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Abstract

In a micro-founded framework in line with the new open economy macroeconomics, the paper shows that more centralized wage setting (CWS) and central bank conservatism (CBC) curb unemployment only if labor market distortions are sizeable. When labor market distortions are sufficiently low, employment may be maximized by atomistic wage setters or a populist CB. The comparison between a national monetary policy (NMP) regime and the monetary union (MU) reveals that a move to a MU boosts inflation in the absence of strategic effects. However, when strategic interactions between CB(s) and trade unions are taken into account, the shift to a MU when monopoly distortions are sizeable unambiguously increases welfare and employment either in presence of a sufficiently conservative CB or with a fully CWS. Finally, when labor market distortions are less relevant, an ultra-populist CB or atomistic wage setters are optimal for the society and a shift to a MU regime is unambiguously welfare improving.

JEL classification: E2, E42, E5, F31, F41

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1 Introduction

The creation of the European Monetary Union (EMU) has ruled out the possibility of using the exchange rate as a substitute for structural reforms among the euro area member states. This implies that the costs of implementing inefficient institutions become more apparent since the lack of nominal exchange rate puts the burden of adjustment on labor

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and product markets. In this respect, adjustment can be achieved through movements in the relative prices and wages.

Compared to the case of national monetary policy (NMP), EMU should impose less discipline on wage setters for they perceive an increase in their wages to have a smaller impact on the union-wide inflation rate relative to the one on their country-specific inflation rate. This point has been recently stressed in literature on strategic wage setting (e.g. Coricelli *et al.,* 2004; Cukierman and Lippi, 2001; Soskice and Iversen, 1998; Grüner and Hefeker, 1999).

However when countries trade with each other new issues arise from the strategic interactions among the Home and Foreign central bank (CB) and Home and Foreign labor unions. Cuciniello (2007) argues that, under a NMP regime, the optimal monetary policies in the two countries are strategic complements and are influenced by the labor market adjustments. This paper aims to extend the setup by Lippi (2003) to an open economy with monopolistic competitive firms so as to contribute with a study on the long run macroeconomic consequences of a monetary regime shift from floating exchange rates to a monetary union (MU).

We use a general-equilibrium model of two countries, different in size and labor market institutions, characterized by monopolistic competition in the product market and unionized labor markets. In a micro-founded framework in line with the new open economy macroeconomics, we show that, aside from the response of real wages to labor market conditions, the move to a MU raises inflation since it increases the common CB's temptation to resort to surprise inflation relative to national CBs. Moreover we demonstrate that welfare and employment are unambiguously higher in a MU when monopoly distortions in the labor market are not so relevant. By contrast, when labor market distortions are sizeable the results may be ambiguous. In particular if the CB conservatism (CBC) is low, there exists a level of Foreign CBC that renders welfare and employment higher under a NMP regime, while for high levels of monetary conservatism employment and welfare are maximized in a MU.

The structure of the paper is as follows. Section 2 develops the model in a MU regime. Section 3-6 compute the optimal strategy of each player. Section 7 analyzes the effects of the number of unions and CBC on employment and inflation in the two regimes. Section 8 presents the conclusions.

2 Economic Setup

The monetary union is formed by two countries, Home (H) and Foreign (F). The world size is normalized to 1; Home agents are indexed by numbers in the interval $[0, \gamma]$, while Foreign agents reside on $(\gamma, 1]$, where $\gamma \in (0, 1)$ is a measure of relative population and economic size.

There are two types of goods in the MU, and each country specializes in the production

of one type that, in turn, can be manufactured by a continuum of monopolistic competitive firms in a variety of brands indexed by $z \in [0,1]$. The main feature of such a hypothesis is that the degree of substitutability between types differs from the degree of substitutability between brands.

Labor is the only factor of production and is supplied in a variety of types defined in the continuous interval $(0,1)$. All labor types are unionized and distributed equally among trade unions. For a given wage, each agent is willing to provide whatever quantity of labor is required to clear the market.

Henceforth we will focus mainly on the domestic country so as to compare its macroeconomic performance under a floating exchange rate (Cuciniello, 2007) and in a MU.

2.1 Supply side

Each firm is the sole producer of a particular brand z that is produced by using a continuum of labor types according to the following decreasing-return-to-scale technology

$$Y_H(z) = \left(\int_0^1 L_i(z)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma\alpha}{\sigma-1}}, \qquad 0 < \alpha < 1,\ \sigma > 1$$

where $Y_H(z)$ is the output of the Home-produced brand z, $L_i(z)$ is the labor type i, σ captures the elasticity of substitution among labor types and α is representing the return to scale parameter. Firms are assumed to have market power in the product market but not in the labor market so that they take wages as given. Cost minimization implies the following demand for each labor type i

$$L_i(z) = \left(\frac{W_i}{W} \right)^{-\sigma} (Y_H(z))^{\frac{1}{\alpha}} \tag{1}$$

where

$$W = \left(\int_0^1 W_i^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$$

is the aggregate wage index defined as the minimal nominal cost of producing a unit of output and $P_H(z)$ is the price for a brand z charged by a domestic firm at Home.

2.2 Preferences

Each agent consumes a continuum of differentiated goods and supplies a differentiated labor type. The agent j's utility is defined over consumption and hours worked as follows:

$$U_j = \log C_j - \frac{k}{2} (\log L_j)^2, \qquad k > \alpha$$

where k is a preference parameter[1]. Following Obstfeld and Rogoff (1998), C_j is an index of consumption of Home and Foreign goods (for a representative agent) defined as follows:

$$C_j = \frac{C_{j,H}^{\gamma} C_{j,F}^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}$$

with

$$C_{j,H} = \left[\left(\frac{1}{\gamma} \right)^{\frac{1}{\lambda}} \int_0^1 \left(C_{j,H}(z) \right)^{\frac{\lambda-1}{\lambda}} dz \right]^{\frac{\lambda}{\lambda-1}},$$

$$C_{j,F} = \left[\left(\frac{1}{1-\gamma} \right)^{\frac{1}{\lambda}} \int_0^1 \left(C_{j,F}(z) \right)^{\frac{\lambda-1}{\lambda}} dz \right]^{\frac{\lambda}{\lambda-1}}, \ \lambda > 1.$$

It is clear that the elasticity of substitution across brands produced within a country is λ, while the elasticity of substitution between Home and Foreign goods is 1.[2]

The optimal consumption allocation of a representative individual across the Home and Foreign good is respectively

$$C_{j,H} = \gamma \left(\frac{P_H}{P} \right)^{-1} C_j \quad ; \quad C_{j,F} = (1-\gamma) \left(\frac{P_F}{P} \right)^{-1} C_j$$

where

$$P = P_H^{\gamma} P_F^{1-\gamma} \tag{2}$$

is the consumer price index (CPI) and

$$P_H = \left[\frac{1}{\gamma} \int_0^1 P_H(z)^{1-\lambda} dz \right]^{\frac{1}{1-\lambda}} \quad ; \quad P_F = \left[\frac{1}{1-\gamma} \int_0^1 P_F(z)^{1-\lambda} dz \right]^{\frac{1}{1-\lambda}}, \tag{3}$$

are the Home and Foreign producers index, respectively.

2.3 Individual budget constraints

To complete the qualification of the individual's problem, we consider the agent's budget constraint. Each j-th individual draws a salary for the labor type supplied to firms which, in turn, distribute dividends evenly among their owners (all of the workers). Markets are

[1] Two conditions are to be satisfied by the utility function. The first is the disutility of work ($\frac{\delta U_j}{\delta L_j} < 0$, which implies $\log L_j > 0$). The second is the concavity of the utility function in leisure ($\frac{\delta^2 U_j}{\delta L_j^2} = -\frac{k}{L_j^2}(1 - \log L_j) < 0$, implying that $\log L_j < 1$). The assumption $k > \alpha$ guarantees that in equilibrium $0 < \log L_j < 1$ holds (see equation (38)).

[2] The parameter $\lambda > 1$ is the price elasticity of demand faced by each monopolist. The inequality constraint ensures an interior equilibrium with a positive level of output. This relationship will become apparent later when we solve for the optimal price setting.

complete domestically and international equity trade is forbidden[3]. Moreover, in order to pay for nominal expenses, cash in advance is needed. Under these assumptions, the agent's budget constraint is given by

$$M_j \geq PC_j = W_j L_j + D_j, \tag{4}$$

where M_j are individual j's money balances, W_j is the nominal wage and D_j are agent j's dividends received by all domestic firms.

2.4 Demand side

The allocation of a representative individual's demand across the Home- and Foreign-produced brands yields

$$C_{j,H}(z) = \frac{1}{\gamma}\left(\frac{P_H(z)}{P_H}\right)^{-\lambda} C_{j,H} = \left(\frac{P_H(z)}{P_H}\right)^{-\lambda}\left(\frac{P_H}{P}\right)^{-1} C_j, \tag{5}$$

$$C_{j,F}(z) = \frac{1}{1-\gamma}\left(\frac{P_F(z)}{P_F}\right)^{-\lambda} C_{j,F} = \left(\frac{P_F(z)}{P_F}\right)^{-\lambda}\left(\frac{P_F}{P}\right)^{-1} C_j \tag{6}$$

where $P_H(z)$ and $P_F(z)$ are the prices for a brand z charged by a domestic and foreign firm at Home, respectively[4]. The law of one price is assumed to hold across all individual brands, so that $P_c(z) = P_c^*(z)$, $\forall z \in [0,1]$, where asterisks denote Foreign values of the corresponding Home variables, and $c \in [H, F]$. Moreover, because Home and Foreign agents have identical preferences, the law of one price implies that purchasing power parity must hold for the consumer price indexes:

$$P = P^*.$$

Thus integrating the demand for a Home-produced brand (5) and Foreign-produced brand (6) across all agents yields the total demand faced by a firm z:

$$Y_c(z) = \left(\frac{P_c(z)}{P_c}\right)^{-\lambda}\left(\frac{P_c}{P}\right)^{-1} C_W \tag{7}$$

where $C_W \equiv \gamma\overline{C} + (1-\gamma)\overline{C}^*$ is the total consumption in the world economy, $\overline{C} \equiv \frac{1}{\gamma}\int_0^{\gamma} C_j dj$ is the per capita consumption of a Home agent and $\overline{C}^* \equiv \frac{1}{1-\gamma}\int_{\gamma}^{1} C_j dj$ is the per capita consumption of a Foreign resident[5].

[3] However, securities markets are redundant in this model so as current accounts always balance in equilibrium (Obstfeld and Rogoff, 1998).

[4] Recall that $\lambda > 1$ captures the elasticity of substitution among varieties, while the elasticity of substitution between the domestic and foreign good is equal to 1.

[5] Note that C_W is both per capita and total world consumption.

The goods-market-clearing condition implies that total output demands equal supplies, i.e.

$$\gamma\left[\gamma P\overline{C}+(1-\gamma)P\overline{C}^{*}\right]=P_{H}Y_{H} \tag{8}$$

$$(1-\gamma)\left[\gamma P\overline{C}+(1-\gamma)P\overline{C}^{*}\right]=P_{F}Y_{F} \tag{9}$$

where $Y_H \equiv \int_0^1 Y_H(z)dz$ and $Y_F \equiv \int_0^1 Y_F(z)dz$. From equation (8) and (9) we can derive the following expression:

$$P_H\overline{Y}_H = P_F\overline{Y}_F \tag{10}$$

where $\overline{Y}_H \equiv \frac{1}{\gamma}\int_0^1 Y_H(z)dz$ and $\overline{Y}_F \equiv \frac{1}{1-\gamma}\int_0^1 Y_F(z)dz$. Relation (10), together with the assumption that agents do not hold international assets, implies that current accounts always are zero (Obstfeld and Rogoff, 1998) and that

$$C_W = \overline{C} = \overline{C}^{*}.^{6} \tag{11}$$

Let $M_H \equiv \int_0^\gamma M_j dj$ and $M_F \equiv \int_\gamma^1 M_j dj$ be the total money supply in the Home and Foreign country, respectively. We assume that total money supply in the monetary union is distributed across the two regions according to the country size as follows

$$M_U = M_H^{\gamma} M_F^{1-\gamma}. \tag{12}$$

Normalizing the previous period nominal money supply, the current nominal money supplies can be expressed as

$$M_U = 1 + m_U$$

where $m_U \approx \log M_U$ stands for percentage increases.

Finally, using equation (11), (8) and the cash in advance hypothesis, the aggregate-nominal demand (7) in the domestic country can be rewritten as

$$P_H Y_H \equiv \int_0^1 P_H(z)Y_H(z)dz = M_H. \tag{13}$$

Likewise in the Foreign country the aggregate nominal demand is proportional to money supply

$$P_F Y_F \equiv \int_0^1 P_F(z)Y_F(z)dz = M_F. \tag{14}$$

[6] This can be easily proved by using the relation (10) into the individual budget constraint as follows:

$$\overline{C} = \frac{P_H\overline{Y}_H}{P},\ \overline{C}^{*} = \frac{P_F\overline{Y}_F}{P}.$$

2.5 Unions

The Home country is populated by a finite number of unions, n_H. Since all labor types are unionized and equally distributed among unions, each union has mass $1/n_H$. In our setup the degree of centralization of wage setting (CWS) is equal to union size so that the smaller is the number of unions, the more relevant is the impact of their wage settlement on aggregate variables. In this respect the CWS is directly related to the unions' capacity to internalize the macroeconomic consequences of wage variations[7].

The representative union is benevolent, i.e. it maximizes the utility of her members under the workers' budget constraint (4):

$$V_i = n_H \int_{j \in i} U_j dj. \tag{15}$$

We assume that each worker (and the union that represents her) takes profits as given[8]. The Home union sets the same rate of growth of the nominal wage ω_i among her members so as to maximize her own objective function. It is convenient to express the nominal wage of worker i, W_i, and the CPI in the Home country as

$$W_i = 1 + \omega_i \quad ; \quad P = 1 + \pi,$$

where π is domestic inflation rate[9].

The benevolent union hypothesis is in line with the trade union behavior surveyed by Oswald (1982) whose objective function usually includes real wages and unemployment[10].

2.6 Central Bank

Drawing on the literature on time inconsistency in monetary policy, we assume that the monetary authority is inflation averse and cares about the real performance in the economy, which in our setup corresponds to agents' utility[11].

We draw on Lippi (2003) and assume that the common CB aims at maximizing the following targeting rule:

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[7] Drawing on Guzzo and Velasco (1999) we refer to such capacity as *internalization effect*.

[8] Aside from monopoly power, this adds an other distortion introduced in the model. Conversely, when we present the CB problem below, the CB will allow for all economy-wide interactions so as to internalize the effect of D on the welfare of agents.

[9] The previous period of nominal wage and inflation are nomalized to unity without loss of generality since equilibrium outcome does not depend on it.

[10] Grüner and Hefeker (1999), Soskice and Inversen (2001), Cukierman and Lippi (2001) evaluate the macroeconomic effect of monetary unification when unions are averse to inflation. However we focus on microeconomic instead of macroeconomic foundations to analyze unions' behavior.

[11] The paper investigates how the design of the monetary institution affects the country performance. The notion of an inflation averse CB may be interpreted also as a kind of general institutional constraint in the economy.

$$\Omega_U = \int_0^1 U_j dj - \frac{\beta_U}{2}\pi^2 \qquad \beta_U \geq 0. \tag{16}$$

The parameter β_U is the CB's degree of conservatism (Rogoff, 1985a). If the level of conservatism is zero the CB becomes a benevolent planner who cares only about the agents' welfare.

2.7 Timing structure of the model

In the first stage (at time 1), each union chooses the rate of growth of the nominal wage of her members in a simultaneous game with Foreign and the other domestic unions so as to maximize her objective function (15). Moreover, in the maximization problem each union anticipates the reaction of the CB and of firms to her wage choice. The timing sequence is built on the notion that nominal wages are substantially stickier than prices and monetary policy. The rationale for such an assumption is that workers are normally under contract for at least a year; thus, wage setters are committed to the bargained wage over the whole period of the game.

In the second stage (at time 2) the common CB sets the money supply taking as given the preset nominal wages and internalizing the reaction of firms. Monetary policy is hence stickier than price setting[12].

In the last stage (at time 3) each monopolistic competitive firm sets the price of her own brand so as to maximize her profit, taking the general price level, nominal wages and money supply as given[13].

The three-stage game between firms, the monetary authority and labor unions is solved by backward induction so as to find the Nash sub-game perfect equilibrium.

3 Price setting

In the last stage of game each domestic firm maximizes the real profit function

$$\Pi(z) = \frac{P_H(z)}{P} Y_H(z) - \frac{1}{P}\int_0^1 W_i L_i(z) di \tag{17}$$

under the following constraints:

$$\int_0^1 W_i L_i(z) di = W Y_H(z)^{\frac{1}{\alpha}} \text{ and } Y_H(z) = \left(\frac{P_H(z)}{P_H}\right)^{-\lambda} \left(\frac{P_H}{P}\right)^{-1} C_W. \tag{18}$$

[12] Models with a New Keynesian orientation *à la* Clarida, Gali and Gertler (1999) suppose that price setters move first than the monetary authority. However, the assumption of prices stickiness is more debatable than wages stickiness (see Cukierman, 2004).

[13] Notice that the timing of the game implies no precommitment of the CB. Monetary policy is hence set in a "discretionary" way. Moreover since firms are the last to move, prices may be considered as fully flexible.

The first constraint stems from the cost minimization problem of firms. The second one is the result of the consumer problem derived previously. The usual profit maximization condition that marginal revenue equals marginal cost may hence be written[14]:

$$\frac{P_H(z)}{P}\left(1-\frac{1}{\lambda}\right)=\frac{1}{\alpha}\frac{W}{P}Y_H(z)^{\frac{1-\alpha}{\alpha}} \tag{19}$$

In a symmetric equilibrium, where all firms have the same optimal price rule, the price of a brand, $P_c(z)$, coincides with the producer price index, P_c, and the output of a representative firm $Y_c(z)$ equals the output of the country Y_c for all z. Thus taking the logarithms of condition (19) and using (13), the first order condition yields[15]

$$\pi_H-\pi=\alpha(\omega-\pi)+(1-\alpha)(m_H-\pi). \tag{20}$$

This relation shows that, although prices are fully flexible, they do not completely move when the money supply changes. As a matter of fact, it is not optimal for profit maximizing firms to respond exactly in kind to the money supply as long as nominal wages have not been changed. This implies that the monetary authority may affect real variables, even when prices are fully flexible, for nominal wages are contractually fixed (Cukierman, 2004).

Arranging equation (20), we obtain the following negative relation between real money balances and wages:

$$m_H-\pi_H=-\frac{\alpha}{1-\alpha}(\omega-\pi_H) \tag{21}$$

From the definition of the CPI (2), the previous equations imply that the general price level can be rewritten in terms of Home and Foreign wages and money supplies as follows:

$$\pi^U=(1-\alpha)m_U+\alpha\omega_U \tag{22}$$

where $\omega_U\equiv\gamma\omega+(1-\gamma)\omega^*$.

An accommodating monetary policy operates in a country through the expansion of the demand faced by each monopolistic firm boosting in this way the inflation rate. At this stage Home and Foreign wages affect inflation in the country only through their impact on input costs which in turn determine Home and Foreign good prices, respectively. In the following sections we will see that the monetary policy is also influenced by Home and Foreign wage settlements through strategic interactions.

[14] Coricelli *et al.* (2000) introduced for the first time the optimal price setting in the literature on nominal wage bargaining systems.

[15] In deriving the following expression, we neglect the costant $\alpha\log\frac{\lambda}{(\lambda-1)\alpha}$.

4 Inflation-employment trade-off

This section explains how a move from a NMP regime, i.e. a setup where each country has its own CB setting the money supply, to a MU with a common CB may affect the trade-off between inflation and employment for the CB. Henceforth we base the comparison on the results obtained under a NMP regime in Cuciniello (2007).

In setting her optimal monetary policy the CB faces a trade-off between inflation and employment. Since all firms have the same reaction function, from cost minimization we achieve the following aggregate demand for labor

$$L_c = (Y_c)^{\frac{1}{\alpha}} = \left(\frac{M_c}{P_c}\right)^{\frac{1}{\alpha}}, \quad c \in [H, F] \tag{23}$$

where the second equality stems from equation (13) and (14). Then taking logs and plugging equation (20) into equation (23) yields

$$l_c \equiv \log L_c = m_c - \omega_c. \tag{24}$$

Now the MU Phillips curve is obtained by solving for money supply equation (24) and substituting it into (22),

$$\pi^U = (1 - \alpha) l^U + \omega_U \tag{25}$$

where $l^U \equiv \gamma l_H + (1 - \gamma) l_F$. The slope of the Phillips curve in the MU is hence

$$\frac{d\pi^U}{dl^U} = 1 - \alpha > 0. \tag{26}$$

It can be shown[16] that under a NMP regime the slope of the Home Phillips curve is given by,

$$\frac{d\pi^N}{dl_H} = 1 - \alpha\gamma > 0. \tag{27}$$

It is apparent that the slope of the Phillips curve depends on the monetary regime set up in the country as the following proposition summarizes.

Proposition 1 *The formation of a MU leads a change in the trade-off between inflation and employment faced by the CB so that the Phillips curve is flatter in the MU,* $\frac{d\pi^N}{dl_H} > \frac{d\pi^U}{dl_U}$.

Intuitively, the impact of money supply on aggregate employment is always equal to one (see equation (24)). Conversely, the general level of price is affected differently by the CB in a MU and under a NMP. Under floating exchange rates, the Home CB influences the CPI via the producer price index and the nominal exchange rate. In a MU this second channel is ruled out. The Proposition 1 simply states that the two channels of transmission

[16] See Cuciniello (2007).

of the monetary policy under a NMP regime have a larger impact on CPI than the single channel of the common CB in a MU.

5 Monetary policy

This section examines the optimization problem of the common CB under a MU regime and how the CB responds to wage hikes. Monetary policy is decided in the second stage of the game.

The CB chooses the union-wide money supply taking as given nominal wages in the economy and internalizing the firms reaction function so as to maximize (16) under the MU Phillips curve investigated in the previous section (25). In other words, the CB acts as Stackelberg-follower player vis-à-vis trade unions (Stackelberg leaders) and as Stackelberg-leader vis-à-vis firms (Stackelberg followers).

The CB payoff (16) may be rewritten as

$$\Omega = \alpha l^U - \frac{k}{2}(l^U)^2 - \frac{\beta_U}{2}\left(\pi^U\right)^2.$$

Thus the first order condition of the CB is given by[17]

$$\begin{aligned} \frac{d\Omega}{dm_U} &= \alpha - kl^U - \beta_U \frac{d\pi^U}{dl^U}\pi^U = 0 \Longleftrightarrow \\ \frac{\alpha}{k} - l^U - \frac{\beta_U \pi^U (1-\alpha)}{k} &= 0. \end{aligned} \tag{28}$$

According to expression (28), as long as the employment level is below the competitive one[18], α/k (see equation (38)), it is optimal for the CB to fuel a positive inflation rate through her monetary policy.

Moreover, relation (28) shows the role played by the Phillips curve in the CB balances of unemployment and inflation. The weight attached to inflation depends on the degree of conservatism and the slope of the Phillips curve. As a matter of fact, both CBC and the slope of the Phillips curve have the same function: they determine the relative significance attached to inflation by the CB. It is easy to see that, ceteris paribus, the effect of a flatter Phillips curve is similar to the effect of smaller CBC. The CB will adopt a more accommodating monetary policy either with a smaller degree of conservatism or a flatter Phillips curve. In both cases the CB would realize a higher loss from reducing inflation rather than unemployment[19].

[17] Since the CB is a large agent, profits are not taken as given.

[18] i.e. the level of employment that maximizes the workers' welfare equating the consumption/leisure marginal rate of substitution ($k \log L$) to the (efficient) technical rate of transformation ($\frac{1}{\alpha}$).

[19] We will see below that, since the CB's reaction function is common knowledge for labor unions, workers anticipate the incentive of the CB to inflate. In the "time-consistent" equilibrium the marginal benefit to higher inflation exactly offsets the marginal cost. The monetary authority could inflate above and beyond

Using (22) and (24), we explicitly solve (28) for the money supply

$$m_U = \frac{\alpha + [k - \alpha(1-\alpha)\beta_U]\,\omega_U}{k + \beta_U(1-\alpha)^2}. \tag{29}$$

Drawing on Proposition 1 and equation (28), it is apparent that the marginal cost faced by the CB is lower in the MU than under a floating exchange rate regime. It follows that, ceteris paribus, the CB is encouraged to inject more money in the monetary system so as to equate the marginal benefit and marginal cost. However, the common CB cares about MU employment that is not necessarily equal to the Home country level.

Now from equation (29) we can investigate how the CB reacts to change in Home and Foreign wages. The following proposition underlines the importance of the degree of conservatism in determining the tightening or the accommodation in the monetary policy to a wage increase.

Proposition 2 *For values of CBC below (above)* $\widehat{\beta}_U = \frac{k}{\alpha(1-\alpha)}$ *the CB accommodates (contracts) the money supply response to Home and Foreign wage increases.*

Proof. At a symmetric equilibrium, from equation (29) we obtain $\frac{dm_U}{d\omega_U} = \frac{k-\alpha(1-\alpha)\beta_U}{k+\beta_U(1-\alpha)^2}$ whose sign depends clearly on the CBC. ■

A rise in wages increases both inflation and employment. A conservative CB, i.e. when $\beta_U > \frac{k}{\alpha(1-\alpha)}$, responds to any wage hike by tightening her money supply since she attaches more weight to inflation than unemployment. Conversely, a populist CB, i.e. when $\beta_U < \frac{k}{\alpha(1-\alpha)}$, cares more about unemployment than inflation and so her response to wage is accommodating.

6 Wage setting

In this section we evaluate how wage setting is affected by the a shift from a NMP regime to a MU.

In the first stage of the game unions act as Stackelberg leaders vis-à-vis the monetary authority and firms, i.e. the labor unions anticipate the reaction functions of the CB and firms. Home union i chooses the rate of growth of the nominal wage, ω_i, so as to maximize (15) subject to (4) and (29). In doing that the union takes profits, D_i, and the nominal wages set by the other unions at Home and abroad as given. The typical union i first order condition is hence[20]

$$\alpha\left(\frac{d\log W_{i,r}}{d\omega_i} - s_r - \varepsilon_r\right) + \varepsilon_r kl_i = 0, \quad r \in [N, U] \tag{30}$$

the worker (rational) expectations, but it is not in her interest to do so.

[20] See the Appendix for details.

where s_r is the impact effect (elasticity) of ω_i on inflation when the nominal wages of other unions are taken as given in a monetary regime $r \in [N, U]$:

$$s_N \equiv \frac{d\pi^N}{d\omega_i} = \frac{1}{n_H}\left[\alpha\gamma + (1-\alpha\gamma)\mu_{HH} - (1-\gamma)\alpha\mu_{FH}\right] \in (0,1) \tag{31}$$

$$s_U \equiv \frac{d\pi^U}{d\omega_i} = \frac{\gamma}{n_H}\left[(1-\alpha)\mu_U + \alpha\right] \in (0,\gamma) \tag{32}$$

with μ_{HH} (μ_{FH}) representing the reduced form elasticity of Home (Foreign) money supply to Home aggregate wages under a NMP regime, while μ_U is the elasticity of union-wide money supply to union-wide wages under a MU regime[21]. ε_r is the elasticity of labor demand to the nominal wage of union i in the monetary regime r:

$$\varepsilon_N \equiv -\frac{dl_i^N}{d\omega_i} = \sigma\left(1 - \frac{1}{n_H}\right) + (1-\mu_{HH})\frac{1}{n_H}, \tag{33}$$

$$\varepsilon_U \equiv -\frac{dl_i^U}{d\omega_i} = \gamma\sigma\left(1 - \frac{1}{n_H}\right) + (1-\mu_U)\frac{\gamma}{n_H}. \tag{34}$$

Note that equation (33) and (34) are a weighted average of the elasticity of substitution among labor types and the elasticity of aggregate labor demand. Dividing (30) by $\frac{d\log W_{i,r}}{d\omega_i} - s_r$, we can express the first order condition in terms of the real wage elasticity of labor demand, η_r, as follows[22]

$$\alpha(1-\eta_r) + k\eta_r l_i = 0. \tag{35}$$

Equation (35) shows that an increase in the union i's wages has two opposing effects on the utility of workers. On one hand it increases the real wage and reduces employment; since the latter effect is larger, there is a reduction in consumption (the first term in (35)). On the other hand, a wage rise increases utility through leisure (the second term in (35)). Thus, each union sets a nominal wage growth according to her consumption/leisure preferences, k.

Under a NMP regime the elasticity of domestic labor demand (in absolute value) is given by

$$\eta_N(^*) \equiv \frac{\varepsilon_N}{1-s_N} = \frac{1-\mu_{cc}+(n_c-1)\sigma}{n_c - 1 + \theta_c(1-\mu_{cc}) + (1-\theta_{-c})\mu_{-cc}} \in (1,\infty) \tag{36}$$

where $\theta_H \equiv 1-\alpha\gamma$ and $\theta_F \equiv 1-(1-\gamma)\alpha$.

Similarly we may derive the labor demand elasticity in the Home and Foreign country

[21] See Appendix for details.

[22] Derivation in Appendix.

under a MU regime as follows

$$\eta_U(^*) \equiv \frac{\varepsilon_U}{\gamma - s_U} = \frac{1 - \mu_U + (n_H - 1)\sigma}{n_H - 1 + (1-\alpha)(1-\mu_U)} \in (1, \infty). \tag{37}$$

It is worth noticing that when unions internalize the impact of their wages on the CB reaction abroad, μ_{FH}, such variable increases the elasticity of labor demand[23]. Intuitively, an increase in Home wages boosts the price of the Home-produced good. The Foreign country undergoes an imported inflation since it consumes the Home good as well. Thus, the Foreign CB is induced to counteract the inflationary wage settlement with a restrictive monetary policy so as to keep current account balance and consumption constant across the two countries (see equation (11)).

In the next section we will see how employment and inflation are determined by macroeconomic institutional variables that affect the labor demand elasticity. In doing that we will assume that the CBC is not affected by the monetary regime, i.e. $\beta_U = \beta_H = \beta$.

7 Equilibrium employment and inflation

Since unions are identical, in a symmetric equilibrium $l_i = l$ for all $i = 1, ..., n_H$ we can derive employment from equation (35) as follows:

$$l_r = \frac{\alpha}{k}\left(1 - \frac{1}{\eta_r}\right) \in (0, 1). \tag{38}$$

Equation (38) points out that equilibrium employment is an increasing function of the elasticity of labor demand, η_r. When the elasticity of labor is finite ($\eta_r < \infty$) unions have some market power[24]. The smaller is the labor elasticity, the higher is the unions' incentive to raise her nominal wages. In fact, a nominal wage claim sends ripples through employment to a less extent in presence of market power[25]. By contrast, when the elasticity of labor demand goes to infinity we achieve the competitive (optimal) level of employment $\frac{\alpha}{k}$.

The area-wide price level is calculated by plugging equation (38) into the CB reaction function (28). Assuming a symmetric equilibrium, we obtain the inflation rate in the two regimes as follows

$$\pi_N = \frac{\alpha}{\beta(1 - \alpha\gamma)}\left(\frac{\gamma}{\eta_N} + \frac{1-\gamma}{\eta_N^*}\right) \tag{39}$$

[23] The elasticities of money supply with respect to nominal wages abroad, μ_{-cc}, are always negative (Cuciniello, 2007).

[24] As in Kydland and Prescott (1977) and Barro and Gordon (1983), equilibrium employment is at suboptimal level.

[25] The monopolistic nature of the labor market and the effects on employment are in accord with Blanchard and Kiyotaki (1987) results.

$$\pi_U = \frac{\alpha}{\beta\,(1-\alpha)}\left(\frac{\gamma}{\eta_U} + \frac{1-\gamma}{\eta_U^*}\right). \tag{40}$$

It is clear that labor market characteristics play a key role in determining equilibrium inflation as well. In particular, the inflation rate is negatively affected by the elasticity of labor demand. Moreover, equation (39) and (40) indicate an inflation bias. With no precommitment of any kind for the monetary authority, this is a standard result in the literature on the time inconsistency of monetary policies. We therefore can state that

Remark 3 *The conventional wisdom that discretionary policymaking by the CB yields an inflation bias, while leaving employment at suboptimal levels, still holds in an open economy when the elasticity of labor demand is finite.*

It is crucial at this point to compare the labor demand elasticity η_N and η_U so as to assess the impact of macroeconomic institutions on employment and inflation. Before doing that, it is worth noticing that if we assume identical labor demand elasticity, i.e. $\eta_U = \eta_N$ and $\eta_U^* = \eta_N^*$, inflation is lower under a NMP than in a MU for a given level of employment. Since the Phillips curve is flatter in a MU, the common CB has a stronger incentive to inflate as long as the employment level is below the competitive one. Non-atomistic trade unions anticipate the reduced cost faced by the common CB in terms of inflation and demand for higher wages which, in turn, lead to higher inflation.

However as shown in the Appendix, the elasticities of money supply to nominal wage differ among the two regimes and, consequently, the labor demand elasticity. Removing the assumption of equality renders the framework richer. The labor market structure (i.e. the labor demand elasticity) is in fact ultimately determined by the number of unions, the elasticity μ_{HH} and μ_{FH}, when the monetary policies are uncoordinated, and μ_U with a common CB (see equation (36) and (37)). Thus, in the following section we assess how CBC, CWS and country size may modify the labor demand elasticity.

7.1 Role of central bank conservatism

How do employment and inflation depend on the CBC? Rewriting the labor demand elasticity with respect to the real wage as follows[26]

$$\eta_r = \frac{\beta\theta_r}{k}\frac{s_r}{\frac{d\log W_{i,r}}{d\omega_i} - s_r} + \frac{n_H - 1}{n_H}\frac{\sigma}{\frac{d\log W_{i,r}}{d\omega_i} - s_r}, \tag{41}$$

where $\theta_N \equiv \theta_H \equiv 1 - \alpha\gamma$ and $\theta_U \equiv 1 - \alpha$.

It is clear that a higher degree of conservatism has two opposing effects on labor unions. On the one hand, a non-atomistic wage setter becomes aware of the fact that an increase in her nominal wages causes higher inflation which, in turn, reduces employment

[26] The elasticity of labor is obtained by substituting the CB reaction function in terms of aggregate labor into $l_i = -\sigma(\omega_i - \omega) + l$ and differentiating with respect to ω_i.

through the CB reaction function (equation (28)). The higher is the degree of CBC, the more severe are the employment consequences of wage aggressiveness[27]. Drawing on Lippi (2003) terminology we refer to it as *adverse output effect*.

On the other hand, since a conservative CB leads unions to perceive less the inflationary impact of their wage, they also anticipate the real wage of other unions to decrease to a lesser extent and, hence, the shift of labor demand towards cheaper labor types is smaller[28]. This *adverse competition effect* encourages wage aggressiveness (Lippi, 2003).

Now it may be interesting analyzing the two limit cases of a CB ultra-populist and ultra-conservative. Letting the CBC go to zero, i.e. assuming that the CB does not care about inflation but only about agents' utility, we obtain the monopolistic competition level of employment[29]

$$[l]_{\beta=0} = \frac{\alpha}{k}\left(1 - \frac{1}{\sigma}\right). \tag{42}$$

When the CB is ultra-populist the strategic interaction channel between trade unions and CB is halted[30]. In such a case, the employment level is below the Pareto efficient one, $\frac{\alpha}{k}$, and it depends on the degree of substitutability among labor types. As specified in section 5, an ultra-populist CB accommodates any domestic wage hike one-to-one which implies that wage setters can not affect employment.

The other extreme case of a CB that cares only about inflation, i.e. an ultra-conservative CB, yields the following equilibrium employment level under a NMP and a MU regime respectively

$$\lim_{\beta\to\infty} l = \frac{\alpha}{k}\left(1 - \frac{1}{\frac{1}{n_H}\frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)} + \left(1-\frac{1}{n_H}\right)\sigma}\right) \tag{43}$$

$$\lim_{\beta\to\infty} l = \frac{\alpha}{k}\left(1 - \frac{1}{\frac{1}{n_H}\frac{1}{1-\alpha} + \left(1-\frac{1}{n_H}\right)\sigma}\right). \tag{44}$$

From the relation (42), (43) and (44), we can make the following remark.

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[27] Formally this can be seen by differentiating the first term of equation (41) with respect to CBC: $\frac{d}{d\beta}\left(\frac{\beta\theta_N}{k}\frac{s_N}{1-s_N}\right) = \frac{\beta\theta_N}{k}\frac{s_N}{1-s_N}\left(\frac{1}{\beta} + \frac{\frac{ds_N}{d\beta}}{1-s_N}\right) = \frac{k(n_H-1)(k+\beta_F\theta_F^2)^2\theta_N}{\left[k(n_H-1)(k+\beta_F\theta_F^2)+n_H\beta\beta_F\theta_N\theta_F(\theta_F-1)+n_H\beta(k+\beta_F\theta_F)\theta_N^2\right]^2} > 0$ where $\theta_F \equiv 1-\alpha(1-\gamma)$ and β_F is the degree of the Foreign CBC. In a MU, $\frac{d}{d\beta}\left(\frac{\beta\theta_U}{k}\frac{s_U}{1-s_U}\right) = \frac{k(1-\alpha)(n_H-\gamma)\gamma}{\left[n_H(1-\alpha)^2\beta+k(n_H-\gamma)\right]^2} > 0$.

[28] Formally this can be seen by differentiating the second term of equation (41) with respect to CBC: $\frac{d}{d\beta}\left(\frac{n_H-1}{n_H}\frac{\sigma}{1-s_N}\right) = \frac{n_H-1}{n_H}\frac{\sigma}{1-s_N}\frac{\frac{ds_N}{d\beta}}{1-s_N} = -\frac{kn_H^2(k+\beta_F\theta_F^2)^2\theta_F[k\theta_H+\beta_F\theta_F(1-\alpha)]\sigma}{(n_H-1)\left[k(n_H-1)(k+\beta_F\theta_F^2)+n_H\beta\beta_F\theta_N\theta_F(\theta_F-1)+n_H\beta(k+\beta_F\theta_F)\theta_N^2\right]^2} <$ 0 and in a MU $\frac{d}{d\beta}\left(\frac{n_H-1}{n_H}\frac{\sigma}{1-s_U}\right) = -\frac{kn_H^2(1-\alpha)^2\gamma\sigma}{(n_H-1)\left[n_H(1-\alpha)^2\beta+k(n_H-\gamma)\right]^2} < 0$.

[29] The values of η_r in the case of an ultra-populist and ultra-conservative CB are derived in the Appendix.

[30] The CB has only one target (employment) and hence the trade-off between inflation and employment in its optimal monetary policy is prevented. An increase in nominal wage will cause an equal increase in money supply. This implies that labor unions can not affect their real wages.

Remark 4 *(i) In the case of an ultra-populist CB, when $\beta = 0$, the labor demand elasticity under a NMP regime, η_N, and the labor demand elasticity in a MU, η_U, coincide and are equal to σ; (ii) in the case of an ultra-conservative CB, when $\beta \to \infty$, the labor demand elasticity under a NMP regime, η_N, is always smaller than the labor demand elasticity in a MU.*

According to Remark 4, if a CB does not care about inflation before and after a move to MU, the regime shift does not have any impact on the labor demand elasticity which is equal to the labor substitution elasticity. This is due to the fact that when $\beta = 0$, the CB has only one target (the employment level) which can be always achieved ruling out the strategic interaction with the labor unions through the price level. The CB in fact accommodates any Home wage hike one-to-one so that unions can not modify their real wage.

Notice that, under uncoordinated monetary policies, even though a domestic CB does not care about inflation at all, the CB abroad always counteracts domestic wage aggressiveness with a restrictive monetary policy which, in turn, causes a depreciation of the domestic exchange rate. This boosts inflation further and acts as a discipline effect on wage claims, since a nominal wage increase ends in a real wage improvement to a lesser extent. Nevertheless, when $\beta = 0$, also the Foreign CB impact to domestic wages fades away. As a matter of fact, the (negative) response of the CB abroad to a domestic wage hike is exactly offset by the (positive) response induced by the expansionary money supply at Homey[31].

By contrast, the second part of Remark 4 states that, when a CB cares only about inflation, the labor demand elasticity is larger in a MU than under a NMP regime. The main reason for a such result is due to the change in the slope of the Phillips curve (see section 4). The flatter Phillips curve in a MU entails that, ceteris paribus, the CB is willing to forego a larger level of employment in order to stabilize inflation. It is worth noticing that the presence of a Foreign CB under uncoordinated monetary policies increases the employment consequences of domestic wage rises but Remark 4 stresses that, with an ultra-conservative CB, the adverse output effect in a MU is always larger than under a NMP regime and, consequently, it discourages wage aggressiveness to a larger extent.

Is labor demand elasticity and, hence, macroeconomic consequences more sizeable with a conservative or liberal CB? As the following proposition points out, this depends on the monopolistic distortion in the factor market.

Equation (43) and (44) show that when a CB has inflation as overriding objective, the employment level may be larger or smaller than equation (42). Thus the idea that an ultra-conservative CB can always restore efficiency is rejected. In general labor demand elasticity and, hence, the macroeconomic consequences of a conservative CB depends on

[31] Domestic and foreign money supply are strategic complements (see Cuciniello, 2007).

the monopolistic distortion in the factor market as summarized in the following proposition.

Proposition 5 *(i) For a number of unions $n_H \in (1, \infty)$, an increase in CBC raises employment in a MU and under a NMP regime only if $\sigma < \frac{1}{1-\alpha}$ and $\sigma < \frac{k+\beta_F \theta_F^2}{k\theta_N + \beta_F \theta_F (1-\alpha)}$, respectively. (ii) If either $n_H = 1$ or $n_H \to \infty$, the impact of CBC on employment is nil.*

Proof. In the Appendix. ■

As β rises, the elasticity of money supply with respect to local wages switches from positive to negative values. Thus, an increase in CBC reduces the inflationary repercussions of wage settlement and enlarges the unemployment consequences (as apparent in equations (31)-(34)). Since the CBC affects the first term (adverse output effect) of the elasticity of labor demand (41) positively and the second one (adverse competition effect) negatively, the effect of CBC on the adverse output effect prevails only if the condition in Proposition 5 holds. In other words, if labor power is sizeable, i.e. σ is sufficiently small, the i-th union understands that inflation (caused by her nominal wage rise) reduces employment by triggering a restrictive monetary policy[32]. On the contrary, if σ is large, since the inflationary consequences of a wage claim are kept down by a more conservative CB, unions anticipate a less reduction in the real wages of their competitors yielding wage aggressiveness.

The impact of CWS on employment will be tackled in the next section. However the second part of Proposition 5 states that monetary policy is neutral in the case of a single all-encompassing union ($n_H = 1$) and when unions are atomistic ($n_H \to \infty$). It is worth noticing that when $n_H \to \infty$ unions do not perceive wage demands to have any impact on inflation ($s_r = 0$), and when $n_H = 1$ wage differentials are ruled out. In both cases monetary neutrality arises since unions perceive they can not affect the real wages of the other unions[33]. The assumption of non-atomistic and uncoordinated wage setting is hence crucial when wages are negotiated in nominal terms (Lippi, 2003).

What about the Foreign monetary policy under a NMP regime? In Cuciniello (2007) it is shown that the CB abroad always counteracts domestic wage demands by a restrictive monetary policy which triggers the depreciation of the domestic exchange rate. This boosts inflation further dampening wage claims, since a nominal wage increase ends in a real wage improvement to a lesser extent. Thus, the higher is the Foreign CBC, the stronger is domestic wage restraint.

Nevertheless, if the domestic CB is ultra-populist or wage setters are atomistic, the Foreign CB impact on domestic wages fades away. This is because the strategic interaction between CB and unions is broken and the (negative) response of the CB abroad to a

[32] Similarly a wage increase is perceived by the i-th union to rise aggregate real wage (calculated by taking account of the producer price index) which dampens its wage demands.

[33] The source of non-neutrality in policy games is analysed in Acocella and Di Bartolomeo (2004).

domestic wage hike is exactly offset by the (positive) response of the ultra-populist CB at Home or is perceived nil by atomistic wage setters[34].

As to inflation, equation (39) and (40) reveal the following proposition.

Proposition 6 *(i) in the absence of different strategic effects, i.e.* $\eta_U = \eta_N$ *and* $\eta_U^* = \eta_N^*$*, the inflation rate under a NMP regime is always lower than in a MU for a given level of employment. (ii) A higher degree of the CBC,* β*, reduces the inflation bias (*$\frac{d\pi^r}{d\beta} < 0$*).*

Proof. The first part of the proposition is immediately proved by observing equation (39) and (40). For the second part, see equation (53). ■

The motive the shift to a MU raises inflation is the different trade-off between employment and inflation faced by the common CB. Since the Phillips curve in a MU is flatter than under a NMP regime, the common CB has stronger incentive to resort to surprise inflation (Rogoff, 1985b). Unions anticipate this inflationary inducement and strive to keep CB from modifying their real wages which culminates in a higher inflationary bias. In this respect, Proposition 6 explains why the ECB has a statute that is more conservative than the one of the pre-MU Bundesbank considered the most conservative CB in Europe (Piga, 2000).

Contrary to Coricelli *et al.* (2004) where a higher degree of CBC is always associated with lower inflation and unemployment, a more conservative CB in this model does curb inflation while reduces unemployment only if the adverse output effect is stronger than the adverse competition effect. The different upshot in Coricelli *et al.* (2004) is mainly due to the absence of labor substitutability in the production function. Thus, the adverse output effect always dominates the adverse competition effect and a more inflation averse CB makes unions perceive higher labor demand elasticity, which results in lower real wages.

Now according to Proposition 5, the impact of CBC on labor elasticity depends on the predominance of the adverse output or the competition effect. Hence, employment will be an increasing function of CBC if the labor market distortion are high. Since the adverse output effect is always larger in a MU relative to the adverse output effect under a NMP regime, three cases are feasible[35].

First, the adverse competition effect may prevail in both regimes (Figure 1). Employment is therefore a decreasing function of CBC and an ultra-populist CB is the first best for the economy in terms of employment. Note that, under a NMP regime, an increase in Foreign CBC boosts employment at Home by raising labor demand elasticity. However, employment level is unambiguously higher in a MU when the CB is inflation averse.

Second, the adverse competition effect may prevail under a NMP regime but not in a MU (Figure 2). In such a case labor market power is low at country level but relatively

[34] When the domestic CB does not care about inflation and wage setters are atomistic, the labor demand elasticity is equal to σ.

[35] Analytically proved in the Appendix. As for the following simulation, we let $n_H = 3$, $\gamma = 1/2$, $k = 1$ and $\alpha = 3/4$.

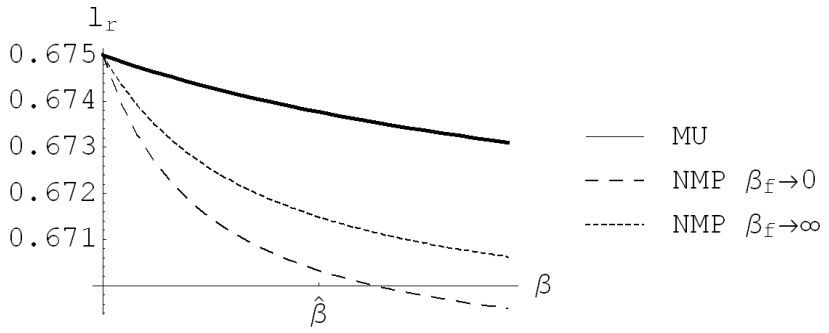

Figure 1: Employment and CBC when adverse competition effect prevails in both regimes. For values of $\beta > \widehat{\beta}$ the common CB is conservative, while for values of $\beta < \widehat{\beta}$ is populist.

relevant in the union-wide economy[36]. This could be, for instance, the situation of UK vis-à-vis the EMU where unions do not play a key role in the domestic labor market and the national CB is liberal. An ultra-populist CB maximizes employment under a NMP regime. However, if the CB is inflation averse, the move to the EMU unambiguously improves employment. In other words, an ultra-populist CB under a NMP regime produces only a second best result for UK since an ultra-conservative ECB might increase employment further.

Finally, labor market distortions can be sizeable under both regimes (Figure 3) so that CBC always boosts employment. Note that an increase in the Foreign CB boosts employment in the domestic country since it raises the labor demand elasticity. However, there exists some "small" level of CBC associated with a higher employment level under a NMP regime; indeed, with an ultra-conservative CB, employment is unambiguously larger in a MU. The possibility of higher labor demand elasticity under a NMP is due to the Foreign CB restrictive policy that in presence of a populist Home CB reinforces the discipline effect on wage settlement[37].

7.2 Role of centralization of wage setting

What is the effect of the number of unions on employment and inflation? Here we tackle these questions holding constant the degree of CBC so as to focus only on the degree of CWS.

From equations (36)-(40), union numerosity affects employment and inflation via the elasticity of labor demand, η_r. In particular, an increase in the labor market elasticity, i.e. in the competitiveness of labor market structure, diminishes both inflation and unemployment.

[36] It may be due to some sort of friction in labor mobility across countries, e.g. language differences, bureaucracy and legal barriers.

[37] The possibility that such a result arises is analytically derived in the Appendix.

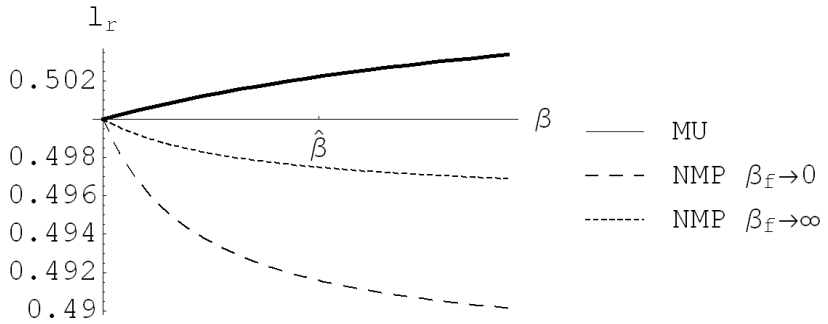

Figure 2: Employment and CBC when adverse competition effect prevails under a NMP regime but not in a MU. For values of $\beta < \widehat{\beta}$ the common CB is populist, while for values of $\beta > \widehat{\beta}$ is conservative.

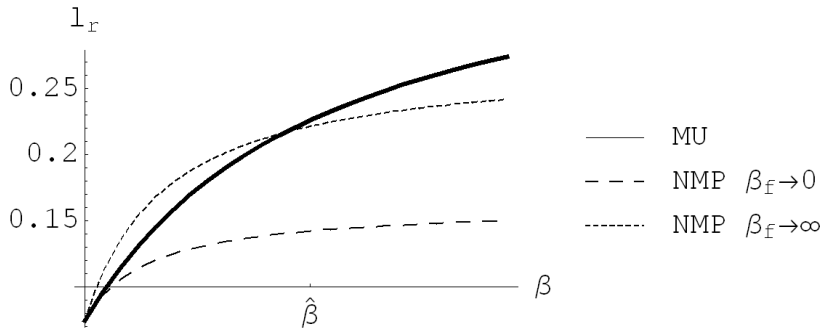

Figure 3: Employment and CBC when adverse output effect prevails in both regimes. For values of $\beta < \widehat{\beta}$ the common CB is populist, while for values of $\beta > \widehat{\beta}$ is conservative.

Once again the adverse output and competition effect play a fundamental function in settling the impact of the CWS on macroeconomic outcomes as summarized in the following proposition:

Proposition 7 *(i) For a given level of CBC, an increase (decrease) in CWS, smaller (larger) n_H, reduces (raises) inflation and raises (reduces) employment under a MU and a NMP regime if $\sigma < \frac{1}{1-\alpha}$ and $\sigma < \frac{k+\beta_F\theta_{-c}^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}$, respectively; (ii) for a value of $\beta = \widehat{\beta}$ such that the CB is neither conservative or populist, the elasticity of labor demand is always larger in a MU than under a NMP regime.*

Proof. In the Appendix. ■

Intuitively, a non-atomistic labor union sets a higher nominal wage for her members as long as this does not reduce their employment, i.e. if her real aggregate wage does not exceed the real aggregate wage[38]. Thus, the smaller is the number of unions, the more each union internalizes the inflationary repercussions of their wage claims (*internalization* effect). On one side, the wage setter expects a higher inflation rate in the wake of an increase in nominal wage and, hence, less consequences on the aggregate real wage and the aggregate labor demand. This entails wage aggressiveness. On the other side, a higher level of centralization lets union anticipate that her own wage demand finishes in a higher aggregate nominal wage which, ceteris paribus, raises the real wage. This second effect discourages wage aggressiveness and is overwhelming if the conditions in Proposition 7 hold, i.e. when monopoly distortions are high enough so as to lead a large union to perceive an increase in her own nominal wage as a raise in her real relative wage (Cavallari, 2004).

Now we assess graphically the three conceivable combinations of the adverse output and competition effect at Home. Since inflation and employment are monotonic functions of labor demand elasticity, η_r, we focus on the linkage between this key variable and CWS. In order to control for the CBC, we assume that the CB is neither conservative nor populist[39].

When the adverse output effect is larger than the adverse competition one, monopoly distortions are relatively high and a more CWS lets unions internalize the unemployment consequences of their wage demand through the CB reaction function (see equation (41))[40]. Under such circumstances, labor demand elasticity is decreasing in the number of unions and converging to σ in presence of atomistic wage setters (as illustrated in Figure 4).

By contrast, if the adverse competition effect is larger than the adverse output one, a more decentralized wage setting renders unions relatively less aware of their inflationary

[38] When employment is below the Pareto-efficient level, the welfare gain of a reduction in employment is lower than the welfare loss of a reduced consumption.

[39] Note that the value of CBC for which μ_{HH} and μ_U are equal to zero is $\widehat{\beta} = \frac{k\left(k+\beta_F\theta_F^2\right)}{(1-\theta_N)\theta_F(k+\beta_F\theta_F)}$ under a NMP regime and $\widehat{\beta} = \frac{k}{\alpha(1-\alpha)}$ in a MU.

[40] Multinational firms, for instance, may indirectly promote international wage coordination menacing to move the production where labor costs are lower (Calmfors, 2001).

wage settlement but increases the demand of firms for cheaper labor. In such a case, a competition effect would discourage wage aggressiveness to a larger extent since by assumption is higher than the adverse output (Figures 5).

Finally Figure 6 illustrates the case in which the adverse output effect prevails in a MU but not under a NMP regime. If the monetary unification induces to higher centralization at the union-wide level, macroeconomic performance improves.

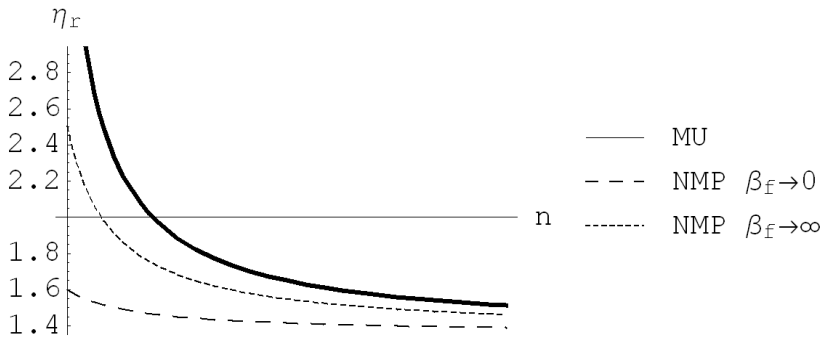

Figure 4: Labor demand elasticity and CWS when the adverse output effect prevails and $\mu_{HH} = \mu_U = 0$.

The results in this section are in sharp contrast with the U-shaped curve *à la* Calmfors and Driffill (1988). In order to have the U-shaped relationship between the CWS and economic performance three assumptions have to be satisfied[41]:

(a) There exists a monotonic relation between the CWS and the internalization effect.

(b) An increase in CWS always reduces competition in the labor market.

(c) In a decentralized wage setting the competition effect prevails on the internalization one, while under a centralized wage setting is the internalization effect to be dominant.

Condition (a) always holds in our model, while (b) is met only if the adverse output effect is smaller than the adverse competition one. The union i's labor demand elasticity with respect to her wage is an indicator of the degree of competitiveness in the labor market: an elastic labor demand shrinks monopoly power in the labor market. As said before, this elasticity can be increasing or decreasing in the CWS. However, the third assumption (c) is never satisfied since with atomistic wage setters (i.e. monopolistic competition, $n_H \to \infty$) the labor demand elasticity converges to σ.

[41] These conditions are pointed out in Guzzo and Velasco (1999).

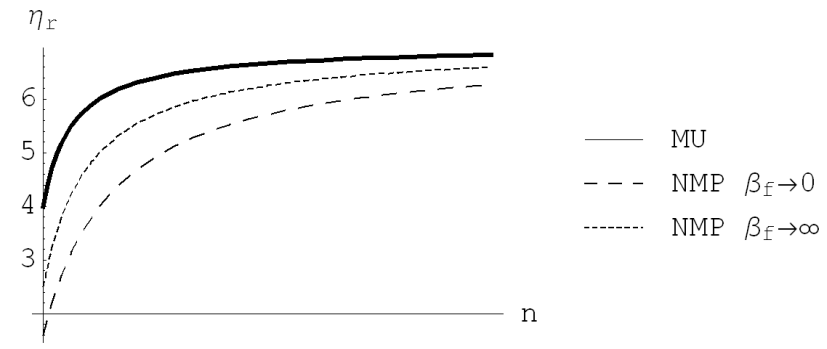

Figure 5: Labor demand elasticity and CWS when the adverse competition effect prevails and $\mu_{HH} = \mu_U = 0$.

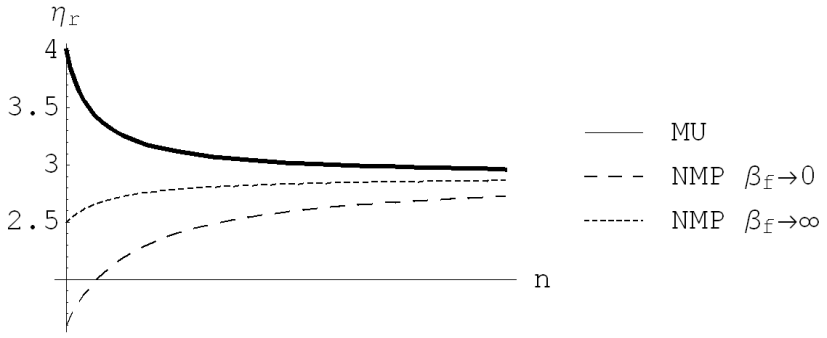

Figure 6: Labor demand elasticity and CWS when the adverse competition effect prevails under NMP regime but not in a MU with $\mu_{HH} = \mu_U = 0$.

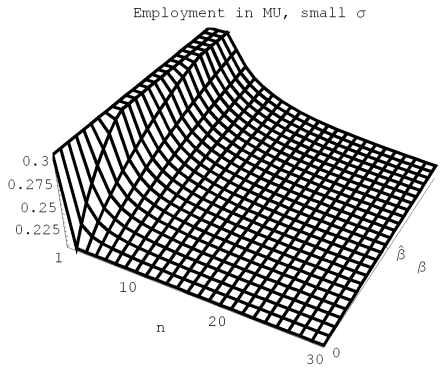

Figure 7: Home employment, CBC and n_H for σ small.

7.3 Interactions between central bank conservatism and centralization of wage setting

Here we combine the effect of CWS and CBC on employment and inflation relying on the results obtained in the previous sections. As for employment, the upshots for the Home country in a MU are shown in Figure 7 and 8[42].

When σ is small, according to Proposition 5, employment is an increasing function of CBC as in Figure 7. An inflation averse CB is, actually, willing to contract her money supply so as to create more unemployment in the economy and reduce inflation. Labor unions are aware of the unemployment threat arising from a conservative CB and hold down their wage demands.

Moreover, for a given level of CBC, employment is always decreasing in the number of unions which is inversely related to their degree of internalization. With a single all-encompassing union, employment is maximized independently of the monetary conservatism. In such a context, it is not necessary to carry out a monetary contraction threat, for coordinated wage setters fully internalizes the aggregate labor demand. Note that in the case of monopolistic competition, i.e. when n_H goes to infinity, unions do not internalize at all the macroeconomic impact of their wage claims on inflation and the strategic interactions with the CB is ruled out[43].

Conversely, in Figure 8 labor market distortions are less relevant and a higher degree of CBC diminishes labor demand elasticity. Since unions are less concerned about the aggregate unemployment consequences of their wage hikes, they are tempted to set higher nominal wages which, in turn, increase their own relative real wages. In this case a more conservative CB is particularly costly in presence of very few unions. In fact, the less is the number of unions, the more they internalize the real wage gain. For a given level of CBC, we see a sharp monotonicity between employment and decentralization of the wage

[42] The graphics under a NMP regime reveal indeed similar behavioral patterns.

[43] The labor demand elasticity is in fact equal to σ.

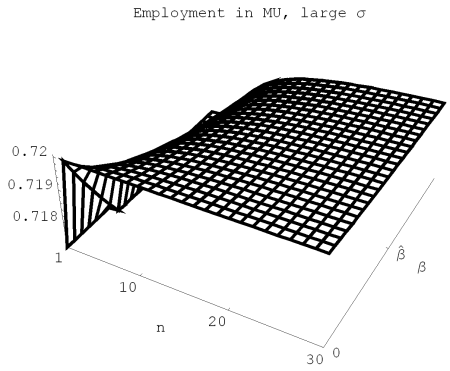

Figure 8: Home employment, CBC and n_H for σ large.

bargaining.

Only an ultra-populist CB may nullify the chance of achieving higher real wages; indeed, when $\beta = 0$ the level of employment is equal to the first best regardless of the number of unions, so that the monotonic relationship between employment and the number of unions disappears. Furthermore, the decrease in employment stemming from a greater monetary conservatism is dampened by the number of unions (the grid becomes flat for large n_H). This conforms with the results in the earlier sections, where CBC does not affect labor elasticity as $n_H \to \infty$.

Next we account for the joint effect of the number of unions and CBC on the rate of inflation. The simulation is contained in Figure 9 and 10.

In both case inflation is a decreasing function of the degree of CBC as we expected. The main difference is the role played by the CWS with different degrees of σ. When labor market distortion are high, a lower number of unions may reduce inflation while it does not have any impact if substitutability among labor types is substantial (σ is high). This means that the effect of CBC on inflation seems to be largest (smallest) at very high level of CWS if σ is low (high).

The reason why inflation is not affected by a large number of trade unions is related to the internalization effect. Atomistic wage setters ($n_H \to \infty$) do not perceive to have any impact on inflation (see equation (32)). A non-atomistic union, instead, realizes that an increase in wage affects positively inflation triggering the response of the CB. What is key to large unions, however, is that monetary conservatism may influence their monopolistic power. In Figure 9 they have high monopoly power and CBC reduces it by boosting the elasticity of labor demand. By contrast, in Figure 10 monopoly power is low and CBC increases it by diminishing the elasticity of labor demand.

Finally, drawing on the employment analysis, we can consider the joint effect of the number of unions and CBC on individual welfare. The welfare analysis vis-à-vis labor market distortion is shown in Figure 11 and 12. The following proposition summarizes the main results in terms of individual welfare.

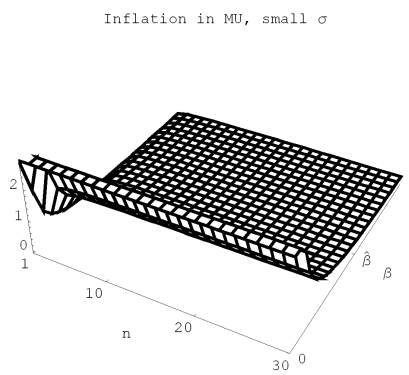

Figure 9: Home inflation, CBC and n_H for σ small.

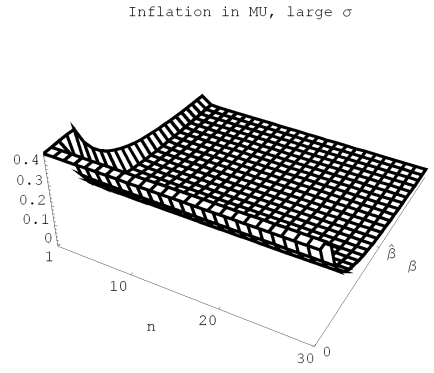

Figure 10: Home inflation, CBC and n_H for σ large.

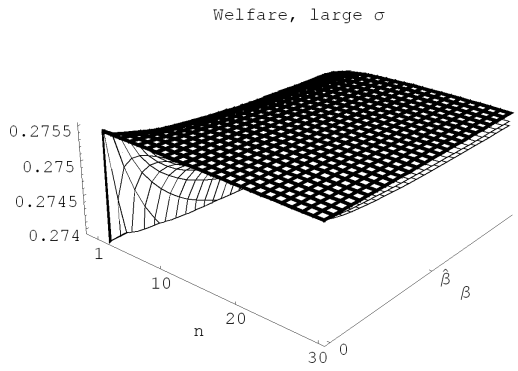

Figure 11: Home welfare, CBC and n_H for large σ.

Proposition 8 *(i) A nationally centralized wage bargaining system maximizes individual welfare if labor market distortion are sizeable. (ii) In presence of keen competition in the labor market, an ultra-populist CB or atomistic wage setters are optimal for the society. (iii) a MU is a welfare maximizing regime when labor market distortions are not sizeable. (iv) a MU is a welfare maximizing regime when labor market distortions are sizeable if $n_H = 1$ or β is sufficiently large.*

Proof. In the Appendix.

■

As long as the employment level is below the optimal one, a rise in employment is welfare augmenting. Hence, if labor market distortions are sizeable, we know that the smaller is the number of the unions, the better is employment performance, and, consequently welfare (see Proposition 7). Conversely, when σ is large, the monopolistic competitive outcome is optimal and both an ultra-populist CB and atomistic wage setters can replicate it.

As to the welfare effect of a monetary unification. Note that employment level and hence welfare are increasing functions of labor substitutability, σ. As a matter of fact, the higher is the labor substitution, the higher is the labor demand elasticity. Thus we know that labor markets with sizeable distortions will perform worse, in terms of employment and welfare, than labor markets where such distortions are lower or nil.

The comparison of welfare between the two regimes when σ is large is shown in Figure 11. The surface with a thicker mesh stands for the MU regime, while the surface with a thinner mesh points out the NMP regime both with an ultra-populist and ultra-conservative foreign CB. It is apparent that the shift to a MU is unambiguously welfare increasing if the CB cares about inflation. In this respect, the higher adverse output effect in the MU vis-à-vis the NMP one renders η_U more elastic than η_N for any value of $\beta \neq 0$. By contrast, in the case of ultra-populist CB, a move to a MU leaves welfare unchanged[44].

[44]Remember both labor demand elasticity are equal to σ with an ultra-populist CB.

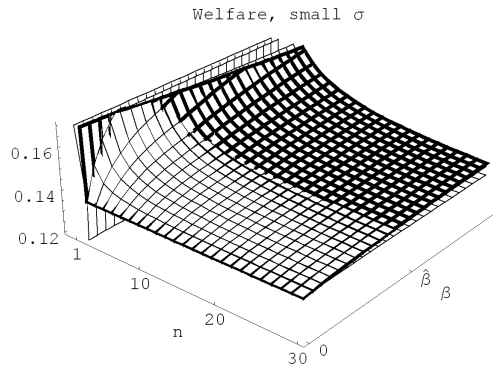

Figure 12: Home welfare, CBC and n_H for small σ.

When labor market exhibits significant monopoly distortions, labor demand elasticity is positively associated with monetary conservatism. However, for some small level of CBC, the elasticity of labor demand may be higher under a NMP regime than in a MU. This result is in contrast with Cavallari (2004) where a move to a MU always increases labor demand elasticity (and hence welfare) when monopoly distortions are relevant.

Here as shown for instance in Figure 12 in presence of an ultra-conservative Foreign CB, welfare under a NMP regime may exceed the MU one if the Home CB is relatively populist. However, as we expected, a single monopoly union leads to the first best in both regimes[45] and, for a sufficiently high level of CBC, a MU becomes the second-best choice in presence of more than a trade union.

8 Conclusions

The creation of a monetary union (MU) may alter the incentives to reform the labor market. This issue is particularly relevant in Europe where labor markets are characterized by the presence of large trade unions and the impact of domestic wages on the union-wide inflation rate is diluted. Switching to a MU, the monetary policy of the central bank (CB) is now addressed to union-wide targets instead of country-specific ones which implies a new trade-off between inflation and employment in setting her optimal policy.

We have investigated the strategic impact of centralization in wage setting (CWS) and CB conservatism (CBC) on economic performance by extending Lippi (2003) analysis so as to introduce monopolistic competition and openness to trade in the product market. We find in line with the case of a floating exchange rate regime (Cuciniello, 2007) that the move towards higher level of CWS and CBC may increase employment and reduce inflation in a MU if monopoly distortions in the labor market are significant. In such a case, a conservative CB is willing to contract her money supply by causing more unemployment

[45] In the Appendix it is proved that welfare in a fully centralized wage bargaining system is always higher in a MU than under a NMP regime.

in the economy and controlling inflation. Labor unions are aware of the unemployment threat arising from a conservative CB and hold down their wage demands. Since the number of unions is inversely related to their degree of internalization of the monetary threat, more centralization will increase the economic performance.

The comparison between the national monetary policy (NMP) regime and the MU reveals that a move to a MU boosts inflation in the absence of strategic effects. This is due to a flatter Phillips curve faced by the common CB. However, when strategic interactions between CB(s) and trade unions are taken into account, the shift to a MU unambiguously increases welfare and employment when monopoly distortions are sizeable either in presence of a sufficiently conservative CB or with fully CWS.

Conversely, when labor market distortions are less relevant, a higher degree of CBC diminishes labor demand elasticity. Since unions are less concerned about the aggregate unemployment consequences of their wage hikes, they are tempted to set higher nominal wages which, in turn, increase their own relative real wages. In this case a more conservative CB is particularly costly in presence of very few unions. In fact, the less is the number of unions, the more they internalize the real wage gain. As for the welfare analysis, the paper shows that in presence of keen competition in the labor market, an ultra-populist CB or atomistic wage setters are optimal for the society and a shift to a MU regime is unambiguously welfare improving.

9 Appendix

Elasticities of money supply to nominal wages. Following Cuciniello (2007) let $\theta_H \equiv 1-\alpha\gamma$ and $\theta_F \equiv 1-\alpha(1-\gamma)$ be the slope of the Phillips curve under a NMP regime in the Home and Foreign country respectively[46]. The elasticity of domestic money supply to local nominal wages is[47]

$$\mu_{cc} = 1 - \frac{\beta_c(k+\beta_{-c}\theta_{-c}^2)\theta_c}{k^2+\beta_c\beta_{-c}\theta_c\theta_{-c}(1-\alpha)+k(\beta_{-c}\theta_{-c}^2+\beta_c\theta_c^2)}, \quad c\in[H,F] \tag{45}$$

Since both domestic and Foreign CBC negatively affects μ_{HH}, it can range from 1 to $-\frac{\alpha\gamma}{1-\alpha}$ in the case of ultra-populist (when $\beta_H \to 0$) and ultra-conservative (when $\beta_H \to \infty \wedge \beta_F \to \infty$) CB, respectively. The elasticity of money supply to nominal wage abroad is instead given by[48]

$$\mu_{-cc} = -\frac{\beta_{-c}\beta_c\theta_{-c}(1-\theta_c)\theta_c}{k^2+\beta_c\beta_{-c}\theta_c\theta_{-c}(1-\alpha)+k(\beta_{-c}\theta_{-c}^2+\beta_c\theta_c^2)}, \quad c\in[H,F]\,. \tag{46}$$

[46] These results are derived in Cuciniello (2007).

[47] Note that $\mu_{HH}=\mu_{FF}$ only if $\gamma=1/2$ and $\beta_H=\beta_F$.

[48] Note that $\mu_{HF}=\mu_{FH}$ only if $\gamma=1/2$.

Thus the range of μ_{FH} is $-\frac{\alpha\gamma}{1-\alpha}$ and 0 in presence of an ultra-conservative ($\beta_H \to \infty \wedge \beta_F \to \infty$) and populist CB ($\beta_H \to \infty \vee \beta_F \to \infty$) respectively. In the case of a MU, the elasticity of money supply to union-wide wages is given by

$$\mu_U = 1 - \frac{(1-\alpha)\beta_U}{k + \beta_U(1-\alpha)^2}$$

whose range spanned by CBC is $\left(-\frac{\alpha}{1-\alpha}, 1\right)$. The impact of CBC on μ_U is

$$\frac{d\mu_U}{d\beta_U} = -\frac{k(1-\alpha)}{\left[k + (1-\alpha)^2\beta_U\right]^2} < 0.$$

■

A typical union first order condition. The typical union i maximizes (15) with respect to ω_i subject to (4) and (29), taking as given profits, D_i, and the nominal wages set by other unions at Home and abroad. Note that individual union dividend flows are $D_i = P_H \frac{Y_H}{n}(1-\alpha)$. In a symmetric equilibrium in which all D_i are the same, profit per union is

$$D_i = P_H Y_H (1-\alpha) = (1-\alpha) P C_i.$$

From the budget constraint (4), we obtain for all domestic firms

$$PC_i = W_i L_i + (1-\alpha) PC_i$$

so that $\alpha PC_i = W_i L_i$. The first order condition with respect to ω_i yields

$$\alpha\left(\frac{d\log W_i}{d\omega_i} - \frac{d\log P}{d\omega_i} + \frac{d\log L_i}{d\omega_i}\right) + k\log L_i \frac{d\log L_i}{d\omega_i} = 0 \tag{47}$$

where we used $\frac{1}{C_i}\frac{dC_i}{d\omega_i} = \frac{W_i L_i}{PC_i}\left[\frac{d\log W_i}{d\omega_i} - \frac{d\log P}{d\omega_i} + \frac{d\log L_i}{d\omega_i}\right]$ and $\frac{W_i L_i}{PC_i} = \alpha$. Dividing expression (47) by $\frac{d\log W_i}{d\omega_i} - \frac{d\log P}{d\omega_i}$ and using the real wage elasticity definition $\eta \equiv -\frac{d\log L_i}{d\log \frac{W_i}{P}}$ yields equation (35). ■

Analysis of CBC and macroeconomic outcome. From equation (36) and (37), it appears that the value of labor demand elasticity is mainly determined by the elasticity of money supply to nominal wages. According to the degree of CBC, the range of $1-\mu_{HH}$ is 0 and $\frac{k+\beta_F\theta_F^2}{(1-\alpha)\beta_F\theta_F+k\theta_N}$ in the case of ultra-populist and ultra-conservative CB respectively. Similarly $1-\mu_U$ is equal to 0 and $\frac{1}{1-\alpha}$ in presence of an ultra-populist and ultra-conservative CB respectively. When $1-\mu_{HH}=0$ and $1-\mu_U=0$, i.e. in presence of an ultra-liberal domestic CB, the elasticity of labor demand is σ in both regimes. When the CB is ultra-

conservative, instead, the labor demand elasticities are[49]

$$\lim_{\beta\to\infty}\eta_N = \frac{1}{n_H}\frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)} + \left(1-\frac{1}{n_H}\right)\sigma, \tag{48}$$

$$\lim_{\beta\to\infty}\eta_U = \frac{1}{n_H}\frac{1}{1-\alpha} + \left(1-\frac{1}{n_H}\right)\sigma. \tag{49}$$

These relations prove equation (42), (44) and (43). In general, the sign of $\frac{d\eta_N}{d\beta}$ not only depends on the adverse output and competition effect but also on the other CBC as follows:

$$\frac{d\eta_N}{d\beta} = \frac{k(n_H-1)(k+\beta_F\theta_F^2)\theta_N\left[k+\beta_F\theta_F^2-(k\theta_N+\beta_F\theta_F(1-\alpha))\sigma\right]}{\left[k(n_H-1)(k+\beta_F\theta_F^2)+n_H\beta(\beta_F\theta_N\theta_F(1-\alpha)+k\theta_N^2)\right]^2}. \tag{50}$$

The sign of $\frac{d\eta_N}{d\beta}$ is hence

$$sign\left(\frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}-\sigma\right).$$

The sign of $\frac{d\eta_N}{d\beta_F}$ is instead always positive:

$$\frac{d\eta_N}{d\beta_F} = \frac{k\beta(1-\theta_F)\theta_F(1-\theta_N)\theta_N\left[k(n_H-1)\sigma+n_H\beta\theta_N\right]}{\left[k(n_H-1)(k+\beta_F\theta_F^2)+n_H\beta(\beta_F\theta_N\theta_F(1-\alpha)+k\theta_N^2)\right]^2} > 0. \tag{51}$$

In the case of a MU the sign of

$$\frac{d\eta_U}{d\beta} = \frac{k(n_H-1)(1-\alpha)\left[1-(1-\alpha)\sigma\right]}{\left[k(n_H-1)+n_H(1-\alpha)^2\beta\right]^2} \tag{52}$$

is given by

$$sign\left(\frac{1}{1-\alpha}-\sigma\right).$$

The first part of Proposition 5 is proved by taking the partial derivative of (38), (39) and (40) with respect to CBC and using equation (50) and (52) as follows:

$$\frac{dl}{d\beta} = \frac{\alpha}{k}\frac{1}{\eta_r^2}\frac{d\eta_r}{d\beta}$$

$$\frac{d\pi}{d\beta} = -\frac{\alpha}{\theta_r\eta_r\beta^2}\left[1+\frac{\beta}{\eta_r}\frac{d\eta_r}{d\beta}\right] < 0. \tag{53}$$

Notice that the term in brackets in equation (53) is always positive since $\left|\frac{\beta}{\eta_r}\frac{d\eta_r}{d\beta}\right| < 1$. The adverse output effect under a NMP regime is an increasing function of β_F and is always smaller than the adverse output in a MU, $\frac{1}{1-\alpha}$. Now what remains to assess is whether the labor demand elasticity in MU and NMP intersect in the (β,η_r) plane. As a matter

[49] Note that $\frac{k+\beta_F\theta_F^2}{(1-\alpha)\beta_F\theta_F+k\theta_N} < \frac{1}{1-\alpha}$.

of fact, the NMP and MU labor demand elasticity coincide when $\beta = 0$ and the latter is larger than the former when $\beta \to \infty$. Thus it is sufficient to analyze if the slope of $\frac{d\eta_N}{d\beta}$ evaluated at $\beta = 0$ is greater than $\frac{d\eta_U}{d\beta}$ evaluated at $\beta = 0$. The impact of CBC on money supply elasticity in both regimes at $\beta = 0$ is

$$\left[\frac{d\eta_U}{d\beta}\right]_{\beta=0} = \frac{(1-\alpha)(1-(1-\alpha)\sigma)}{k(n-1)} \tag{54}$$

and

$$\left[\frac{d\eta_N}{d\beta}\right]_{\beta=0} = \frac{\theta_H\left[k+\beta_F\theta_F^2-(k\theta_H+\beta_F\theta_F(1-\alpha))\sigma\right]}{k(n-1)(k+\beta_F\theta_F^2)}. \tag{55}$$

Note, first, that expression (55) is an increasing function of β_F. When $\sigma > \frac{1}{1-\alpha}$ the ratio

$$\frac{\left[\frac{d\eta_N}{d\beta}\right]_{\beta=0\wedge\beta_F=0}}{\left[\frac{d\eta_U}{d\beta}\right]_{\beta=0}} = \frac{1-\alpha\gamma-(1-\alpha\gamma)^2\sigma}{1-\alpha-(1-\alpha)^2\sigma} > 1 \tag{56}$$

which implies that there not exists a level of $\beta \neq 0$ where the labor demand elasticity η_N and η_U are equal. When $\sigma < \frac{1}{1-\alpha}$ the expression (56) holds iff $\sigma < \frac{1}{1-\alpha+1-\alpha\gamma}$. In such a case there exists a level of $\beta \neq 0$ where the labor demand elasticity η_N and η_U intersect. The second part of Proposition 5 is achieved by evaluating equation (50) at $n_H = 1$ and $n_H \to \infty$. ■

Analysis of CSW and macroeconomic outcome. The marginal impact on labor elasticity of a more decentralized wage setting is

$$\frac{d\eta_N}{dn_H} = \frac{\left[(k\theta_N+\beta_F\theta_F(1-\alpha))\sigma-(k+\beta_F\theta_F^2)\right]Z_2}{\left[k(n_H-1)(k+\beta_F\theta_F^2)+n_H\beta(\beta_F\theta_N\theta_F(1-\alpha)+k\theta_N^2)\right]^2}$$

where $Z_2 \equiv \beta\theta_N\left[k^2+\beta_F\beta\theta_N\theta_F(1-\alpha)+k(\beta_F\theta_F^2+\beta\theta_N^2)\right] > 0$ and the sign of η_N depends on the

$$sign\left(\sigma-\frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}\right)$$

By the same token, the derivative of the labor demand elasticity with respect to unions numerosity is

$$\frac{d\eta_U}{dn} = \frac{(-1+\mu_U)\left[1-(1-\alpha)\sigma\right]}{\left[n+\alpha(-1+\mu_U)-\mu_U\right]^2}$$

and the sign is determined by the

$$sign\left(\sigma-\frac{1}{1-\alpha}\right)$$

which proves Proposition 7. Interestingly, both labor elasticity tends to σ in presence of atomistic wage setting (i.e. $n_H \to \infty$). In order to compare the effect of CWS in the two

regimes and get rid of the impact of domestic CBC, we assume in section 7.2 that the CB is neither conservative nor populist, i.e. we evaluate the labor demand elasticity when $\mu_U = \mu_{HH} = 0$ which yields

$$[\eta_U]_{\beta=\widehat{\beta}_U} = \frac{(n-1)\sigma - 1}{n - \alpha} \tag{57}$$

and

$$[\eta_N]_{\beta=\widehat{\beta}_H} = \frac{\left(k + \beta_F \theta_F^2\right)\left[1 + (n_H - 1)\sigma\right]}{\beta_F \theta_F \left(n_H \theta_F - 1 + \theta_N\right) + k(n_H - 1 + \theta_N)} \tag{58}$$

where $\widehat{\beta}_H = \frac{k\left(k+\beta_F\theta_F^2\right)}{(1-\theta_N)\theta_F(k+\beta_F\theta_F)}$ and $\widehat{\beta}_U = \frac{k}{\alpha(1-\alpha)}$. There is no value of n_H belonging to the relevant domain in which the elasticity (57) and (58) cross each other[50]. The expression (57) evaluated at $n_H = 1$ yields

$$[\eta_U]_{\beta_U=\widehat{\beta}_U \wedge n=1} = \frac{1}{1-\alpha}. \tag{59}$$

Note that expression (58) is an increasing function of foreign CB hence we evaluate it when $\beta_F \to \infty$ as follows:

$$[\eta_N]_{\beta_H=\widehat{\beta}_H \wedge n=1 \wedge \beta_F \to \infty} = \frac{\theta_F}{1-\alpha}. \tag{60}$$

It is apparent that expression (59) is always larger than (60).which proves Proposition 7. ■

Welfare and macroeconomic institutions. It is straightforward to compute that welfare level as follows:

$$U_i = \frac{1}{2}\frac{\alpha^2}{k}\left[\left(1 - \frac{1}{\eta_r}\right)\left(2 - \left(1 - \frac{1}{\eta_r}\right)\right)\right] = \frac{1}{2}\frac{\alpha^2}{k}\left(1 - \frac{1}{\eta_r^2}\right). \tag{61}$$

Now consider the problem of maximizing the individual welfare on the constraint set as follows:

$$\begin{array}{rcl} & \max\limits_{n_H,\beta} U_i & \\ s.to \;\; n_H & \geq & 1 \wedge \beta \geq 0. \end{array} \tag{62}$$

The solution of the Kuhn-Tucker conditions yields

$$\begin{array}{rcl} \text{if } \sigma & > & \dfrac{k + \beta_F \theta_F^2}{k\theta_N + \beta_F \theta_F (1-\alpha)},\ \beta = 0 \wedge n_H > 1 \\ \text{if } \sigma & < & \dfrac{k + \beta_F \theta_F^2}{k\theta_N + \beta_F \theta_F (1-\alpha)},\ \beta > 0 \wedge n_H = 1. \end{array}$$

[50] Such a value is in fact $n = \frac{\sigma-1}{\sigma}$.

If we evaluate the (61) at the $n_H = 1$ and $\beta = 0$, we obtain

$$[U_{i,N}]_{n_H=1} = \frac{\alpha^2}{2k}\left[1 - \frac{1}{\left(\frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}\right)^2}\right], \tag{63}$$

$$[U_{i,U}]_{n_H=1} = \frac{\alpha^2}{2k}\left[1 - \frac{1}{\left(\frac{1}{1-\alpha}\right)^2}\right] \tag{64}$$

and

$$[U_{i,N}]_{\beta=0} = [U_{i,U}]_{\beta=0} = \frac{\alpha^2}{2k}\left[1 - \frac{1}{\sigma^2}\right]. \tag{65}$$

It is apparent that expression (63) is greater (smaller) than expression (65) iff $\sigma < \frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}$ ($\sigma > \frac{k+\beta_F\theta_F^2}{k\theta_N+\beta_F\theta_F(1-\alpha)}$). Similarly expression (64) is greater (smaller) than expression (65) iff $\sigma < \frac{1}{1-\alpha}$ ($\sigma > \frac{1}{1-\alpha}$). Moreover relation (64) is always larger than relation (63). Recall that both an ultra-populist CB and atomistic wage setters lead the labor demand elasticity to be equal to σ, i.e. the case of monopolistic competition. ■

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