (16)$$

where $\mu \equiv \frac{l_0 - \frac{\rho(1-\alpha)}{\alpha} + [\rho(1-\alpha) + p_{-1}](1-\alpha)I}{1 + (1-\alpha)^2 I}$. Depending on the degree of CB conservativeness (or independence) I , the CB either counteracts or accommodates an increase in nominal wages. If the CB is sufficiently conservative, in the sense that $1 - \alpha(1 - \alpha) I < 0$, a nominal wage increase will trigger a tightening of the money supply. If the CB is relatively liberal, as when $1 - \alpha(1 - \alpha) I > 0$ holds, it will partially accommodate wage increases. This is a central implication of our paper that is consistent with the behavior of the Bundesbank in the pre EMU period (details appear at the end of this subsection).

The intuition underlying this result is as follows. Firms respond to an increase in nominal wages by increasing their prices. This raises the rate of inflation and, for a given nominal money supply, reduces real money balances. The second effect reduces the derived demand for labor and pushes unemployment up. The upshot is that, in the absence of any reaction by the CB, an increase in the average level of nominal wages raises both inflation and unemployment. The response of the CB is designed to optimally spread the costs of those two "bads" between the two components of its loss function. If it cares relatively more about price stability, the CB partially

counteracts the effect of wage increases on inflation at the cost of even higher unemployment. If it cares relatively more about unemployment, the CB partially counteracts the adverse effect of higher wages on unemployment at the cost of even higher inflation.

Casual evidence about the industrial organization of labor negotiations in Germany as well as recent empirical evidence concerning monetary policy reaction functions supports the theoretical discussion above. Studies on industrial relations in Germany like Berghan and Detlev (1987) and Streek (1994) report that the Bundesbank often threatened to tighten monetary policy in response to excessive wage settlements. Hall (1994, p.12) and Hall and Franzese Jr. (1998) note that, due to the high level of independence of the Bundesbank, labor unions usually took this threat seriously but that, from time to time, the German CB actually tightened monetary policy in response to high wage settlements in order to maintain its credibility. This point of view is corroborated by empirical reaction functions from Cukierman, Rodriguez and Webb (1998) that provide estimates of the degree of monetary accommodation (characterized by the reaction of high powered money growth to wage inflation) in a group of developed economies between the mid-seventies and the beginning of the nineties. Cukierman *et. al.* find that in countries with low CBI the coefficient of accommodation tends to be significantly positive; in countries with intermediate levels of CBI it is insignificantly different from zero; and in high CBI countries like Germany and Austria it is significantly negative. Those findings support a reaction function of the type that appears in equation (16). In countries with a highly independent CB, the monetary authority leans against inflationary wage increases by contracting money growth in response to wage inflation.

2.3 Choice of wages by the unions

In the first stage of the game each union takes nominal wages set by other unions as given and chooses its own nominal wage so as to minimize its losses, given by equation (5). In doing so, each union takes into consideration the consequences of its wage policy for the prices that will be subsequently set by firms, as well as the response of the CB in equation (16).

Let w_i and w_{-i} be respectively the nominal wage of union i and the average nominal wage of all other unions. Taking w_{-i} as given, union i sets a common wage w_i for all its members,

which are all the workers attached to firms in the interval $[\frac{i}{n}, \frac{i+1}{n}]$. The relevant average rate of unemployment per firm is given by the difference between the number of workers attached to each firm and the average labor demand for a firm represented by union i :

$$u_i = l_0 - \left\{ \frac{\int_{i/n}^{(i+1)/n} l_{ij}^d dj}{\int_{i/n}^{(i+1)/n} dj} \right\} = l_0 - l_{ij}^d. \quad (17)$$

From equation (8), labor demand l_{ij}^d of firm j in the interval $[\frac{i}{n}, \frac{i+1}{n}]$ is a function of aggregate real money balances and of its relative price. Since all firms in the interval $[\frac{i}{n}, \frac{i+1}{n}]$ face a common nominal wage w_i , equation (7) implies that $p_{ij} = p_i$ for all $j \in [\frac{i}{n}, \frac{i+1}{n}]$. Consequently, union i anticipates that all the firms employing its members will react to a common wage level by setting the *same* relative price for their products. Thus, equation (17) can be rewritten as:

$$u_i = l_0 + \frac{1}{\alpha} [\eta (p_i - p) - (m - p)]. \quad (18)$$

Note that u_i is also equal to the unemployment *rate* among union i 's members. Minimizing the loss function in equation (5) with respect to the nominal wage w_i subject to equation (12) yields the following first order condition

$$- \left[1 - \frac{dp}{dw_i} \right] + A u_i \frac{du_i}{dw_i} + B \pi \frac{dp}{dw_i} = 0 \quad (19)$$

This condition holds for all unions ($i = 1, \dots, n$). This system of n first order conditions implies that the equilibrium is *symmetric in both prices and wages*, that is, $w_i = w$ and $p_{ij} = p_i = p$ (see appendix for a proof). To emphasize the impact of monopolistic unions on equilibrium outcomes, we express the (symmetric) solution to the unions' game in terms of the wage premium ϕ , defined as the difference between the common real wage of each union, w_r , and the competitive real wage, $w_r^c = -(1 - \alpha)l_0 + \frac{1-\alpha}{\alpha}\rho$.¹⁴ It is shown in the appendix that the equilibrium premium is given by

$$\phi \equiv w_r - w_r^c = \frac{(1 - \alpha)^2 I Z_w}{(1 - \alpha) A I Z_u + B(1 - Z_w)} \quad (20)$$

¹⁴The competitive real wage is derived in the appendix.

where

$$1 - \frac{dp}{dw_i} \equiv Z_w = 1 - \frac{1}{n [1 + (1 - \alpha)^2 I]} > 0 \quad (21)$$

and

$$-\frac{dl_{ij}^d}{dw_i} = \frac{du_i}{dw_i} \equiv Z_u = \frac{1}{\alpha} \left[\eta \frac{d(p_i - p)}{dw_i} - \frac{d(m - p)}{dw_i} \right] = \frac{1}{n} \left[\frac{\eta(n - 1)}{\alpha + \eta(1 - \alpha)} + \frac{(1 - \alpha)I}{1 + (1 - \alpha)^2 I} \right] > 0. \quad (22)$$

Notice that the wage premium is always non negative and that it increases with Z_w and decreases with Z_u and B . Z_w is the overall elasticity of the union's **real** wage with respect to the nominal wage. Z_u is the (absolute value of) the overall elasticity of employment (and of unemployment) among union members with respect to the union's nominal wage. The overall elasticities, Z_w and Z_u , internalize the subsequent reactions of monetary policy and of prices to union i 's wage decision.

The expression for Z_u embeds (n, η, I) , the central parameters of the model. Note first that Z_u is larger the higher the centralization of wage bargaining (the lower n). Further, for any given n , the marginal impact of a nominal wage increase on the union's unemployment is composed of two effects: a *relative price* effect, and a generalized *real balance* effect (see equation (8))¹⁵. The relative price effect works through goods substitution. When a union raises its nominal wage, the firms employing its labor will increase their prices relative to competitors, and will experience a reduction in product demand. Consequently, the demand for the union's labor falls. This effect is captured by the first term in brackets in each of the expressions in equation (22). Not surprisingly, the size of this effect depends on the parameter η , characterizing the degree of substitutability among consumption goods. The larger η , the larger the substitutability between products of different firms and, thus, the larger the substitutability between the labor of different unions. The real balance effect is given by the second terms in brackets in equation (22), and captures the marginal impact on the union's labor demand of a higher nominal wage through lower real money balances. The decrease in money balances due to a higher wage-level

¹⁵Footnote 9 explains the meaning of the term "generalized".

is generated both by an increase in the price-level, and by the monetary policy response which, as shown above, may be either positive or negative depending on the level of CBI. However, the combined impact of those two components on real balances is always negative. Hence, the overall effect of an increase in the nominal wage on employment via the real balance effect is always negative too. Furthermore, the size of this effect is higher the higher is CBI, as denoted by I .¹⁶ This fact plays an important role in what follows.

The overall rate of unemployment, u , and the aggregate price level, p , can be expressed as simple functions of the wage premium. From equations (14) and (10), the equilibrium rate of unemployment is

$$u = \frac{1}{1 - \alpha} \phi \quad (23)$$

Using the CB reaction function (equation (16)) in equation (12), and rearranging, the equilibrium rate of inflation can be expressed as

$$\pi = p - p_{-1} = \frac{1}{(1 - \alpha)^2 I} \phi. \quad (24)$$

3 The effects of CBI, centralization of wage bargaining and the degree of product differentiation on economic performance

We now investigate how the wage premium, unemployment and inflation are affected by: *(i)* CBI, as characterized by I , *(ii)* the centralization of wage bargaining, as characterized by n , and *(iii)* the degree of product differentiation, as characterized by η .

¹⁶Not surprisingly, when $I = \frac{1}{\alpha(1-\alpha)}$, so that the CB does not react to wage changes, the real wage and the wage premium do not depend on CBI. A full discussion of this case is given in Coricelli, Cukierman, and Dalmazzo (2000), Section 4.

3.1 CBI and economic performance

A quick look at equations (20) through (22) reveals that I affects the bargaining power of the union, and therefore the equilibrium wage premium. The direction of this effect depends on the aversion of the union to inflation in comparison to its aversion to unemployment among the union's members. The following proposition shows that when unions' inflation aversion, B , is small relative to its unemployment aversion, A , the wage premium, the rate of unemployment, and inflation are all lower the higher the degree of CB conservativeness (or CBI), I .

Proposition 1 *A necessary and sufficient condition for*

$$\frac{d\phi}{dI} < 0, \quad \frac{du}{dI} < 0, \quad \frac{d\pi}{dI} < 0$$

$$\frac{B}{A} < \left(\frac{B}{A}\right)_c \equiv \frac{\alpha(1-\alpha)^2(n-1)I^2}{[\alpha + \eta(1-\alpha)][(n-1) + 2n(1-\alpha)^2I]}.$$

Proof. See Appendix. ■

In words the proposition states that the real wage premium, unemployment and inflation are all lower the more conservative the CB, if and only if, the relative aversion of the union to inflation and to unemployment among its members is below some threshold. The intuition underlying this condition follows. An increase in the degree of CB conservativeness, or independence, triggers two opposing effects on the wage premium. These effects are generated by "fear of inflation" and by "fear of unemployment" on the part of unions. On one hand, a more conservative CB reduces the unions' concerns for price-inflation, inducing more wage aggressiveness.¹⁷ On the other hand, a more conservative CB favors wage moderation on the part of unions, since a conservative CB will provide little accommodation and may even tighten the money supply in response to wage pressure, generating higher unemployment. In effect, as a by-product of its worry for price stability, a conservative CB is expected to punish higher wages by raising unemployment. Thus, the deterrence exerted by unions fear of unemployment is stronger when

¹⁷As in Cukierman and Lippi (1999) this happens for two reasons. First a stronger anti-inflationary stance on the part of the CB means that a unit increase in the nominal wage translates into a larger increase in the real wage (Z_w is higher). Second, an increase in CB conservativeness reduces the inflationary cost of a given nominal wage increase for inflation-averse unions ($B > 0$).

the CB is more conservative.¹⁸

In conclusion, when the condition $\frac{B}{A} < \left(\frac{B}{A}\right)_c$ is satisfied, an increase in I raises unions' fear of unemployment by more than it alleviates inflationary fears. This implies that a higher level of CBI is conducive to less inflation, as well as to lower unemployment. The condition in the Proposition is obviously satisfied in the extreme case in which unions are not averse to inflation at all ($B = 0$).

Notice that the threshold $\left(\frac{B}{A}\right)_c$ depends on CB conservativeness, I . Using this dependence it can be shown that, given the other parameters of the model, there exists a critical level of CBI, I_c , such that for higher (lower) levels of independence the real wage premium, unemployment and inflation are all lower (higher) the more conservative the CB.¹⁹ Furthermore, this critical value is smaller the lower the relative aversion, $\frac{B}{A}$, of unions to inflation versus unemployment, and it tends monotonically to zero as $\frac{B}{A}$ tends to zero. Thus, as $\frac{B}{A}$ goes down the range of parameters for which higher CBI is associated with better macroeconomic performance expands, encompassing the entire range of parameters in the limit. Section 4 on the optimal level of conservativeness takes up this issue in more detail.

3.2 Centralization of wage bargaining and economic performance

The following proposition characterizes the relation between economic performance and decentralization in wage-setting.

Proposition 2 *The wage premium, the rate of unemployment and inflation are all increasing in the degree of decentralization of the labor market, as measured by the number of unions, n .*²⁰

¹⁸A similar conclusion appears in Soskice and Iversen (2000) who show that the degree of accommodation of prices by the CB has real effects. To facilitate comparison with their results, we first re-express the money-supply rule (16) in terms of prices. Combining equation (16) with the expression for the (log of the) price-level (11), the reaction function of the CB can be expressed as: $m = \theta_0 + [1 - \alpha(1 - \alpha)I]p$, where θ_0 is a constant (Notice that $\text{sgn}\left(\frac{dm}{dp}\right) = \text{sgn}\left(\frac{dm}{dw}\right)$). Taking anti-logs, our reaction function can be expressed, in terms of Soskice and Iversen's formulation, as $M = \Theta_0 \cdot (P)^{1 - \alpha(1 - \alpha)I}$, where Θ_0 is a positive constant. Since $I \in [0, \infty)$, it follows that $[1 - \alpha(1 - \alpha)I] \in (-\infty, 1)$. Soskice and Iversen by-pass the CB's optimum problem and postulate that the CB follows the (exogenously given) reaction function $M = P^a$, where $a \in [0, 1]$. This restriction on a excludes the possibility that a CB may react to price (or wage) increases by **reducing** the money supply (see subsection 2.2).

¹⁹Details appear in proposition 2 of Coricelli, Cukierman and Dalmazzo (2000).

²⁰In the extreme cases $n = 1$ and $n \rightarrow \infty$ the wage premium is given respectively by $\phi(n = 1) = \frac{(1 - \alpha)^4 I^2}{1 - \alpha)^2 I^2 A + B}$

Proof. See Appendix. ■

The unambiguous result in proposition 2 is the sum total of a number of effects some of which operate in opposite directions. In order to understand the various channels through which decentralization affects the wage premium, we examine the effect of n on Z_w and Z_u , defined in Section 2.3. An increase in n unambiguously raises Z_w , leading to a *higher* wage premium. When the labor market is highly decentralized (n large), the increase in the nominal wage of a typical union has a small impact on the aggregate price level p . Thus, the marginal gain to the union in terms of real wage is relatively large.²¹ However, the impact of an increase in n on Z_u is ambiguous in general, as the relative price effect and the generalized real balance effect react in opposite direction to changes in n . An increase in n raises Z_u through the *relative price effect*, and tends to *reduce* the wage premium. This reflects the fact that when the fraction $1/n$ of firms affected by an adverse price change is small, competition is stronger because consumers find it easier to shift their demand towards goods produced by firms whose unions did not raise wages.²² The second component of Z_u captures the impact of the generalized *real balance effect* on firms' labor demand. When n is larger, each union perceives that an increase in its nominal wages will have a negligible effect on the *aggregate* wage level w , which eventually determines the magnitude of the reaction by the CB. Therefore, an increase in n tends now to *increase* the wage premium, since unions internalize the adverse effects of a nominal wage increase to a lesser extent.

Proposition 2 states that, although the competition effect of more decentralization operates in the model, it is dominated by the strategic effects. Thus, the present model does not generate the "hump-shaped" relation between unemployment and labor market centralization stressed by Calmfors and Driffill (1988), and more recently by Cukierman and Lippi (1999).²³

and by $\phi(n \rightarrow \infty) = \frac{1-\alpha}{A} \frac{\alpha+\eta(1-\alpha)}{\eta}$. Simple algebra verifies that $\phi(n \rightarrow \infty) > \phi(n = 1)$ as implied by the proposition.

²¹This is analogous to the strategic effect in Cukierman and Lippi (1999) and to the "internalization effect" in Guzzo and Velasco (1999).

²²Note that in the extreme case of full centralization ($n = 1$), the change in the nominal wage of the union induces a uniform change in the prices of *all* firms, and this effect disappears.

²³Cukierman and Lippi (1999) and Guzzo and Velasco (1999) have noted that when decentralization, n , goes up there are two opposing effects on the wage premium: the "competition" effect, and the "strategic" effect. On one hand, since competition among labor of different unions goes up with their number the real wage goes down. On the other hand, since the impact of each union on the inflationary reaction of the CB is smaller when n is

This feature obviously depends on the particular structure of the model. However, the result in proposition 2 is consistent with empirical evidence suggesting that countries with a high degree of coordination in wage setting have lower unemployment (Nickell (1997), OECD (1997) and Nickell (1999)).

3.3 The effects of the degree of product substitutability on economic performance.

The degree of product substitutability is characterized by the relative price elasticity, η , of the demand for goods. The larger this elasticity, the larger competition in product markets.

Proposition 3 *The wage premium, the rate of unemployment and inflation are all decreasing in the relative price-elasticity of the demand for goods, η .*

Proof. See Appendix. ■

The intuition for this result is simple. A larger η raises the size of the relative price effect generated by an increase in the nominal wage (this effect is contained in Z_u), and thus the employment loss.²⁴ More competitive product markets translate, via the derived demands for labor, into more competitive labor markets. Interestingly, interpreting the wage premium as a measure of labor market rigidity, it follows that higher market power in the goods market, as characterized by low values of η , induce rigidities in the labor market. This implication is consistent with findings reported in Nickell (1999). After considering several studies on the relation between wages and the degree of imperfect competition on product markets, Nickell concludes that there is evidence supporting the view that the real wage of unionized firms is higher in sectors with more market power.²⁵

larger, unions become more aggressive and the real wage goes up.

²⁴Note that even when the goods market approximates perfect competition ($\eta \rightarrow \infty$) the wage premium remains strictly positive. Even in this case, monopolistic unions manage to set wages above the competitive level by artificially restricting the supply of their members. This result is a consequence of the assumption that the typical firm can employ only the labor of its own union.

²⁵Related evidence on the adverse effects of product and labor market rigidities on macroeconomic performance in European countries appears in Koedijk and Kremers (1996).

3.4 Interactions between CBI, centralization of wage bargaining and product market competition when $B = 0$

This section investigates how different degrees of centralization of wage bargaining and of product market differentiation affect the marginal impact of CB conservativeness on the wage premium and unemployment. For simplicity the discussion is limited to the case in which unions are not averse to inflation ($B = 0$).

3.4.1 The effect of centralization of wage bargaining on the marginal impact of CB conservativeness on the wage premium.

When unions are not averse to inflation the marginal impact of CB conservativeness on the wage premium and unemployment is always negative. That is, $\frac{d\phi}{dI} < 0$. We analyze how a change in n affects $\frac{d\phi}{dI}$ by calculating, from equation (20), the cross impact on the wage premium of centralization and conservativeness ($\frac{d^2\phi}{dIdn}$). The sign of the resulting expression is given by:

$$\text{sgn} \left(\frac{d^2\phi}{dIdn} \right) = -\text{sgn} \left\{ (1 - \alpha)[\alpha + \eta(1 - \alpha)] - (n - 1)\eta \left[\frac{1}{I} + (1 - \alpha)^2 \right] \right\}$$

For given n , this expression is more likely to be negative the higher the level of I . Moreover, for low levels of centralization (n sufficiently large) the sign of $\frac{d^2\phi}{dIdn}$ tends to be positive, while for high levels of centralization (n relatively low) the sign tends to be negative.²⁶ Thus, the ability of a conservative CB to discourage high wage claims and high unemployment is particularly effective when centralization is at intermediate levels.²⁷ Interestingly, this implication of the theory is consistent with evidence on average unemployment rates for a group of OECD countries at various levels of centralization of wage bargaining and of CB conservativeness, reported in Table 1 of Soskice and Iversen (2000). The main empirical regularity in the table is that

²⁶More formally $\frac{d^2\phi}{dIdn} \text{ R } 0$ as $n \text{ R } 1 + \frac{(1-\alpha)[\alpha+\eta(1-\alpha)]}{\eta[\frac{1}{I}+(1-\alpha)^2]}$. Thus, $\frac{d^2\phi}{dIdn} < 0$ is more likely to hold for higher levels of I .

²⁷This impact effect attains its maximal value when centralization is at the level $(\frac{1}{n})^* = \left[1 + \frac{(1-\alpha)[\alpha+\eta(1-\alpha)]}{\eta[\frac{1}{I}+(1-\alpha)^2]} \right]^{-1}$. For the extreme cases of full centralization ($n = 1$) and full decentralization ($n \rightarrow \infty$) the wage premium is independent of CBI. Soskice and Iversen (2000) obtain a similar result in a somewhat more restricted framework.

at intermediate levels of centralization the difference in average unemployment rates between high independence and low independence countries is negative and significant while at either low or high levels of centralization there is no significant difference in average unemployment rates between countries with high and low levels of CBI.

Holden (2001) considers a model in which the degree of coordination of wage setting among unions is determined endogenously and argues that it is easier to sustain such coordination when the CB is relatively accommodative. His argument builds on the result that CB conservativeness is more effective in restraining unemployment when the labor market is not fully centralized. Thus, an accommodating CB generates a stronger incentive to coordinate wage setting, so as to achieve wage moderation and lower unemployment. In conjunction with the result in this subsection Holden's conclusion implies that the incentive to coordinate wage setting for this reason is stronger in relatively decentralized labor markets

3.4.2 The effect of product market competition on the impact of CBI on the wage premium.

We turn next to investigate how the degree of product market competition, as characterized by η , affects the size of $\frac{d\phi}{dI} < 0$. It is straightforward to show that, for $B = 0$, $\frac{d^2\phi}{dId\eta} > 0$. Therefore, an increase in the level of competitiveness on product markets reduces the absolute value of the negative effect of CBI on the wage premium and unemployment, implying that more competition on product markets tends to reduce the benefits associated with CB conservativeness. Another way of stating the same result is that the beneficial effect of a more conservative CB for employment is larger the lower the level of competitiveness on product markets.

4 The socially optimal level of conservativeness

Ever since Rogoff (1985), the idea that it is socially optimal to appoint a central banker that is more conservative than society constituted a basic benchmark in discussions of the optimal design of monetary institutions. In the absence of shocks, Rogoff's framework implies that the optimal level of conservativeness is infinite. Thus, the CB should care only about price stability. By contrast, Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999) (as corrected

by Lippi (2002)) and Lawler (2000) have recently shown that in the presence of an inflation averse monopoly union the socially optimal level of CB conservativeness is zero (the "populist CB" view in the sequel). Those frameworks assume that the CB directly controls inflation and that firms are price takers thereby abstracting from aggregate demand transmission channels of monetary policy. On the other hand Soskice and Iversen (1998, 2000), while abstracting from the inflation fears of unions, incorporate the aggregate demand channel and conclude that a non accomodating CB brings about a better macroeconomic performance. Having established the relation between conservativeness and accomodation on one hand and the relation between the relative aversion of unions to inflation/unemployment and the impact of conservativeness on the other, we are now in a position to form a more informed opinion on those opposing views. Following Rogoff and others let the social loss function be

$$\Lambda = u^2 + S \pi^2 \quad (25)$$

where $S \in (0, \infty)$ represents society's relative aversion to inflation, that may generally differ from the relative inflation aversion of the CB, I .²⁸ The main issue then is the following: If society delegates the conduct of monetary policy to a central banker, what is the level of CB conservativeness (or inflation aversion) that is optimal for a society with relative inflation aversion S ? Inserting the equilibrium expressions for u and π from equations (23) and (24) into equation (25) this problem is equivalent to the minimization, with respect to I , of the following expression

$$\Lambda(I) = \left(\frac{\phi(I)}{1 - \alpha} \right)^2 + S \left(\frac{\phi(I)}{(1 - \alpha)^2 I} \right)^2 \quad (26)$$

where $\phi(I)$ is given by equation (20). Note that social losses depend on central bank conservativeness directly, as well as through the effect that conservativeness has on the wage premium, $\phi(I)$.

When unions do not care about inflation ($B = 0$), the following holds:

Proposition 4 : *When $B = 0$ an ultra conservative central banker is socially optimal.*

Proof. See Appendix. ■

²⁸Woodford (1999) discusses the circumstances under which such a quadratic welfare function is a good approximation of welfare in a model that is explicitly based on utility.

The intuition underlying the proposition is simple. When unions are averse only to unemployment, an extremely conservative CB has a maximal moderating effect on unions' real wage demands. This in turn implies that, under such a central banker, unemployment and inflation will be at their lowest levels. No matter how strong is the inflation aversion of society, it therefore pays to appoint an "ultra conservative" central banker.²⁹

We turn next to the more general case where the relative inflation aversion of unions is **strictly positive** but moderate; i.e., $\frac{B}{A}$ is strictly positive but not too large. The following proposition provides some overly strong conditions for an ultra conservative CB to be socially optimal when there is more than one union.

Proposition 5 : (i) *If*

$$\frac{B}{A} < \text{Min} \left\{ S \left(1 - \frac{\alpha}{2} \right), \frac{1}{2(1 - \alpha)} \right\}$$

the social optimum problem does not have an internal solution.

(ii) *If there is more than one union, the condition in part (i) is satisfied, and*

$$\frac{B}{A} < \frac{2 - \alpha}{2(1 - \alpha)} \sqrt{S}$$

an ultra conservative CB is socially optimal.

Proof. See Appendix. ■

Proposition 5 states that if the inflation aversion of unions is sufficiently small in comparison to their aversion to unemployment an ultra conservative central banker maximizes social welfare. For the standard case in which the parameter α is equal to $2/3$, the conditions in the proposition reduce to $\frac{B}{A} < \min \left\{ \frac{2}{3}S, \frac{3}{2}, 2\sqrt{S} \right\}$. Since unions are likely to be relatively more concerned about unemployment than about inflation, this condition is likely to be satisfied in reality (see Calmfors (2001) for a discussion).

Thus, for the case of more than one union, an ultra conservative central banker is socially

²⁹Although monotonically decreasing in I , the wage premium remains positive when $I \rightarrow \infty$. It is worth noting, at the risk of some repetition, that this analysis abstracts from the potential gains from stabilization policy.

optimal unless $\frac{B}{A}$ is implausibly large.³⁰ Thus, the optimality of the populist CB is very likely to be the exception rather than the rule.³¹ The root cause of the difference is that the populist CB view abstract from the deterring effects of contractionary monetary policy designed to reduce the inflationary consequences of higher nominal wages. Since such contractionary policy reduces the demand for labor, unions moderate their wage demands mainly because of fear of unemployment among their members, rather than because of their inflationary fears. This mechanism is, in turn, absent in the frameworks used to derive the populist CB result because they assume that the CB can choose the price level directly and producers are price-takers. Soskice and Iversen (1998, 2000) recognize this channel but, since they abstract from the inflation fears of unions, their framework is not sufficient to settle the issue.

To sum up, deterrence generally operates via two channels. A relatively liberal CB has a comparative advantage at deterring unions from setting high wages via their inflation aversion, while a relatively conservative CB has a comparative advantage in deterring them through their aversion to unemployment. This is why the results in Propositions 4 and 5 depend on conditions that make unions' aversion to unemployment sufficiently larger than inflation aversion. In most realistic circumstances, we conclude that, in the absence of shocks, social welfare will be maximized by an ultra conservative CB.

5 Concluding remarks

This paper has proposed a general equilibrium framework with endogenous monetary policy that characterizes the effects of CB conservativeness, product market differentiation, and the degree of centralization of wage bargaining on wages, employment and inflation. A central feature of the model is that -unlike much of the literature on strategic monetary policy- the price level is determined by the optimizing decisions of individual firms and the policy instrument of the CB

³⁰This conclusion is backed by numerical simulations in which social losses are minimized when I tends to infinity unless B is much larger than A .

³¹Guzzo and Velasco (1999) have claimed that a populist central banker is socially optimal at **all** levels of centralization of wage bargaining. But this is due to their implicit assumption that wages are contracted in real terms. As shown by Lippi (2002) (and recognized in Guzzo and Velasco (2002)) when wages are contracted in nominal terms the Guzzo and Velasco model implies, as do the other models, that a populist CB is socially optimal provided there is a single monopoly union.

is the money supply.

Some of the main results follow. First, the degree of monetary accommodation in response to nominal wage increases depends on CB conservativeness. The more conservative the CB the less accommodative it is. Second, the coefficient of accommodation is not limited to positive values. In particular, a sufficiently conservative CB will **reduce** money growth in response to nominal wage inflation, consistently with casual and econometric evidence on countries like Germany characterized by highly conservative central banks (Hall and Franzese Jr. (1998), Cukierman, Rodriguez and Webb (1998)). Third, when unions' aversion to unemployment is sufficiently larger than their inflation aversion, an ultra conservative CB is socially optimal.³² For reasonable relative values of those two aversion parameters this result supports, within a richer and more realistic framework, the point of view of Soskice and Iversen (1998, 2000) rather than that of the "populist CB" view. Fourth, when unions do not care about inflation, CB conservativeness and unemployment are always negatively related. Fifth, the moderating marginal impact of CB conservativeness on unemployment is largest at intermediate levels of centralization of wage bargaining. This is consistent with evidence presented in Soskice and Iversen (2000). Sixth, the effectiveness of a conservative CB in reducing unemployment is higher the lower competition on product markets. Finally, the extent of both real and of nominal wage rigidities depends on the nature of monetary institutions. In particular, high CB conservativeness reduces downward real and nominal wage rigidity, making wages closer to their market clearing level. This is an instance of the Lucas critique.

>From a methodological point of view, the paper integrates two recent strands of literature on labor markets and monetary policy. On one hand, the work of Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999) and Lawler (2000) builds on unions' "fear of inflation". These papers consider the interaction between CB's preferences and inflation averse unions in a framework where the CB is assumed to pick inflation directly. As a consequence monetary policy in those papers affects the economy via supply but not via demand. Soskice and Iversen (2000), on the other hand, incorporate such a demand channel but abstract from unions' inflation aversion.³³

³²This abstracts from the existence of shocks and stabilization policy.

³³They develop two separate models, with either monopolistically competitive price setting firms, or wage

Our framework integrates all those elements and goes somewhat beyond. First, it features both supply and demand driven transmission channels of monetary policy. The Keynesian aggregate demand effect of monetary policy operates in spite of the fact that prices are flexible. In our framework the real effects of monetary institutions arise because of the conjunction of wage stickiness and a strategic interaction between large wage setters and the monetary authority. Second, we consider both wage-setting and price-setting within the **same** framework. This makes it possible to discuss the distinct roles of imperfections in the labor and in the goods markets, the interactions between those two types of imperfections and, finally, the relationship between these imperfections and the nature of monetary policymaking institutions. Third, we derive the reaction function of the CB endogenously from its employment and inflation objectives. This makes it possible to characterize the equilibrium relation between the money-supply rule and the degree of CB conservativeness.³⁴

The paper provides further support for the conservative CB paradigm, pioneered by Rogoff (1985).³⁵ It sheds additional light on the recent debate regarding the optimal degree of CB conservativeness in the presence of non atomistic wage setters by showing that the "populist CB" result is a rather special extreme case.

We have limited our discussion to the case in which there are no stochastic shocks and the public is fully informed about the degree of conservativeness of the CB. The framework of this paper could provide a useful point of departure to investigate the additional trade-offs introduced by the desire to use monetary policy to stabilize shocks to the economy, as well as for the investigation of situations in which a relatively conservative CB has not yet fully established its credentials.³⁶ The latter case involves a familiar trade-off between current and future unemployment since, to establish credentials, a conservative CB has to be relatively

setting unions and take the reaction function of the monetary authority as exogenously given. Soskice and Iversen show that unions' aversion to unemployment induces more wage moderation the less accomodative is the CB.

³⁴As a consequence, our specification admits the possibility that the money supply goes down in response to nominal wage increases. The specification in Soskice and Iversen (2000) does not admit such a possibility.

³⁵However, rather than focussing on the tradeoff between stabilization policy and the inflation bias, the focus here (as well as in related papers with unionized labor markets) is on the effect of CB conservativeness on the level of real wages and through them on unemployment and inflation.

³⁶Bratsiotis and Martin (1999) develop a framework with shocks and stabilization policy in the presence of unions and product market imperfections and use it to investigate the relative desirability of alternative targeting methods.

contractionary in the present. We leave these and other extensions to future work

6 Appendix

6.1 Derivation of equilibrium wages

Differentiating equation (16) with respect to the nominal wage of union i

$$\frac{dm}{dw_i} = \frac{1 - \alpha(1 - \alpha)I}{n[1 + (1 - \alpha)^2I]} \quad (27)$$

where use has been made of the fact that $w = \frac{1}{n}w_i + \frac{n-1}{n}w_{-i}$. Differentiating (11) with respect to w_i and using the last relation yields:

$$\frac{dp}{dw_i} = (1 - \alpha)\frac{dm}{dw_i} + \alpha\frac{dw}{dw_i} = \frac{1}{n[1 + (1 - \alpha)^2I]}. \quad (28)$$

>From equation (10) one obtains

$$\frac{d(m - p)}{dw_i} = -\frac{\alpha}{(1 - \alpha)}\frac{d(w - p)}{dw_i}$$

Differentiating (7) with respect to w_i and using the previous expression yields:

$$\frac{d(p_{ij} - p_i)}{dw_i} = \frac{\alpha}{\alpha + \eta(1 - \alpha)} \left[1 - \frac{dp}{dw_i} - \frac{d(w - p)}{dw_i} \right]. \quad (29)$$

Using $w = \frac{1}{n}w_i + \frac{n-1}{n}w_{-i}$ and equation (28)

$$\frac{d(w - p)}{dw_i} = \frac{(1 - \alpha)^2I}{n[1 + (1 - \alpha)^2I]}. \quad (30)$$

Substituting (28) and (30) into (29) and rearranging yields

$$\frac{d(p_{ij} - p)}{dw_i} = \left(\frac{n - 1}{n} \right) \frac{\alpha}{\alpha + \eta(1 - \alpha)} \quad (31)$$

Differentiating equation (10) with respect to w_i , using (30), and rearranging yields

$$\frac{d(m-p)}{dw_i} = \frac{-\alpha(1-\alpha)I}{n[1+(1-\alpha)^2I]}. \quad (32)$$

Differentiating (18) with respect to w_i , using equations (31) and (32), and rearranging yields:

$$\frac{du_i}{dw_i} = \frac{1}{n} \left[\frac{\eta(n-1)}{\alpha + \eta(1-\alpha)} + \frac{(1-\alpha)I}{[1+(1-\alpha)^2I]} \right]. \quad (33)$$

Using (28) and (33) in equation (19) the first order condition of union i can be rewritten as:

$$-Z_w + A \underbrace{\left\{ l_0 + \frac{1}{\alpha} [\eta(p_i - p) - (m - p)] \right\}}_{u_i} Z_u + B \pi (1 - Z_w) = 0 \quad (34)$$

where $Z_w \equiv 1 - \frac{1}{n[1+(1-\alpha)^2I]}$, $Z_u \equiv \left[\frac{\eta}{D} \frac{n-1}{n} + \frac{(1-\alpha)I}{nK} \right]$, $D \equiv [\alpha + \eta(1-\alpha)]$, and $K \equiv [1 + (1-\alpha)^2I]$.

We now show that the existence of a Nash equilibrium in wages requires symmetry in prices, that is: $p_i = p$. Given symmetry in prices, we then show that the Nash equilibrium in wages itself is *symmetric*. First, to show that price symmetry is necessary for the existence of a Nash equilibrium in wages, notice that a condition like (34) must simultaneously hold for each union i , with $i = 1, \dots, n$. These n conditions may differ, if at all, from one another *only* in the linear terms in $(p_i - p)$. The first order conditions for any two unions, s and q , imply, therefore, that $(p_s - p) = (p_q - p)$: the two unions first order conditions can be *simultaneously* satisfied if and only if the monopolistically competitive firms set identical prices on their products. Since this is true for any two first order conditions it follows that $p_i = p$, for every $i = 1, \dots, n$. Using this result in equation (34) implies that the first order conditions of all unions are identical. Hence they all set the *same* nominal wage.

The reaction function of the CB in equation (16), the expression for the equilibrium price level in equation (11) and the typical union first order condition in equation (34) provide a system of three linear equations from which w , p and m can be solved. The solution for the wage premium is obtained, after a substantial amount of algebra, by using the first two equations in the last one and by using the expression for the competitive real wage.

6.2 Derivation of the competitive real wage w_r^c

The competitive real wage, w_r^c , is the wage level that equates labor supply and labor demand, or

$$\int_0^1 l_0 dj = \int_0^1 l_{ij}^d dj.$$

When the labor market is competitive all firms face the same wage and set, therefore, the same price. Hence the derived demand for labor (equation (8)) reduces to

$$l_{ij}^d = \frac{1}{\alpha}(m - p)$$

Using the last expression in the previous one, the labor market clearing condition can be rewritten as:

$$l_0 = \int_0^1 \left[\frac{1}{\alpha}(m - p) \right] dj = \frac{1}{\alpha}(m - p).$$

Using equation (10), which relates real money balances to the average real wage level, and rearranging we obtain the solution for the competitive wage:

$$w_r^c = -(1 - \alpha)l_0 + \frac{1 - \alpha}{\alpha}\rho.$$

6.3 Proof of Proposition 1

Differentiating equation (20) totally with respect to I and rearranging, it can be shown that

$$Sgn \left\{ \frac{d\phi}{dI} \right\} = Sgn \left\{ [(n - 1) + 2n(1 - \alpha)^2 I] B - \frac{\alpha(1 - \alpha)^2(n - 1)I^2}{\alpha + \eta(1 - \alpha)} A \right\}.$$

This expression is negative and the wage premium is decreasing in I if and only if $\frac{B}{A} < \left(\frac{B}{A}\right)_c$. Given this condition, equations (23) and (24) imply that unemployment and inflation are also decreasing functions of CBI. QED

6.4 Proof of Proposition 2

By totally differentiating the equilibrium expression for the wage premium in equation (20) with respect to n and rearranging, one obtains that $Sgn \left\{ \frac{d\phi}{dn} \right\} = Sgn \{ \alpha \} > 0$. Since α is positive it follows that the wage premium is increasing in the number of unions, n . In addition, since, from equations (23) and (24), unemployment and inflation are positively related to ϕ it follows that they too rise with decentralization of bargaining in the labor market. QED

6.5 Proof of Proposition 3

Examination of equation (20) reveals that the wage premium depends on η only via Z_u . It is easy to see, from equation (22) that Z_u is increasing in η , and that the wage premium is, therefore, decreasing in η . The results for inflation and unemployment follow directly from equations (23) and (24). QED

6.6 Proof of Proposition 4

Proposition 1 implies that, for $B = 0$, the wage premium is a decreasing function of I in the entire economically meaningful range of I . It follows that social losses are minimized when the CB is ultra conservative ($I \rightarrow \infty$). QED

6.7 Proof of Proposition 5

Part (i). We start by showing that, when $\frac{B}{A} < \frac{S}{2} \left(\frac{\alpha + \eta(1-\alpha)n}{\alpha + \eta(1-\alpha)} \right)$ and $\frac{B}{A} < \frac{\eta(n-1)^2}{n(1-\alpha)[\alpha + \eta(1-\alpha)]}$ hold simultaneously, the social optimum problem does not have an internal solution. We first differentiate equation (26) with respect to I :

$$\frac{d\Lambda(I)}{dI} = \frac{2\phi(I)}{(1-\alpha)^2} \left[\left(1 + \frac{S}{(1-\alpha)^2 I^2} \right) \frac{d\phi(I)}{dI} - \frac{S}{(1-\alpha)^2 I^3} \phi(I) \right]. \quad (35)$$

If there is an internal extremum this expression equals zero. Thus, for an internal solution to exist, the following must hold

$$\frac{d\phi(I)}{dI} \frac{I}{\phi(I)} = \frac{S}{(1-\alpha)^2 I^2 + S}. \quad (36)$$

Condition (36) in conjunction with the derivative of the wage premium with respect to I (obtained from equation (20)) generates, after some algebra, the following equation:

$$\Psi(I) \equiv K_3 I^3 + K_2 I^2 + K_1 I + K_0 = 0 \quad (37)$$

where

$$K_3 \equiv \frac{-\alpha(1-\alpha)^3(n-1)}{D}, \quad (38)$$

$$K_2 \equiv (1-\alpha)^3 n \left(2\frac{B}{A} - S\frac{\eta n(1-\alpha) + \alpha}{D} \right), \quad (39)$$

$$K_1 \equiv (1-\alpha)(n-1) \left(\frac{B}{A} - 2S\frac{\eta n(1-\alpha) + \alpha}{D} \right), \quad (40)$$

$$K_0 \equiv S \left(\frac{B}{A}(1-\alpha)n - \frac{\eta(n-1)^2}{D} \right). \quad (41)$$

Since $I \geq 0$, the equation $\Psi(I) = 0$ cannot be satisfied whenever the coefficients K_0, K_1, K_2, K_3 are all negative. In this case, an internal solution ($0 < I^* < \infty$) to the social optimum problem does not exist. The proof of Part (i) is completed by noting that when the conditions

$$\frac{B}{A} < \frac{S}{2} \left(\frac{\alpha + \eta(1-\alpha)n}{\alpha + \eta(1-\alpha)} \right) \quad (42)$$

and

$$\frac{B}{A} < \frac{\eta(n-1)^2}{n(1-\alpha)[\alpha + \eta(1-\alpha)]} \quad (43)$$

hold simultaneously the constants K_0, K_1, K_2, K_3 are all negative. Since the bounds on the right hand side of these conditions are monotonically increasing in both η and n , they attain their smallest values when η and n are at their lowest permissible values which are 1 and 2 respectively. If $\frac{B}{A}$ is smaller than these minimal upper bounds, it is *a fortiori* lower than the upper bounds at higher values of η and n . Inserting the condition $\eta = 1$ and $n = 2$ into the upper bounds yields the conditions reported in Part (i) of the proposition.

Part (ii): Under the conditions stated in Part (i) of the proposition, the socially optimal level of conservativeness is either zero or infinity. To characterize the set of circumstances under which either of those two extreme types is socially optimal we evaluate the values of inflation, of unemployment and of social losses in equation (26) for each of them. Under an ultra liberal central banker the wage premium and unemployment are zero and inflation and social losses are given respectively by

$$\pi = \frac{n-1}{B} \quad (44)$$

and

$$\Lambda(0) = S \left(\frac{n-1}{B} \right)^2. \quad (45)$$

Thus, as in Cukierman and Lippi (1999) and Lippi (2000), an ultra liberal CB totally eliminates unemployment by riding on the inflationary fears of unions. But it also totally eliminates inflation only in the extreme case in which there is a single monopoly union. Hence in the case of a monopoly union an ultra liberal CB is socially optimal.

Under an ultra conservative central banker inflation is zero and unemployment and social welfare are given respectively by

$$u = \frac{1-\alpha}{A} \frac{[\alpha + \eta(1-\alpha)]n}{\alpha + \eta(1-\alpha)n} \quad (46)$$

and

$$\lim_{I \rightarrow \infty} \Lambda(I) = \left(\frac{1-\alpha}{A} \frac{[\alpha + \eta(1-\alpha)]n}{\alpha + \eta(1-\alpha)n} \right)^2. \quad (47)$$

An ultra liberal or an ultra conservative CB is socially optimal depending on whether $\Lambda(0)$ is smaller or larger than $\lim_{I \rightarrow \infty} \Lambda(I)$. Not surprisingly the welfare ranking of those two cases depends on society's relative inflation aversion. The socially optimal level of conservativeness will be infinity if and only if $\lim_{I \rightarrow \infty} \Lambda(I) < \Lambda(0)$: equations (45) and (47) imply that this condition is equivalent to the condition $\frac{B}{A} < \left(\frac{\alpha + (1-\alpha)\eta n}{(1-\alpha)(\alpha + (1-\alpha)\eta)} \right) \left(\frac{n-1}{n} \right) \sqrt{S}$. Since the bound on the right hand side is increasing in both η and n , it will attain its smallest value when $\eta = 1$ and $n = 2$,

yielding the condition $\frac{B}{A} < \frac{2-\alpha}{2(1-\alpha)}\sqrt{S}$ reported in Part (ii) of the proposition.

Thus, provided that the conditions in the proposition are satisfied, the social welfare function has no internal minimum, and an ultra conservative CB is optimal. QED

7 References

Berghahn V. and K. Detlev (1987), **Industrial Relations in West Germany**, Oxford: Berg.

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

Blanchard O. and S. Fischer (1989), **Lectures in Macroeconomics**, The MIT Press, Cambridge, MA.

Bratsiotis G. and C. Martin (1999), "Stabilization, Policy Targets and Unemployment in Imperfectly Competitive Economies", **Scandinavian Journal of Economics**, 101, 241-256.

Calmfors L. (2001), "Wages and Wage-Bargaining Institutions in the EMU - A Survey of the Issues", **Empirica**, 28, 325-351.

Clarida R., J. Galí, and M. Gertler (1999), "The Science of Monetary Policy: A New-Keynesian Perspective", **Journal of Economic Literature**, 37, 1661-1707.

Coricelli F., A. Cukierman, and A. Dalmazzo (2000), "Monetary Institutions, Monopolistic Competition, Unionized Labor Markets and Economic Performance", CEPR DP No.2407.

Cubitt R. (1992), "Monetary Policy Games and Private Sector Precommitment", **Oxford Economic Papers**, 44, 513-530.

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

Cukierman A. and F. Lippi (2001), "Labour Markets and Monetary Unions: A Strategic Analysis", **Economic Journal**, 111, 541-565.

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

Dixit A. and J. Stiglitz (1977), "Monopolistic Competition and Optimum Product Diversity", **American Economic Review**, 67, 297-308.

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

Guzzo V. and A. Velasco (2002), "Revisiting the Case for a Populist Central Banker: A Comment", **European Economic Review**, 46, 613-621.

Gylfason T. and A. Lindbeck (1994), "The Interaction of Monetary Policy and Wages", **Public Choice**, 79, 33-46.

Hall P. A. (1994), "Central Bank Independence and Coordinated Wage Bargaining: Their Interaction in Germany and Europe", **German Politics and Society**, Issue 31, 1-23.

Hall P. A. and R. J. Franzese Jr. (1998), "Mixed Signals: Central Bank Independence, Coordinated Wage Bargaining, and European Monetary Union", **International Organization**, 52, 3, 505-535.

Holden S. (2001), "Monetary Regimes and the Coordination of Wage Setting", CESifo Working Paper No.429, Munich.

Jensen H. (1997), "Monetary Policy Cooperation May Not Be Counterproductive", **Scandinavian Journal of Economics**, 99, 1, 73-80.

Koedijk K. and J. Kremer (1996), "Market Opening, Regulation and Growth in Europe", **Economic Policy**, 443-460.

Lawler P. (2000), "Centralised Wage Setting, Inflation Contracts, and the Optimal Choice of Central Banker", **Economic Journal**, 110, 559-575.

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

Mishkin F. (2001) **The Economics of Money, Banking, and Financial Markets**, Addison Wesley, Boston, San Francisco, New York.

Nickell S. (1997), "Unemployment and Labor Market Rigidities: Europe versus North America", **Journal of Economic Perspectives**, 11, No. 3, 55-74.

Nickell S. (1999), "Product Markets and Labour Markets", **Labour Economics**, 6, 1-20.

OECD (1997), **Employment Outlook**, July, Paris.

Oswald A.J. (1982), "The Microeconomic Theory of Trade Union", **The Economic**

Journal, 92, 576-595.

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

Saint-Paul, G. (2000), **The Political Economy of Labour Market Institutions**, Oxford University Press, Oxford ; New York.

Skott P. (1997), "Stagflationary Consequences of Prudent Monetary Policy in a Unionized Economy", **Oxford Economic Papers**, 49, 609-622.

Soskice D. and T. Iversen (1998), "Multiple Wage-Bargaining Systems in the Single European Currency Area", **Oxford Review of Economic Policy**, 14.

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

Streeck W. (1994), "Pay Restraint Without Income Policy: Institutionalized Monetarism and Industrial Unionism in Germany" in R. Dore, R. Boyer and Z. Marn (eds.), **The Return of Income Policy**, Pinter, London.

Taylor J. B. (editor) (1999), **Monetary Policy Rules**, NBER and Chicago University Press, Chicago.

Woodford M. (1999), "Inflation Stabilization and Welfare", Princeton University.