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Labor Markets and Monetary Union: A Strategic Analysis[*]

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Abstract

This paper analyzes the macroeconomic consequences of the establishment of a monetary union in the presence of unionized labor markets. It is shown that the effects of the formation of a monetary union depend on several labor market features, such as the degree of centralization of wage bargaining, labor unions' inflation aversion and the degree of substitutability between the labor of different unions. In particular, the

switch from national monetary policies to a unified monetary policy usually affects both inflation and unemployment, even when all structural parameters of the economy and of unions' and policymakers' preferences remain the same.

The benchmark case of a monetary union between identical countries suggests that the switch to a monetary union is likely to make labor unions more aggressive, increasing unemployment. Qualifications to this result are provided and their robustness is investigated under alternative structural assumptions, like cross-country asymmetries, (pre-union) ERM membership and wage leadership.

1   Introduction

This paper investigates the effects of the establishment of a monetary union on real wages, inflation and unemployment in the presence of unionized labor markets. Conventional wisdom as embodied in the neutrality of money paradigm would seem to suggest that, provided there are no additional structural changes, the formation of a monetary union (MU) *per se* should not affect real variables. However this point of view abstracts from changes in the strategic interaction between non-atomistic labor unions and the central bank brought about by the formation of a monetary union.

We show that in the presence of such interaction the formation of a MU changes the equilibrium values of inflation, real wages and unemployment. In particular, the shift to a MU affects unemployment and inflation in the countries that form the union even when all structural features of those countries, like the level of central bank independence and the industrial organization of labor markets, do not change with the formation of the MU. A basic mechanism driving those results is that all unions become smaller units of a broader monetary area with the formation of the MU. This reduces their perception of the inflationary repercussions of their individual wages, inducing them to be more aggressive in their wage demands. In broader terms, those results are due to the fact that once the endogenous nature of monetary policy is acknowledged the natural rate of unemployment is no longer independent of the structure of monetary institutions if wage setting is done by non-atomistic

unions.[1]

The arguments developed here are based on the analytical framework developed in Cukierman and Lippi (1999), amended to allow for cross-country asymmetries in wage-setting structures. In this framework there are three key parameters that characterize the structure of labor markets: the centralization of wage bargaining, the substitutability between the labor of different unions and, in line with several recent papers on the role of non-atomistic trade unions, the degree of unions' inflation aversion.[2] Monetary institutions are characterized by the degree of conservativeness of the central bank and by whether each country conducts a separate monetary policy or there is a unified monetary policy for all countries under consideration. More precisely, two alternative policy regimes are considered: (i) national monetary policies and (ii) monetary union.

The main results of the paper are derived by comparing the equilibria obtained under a MU with those obtained under national monetary policies (NMP). This is done by considering a two-stage strategic interaction between a central bank (CB) and a number of unions. In the first stage each union in each country sets its own nominal wage taking the nominal wages of other unions and the reaction-function of the CB as given. In the second stage, of the NMP regime, the CB in each country chooses inflation, so as to minimize the combined costs of inflation and of unemployment, taking unions' nominal wage rates as given. Under the MU regime, a single monetary authority chooses the area-wide inflation in the second

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[1]The essence of our formal argument has also been noticed in policy circles. In a recent report on wage setting and EMU the Economic Policy Committee of the European Commission wrote: "the change in the monetary regime with the move to EMU could potentially change the economic agents' behaviour. Before EMU those countries having a centralised/co-ordinated system of wage bargaining could have expected a 'national' policy response following their wage agreements. Under EMU things might be different. The impact on inflation of one country would influence EUR11-wide inflation according to this country's weight in the EUR11 inflation rate. [..] Hence, the 'burden' of the ECB's tighter monetary policy [..] would be externalised to an important extent (1998, p.7)".

[2]The presumption that unions are averse to inflation has gained acceptability during the nineties. A non exhaustive list of references that assume unions to be inflation averse includes Agell and Ysander (1993), Cubitt (1992), Cukierman and Lippi (1999), Grüner and Hefeker (1999), Gylfason and Lindbeck (1994), Jensen (1997), Skott (1997), Velasco and Guzzo (1999), and Yashiv (1989).

stage and this is known by all unions in the first stage. The analysis focuses initially on the impacts of the formation of a MU in the benchmark case in which the parameters of all countries are identical. This is followed by a more detailed study of the variation in these impacts with the relative sizes of member countries and with the relative degrees of centralization of their labor markets.[3]

This paper is closely related to a recent paper by Grüner and Hefeker (1999). However, while they focus on the special case of a single union that encompasses the whole labor force, we develop the analysis for any number of labor unions within each country. The analysis reveals that there are substantial differences between the monopoly union case and the multi-union case, the most significant of which is that, in the presence of more than one union, the change in monetary regime leads to changes in **real** variables even if unions are **not** inflation averse. Soskice and Iversen (1998) also analyze the effects of the establishment of a MU on wage bargaining in the countries of the Euro area. Although the model they use is different from ours, the results of the two papers are broadly similar. One notable difference is that they consider the effects of a MU among **identical** economies each of which has a **fully** centralized wage-setting process, while we allow for cross-country differences in the number of unions and in other structural parameters.[4] This allows us to study how the effects of the MU vary across the participating countries, depending on country size and on the degrees of centralization of national labor markets.

The paper is organized as follows. Section 2 presents the basic analytical framework and characterizes equilibrium in each country under a regime of NMP. Equilibrium in a two-country MU is derived in section 3. The impact of the formation of a MU on employment,

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[3]We deliberately abstract from open-economy spillovers of the type studied by Jensen (1993) and Zervoyianni (1997) in order to focus on the effects of MU which originate from changes in the strategic environment faced by unions. Holden (1998) develops a related open-economy model in which the monetary framework has systematic effects on employment.

[4]Another important difference is that in our model the reaction function of the central bank is derived explicitly from the objectives and constraints of the monetary authorities and is therefore endogenous. By contrast in Soskice and Iversen (1998) the policy rule for the money supply is postulated exogenously (see their Mathematical Appendix, p.123).

real wages and inflation is discussed in section 4. Three particular cases are studied: the first one considers identical countries; the second one allows for cross country asymmetries in the degrees of labor market competitiveness and the third one considers the case of labor unions that are indifferent to inflation. Section 5 discusses the effects of the formation of a MU under two alternative structural assumptions, that may be relevant for Europe. The first relates to the fact that several countries were in a regime of unilateral pegs before entering the MU, rather than in a regime of independent NMP. The second modifies the Nash wage bargaining framework used in the previous sections in order to allow for wage-leadership by the unions of a country. This is followed by concluding remarks.

2   Labor Markets and Monetary Policy under National Monetary Policies[5]

A representative national economy consists of n independent unions and of a CB whose degree of inflation aversion is characterized by a parameter I.[6] A typical union, j, prefers a higher real wage rate (w_{rj}) for its members, dislikes unemployment among its members and dislikes inflation. This is captured by the following loss function:

$$\Omega_j \equiv -2w_{rj} + Au_j^2 + B\pi^2 \tag{1}$$

where u_j is the rate of unemployment among members of union j, $\pi \equiv p - p_{-1}$ is the rate of inflation (defined as the difference between adjacent values of the log of the price level) and A and B are positive parameters. The first two arguments reflect the union's sectorial interest and are conventional in the theory of trade unions' behavior.[7] The third one reflects

[5]Since the analytical framework for a single country is borrowed from Cukierman and Lippi (1999) it is presented rather briefly. The interested reader may find further details concerning the mechanics and intuition of this model in the above mentioned paper.

[6]An independent union is a union that has the authority to decide its wage policy in an independent manner.

[7]See for example Oswald (1982).

the union's aversion to inflation.[8]

The CB dislikes both aggregate unemployment (u) and inflation. More precisely, the objective of the CB is to minimize the following loss function:

$$\Gamma \equiv u^2 + I\pi^2 \tag{2}$$

where I is a measure of the relative inflation aversion of the CB. This parameter is Rogoff's (1985) well known degree of (multiplicative) CB conservativeness. We consider a two-stage game and solve it by backward induction. In the second stage, the CB chooses inflation, taking the nominal wages previously set by all the unions as given, so as to minimize its loss function. In the first stage each union chooses its nominal wage rate so as to minimize the loss function in equation (1), taking the nominal wage rates chosen by all other unions and the subsequent central bank reaction as given.

2.1 The labor market

Total labor supply in the economy is L. All labor is (effectively) unionized and is **evenly** distributed over the n unions. Although the labor of any given union can be usefully employed in all industries it is not perfectly substitutable for the labor of other unions.[9] Labor of a given union is supplied completely inelastically and is mobile across industries. The demand for the labor of workers in union j is given by:

$$L_j^d = \left[\frac{\alpha}{n}(d - w_{rj}) - \gamma(w_{rj} - \overline{w}_r) \right] L \tag{3}$$

where L_j^d is demand for the labor of that union, w_{rj} is the (logarithm) of the real wage obtained by its members and $\overline{w}_r \equiv \sum_{j=1}^{n} \frac{w_{rj}}{n}$ is the (arithmetic) mean of w_{rj} over all unions in the economy. This demand function states that the share (in total labor force) of labor

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[8]This is at least partly due to the fact that the income, pensions and other wealth of union members is not fully indexed. Grüner and Hefeker (1999) report that the representatives of German labor unions recently demanded that inflation continue to be low in the newly formed European Monetary Union.

[9]The notion underlying this specification is that labor is generally differentiated.

demand facing union j is decreasing in its own real wage and increasing in the average real wage in the economy. Summing over unions, aggregate demand for labor in the economy is given by:

$$L^d \equiv \sum_{j=1}^{n} L_j^d = \alpha(d - \overline{w}_r)L \ . \tag{4}$$

Equation (4) states that aggregate demand for labor depends (negatively) **only** on the **average** real wage $\overline{w}_r$. In particular aggregate demand for labor **does not** depend on the number of unions in the economy. Equation (3) implies that any union that sets its real wage equal to the average real wage in the economy obtains $1/n$ of aggregate labor demand. When it sets the real wage above (below) the mean wage its total share of aggregate demand is lower (higher) than $1/n$. But since labor is differentiated deviations of the real wage of a particular union from the economy wide average do not induce a total loss of demand or an infinite demand. For a given number of unions the parameter γ measures the degree of substitutability between the labor of different unions.

Equation (3) implies that the absolute value of the elasticity of labor demand facing union j, η_j, with respect to the (level of the) real wage set by union is:

$$\eta_j = \frac{\alpha + \gamma(n-1)}{\alpha(d - w_{rj}) - n\gamma(w_{rj} - \overline{w}_r)}. \tag{5}$$

In a symmetric equilibrium this elasticity is increasing in the degree of decentralization of wage bargaining, as measured by n,.[10] Thus, equation (3) implies that, although **total** labor demand does not depend on the degree of centralization of wage bargaining, the extent of wage competition among unions is larger when the labor force is spread over a larger number of bargaining units. This is the competition effect of more decentralization discussed by Calmfors and Driffill (1988) and Calmfors (1993).

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[10]The sign of the partial derivative of η_j with respect to n is determined by the sign of: $\alpha(d - \overline{w}_r) - \gamma(w_{rj} - \overline{w}_r)$ which is positive if and only if: $w_{rj} < \overline{w}_r + \frac{\alpha}{\gamma}(d - \overline{w}_r)$. Provided aggregate labor demand is positive, $d - \overline{w}_r$ is positive as well, implying that as long as the real wage chosen by an individual union is not "too much" above the economy wide real wage η_j is increasing in n. This condition is always satisfied in a symmetric equilibrium.

2.2 The central bank problem

In the second stage of the game, the monetary authority chooses the inflation rate after nominal wages have been set in stage one. We thus focus on discretionary monetary policy. Reformulating the labor demand equation in terms of nominal wages and inflation leads to the following aggregate unemployment equation:

$$u \equiv \frac{L - L^d}{L} = \alpha \left(\overline{w} - \pi - p_{-1} - w_r^c \right) \tag{6}$$

where $\overline{w} \equiv \sum_{j=1}^{n} \frac{w_j}{n}$ is the average nominal wage, p_{-1} is the (log of) previous period price-level, $w_j \equiv w_{rj} + p$ and $w_r^c \equiv d - \frac{1}{\alpha}$ is the market clearing real wage (at which $u = 0$).[11] The central bank problem in the domestic country is to choose the inflation rate to minimize the loss function (2), subject to (6), taking $\overline{w}$ as given. This yields the following monetary policy reaction function:

$$\pi = \frac{\alpha^2}{\alpha^2 + I} \left(\overline{w} - w_r^c - p_{-1} \right). \tag{7}$$

Equation (7) can be rewritten, splitting the nominal wage into its real and expected price-level components $\left(\overline{w} = \overline{w}_r + Ep \right)$ as:

$$\pi = \frac{\alpha^2}{\alpha^2 + I} (\overline{\phi} + E\pi) \qquad \text{where } \overline{\phi} \equiv \overline{w}_r - w_r^c \tag{8}$$

where the variable $\overline{\phi}$ is defined as the average real wage premium in excess of the real competitive wage and $E\pi$ is expected inflation. Imposing the rational expectations condition that $\pi = E\pi$ and rearranging, the equilibrium expression for inflation is:

$$\pi = \frac{\alpha^2}{I} \overline{\phi}. \tag{9}$$

This equation confirms, within our multiunion framework, the well known Kydland and Prescott (1997), Barro-Gordon (1983) result that inflation is positive when the "natural"

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[11] Given the assumption of symmetry between unions the real competitive wage level is the same for all unions.

unemployment rate is above the desired rate (zero in our case).[12] It also appears that, for a given wage premium, inflation is lower the higher is central bank conservativeness as characterized by I.

2.3   Wage-setting

In the first stage each union chooses the nominal wage w_j that minimizes the loss function (1), taking the nominal wages of other unions and the reaction function of the monetary policy to nominal wages (7) as given. Assuming, for simplicity, that all unions within each country are identical in size, each of them has a total labor supply equal to $L_j = L/n$. The unemployment rate for union j workers is thus given by:

$$u_j \equiv \frac{L_j - L_j^d}{L_j} = \alpha \left(w_j - \pi - p_{-1} - w_r^c\right) + \gamma n(w_j - \bar{w}). \tag{10}$$

Using (10) in equation (1) the optimization problem of a typical union can be formulated as:

$$\underset{w_j}{Min}\ E\left\{-2(w_j - \pi - p_{-1}) + A\left[\alpha\left(w_j - \pi - p_{-1} - w_r^c\right) + \gamma n(w_j - \bar{w})\right]^2 + B\pi^2\right\} \tag{11}$$

where E is the expectations operator. The first order condition for the typical union's problem is (the superscript N denotes outcomes obtained under a NMP regime):

$$2E\left\{-(Z^N) + A\left[\alpha\left(w_j - \pi - p_{-1} - w_r^c\right) + \gamma n(w_j - \bar{w})\right]\left(\alpha Z^N + \gamma(n - 1)\right) + B\pi(1 - Z^N)\right\} = 0 \tag{12}$$

where

$$Z^N \equiv 1 - \frac{d\pi}{dw_j} = 1 - \frac{\alpha^2}{(\alpha^2 + I)n}, \qquad j = 1...n$$

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[12] Unemployment appears in our model when the real wage exceeds the competitive benchmark level (i.e. for all $\bar{\phi} > 0$).

and the superscript "N" stands for the NMP regime. Summing over all unions and dividing equation (12) by n, yields the equilibrium real wage premium (recall that $\overline{\phi} \equiv \overline{w} - Ep - w_r^c$) demanded by unions under the NMP regime. This yields:

$$\overline{\phi}^N = \frac{Z^N}{\alpha \left\{ (1 - Z^N) B \frac{\alpha}{I} + A \left[\alpha Z^N + \gamma(n - 1) \right] \right\}} = \phi_j^N, \qquad j = 1...n. \qquad (13)$$

This is also the wage premium of each individual union since the problem is symmetric. Note that the wage premium is lower, and employment higher, the higher the parameters A and B. Z^N is the impact of a one unit increase in the nominal wage rate on the typical union's real wage rate, under NMP, taking into consideration the reaction function of the CB. Thus Z^N is a measure of the effectiveness of changes in the nominal wage in bringing about changes in the real wage. For finite values of CB conservativeness and of the number of unions this parameter is smaller than one. This implies that in order to raise its real wage by one unit the union has to raise its nominal wage rate by more than one unit. The expression for Z^N suggests that this effectiveness parameter is lower the smaller the number of unions and the more liberal is the CB (the lower I). It can be shown that, other things the same, the wage premium is an increasing function of Z^N. Substituting the expression for Z^N into equation (13) and rearranging, the wage premium can be expressed as

$$\overline{\phi}^N = \frac{I \left[(n - 1)\alpha^2 + nI \right]}{\alpha \left\{ B\alpha^3 + AI \left[\alpha((n - 1)\alpha^2 + nI) + \gamma(n - 1)n(\alpha^2 + I) \right] \right\}} = \phi_j^N, \qquad \forall \ j's. \qquad (14)$$

2.4   Macro outcomes under national monetary policies

The equilibrium rates of unemployment and of inflation are, from equations (6) and (9), proportional to the wage premium. They are given respectively by:

$$u^N = \alpha \overline{\phi}^N \ \ and \ \ \pi^N = (\alpha^2/I)\overline{\phi}^N. \qquad (15)$$

It appears from (14) that the equilibrium average wage premium is positive, and therefore so are unemployment and inflation. The former is a consequence of the fact that each union

is willing to inflict some unemployment on its members in order to raise the real wage of the employed members above the competitive level. The latter is due to the policymaker's incentives under discretionary policy. Simple comparative statics of the equilibrium wage-premium reveal some basic properties of the model. They are summarized in the following four propositions:[13]

Proposition 1 *The more unions care about price stability (B) and/or the higher is substitutability between the labor of different unions (γ), the lower is the equilibrium real wage premium, and correspondingly, the lower the rates of unemployment and of inflation.*

Unions' concern with price stability **moderates** their wage demands. The reason is that each union realizes that by raising its real wage it increases the CB incentives to inflate in order to reduce unemployment. When unions dislike inflation, this recognition of CB incentives moderates wage demands. This moderating effect is stronger when the number of unions is small.

Differentiating (14) with respect to n and rearranging yields:

$$\frac{\partial \overline{\phi}^N}{\partial n} = \frac{I(\alpha^2 + I)}{\alpha D^2} \left[B\alpha^3 + AI\gamma \left(\alpha^2(2n-1) - (\alpha^2 + I)n^2 \right) \right] \tag{16}$$

where D is the expression in the curly bracket appearing in the denominator of (14). This leads to:

Proposition 2 *i. If $B < \frac{AI^2\gamma}{\alpha^3} \equiv B_c$, $\frac{\partial \overline{\phi}^N}{\partial n} < 0$ at all n.*
ii. If $B > B_c$, $\frac{\partial \overline{\phi}^N}{\partial n} > 0$ at low n and $\frac{\partial \overline{\phi}^N}{\partial n} < 0$ at high n.

Changes in n trigger two opposite effects on real wages, unemployment and inflation. The increase in the number of unions increases the substitutability between the labor of different unions and therefore the degree of effective competition between them. This "increased competition effect" lowers real wages, unemployment and inflation. But the increase in

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[13]Empirical evidence and a fuller discussion of the features of equilibrium outcomes under the NMP regime are provided in Cukierman and Lippi (1999).

the number of unions also reduces the moderating effect of inflationary fears on the real wage demands of each union. This "strategic effect" raises real wages, unemployment and inflation. Part i of proposition 2 states that when unions' concern for price stability is smaller than a certain threshold, the first effect dominates and hence unemployment and inflation are decreasing in the number of unions. The second part of proposition 2 states that, when unions' aversion to inflation is larger than the threshold, the strategic effect dominates the competition effect at low levels of n, thus producing a Calmfors - Driffill relation between real wages and the number of independent unions. The threshold $B_c \equiv \frac{AI^2\gamma}{\alpha^3}$ implies that an inverted U relation between real wages and centralization (the reciprocal of n) is more likely to arise the lower the substitutability between the labor of different unions (lower γ), the lower I and the less unions care about unemployment among their members (the lower A).

A third feature of the equilibrium is that the structure of monetary policy institutions affects real macroeconomic variables like unemployment. Since this is due to the strategic interaction between unions and monetary authorities we refer to those non-neutralities as "strategic". Differentiating (14) with respect to I yields:

$$\frac{\partial \overline{\phi}^N}{\partial I} = \frac{\alpha}{D^2} \left[\left(\alpha^2(n-1) + 2In \right) B\alpha + AI^2\gamma n(n-1) \right] \tag{17}$$

This leads to:

Proposition 3 *An increase in the degree of central bank conservativeness raises the rate of unemployment if at least one of the following conditions holds:*

i. $B > 0$ (unions are averse to inflation)

ii. $\gamma > 0$ and $n > 1$ (there are at least two unions and some degree of substitutability in the demands for their labor).

As unions become atomistic ($n \to \infty$) this effect becomes negligible.

The two conditions in the proposition correspond to two different kinds of strategic non-neutralities. The first one operates through trade unions' concern about price stability ($B > 0$). It is due to the fact that the higher CB conservativeness the smaller are the

inflationary consequences of a higher wage premium. Hence a more conservative central bank induces unions to demand higher real wages (as this triggers a milder inflationary reaction by the CB).

Provided there is more than one union in the economy, there is a second source of "strategic non-neutrality" which operates even when unions are not concerned with price stability ($B = 0$). It is due to the fact that under nominal contracting, the marginal tradeoff between the real wage and the relative wage facing the individual union depends on the level of CBI. More precisely, the marginal impact of a unit increase in a union's nominal wage rate on its real wage depends (positively) on CBI whereas its impact on the relative wage does not depend on CBI. As a consequence, to obtain a unit increase in its real wage rate, the union has to accept an increase in its relative wage that is larger the smaller CBI. Thus, a less inflation averse central bank leads unions to perceive a given increase in their own real wage as more costly in terms of competitiveness (relative wage). This **adverse competitive effect** moderates unions' real wage demands and is larger the larger is the degree of substitutability between the labor of different unions (γ). This second non neutrality contrasts with most of the literature on monetary policy games under perfect information in which (when unions are indifferent to inflation) CBI affects inflation but does not affect real variables. Neutrality reappears, however, even when conditions i and ii hold, when n is large since in this case each individual union basically neglects the effect of its own actions on inflation.[14]

Finally, we focus on the effect of higher central bank conservativeness on inflation which, from equations (14) and (15), is given by:

$$\frac{\partial \pi^N}{\partial I} = \frac{\alpha^2}{I^2}\left[\frac{\partial \overline{\phi}^N}{\partial I}I - \overline{\phi}^N\right] = \tag{18}$$

$$= \frac{\alpha^2\left\{n\alpha^2 B + n(n-1)\alpha A\gamma I - A\left[(n-1)\alpha^2 + nI\right]\left[(n-1)(n\gamma\frac{(I+\alpha^2)}{\alpha} + \alpha^2) + nI\right]\right\}}{D^2}$$

The main implication of equation (18) is summarized in the following (the proof is in the

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[14]This can be seen by noting that expression (17) converges to zero as n tends to infinity (a higher power of n appears in the denominator than in the numerator).

appendix):

Proposition 4 *An increase in CB conservativeness reduces inflation for a sufficiently large n, but may be positive for given values of n if B is sufficiently large.*

The proposition implies that the marginal impact of CBI on inflation may be positive at high levels of centralization but that it is always negative for sufficiently low levels of centralization. The reason is that, at high levels of centralization, the inflationary impact of an increase in the real wage premium due to an increase in CBI may dominate the direct negative effect of higher CBI on inflation. As the number of unions rises, the second effect eventually dominates. This happens since smaller unions internalize the expansionary reaction of the CB to a lesser extent into their wage decisions. Thus, a sufficiently large number of unions delivers the "traditional" result that higher central bank conservativeness (or "independence") reduces inflation.

3 A Two-Country Monetary Union

The basic issue addressed in this section is whether the strategic linkages between the choices of wage-setters and those of the CB imply that the establishment of a MU alters the equilibrium values of inflation and of other variables in the participating countries. To determine whether there are such effects we start by considering the simple benchmark case of a MU between two identical countries (i.e. with the same structural parameters, and the same agents' preferences). In order to focus on the direct effects of a MU we also assume that the establishment of a MU does not cause any changes of the pre-union parameters (including the CB inflation aversion). Finally, it is assumed that all unions set wages simultaneously, i.e. no union (or country) is a leader in wage setting. The consequences of partial relaxation of this assumption are studied in subsection 5.2.

It would seem at first blush that, under those circumstances, the shift to a MU should not affect real variables. This, at least, is the implication of a standard Barro-Gordon framework in which unions' choices are not modeled explicitly. Account of trade unions' incentives,

however, yields, as we shall see, a different answer. The formation of a MU unambiguously reduces the impact of each union's wage decisions on the subsequent rate of inflation. This happens because the number of unions interacting with the central bank is larger in the MU. When a typical union is concerned about inflation, a decrease in its relative size diminishes its perception of how much inflation is caused by its individual wage choice. This leads to a higher wage premium and therefore to higher unemployment and inflation.

The total direct effect of a MU on unions' behavior is likely to depend on several parameters, such as the relative size of the countries joining the MU and the inflation aversion of the single central bank. A more precise analytical framework is therefore needed to assess the relative importance of those effects. Such a framework follows.

3.1 A simple monetary union model

We consider two countries named 1 and 2 with total labor supplies given by L_1 and L_2. Countries are allowed to differ in the sizes of their labor forces (L_i), in number of unions (n_i) and in the degrees of substitutability between the labor of different unions within a given country (γ_i). As in the NMP case, the typical union j ($j = 1, 2, .., n_i$) in country i ($i = 1, 2$) faces the following labor demand:

$$L_{ij}^{dU} = \left[\frac{\alpha}{n_i}(d - w_{ij} + \pi + p_{-1}) - \gamma_i(w_{ij} - \overline{w}_i) \right] L_i \tag{19}$$

where the previous period price level p_{-1} is, without loss of generality, assumed to be the same across countries.[15] The labor demand specification in (19) is the exactly analogous to (3). This reflects our presumption that, at least to a first approximation, the formation of a MU does not alter the degree of competition in the labor market.[16] The aggregate unemployment rate in the area is therefore given by:

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[15] Given that countries in the MU have the same inflation rate π, a common price level, p, for both countries is obtained by normalizing one of the previous-period price indices, $p_{i,-1}$, to the level of the other (assumed to be the new common currency).

[16] Competition might increase in the MU if labor substitutability increases due to higher labor or capital mobility in the MU. This view is stressed, among others, by Burda (1999).

$$u^U = \frac{L_1 + L_2 - \left(L_1^{dU} + L_2^{dU}\right)}{L_1 + L_2} = s_1 u_1^U + s_2 u_2^U$$

where $s_i \equiv \frac{Li}{L_1+L_2}$ is a measure of the country size (in terms of relative labor supply), $u_i \equiv \frac{L_i - L_i^{dU}}{L_i}$ is country's i rate of unemployment and L_i^{dU} is total demand for labor in country i. The competitive real wage level is the same in the two countries, as the structural parameters that determine it are, for simplicity, assumed to be the same. Hence $w_r^c \equiv d - \frac{1}{\alpha}$ as in section 2. Using equation (6) for the unemployment rate in each country, the area-wide unemployment rate can be written as:

$$u^U = \alpha \left(\overline{w}^U - \pi^U - w_r^c - p_{-1}\right) \tag{20}$$

with $\overline{w}^U \equiv s_1 \overline{w}_1^U + s_2 \overline{w}_2^U$.[17] The loss function of the single central bank in the MU is given by equation (2) where the inflation and unemployment arguments are now the corresponding area-wide measures. The monetary policy authority reaction function, which in terms of area-wide variables is identical to (7), can be rewritten as:

$$\pi^U = \frac{\alpha^2}{\alpha^2 + I} \left[s_1 \overline{w}_1^U + s_2 \overline{w}_2^U - w_r^c - p_{-1}\right]. \tag{21}$$

Union j in country i minimizes the loss function (1) subject to (10) and to (21) taking the nominal wages of the other unions, both at home and abroad, as given. Algebraic manipulations of a typical country 2 union's first order condition make it possible to write the average wage premium in country 2 in terms of the average wage premium in country 1. Given that within each country unions are symmetric the premium requested by each individual union within a given country is identical to the country's average. In the MU regime (superscript U), the reaction function of the average wage premium in country 2 to the average wage premium in country 1 turns out to be:

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[17] Obviously $s_2 = 1 - s_1$ in the two-country MU we study here. However, the model can be easily extended to the case of a m-country MU.

$$\overline{\phi}_2^U = \frac{Z_2^U - \frac{B\alpha^2}{I}(1 - Z_2^U)s_1 \cdot \overline{\phi}_1^U}{\alpha A \left(\alpha Z_2^U + \gamma_2(n_2 - 1)\right) + \frac{B\alpha^2}{I}(1 - Z_2^U)s_2} \tag{22}$$

where $Z_i^U \equiv 1 - \frac{d\pi^U}{dw_{ij}} = 1 - \frac{\alpha^2}{(\alpha^2 + I)} \frac{s_i}{n_i}$, $\qquad j = 1, .., n_i,\ i = 1, 2.$

Since we are assuming that unions move simultaneously in all countries an expression analogous to (22) holds for the average wage premium of country 1 in terms of the average wage premium of country 2. It appears from (22) that trade unions' concern about inflation $(B > 0)$ **creates** interdependencies between the **real** wages of the member countries. These cross effects are obviously absent under a regime of national monetary policies.[18] Since the average wage premium of country 1 influences the single monetary policy and therefore the area-wide inflation rate, unions in country 2 take account of that when setting wages. In particular, wage premia turn out to be **strategic substitutes** since a higher average wage premium in one country raises the area-wide inflation and therefore induces unions in the other country to moderate their wage demands.

The intensity of the reaction of "domestic" wages to "foreign" wages depends on a number of country specific features. In particular, the analysis of the partial derivative $\frac{\partial \overline{\phi}_2^U}{\partial \overline{\phi}_1^U}$ delivers the following:

Proposition 5 *The reaction of wages in country 2 ("domestic") to wages in country 1 ("foreign") is almost nil if:*

    (i) unions in the domestic country are atomistic ($n_2 \to \infty$)

    (ii) the relative dimension of the domestic country in the MU is very small ($s_2 \sim 0$)

    (iii) the relative dimension of the foreign country in the MU is very small ($s_1 \sim 0$)

    (iv) the inflation aversion of the central bank is very high ($I \to \infty$)

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[18]When $B = 0$ there is no link between the **real** wages of unions across different countries. There still **is**, however, a link between the **nominal** wages of the two countries under MU (this is demonstrated in subsection 5.2). Intuitively, this occurs because higher nominal wages in one country tend to increase the area-wide inflation. Therefore, unions in the other country increase their nominal wages in order to maintain their (individually optimal) equilibrium real wage.

Intuitively, in cases (i) and (ii) each union in country 2 is essentially atomistic in the MU (i.e. it does not internalize the inflationary reaction of the CB to its wage decisions) and hence ignores foreign wages as well. Under case (iii) there is no reaction to foreign wages as they are nearly irrelevant to the determination of the MU-wide inflation. In case (iv) the CB is so highly conservative that it keeps inflation low at **all** levels of wages. Hence unions can ignore inflation and indulge in their sectorial interests completely freely.

The equilibrium wage premia $\overline{\phi}_1^U$ and $\overline{\phi}_2^U$ are given by the point where the reaction functions (equation (22) and its counterpart for country 1 unions) cross in the $\left(\overline{\phi}_1^U, \overline{\phi}_2^U\right)$ space. The equilibrium value for the wage premium in country 1 is given by the following expression (a completely analogous expression holds for country 2):

$$\overline{\phi}_1^U = \frac{Z_1^U H_2^U + \frac{B\alpha^2}{I}(Z_1^U - Z_2^U)s_2}{H_1^U \left[H_2^U + \frac{B\alpha^2}{I}(1 - Z_2^U)s_2\right] + \frac{B\alpha^2}{I}(1 - Z_1^U)H_2^U s_1} = \phi_{1j}^U \qquad j = 1, .., n_1. \qquad (23)$$

$$\text{where } H_i^U \equiv \alpha A \left(\alpha Z_i^U + \gamma_i(n_i - 1)\right) \qquad i = 1, 2.$$

Simple algebra reveals that expression (23) reduces to (13) when $s_1 = 1$ (hence $s_2 = 0$) which is the case of a national monetary policy by country 1. It also appears from this expression that, as unions of country i become atomistic (i.e. $n_i \to \infty$, $i = 1, 2$), the wage premia converge to zero irrespective of the monetary regime and of country size. Thus, the orthogonality between **real** labor market outcomes and the monetary regime, that one would expect on the basis of a conventional money-neutrality argument, is obtained as a special case in our model when the labor market is competitive or nearly competitive. The following section considers three simple instances of a MU in which this "traditional" neutrality result no longer obtains due to the fact that unions are non atomistic

4 The effects of a monetary union: some particular cases

Equations (22) and (23) reveal that the establishment of a MU induces complex interactions between wages in the two countries. Those interactions depend on the number of unions, country size, union preferences, labor substitutability in each country and on the conservativeness of the CB. In general they may produce various types of results depending on the nature of structural differences between the countries forming the union. To develop some understanding of how those differences influence the outcome we start from a simple benchmark case in which all countries have identical parameters and move gradually to some more complex cases.

In all those cases our aim is to analyze the **direct** effect of the MU on unions' behavior, i.e. to study the impact of the MU in comparison to outcomes obtained under the NMP regime. To reiterate this effect is "direct" in that it is based on the assumption that all relevant parameters are unaltered by the formation of the MU. Formally, the direct effect on country i's real wages of the formation of a MU is defined as $\overline{\phi}_i^U - \overline{\phi}_i^N$ for **unchanged** underlying parameters.[19] Note that once this effect is known it is possible to determine the effects of the MU on the rates of unemployment and on inflation in the two countries by comparing the expressions for unemployment and inflation under NMP (equation (15)) with their counterparts under MU. Minor rearrangements of equations (20) and (21) imply that the expressions for unemployment and inflation under a MU are:

$$u_i^U = \alpha \overline{\phi}_i^U , i = 1, 2 \ \text{ and } \ \pi^U = \frac{\alpha^2}{I}(s_1 \overline{\phi}_1^U + s_2 \overline{\phi}_2^U) \equiv \frac{\alpha^2}{I} \overline{\phi}^U . \tag{24}$$

We start by analyzing the direct effect of a MU between two countries that are identical in every respect. We then study the direct effect of the MU when the degree of labor substitutability differs between the two countries. Third, we study the direct effect of the

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[19] Obviously, additional macroeconomic effects, of the type described (for an individual national economy) in section 2.4, occur if a country also experiences changes in some of its structural economic parameters.

MU under the assumption that unions are not inflation averse $(B = 0)$. The last case is of interest because it relates to the results of our model to the numerous studies in which unions are assumed not to care about inflation. For this case we also analyze how the direct effects of the MU vary with country size, the number of unions in each country and with the degree of competition in the labor market in each country.

4.1   A monetary union between identical countries

It is useful to begin the analysis from the case of a MU between countries which have identical labor forces $(s_1 = s_2 = 1/2)$, number of unions $(n_1 = n_2 = n)$ and the same degree of substitutability between labor $(\gamma_1 = \gamma_2 = \gamma)$. In this case the premium requested by unions in the MU is obtained by substituting the parametric values given above into equation (23), yielding:[20]

$$\overline{\phi}_i^U = \frac{Z_i^U}{H_i^U + \frac{B\alpha^2}{I}(1 - Z_i^U)} = \phi_{ij}^U \qquad i = 1, 2; \; j = 1, ., n_i. \tag{26}$$

To compare the value of the wage premium given by (26) with the value obtained under the NMP regime (13) the latter can be conveniently rewritten as:

$$\overline{\phi}_i^N = \frac{Z_i^N}{H_i^N + \frac{B\alpha^2}{I}(1 - Z_i^N)} = \phi_{ij}^N \qquad i = 1, 2; \; j = 1, ., n_i \tag{27}$$

(where H^N and Z^N are the NMP counterparts of H^U and of Z^U). Comparison of (26) with (27) for identical values of n and γ immediately leads to:

Proposition 6 *If the unions' and the central bank preferences are identical across countries and do not change with the establishment of the MU, then the wage premium in the MU is*

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[20]Since, for this case $Z_1^U = Z_2^U \equiv Z^U$ and $H_1^U = H_2^U \equiv H^U$ the wage premium under MU is the same across all unions in both countries and is given, in terms of basic parameters, by:

$$\overline{\phi}_i^U = \frac{I\left[(n - \frac{1}{2})\alpha^2 + nI\right]}{\alpha\left\{\frac{B\alpha^3}{4} + AI\left[\alpha((n - \frac{1}{2})\alpha^2 + nI) + \gamma(n - 1)n(\alpha^2 + I)\right]\right\}} \qquad i = 1, 2. \tag{25}$$

Figure 1:
Effects of a Monetary Union between Identical Countries

$\boxed{\textbf{Case } \textit{i.}\ \ \textbf{\textit{B}} < \textbf{\textit{B}}_c}$

unemployment,
inflation

MU

NMP

0

1

$\dfrac{1}{n}$ (Centralization)

$\boxed{\textbf{Case } \textit{ii.}\ \ \textbf{\textit{B}} > \textbf{\textit{B}}_c}$

unemployment,
inflation

MU

NMP

0

1

$\dfrac{1}{n}$ (Centralization)
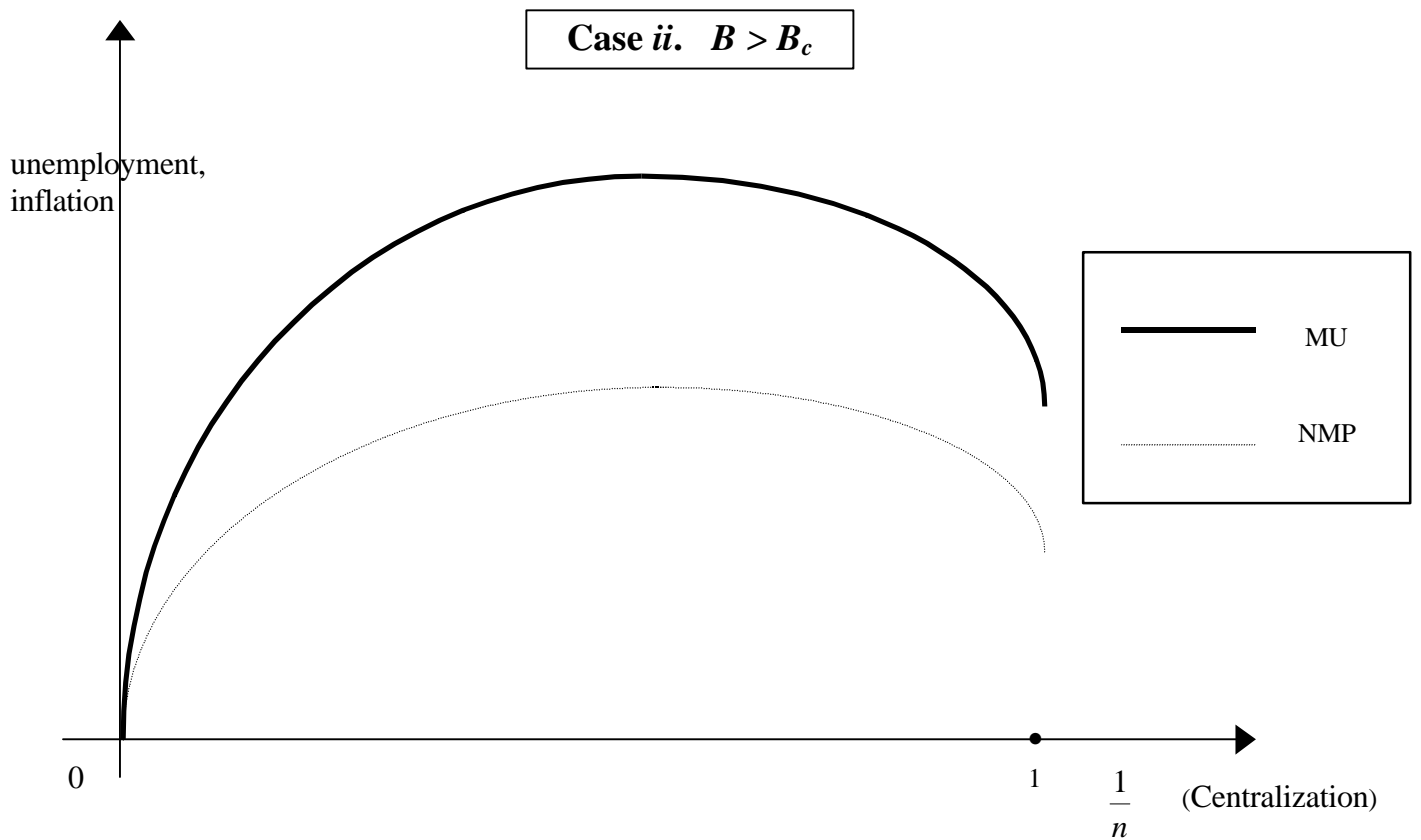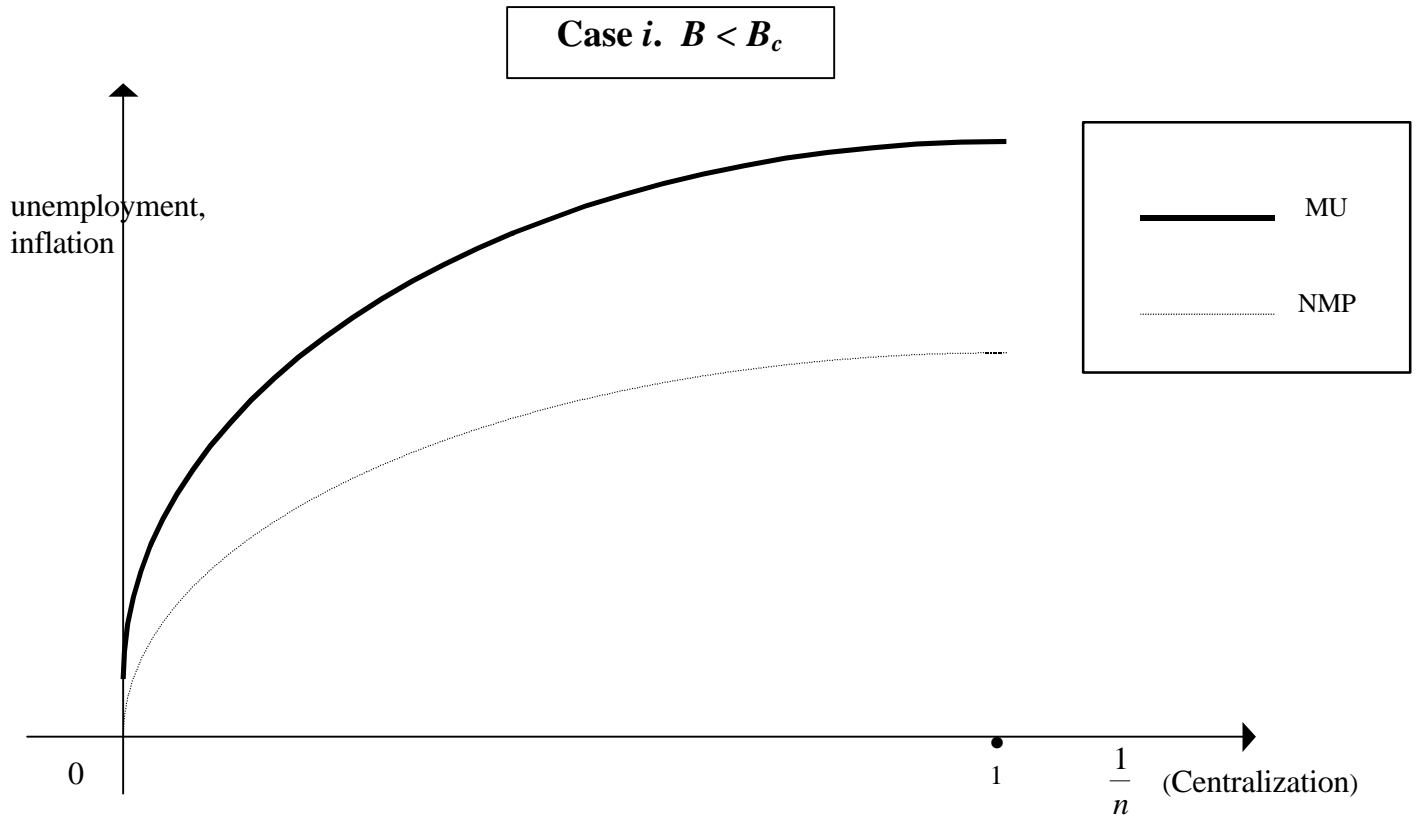
higher than the one obtained under NMP at all levels of n.

Intuitively, the effect of a one unit increase in the nominal wage on its real wage is correctly perceived by a typical individual union to be higher in the MU than in the NMP regime (i.e. $Z^U > Z^N$). In this fully symmetric MU, the switch from the NMP to the MU regime reduces the extent to which each union's internalizes the inflationary repercussions of its own actions, thus raising Z. This alters union behavior via two separate channels. The first one operates through unions' inflation concern ($B > 0$) and the second one through a mitigation of the adverse competitive effect that more inflation causes (when $\gamma > 0$ and $n > 1$). Hence the formation of a MU leads to less moderation in unions' real wage demands through both channels. The upshot is that the switch from IMP to a MU shifts the "Calmfors-Driffill" curve upwards (FIGURE 1).[21] Given the macroeconomic linkages established in equation (24), this result means that both inflation and unemployment (in every country) are increased by the establishment of a MU.

4.2   Differences in labor market competitiveness ($\gamma_1 > \gamma_2$)

We now depart from the fully symmetric benchmark case analyzed above to a somewhat more general case in which the only structural difference between the countries that join the MU concerns the degree of substitutability between the labor of different unions. For concreteness, we assume that $\gamma_1 > \gamma_2$, leaving all other country parameters identical.[22] This implies that, as the substitutability of labor is higher in country 1, effective competition between unions is higher in that country and therefore, under IMP, the wage premium in country 1 is lower than that of country 2.[23]

Since Z^U is the same in both countries equation (23) implies that the wage premium in country 1 in the MU is given by:

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[21] As suggested by proposition 2, what we label as a "Calmfors - Driffill" curve is not necessarily a hump-shaped relation but may also be a monotonic relation between the wage premium and centralization.

[22] Note that this implies that $Z_1^N = Z_2^N$, and that $Z_1^U = Z_2^U$, since it is still the case that $s_1 = s_2$ and $n_1 = n_2$.

[23] This follows from proposition 1.

$$\overline{\phi}_1^U = \frac{Z^U H_2^U}{H_1^U H_2^U + \frac{B\alpha^2}{2 \cdot I}(1 - Z^U)(H_1^U + H_2^U)}.\tag{28}$$

As in the previous experiment, the direct effect of the establishment of a MU is obtained by comparing the premium under NMP (27) with the premium under a MU (28). This leads to the following (the proof appears in the appendix):

Proposition 7 *If the degree of competitiveness across unions is higher in country 1 than in country 2 ($\gamma_1 > \gamma_2$), then the establishment of a MU:*

(i) Leads to a reduction in the wage premium of country 1 provided unions' inflation aversion (B) and the positive competitiveness difference ($\gamma_1 - \gamma_2$) are both sufficiently large. Otherwise the premium increases.

(ii) Leads to an increase in the wage premium of country 2 in comparison to the NMP regime

The intuition underlying the proposition follows. Once in the MU, the relatively more competitive unions of country 1 are faced with the higher wage premium of the unions of country 2. As a consequence, at given pre-MU wage premia, the area-wide wage premium is higher than the premium they faced before joining the MU. Taken in isolation, this effect tends to raise the inflationary response of the CB inducing unions in country 1 to moderate their wage demands in order to avoid excessive inflation. However, the formation of the MU also reduces the relative size of each individual unions in all countries. This raises Z and induces each union to demand a higher wage premium (this is the "pure" MU effect described in the previous subsection). The final outcome of these contrasting effects on country 1 wages depends on the unions' inflation aversion. If they are highly averse to inflation, the first effect dominates and the establishment of a MU leads to a reduction in the average wage premium of the country with the relatively more competitive labor market. The upshot is that the direct effect of the MU on the wage premium in the more competitive country depend on the degree of unions' inflation aversion.

The effect of the MU is unambiguous in the country with less competitive labor markets (country 2) since, at pre-union real wages, labor unions in this country face a lower area-

wide wage premium than they faced before joining the MU. This creates an incentive to push up the wage premium that cumulates on top of the one triggered by the relatively smaller impact that each individual union wage decisions have on the inflationary reaction of the central bank. Thus, the direct effect of the MU, is to increases the wage premium in the country with less competitive labor market, thereby raising the rate of unemployment in that country.

4.3 A MU between countries with heterogeneous structures ($s_1 \neq s_2$, $n_1 \neq n_2$, $\gamma_1 \neq \gamma_2$) when unions do not care about price stability ($B = 0$)

We now consider the direct effect of a MU in the case in which unions are not inflation averse. This allows us to study, albeit in a particular case, how the direct effect of the establishment of a MU varies with country size, the differences between the degrees of competitiveness among unions in each country as well as cross country differences in the centralization of wage bargaining. When $B = 0$ the general expression for the wage premia of individual country in the MU (23) reduces to:

$$\overline{\phi}_i^U = \frac{Z_i^U}{H_i^U} = \left[\alpha^2 A + \alpha A \frac{\gamma_i(n_i - 1)}{1 - \frac{\alpha^2}{\alpha^2 + I} \frac{s_i}{n_i}} \right]^{-1} = \phi_{ij} \qquad i = 1, 2; \; j = 1, .., n_i \qquad (29)$$

Comparison of the wage premium under MU with the corresponding premium under NMP leads to the following proposition (The proof is in the appendix):

Proposition 8 *If unions do not care about price stability ($B = 0$), there is more than one union in the economy (n > 1) and some competitiveness between them ($\gamma > 0$) then:*

(i) the direct effect of a MU is to raise the wage premium in all countries,

(ii) the direct effect of the MU on the wage premium is larger in countries with a relatively smaller size,

(iii) the direct effect of the MU on the wage premium is largest in countries characterized by intermediate levels of centralization of wage bargaining (n) and of labor market

competitiveness (γ).

The first result states that, in the absence of inflation aversion on the part of unions and provided there is more than one union in the economy, the formation of a MU unambiguously increases real wages (and hence inflation and unemployment). This effect is triggered by the **decrease** in the moderating influence that the **adverse competitive effect,** described in proposition 3, has on unions' wage demands. Basically, in a MU each individual labor union internalizes the inflationary impact of its individual actions, and of the associated deterioration in competitiveness, to a lesser extent. This induces each union to adopt a more aggressive wage strategy which, in equilibrium, results in higher real wage premia in **all** countries.

The proposition also reveals that the impact of a MU varies with some structural features of the country that joins the union. The direct effect of joining a MU on a country's real wage is larger the smaller the size, s_i, of the country in the MU . The intuition is that the smaller a country, relative to the whole union, the larger is the relative size change that its labor unions undergo by joining the MU. Since unions in a smaller country internalize the repercussions of their actions on the MU rate of inflation to a lesser extent, their wage-setting strategy becomes more aggressive to a larger extent than that of larger countries. This suggests that the adverse "real" effects of the European Monetary Union could be largest in "small" countries, such as Austria and The Netherlands.

Finally, the proposition states that the effect of the MU is largest at intermediate levels of centralization and of labor market competition (as measured by the labor substitutability parameter, γ). The reason is that when either n or γ are large labor market performance converges towards the competitive, market-clearing level, irrespective of the monetary regime (see propositions 1 and 2). At the other extreme, when $n = 1$ or $\gamma = 0$ the type of monetary regime does not affects the wage premium because, due to the fact that the degree of competition in the labor market is zero, the **adverse competitive effect** does not operate. Therefore, the largest direct effect of the MU occurs in countries with intermediate levels of centralization of wage bargaining and intermediate levels of the degree of substitutability

among the labor of different unions.

5 Two Alternative Institutional Scenarios

This section examines the sensitivity of the results to variations in some of our institutional assumptions. In particular we try to bring the analysis one step closer to the European situation by studying the effects of the MU under two alternative institutional scenarios that may be relevant for Europe. First, we consider the possibility that prior to joining the MU some European countries already had subjugated their monetary policies to that of Germany through the ERM. In this scenario, Germany, the anchor country, conducts its monetary policy independently of area-wide developments in the other countries, and the central banks of those countries make a unilateral commitment to mimic German monetary policy.

Second, we modify the Nash wage bargaining framework used in the previous part of the paper to allow for wage-leadership by the unions of a given country (i.e. we solve a Stackelberg game). This variation is meant to approximate a situation in which some unions are wage leaders and others are followers. The leaders set their wages taking into consideration the wage reaction of the followers who, on their part, take the wages of the leaders as given. This framework may indicate how the existence of some large trade-unions with a history of wage leadership, such as the IGM in Germany, affects economic performance in the EMU.[24]

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[24]Similar exercises are developed by Grüner and Hefeker (1999) and Soskice and Iversen (1998). As discussed in the introduction, one important diffence in comparison to their models is that we abandon the assumption of a single monopoly union and of identical countries.

5.1 The direct effects of switching from a (credible) ERM to the MU

We model the ERM regime as an asymmetric mechanism where the central bank of Germany (the anchor country) conducts its monetary policy independently focusing on domestic conditions while the central banks of the other countries precommit to follow the German inflation rate. In practice, several European countries attempted to reduce inflation towards the lower German rates by joining the ERM, i.e. by stipulating some form of exchange-rate precommitment with Germany. Therefore, by characterizing membership in the ERM as a "direct" precommitment to German inflation by the participating countries, we are implicitly assuming that the ERM exchange rate commitment is fully credible.[25]

Under this characterization of the monetary regime, monetary policy in Germany in the pre-MU period is described by the NMP regime that was presented in section 2, so that the equilibrium wage premium is given by equation (13). The crucial difference made by the existence of a credible ERM, in the pre-MU period, concerns the unions of the countries that precommitted to follow German monetary policy. For those unions domestic inflation is unrelated to their wage premia, because they know that domestic inflation is determined by the German CB that looks **only** at developments in Germany. This implies that each union in the "other" ERM countries (subscript "other") perceives that its individual actions have no impact on the rate of inflation (i.e. that $\frac{\partial \pi}{\partial w_{j,other}} = 0$ implying $Z_{other} = 1$). Hence the wage premium in the "other" countries under the ERM is:

$$\overline{\phi}_{other}^{ERM} = \frac{1}{\alpha A \left[\alpha + \gamma(n-1)\right]} \tag{30}$$

which is larger than the premium obtained under NMP.[26] The fact that under a credible

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[25] Obviously, a precise formalization of the ERM requires the use of a model with foreign trade and exchange rates. On the other hand, if the exchange rate precommitment is not credible, each country essentially follows discretionary monetary policies. But in this case the appropriate characterization of the pre-MU period is provided by the NMP regime analyzed in section 2

[26] This follows from the observation that the wage premium is increasing in Z (see equation 13).

ERM the unions in the "other" countries do not internalize the impact of their actions on inflation eliminates a deterrent to unions' high wage claims and therefore leads them to adopt a more aggressive wage strategy.

This simple reformulation of the model suggests that, other things the same, unemployment should be lower in the anchor country than in the "other" countries under the ERM. Soskice and Iversen (1998), who consider a similar characterization of the ERM, suggest that this prediction is "clearly borne out empirically in the period from 1983 to 1992 (p.120)". Note, however, that the expression for the wage premium suggests that one should also control for cross-country differences in the degree of centralization, labor substitutability and unions' preferences. For instance, if the labor market structure in one of the "other" countries is highly decentralized (high n) or highly competitive because of a high labor substitutability (high γ), or both, the unemployment rate in that country could be lower than in the anchor country.

Keeping this qualification in mind, it is of interest to focus on the effects of the MU in the case of identical countries, as a simple benchmark case. The essential difference between the ERM and the MU is that in the latter inflation is determined by a central bank that reacts to area-wide economic variables, whereas the Bundesbank reacted only to German variables. Under this characterization, the creation of a MU should increase the wage premium of German unions and should lower the premia of unions in "other" countries. The reason is that the creation of a MU **reduces** the perceived impact of each individual German union on inflation while the opposite happens in the "other" countries, whose unions now correctly realize that their wage decisions have a non-zero impact on the inflationary reaction of the monetary union's CB. This moderates wage demands by the unions of the "other" countries.

5.2 The effects of wage leadership by a country in the MU

Wage setting in several European countries was often characterized by wage leadership on the part of a major union, with other unions acting as followers. In Germany, for instance, the metalworkers' union (IG metall) played a leadership role *vis a vis* the other unions.

Soskice and Iversen (1998) report that between 1974 and 1994 the IGM set the norm for wage increases in 15 out of 21 bargaining rounds. It therefore appears interesting to examine how the existence of leading unions may alter macro outcomes in a MU. A full analysis of this case would require the incorporation of the possibility that there are, within **each** country in the MU, **both** leaders and followers. For reason of brevity we present a less ambitious analysis in which all unions in one country are Stackelberg leaders in wage setting and all unions of the other country are Stackelberg followers. Although less general this specification makes it possible to capitalize on some of the earlier results and still get insights about some of the differences in macro outcomes between a MU in which all unions move simultaneously and a MU in which some of the unions act as wage leaders. It may also be of independent interest to the extent that the unions of a large country, like Germany for example, develop a wage leadership position in the future.

To differentiate between leaders and followers we extend the timing structure to three stages. In the first stage the unions of country 1 who are the wage leaders set their nominal wages. The negotiated wages are observed and taken as given by the unions of country 2, when they set their nominal wages in the second stage. In the third stage, after observing the negotiated area-wide wages, monetary policy is chosen by the central bank of the MU. The game is solved by backward induction. In the last stage, monetary policy responds to the negotiated wages according to the reaction function (21). In the second stage, the unions of country 2 set their nominal wages taking as given the nominal wages of unions in country 1. This leads to the following reaction function of the average **nominal** wages in country 2 to country 1 wages:

$$\overline{w}_2 \;=\; \Theta_1 + \Theta_2 \cdot \overline{w}_1 \tag{31}$$

$$\text{where} \quad \begin{cases} \Theta_1 \equiv \dfrac{(p_{-1}+w_r^c)\left[H_2^U(1-\theta)+B(1-Z_2^U)\right]+Z_2^U}{(1-\theta s_2)H_2^U+B(1-Z_2^U)\theta s_2} \\[2em] \Theta_2 \equiv \dfrac{\theta s_1\left[H_2^U-B(1-Z_2^U)\right]}{(1-\theta s_2)H_2^U+B(1-Z_2^U)\theta s_2} < 1 \\[2em] \theta \equiv \dfrac{\alpha^2}{\alpha^2+I} \end{cases}$$

Equation (31) is obtained from the first order condition of a typical union in country 2, after aggregating over all unions. This reaction function is the **nominal wage** counterpart of the reaction function between the real wage premia (equation 22) presented in section 3.[27] Despite its cumbersome algebraic form, equation (31) has a simple interpretation. The slope coefficient Θ_2 shows how nominal wages in country 2 react to increases in the nominal wages of country 1 (i.e. $\frac{\partial \overline{w}_2}{\partial \overline{w}_1}$). Even in the simple case in which unions do not care about inflation ($B = 0$), it appears that nominal wages are linked since if unions in country 1 increase their wages, inflation will increase, and therefore unions in country 2 scale up their wages accordingly in order to maintain the real value of their wages.[28] More generally, when B differs from zero, the sign of Θ_2 depends on the size of B. This is summarized in the following:

Remark 1 *If $B \geq B_T \equiv \frac{H_2^U}{(1-Z_2^U)}$ then $\frac{\partial \overline{w}_2}{\partial \overline{w}_1} \equiv \Theta_2 \leq 0$; otherwise $\frac{\partial \overline{w}_2}{\partial \overline{w}_1} \equiv \Theta_2 > 0$.*

The dependence on B of the sign of the response of country's 2 nominal wages to an increase in country's 1 nominal wages is due to the fact that this increase triggers two opposite effects on nominal wages in country 2. On one hand, due to their inflation aversion country's 2 unions are willing to take a cut in their real wages in order to moderate the inflationary response of the CB to the increase in the nominal wages of country 1. On the other hand, they also wish to, at least partly, maintain their real wages in the face of the

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[27] If expressed in real terms, expression (31) yields equation (22). Obviously, this is true only for the unions of country 2, who take country 1 wages as given both under simultaneous bargaining and under country 1 unions' leadership.

[28] Note that when $B = 0$ there is no link between the **real** wages of the two countries (see equation (22)) but **nominal** wages are still linked (see equation 31).

higher subsequent inflation triggered by the response of the CB to the increase in country's 1 nominal wages. If unions' inflation aversion is sufficiently high $(B \geq B_T)$ the first effect dominates and an increase in country's 1 nominal wages leads unions in country 2 to reduce their nominal wages in order to avoid excessive inflation by the CB of the MU. When unions' inflation aversion is not sufficiently high $(B < B_T)$ the desire to avoid an excessive reduction in the real wage dominates and nominal wages in country 2 go up. But the increase in the nominal wage in this case is **less** than proportional.[29]

Let us now consider the first stage of the game in which the leading unions choose their wages. Each union in country 1 sets its nominal wage taking account of the reaction of nominal wages in country 2 and of the monetary policy reaction function (equations (31) and (21), respectively). The first order condition of the typical union problem in country 1 implies the following reaction function of the average wage premium in country 1 to the average wage premium in country 2 (the superscript "L" denotes leadership):

$$\overline{\phi}_1^L = \frac{Z_1^L - \frac{B\alpha^2}{I}(1 - Z_1^L)s_2 \cdot \overline{\phi}_2^L}{\alpha A\left(\alpha Z_1^L + \gamma_1(n_1 - 1)\right) + \frac{B\alpha^2}{I}(1 - Z_1^L)s_1} \tag{32}$$

$$\text{where } Z_1^L \equiv 1 - \frac{d\pi}{dw_{1j}} = 1 - \left[\frac{\alpha^2}{(\alpha^2 + I)}\frac{s_1}{n_1} + \frac{s_2}{n_1}\Theta_2\right], \qquad j = 1, .., n_1.$$

It appears that the reaction function for the wage premium in equation (32) is analogous to the expression obtained under simultaneous wage bargaining with the crucial difference that Z_1^U is now replaced by Z_1^L.[30] This captures the essential difference between the two scenarios. Under wage leadership, the unions of country 1 internalize the impact of their wage decisions on inflation to a different extent than under simultaneous bargaining. This happens because they do not take nominal wages in country 2 as given, but rather take

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[29]Since $\Theta_2 < 1$, nominal wages in country 2 respond to nominal wages in country 1 less than proportionally. This comfirms that the **real** wage premia are strategic substitutes, as shown in subsection 3.1.

[30]The reaction function of country 2 wage premium to country 1 is unchanged by the assumption of leadership because the unions of country 2 (i.e. the followers) take country 1 wages as given under both scenarios. Hence the reaction of ϕ_2^L to ϕ_1^L is given by equation (22).

account of the reaction of those wages to their own wage decisions.[31] If this reaction is positive (i.e. if $\frac{\partial \overline{w}_2}{\partial \overline{w}_1} \equiv \Theta_2 > 0$), then each union in country 1 perceives a higher impact of its nominal wage choice on inflation, and hence a lower impact on the real wage (a lower Z). The following proposition summarizes the effects of wage leadership on the equilibrium real wage as compared to a MU with simultaneous wage bargaining (The proof appears in the appendix):

Proposition 9 *If the unions of country 1 are wage leaders vis a vis the unions of country 2 then, in comparison to a benchmark of a MU in which all unions move simultaneously:*

(i) if $B < B_T$ (unions' inflation aversion is not sufficiently high) the wage premium of the unions that are leaders is lower and that of the followers is higher,

(ii) if $B > B_T$ (unions' inflation aversion is sufficiently high) the results in part (i) are reversed,

(iii) when $B = B_T$ there is no difference between the wage premia under simultaneous bargaining and under wage leadership.

The origin of dependence of results on the size of B is related to remark 1 and to the discussion that follows it. We saw there that, depending on whether their desire to maintain their real wage in the face of higher inflation is larger or smaller than their desire to moderate this inflation, unions in country 2 respond by raising or lowering their nominal wages. When the first effect dominates, unions in country 1 internalize the consequences of their wage decisions for inflation to a larger extent than under simultaneous bargaining because they are aware of the fact that the inflationary reaction of the MU central bank will be magnified by the response of the unions in country 2 to their own wage decisions. This tends to moderate their wage demands. On the other hand, when the inflation aversion of the followers is sufficiently large, the leading unions can indulge relatively more in higher wage demands since they know that some of the inflationary consequences of their actions will be offset by the decrease in the real wage of the (strongly inflation averse) follower unions of country 2..

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[31]Technically, under simultaneous moves $\frac{d\pi}{dw_{1j}}|_{\overline{w}_2} = \frac{\partial\pi}{\partial w_{1j}}$ while under leadership $\frac{d\pi}{dw_{1j}} = \frac{\partial\pi}{\partial w_{1j}} + \frac{\partial\pi}{\partial \overline{w}_2}\frac{\partial \overline{w}_2}{\partial \overline{w}_1}\frac{\partial \overline{w}_1}{\partial w_{1j}}$.

We saw earlier that the level of the average wage premium in the MU determines inflation and overall unemployment in the area. In particular, equation (24) suggests that those area wide variables are higher the higher is the average wage premium.[32] It is therefore useful to know whether the average wage premium in the MU is larger under wage leadership or under simultaneous bargaining. The following two propositions address this issue.

Proposition 10 *Under wage leadership the average wage premium in the MU and the average wage premium of the leading unions are positively related.*

The proof appears in the appendix. An immediate consequence of the preceding two propositions is:

Proposition 11 *(i) If $B < B_T$, inflation, unemployment and the average level of real wages in the MU are lower under wage leadership than under simultaneous bargaining.*

(ii) If $B > B_T$, inflation, unemployment and the average level of real wages in the MU are higher under wage leadership than under simultaneous bargaining.

(iii) If $B = B_T$, inflation, unemployment and the average level of real wages in the MU are the same under wage leadership and under simultaneous bargaining.

We conclude this subsection with an analysis of how the response of the followers to a change in the nominal wage of the leaders depends on the bargaining structure within the MU. The following observation concerning the reaction of country 2 wages to wages in country 1 provides an intermediate step:

Remark 2 *The cross-partial derivative $\frac{\partial^2 \overline{w}_2}{\partial n_2 \partial \overline{w}_1}$ is positive, i.e. $\frac{\partial \overline{w}_2}{\partial \overline{w}_1}$ is increasing in n_2. If $n_2 \to \infty$ then $\frac{\partial \overline{w}_2}{\partial \overline{w}_1} = \frac{\alpha^2 s_1}{\alpha^2 s_1 + I}$.*

The above implies:

Proposition 12 *As the wage bargaining structure in the "follower" country becomes more decentralized, the wage premium in the "leader" country gets smaller.*

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[32]Average unemployment in the MU under wage leadership is given by $u^L = \alpha(s_1 \overline{\phi}_1^L + s_2 \overline{\phi}_2^L)$ where $\overline{\phi}_i^L$ $i = 1, 2$ is the average wage premium in country i in the presence of wage leadership.

This means that the largest moderating effect on the unions of the leader country occurs if the labor market structure in the "follower" country is highly decentralized. The reason is that in this case the unions of the leader country cannot rely on the inflation aversion of the followers to partly offset the consequences of their own wage demands on the subsequent inflationary response of the CB. As a result, the unions in the leader country internalize the inflationary consequences of their wage decisions to a larger extent. This leads to more wage moderation on their part.

6 Concluding Remarks

This paper presents a strategic analysis of how the establishment of a monetary union (MU) is likely to alter wage setting behavior under alternative institutional scenarios, and through it macroeconomic performance. The paper highlights the effects of the formation of a MU that operate via the change in incentives for wage moderation on the part of unions. The analysis abstracts from other changes that might be associated with the establishment of a MU, such as changes in the degree of the central bank (CB) inflation aversion or changes in the degree of competition in the labor market. The virtue of this simple approach is to show that, in the presence of sufficiently large unions (i.e. non-atomistic), several neutrality results that would be expected on the basis of traditional analysis no longer hold.

The main lesson of the paper is that, in spite of the fact that agents have rational expectations and complete information, the change in the strategic interaction between unions and the CB caused by MU leads to changes in equilibrium values of real variables. This occurs only when unions are non-atomistic and partly internalize, therefore, the repercussions of their own actions on other agents' decisions (the CB and other unions). It is noteworthy that the formation of a MU induces changes in real wages, unemployment and inflation even when all parameters of the game (CB and unions' preferences, number of unions and labor market competitiveness) remain unchanged by the MU. A basic mechanism driving those results is that the formation of a MU unambiguously reduces each union's perception of how inflationary its individual actions are. This happens because in the MU each union

has a relatively smaller size as compared to the pre-MU situation. When a typical union is concerned about inflation, this reduced inflationary perception leads the union to demand a higher wage premium, increasing unemployment and inflation. A similar effect of the MU is presented in Grüner and Hefeker (1999). However, since in their model there is a single monopoly union in each country, the real effects of the MU crucially hinge on the assumption that unions are inflation averse. Our analysis generalizes their result by demonstrating that in a multi-unions world the establishment of a MU has real repercussions even when unions are **not** averse to inflation. This second type of non-neutrality is due to the fact that, when wages are bargained in nominal terms, the degree of inflation aversion of the central bank affects each union's perception of how costly it is, in terms of reduced competitiveness, to increase its individual wage.[33]

As mentioned, a central proposition of the paper is that the MU may lead to a more aggressive wage behavior, and hence to higher unemployment in the participating countries, provided unions are non-atomistic. A number of qualifications to this proposition are discussed in the paper. First, it is shown that, when the degree of competition in labor markets differs across countries, the effects of MU on unemployment may be distributed asymmetrically. In particular, the formation of a MU leads to a larger increase in unemployment in the country in which the labor market is less competitive, and may even decrease unemployment in the other country. Second, the formation of a MU always increases unemployment if unions are not inflation averse, and the increase is larger in smaller countries and maximal at intermediate levels of centralization and of labor market competitiveness.

Finally, the paper examines the robustness of the results to two alternative institutional scenarios which may be relevant for Europe. The first scenario recognizes that several European countries, who belonged to the ERM, were already committed to German monetary policy prior to joining the MU. Under the assumption that this commitment was credible,

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[33]See the discussion after proposition 3. Cukierman and Lippi (1999) discuss this second mechanism in details. Lippi (1999) shows that a related non-neutrality effect appears in a model of imperfect competition of the Dixit and Stiglitz (1977) variety, if unions are non-atomistic and wages are bargained in nominal terms.

the analysis predicts that with the adoption of the MU the unemployment problem may become more serious in Germany (the pre MU anchor country) and less serious in the satellite countries. In the second scenario we study how wage-leadership by the unions of one country alters macro performance in the MU in comparison to a case in which all unions in the MU move simultaneously. The analysis suggests that if unions' inflation aversion is not "too high", the MU average wage premium, as well as that of the unions in the "leader" country, are lower than the corresponding premia in a MU with simultaneous bargaining. Moreover, the moderating effect on average wage demands in the MU, as well as on the wages of unions in the "leader" country, are larger when the labor market structure in the "follower" country is highly decentralized.

Our model can in principle be used to analyze how the MU affects policymakers' incentives to reform the labor market. This issue is relevant for Europe where labor market rigidities are considered by many an important determinant of its poor employment performance (Bean, 1994; Nickell, 1997). Sibert and Sutherland (1998) have recently used a variant of the Barro-Gordon model to analyze this question. In their model monetary policy is discretionary and policymakers face an inflationary bias that is directly proportional to the rate of unemployment. Moreover, due to international spillovers, inflation is higher when monetary policy is implemented in a uncoordinated manner (i.e. NMP) than in the MU. Policymakers have an incentive to reduce labor market distortions because this lowers the equilibrium rate of unemployment and hence of inflation. A main point of their paper is that, since inflation in the MU is lower than under NMP, the incentives to eliminate labor market distortions are lower in the MU than under NMP.[34] This result hinges on the assumption that the MU does not have a direct effect on the unemployment rate. In this paper we showed that this may not be the case. If the MU has a direct positive effect on the unemployment rate this should, in the light of Sibert and Sutherland model, increase the policymaker's incentives for reform. This seems to mitigate the lower incentives for reforms identified by the above mentioned authors. A thorough investigation of this issue, however, might be the

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[34]A similar hypothesis is advanced by Calmfors (1998).

object of a separate paper.

7 Appendix

Proof of Proposition 4: The sign of the derivative is determined by the sign of the expression in the curly brackets in the numerator. This expression is a sum of three terms, the first two of which are positive and the last one negative. When n increases the negative term grows at a faster rate than the two positive terms. Hence, for a sufficiently large n the whole expression eventually becomes negative. For a given n, the expression is positive if B is sufficiently large. ∎

Proof of Proposition 7: Part (i): Using equations (27) and (28) to solve the inequality $\overline{\phi}_1^U > \overline{\phi}_1^N$ reveals that the inequality is satisfied if and only if the following expression is positive:

$$\left\{ \frac{B\alpha^4}{(\alpha^2 + I)In} \left[Z^U H_2^U - Z_1^N \frac{H_1^U + H_2^U}{4} \right] \right\} + H_2^U \left[\alpha A \gamma_1 \frac{(n-1)}{2n} \frac{\alpha^2}{\alpha^2 + I} \right] \quad (33)$$

Note that the assumption $\gamma_1 > \gamma_2$ (more competitiveness in country 1) implies $H_1^U > H_2^U$, $Z_1^U = Z_2^U \equiv Z^U > Z_1^N$ and $H_1^U > H_1^N$. The term in the rightmost square bracket of expression (33) is positive. Hence the expression can only be negative if the term in the curly bracket is sufficiently negative. For the term in the curly bracket to be negative, the term in the first square bracket needs to be negative, which occurs only if γ_1 is sufficiently larger than γ_2. Thus, for a sufficiently large difference between γ_1 and γ_2 the sign of the first square bracket of equation is negative. Given this, for a sufficiently large B the whole expression is negative.

Part (ii): The equivalent of expression (33) for the condition $\overline{\phi}_2^U > \overline{\phi}_2^N$ is always positive if $\gamma_1 > \gamma_2$. ∎

Proof of Proposition 8: Part (i): The direct effect of the MU when unions do not care about price stability is given by the difference: $\overline{\phi}_i^U - \overline{\phi}_i^N$, under the condition that $B = 0$. Comparing expression (29) with equation (14) (with $B = 0$) it appears that the difference is positive.

Part (ii): This follows immediately from the sign of the partial derivative: $\frac{\partial(\overline{\phi}_i^U - \overline{\phi}_i^N)}{\partial s_i}$, which is negative. Part (iii): The sign of the partial derivatives $\frac{\partial(\overline{\phi}_i^U - \overline{\phi}_i^N)}{\partial n_i}$ and $\frac{\partial(\overline{\phi}_i^U - \overline{\phi}_i^N)}{\partial \gamma_i}$ is given by the sign of the expression: $\left[\alpha^2 A - \frac{\gamma_i(n_i-1)^2}{\left[1 - \frac{\alpha^2}{\alpha^2 + I}\frac{s_i}{n_i}\right]\left[1 - \frac{\alpha^2}{\alpha^2 + I}\frac{1}{n_i}\right]}\right]$. Since this expression is positive at $n = 1$ and negative for a sufficiently large n, the direct effect of the MU is maximum at intermediate values of n. Similarly, the expression is positive at $\gamma = 0$ and negative for large γ values (provided $n > 1$), hence the direct effect of the MU is maximum at intermediate levels of γ. ∎

Proof of Proposition 9: The reaction function of country 2 unions to country 1 unions, expressed in terms of average real wage premia, is given by equation (22) and is unaffected by whether wage bargaining is characterized by simultaneous moves or by leadership. Now turn to country 1 reaction function to country's 2 average premium that is given by (32). Note that when $B = B_T$, $Z_1^L = Z_1^U$ so that country's 1 reaction function under leadership is identical to its reaction function under simultaneous bargaining. Hence, when $B = B_T$ the equilibrium wage premia under leadership and under simultaneous bargaining are identical. This establishes part (iii) of the proposition.

More generally, when $B \neq B_T$, the only difference in comparison to the preceding case is that the value of Z_1 in the reaction function of the leaders is Z_1^L rather than Z_1^U. It follows that the equilibrium average wage premium of the group of leading unions is still given by equation (23) with Z_1^U replaced by Z_1^L. Replacing either of these by any value of Z_1, yields:

$$\overline{\phi}_1 = \frac{Z_1 H_2^U + \frac{B\alpha^2}{I}(Z_1 - Z_2^U)s_2}{H_1\left[H_2^U + \frac{B\alpha^2}{I}(1 - Z_2^U)s_2\right] + \frac{B\alpha^2}{I}(1 - Z_1)H_2^U s_1} \tag{34}$$

where $H_1 \equiv \alpha A\left(\alpha Z_1 + \gamma_1(n_1 - 1)\right)$ for any value of Z_1. Differentiating (34) with respect to Z_1 and rearranging

$$\frac{\partial \overline{\phi}_1}{\partial Z_1} = \frac{1}{M^2}\left[\left(H_2^U + \frac{B\alpha^2}{I}\left(1 - Z_2^U\right)s_2\right)M_1 + \frac{B\alpha^2}{I}H_2^U s_1 M_2\right] \tag{35}$$

where

$$M_1 \equiv \alpha A \left[\gamma_1(n_1 - 1)H_2^U + \frac{B\alpha^2}{I}s_2 \left(\gamma_1(n_1 - 1) + \alpha Z_2^U \right) \right] > 0$$

$$M_2 \equiv H_2^U + \frac{B\alpha^2}{I}s_2 \left(1 - Z_2^U \right) > 0$$

and M is the denominator of the expression in (34). Since Z_2^U and Z_1 are bounded between zero and one, and since $n_1 \geqq 1$, the expression in equation (35) is positive so that the average wage premium of the leading unions is a monotonically increasing function of Z_1. The proof of parts (i) and (ii) for the unions of country 1 follows by noting, from remark 1, that Z_1^L is smaller or larger than Z_1^U depending on whether Θ_2 is positive or negative, which depends in turn on whether B is smaller or larger than B_T. The proof of parts (i) and (ii) for the average premium of the unions in country 2 follows by recalling, from equation (22), that the two wage premia are strategic substitutes. ∎

Proof of Proposition 10: The average wage premium in the MU under the wage leadership of unions in country 1 is:

$$\overline{\phi}^L = s_1\overline{\phi}_1^L + s_2\overline{\phi}_2^L = s_1\overline{\phi}_1^L + s_2\frac{Z_2^U - \frac{B\alpha^2}{I}(1 - Z_2^U)s_1\overline{\phi}_1^L}{H_2^U + \frac{B\alpha^2}{I}(1 - Z_2^U)s_2} \tag{36}$$

where $\overline{\phi}^L$, $\overline{\phi}_1^L$ and $\overline{\phi}_2^L$ are respectively the area wide average wage premium and the average wage premia in countries 1 and 2 when the unions of country 1 are wage leaders. The second equality follows from equation (22) and from the fact that the reaction function of country 2 unions is the same under simultaneous bargaining and under wage leadership by the unions of country 1. Differentiating equation (36) with respect to $\overline{\phi}_1^L$ and rearranging

$$\frac{\partial \overline{\phi}^L}{\partial \overline{\phi}_1^L} = \frac{s_1 H_2^U}{H_2^U + \frac{B\alpha^2}{I}(1 - Z_2^U)s_2} \tag{37}$$

which is unambiguously positive establishing that $\overline{\phi}^L$ and $\overline{\phi}_1^L$ are positively related. ∎

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