The Impact of Fiscal-Monetary Policy Interactions on Government Size and Macroeconomic Performance

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Abstract

This paper analyzes the relationship between inflation, output and government size by reexamining the time inconsistency of optimal monetary and fiscal policies in a general equilibrium model with staggered timing structure for the acquisition of nominal money *à la* Neiss (1999), and public expenditure financed by means of a distortive tax. It is shown that, with pre-determined wages, the equilibrium rate of inflation is above the Friedman rule and the equilibrium tax rate is below the efficient level. In particular, the discretionary rate of inflation is nonmonotonically related to the natural output, positively related to the government size, and negatively related to the degree of CB conservatism. Finally, a regime with commitment is always welfare improving relative to a regime with discretion.

1   Introduction

During the 1990s, many OECD countries had declining rates of inflation while their unemployment rates were also falling (see Figure 1). This is clearly in contrast with the negative relationship between inflation and unemployment predicted by a standard Phillips curve. Moreover, Figure 2 depicts a positive (average) relationship between inflation and government size in the same period.[1] Grilli *et al.* (1991) and Campillo and Miron (1997), for instance, also find a positive correlation between inflation and the size of government in the major OECD countries. This paper analyzes these macroeconomic outcomes in terms of time inconsistency in a game theoretical model with three players: the central bank (CB), fiscal authority (FA) and wage-setters.

[1]Countries shown in Figure 1 and 2 have been chosen among the most industrialized OECD countries with trade union density larger than 30 per cent.
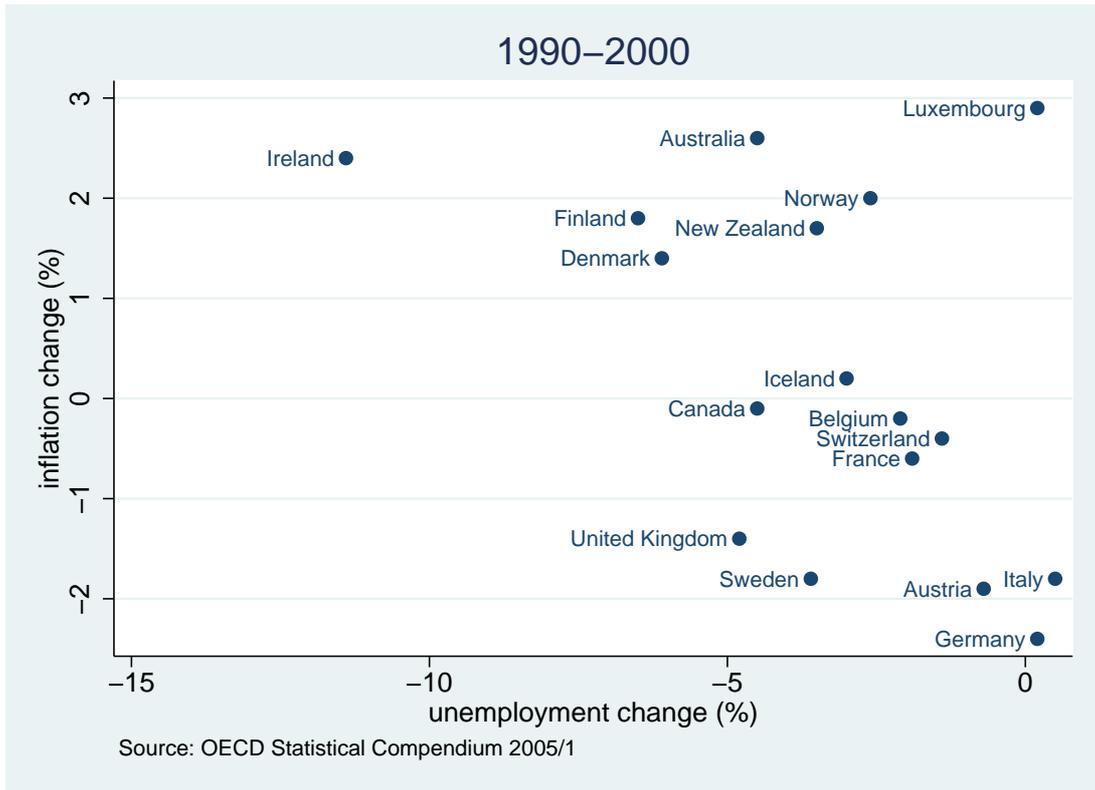
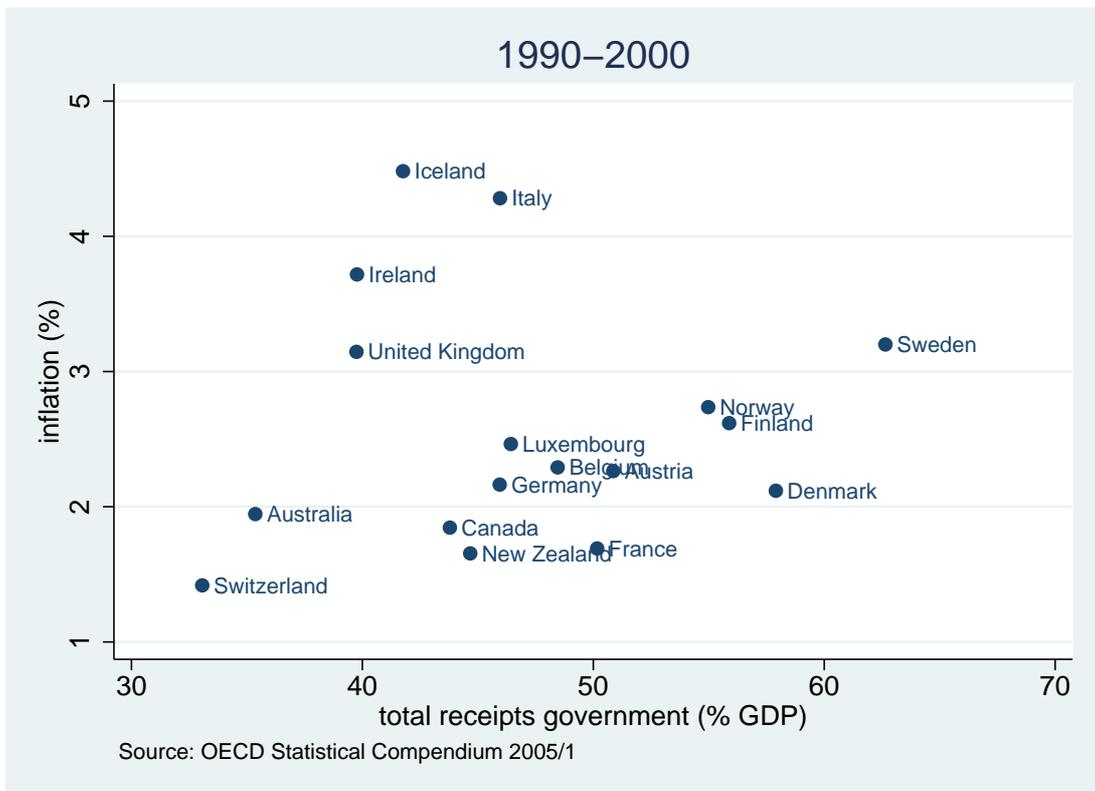Figure 1: Change in inflation and unemployment 1990-2000.

Figure 2: Inflation and total receipts government 1990-2000.

Since the influential papers of Kydland and Prescott (1977) and Barro and Gordon (1983), several authors have addressed the issue of time inconsistency and the desire of policy makers to raise output above its market-clearing level due to the existence of distortions. The optimal monetary policy of low inflation is not credible in the absence of binding commitments; and the time-consistent but sub-optimal monetary policy leaves unemployment unaffected and generates an excessively high rate of inflation.

The bulk of this literature on the importance of dynamic inconsistency has focused on the relationship between institutional aspects governing the CB and inflation. For example, empirical evidence suggests that the appointment of a conservative CB is important for reducing inflation (see, e.g., Alesina, 1989; Grilli *et al.* 1991; Cukierman *et al.* 1992). Although this point has been acknowledged in the aforementioned works, the connection between macroeconomic performance, government size and the problem of time consistency of monetary policy has not been modeled explicitly in a fully micro-founded model.[2] These connections are particularly important because, in most industrialized countries, monetary and fiscal policies are set by two authorities which are, in general, at least partially independent.

The paper builds on Neiss (1999), where a money-in-the-utility-function framework together with staggered timing provide a theoretical basis for a micro-founded inclusion of inflation as a cost in the policymaker's objective function. Public expenditure enters into the utility function and is financed by means of a distortive tax, while labor markets are characterized by monopolistic distortions and nominal rigidities.[3] In particular, there are three areas in which this model provides insights into the relationship between inflation, output and macroeconomic institutions.

First, the different performance in terms of inflation and unemployment shown in Figure 1 may be explained by monopolistic distortions in labor markets and the CB incentive to raise inflation. Intuitively, a reduction in unemployment rate has two contrasting effects on the equilibrium rate of inflation. On the one hand, it causes an increase in the marginal costs of inflating because of lower leisure. However, as unemployment decreases and output rises, the demand for real money rises as well. This implies that, for a given rate of inflation, the marginal cost of inflating falls, because it is decreasing and convex in real balances. These counterbalancing effects lead to a non-monotonic relationship between the discretionary level of inflation and the rate of employment.

Second, the model shows that the discretionary level of inflation is positively related to the weight attached to public expenditure in the utility and to the size of government spending in the economy. In fact, an increase in the government size enlarges the gap between efficient and natural output, and raises real money demand. Both effects induce the CB to overinflate. An increase in the degree of CB conservatism is, instead, found to have a negative impact on the discretionary rate of inflation.

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[2]The role played by institutions in the creation of European unemployment has recently received increasing attention: see, for example, Blanchard and Giavazzi (2003) and Nickell *et al.* (2005).

[3]In most countries in the OECD, wage-setting takes place through collective bargaining between employers and trade unions at the plant, firm, industry or at aggregate level. There is some evidence that labor market institutions, mainly labor union power in wage setting, has a considerable impact on unemployment (Nickell *et al.*, 2005).

Finally, the strategic interaction between the policymakers is analyzed under a regime with discretion or with commitment. The regime with commitment always improves welfare over the discretionary regime. In fact, the level of natural output is equal in the two regimes, while inflation is higher with discretion. This result relies upon the possibility for policymakers of affecting output. With binding commitments, unexpected inflation and/or taxation are ruled out and both fiscal and monetary policy are ineffective on output. However, given that fiscal policy is endogenous, the level of tax distortion and, as a consequence, the level of public expenditure is not invariant to the regime change. Thus, a movement from a discretionary regime to a regime with commitments yields a higher level of government spending because it reduces the government incentive to set a lower tax rate.

The paper is organized as follows: Section 2 presents the model. Section 3 investigates the benchmark cases of a benevolent social planner and fully flexible wage setting. Section 4 considers the strategic interaction between fiscal and monetary policy in presence of pre-determined wage setting under a regime with discretion and commitment, and the effects of a change in economy parameters on the inflation bias and government spending. This is followed by concluding remarks.

2 Economic Setup

The essential elements of the economy setup are taken from the general equilibrium model developed in Neiss (1999). The structure of the model is a money-in-the-utility-function with staggered timing for the acquisition of nominal money. The novelty of the paper is the introduction of real frictions via monopolistic competition in the factor markets and distortive taxation on top of public spending entering in the utility function.

2.1 Firms

A profit-maximizing competitive firm produces a single consumption good using imperfectly substitute labor types, $N_t(j)$, as inputs with $j \in [0,1]$. The firm is price taker in both product and labor markets.[4] The production function exhibits decreasing return to scale as follows

$$Y_t = N_t^{\frac{1}{\alpha}} \qquad \alpha > 1, \tag{1}$$

where α measures the returns to scale in production. Aggregate employment is assumed to be a composite made of a continuum of differentiated labor types with a constant elasticity of substitution between labor types

$$N_t = \left[\int_0^1 N_t(j)^{\frac{\sigma-1}{\sigma}} dj \right]^{\frac{\sigma}{\sigma-1}} \qquad \sigma > 1, \tag{2}$$

where σ measures the elasticity of input substitution.

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[4]Differently from Neiss (1999), monopolistic competition is introduced in the input market instead of the product one.

For a given level of production, demands of each labor type j in period t solve the dual problem of minimizing total cost, $\int_0^1 W_t(j)N_t(j)dj$, subject to the employment index (2), where $W_t(j)$ denotes the nominal wage of labor type j at time t. The demand for labor type j is then given by

$$N_t(j) = \left(\frac{W_t(j)}{W_t}\right)^{-\sigma} N_t. \tag{3}$$

Where W_t is the nominal wage index prevailing in the economy defined as

$$W_t = \left[\int_0^1 W_t(j)^{1-\sigma}dj\right]^{\frac{1}{1-\sigma}}. \tag{4}$$

The wage index has the property that the minimum cost of employing an array of labor types N_t is given by $W_t N_t$. Finally, since $Y_t = N_t^{1/\alpha}$, the aggregate labor demand is achieved by maximization of nominal profits,

$$D_t = P_t Y_t (1 - \tau_t) - \int_0^1 W_t(j)N_t(j)dj, \tag{5}$$

yielding

$$N_t = \left[\frac{\alpha W_t}{P_t(1 - \tau_t)}\right]^{\frac{\alpha}{1-\alpha}}, \tag{6}$$

where P_t is the price of the homogeneous good and τ_t is the proportional tax rate levied on sales by the FA at time t.

2.2 Households

The economy is populated by a large representative household with a continuum of $j \in [0,1]$ members each supplying a differentiated labor type. The household's preferences are defined over per capita consumption, C_t, public spending, G_t, real money balances, M_t/P_t, and quantity of labor supplied as follows:

$$U_0 = \sum_{t=0}^{\infty} \beta^t \left[(1 - \rho)\log C_t + \rho \log G_t - \frac{1}{1+\phi}N_t^{1+\phi} + \frac{\chi}{1-\nu}\left(\frac{M_t}{P_t}\right)^{1-\nu}\right]. \tag{7}$$

Parameter $\rho \in (0,1)$ measures the weight attached to public consumption relative to private consumption, $\beta \in (0,1)$ is the discount factor, $\chi > 0$ is the weight attached to the utility of real balances and $\nu > 1$ controls the convexity of the inflation cost.[5]

In maximizing (7) the household faces the following budget constraint:

$$B_{t+1} + M_{t+1} + P_t C_t = D_t + \int_0^1 W_t(j)N_t(j)dj + P_t T_t + B_t(1 + i_t) + M_t, \tag{8}$$

where B_t are bonds which pay the nominal net rate of interest i_t and T_t are lump-sum transfers by the CB. I assume that $B_0 = 0$; since all households are equal in equilibrium, there will be

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[5]The condition $\nu > 1$ ensures that the monetary authority's choice problem is always a global maximum (see Neiss, 1999)

no trade in bonds (i.e. a zero net asset position). The first-order conditions for the family are given by

$$C_{t+1}P_{t+1} = (1 + i_{t+1})\beta P_t C_t \tag{9}$$

$$\frac{M_{t+1}}{P_t} = \left(\frac{P_{t+1}}{P_t}\right)^{\frac{\nu-1}{\nu}} \left(\frac{\beta(1 + i_{t+1})\chi C_t}{i_{t+1}(1 - \rho)}\right)^{\frac{1}{\nu}}, \tag{10}$$

where eq. (9) is the standard consumption Euler equation linking present and future consumption. Eq. (10) expresses the demand for real money at time t. Drawing on Neiss (1999), M_t is *predetermined* in period t since money holdings are effectively chosen in period $t-1$ and $M_0 > 0$ is given. Such an assumption implies that an expansionary policy raising the price level has an utility cost since it reduces real balances. I postpone the remaining optimality conditions until the union's problem is considered.

2.3 The Fiscal Authority

Each period, the FA consumes G_t units of the homogeneous good. The FA levies a proportional tax on sales, τ, which is controlled in order to maximize the household's utility (7). I assume that government budget is balanced in every period so that

$$\tau_t Y_t = G_t. \tag{11}$$

2.4 The Central Bank

The CB maximizes the following utility function:

$$U_0 = \sum_{t=0}^{\infty} \beta^t \left[(1 - \rho)\log C_t + \rho \log G_t - \frac{1}{1 + \phi}N_t^{1+\phi} + \frac{\chi_B}{1 - \nu}\left(\frac{M_t}{P_t}\right)^{1-\nu}\right], \tag{12}$$

which differs from (7) because of the parameter χ_B. The case of a benevolent monetary authority occurs when $\chi_B = \chi$. Following Svensson's (1999) terminology, the extreme case of $\chi_B \to \infty$ corresponds to strict inflation targeting, whereas the case of a finite χ_B to flexible inflation targeting. A conservative CB ($\chi_B > \chi$) will attach a higher weight to real balance compared to a benevolent one.

I assume that at time t the CB directly controls the next period money supply, M_{t+1}, and rebates the seignorage through a lump-sum transfer, i.e.

$$M_{t+1} - M_t = P_t T_t. \tag{13}$$

Since prices are flexible, when the CB sets money supply M_{t+1} indirectly manages price level P_t via the equilibrium in the money market (10). Thus, for sake of simplicity, I posit that the CB maximizes (12) by setting directly the current inflation rate, denoted by $\pi = (P_t - P_{t-1})/P_{t-1}$.[6]

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[6]The absence of a state variable in the model implies that the current money supply does not affect the household's discounted utility starting from the next period. Hence, in a Markov equilibrium the monetary authority faces the static problem of maximizing the current period's utility.

2.5 Unions

Workers are organized in a continuum of trade unions, each of which represents a set of the family members specialized in a given labor service. Unions are benevolent and maximize the utility function of their represented workers (7) by controlling at time t the wage $W_t(j)$.

Maximization of (7) is subject to the labor demand schedule (3), the aggregate employment index (2), and the household's budget constraint (8). In a symmetric equilibrium, i.e. when $W_t(j) = W_t$, the first order condition associated with such a problem is given by[7]

$$\frac{W_t}{P_t} = \mathcal{M} \frac{N_t^\phi C_t}{1 - \rho}, \tag{14}$$

where $\mathcal{M} \equiv \sigma/(\sigma - 1) > 1$ is the mark-up over the marginal rate of substitution between consumption and leisure. This expression states that the real wage is set so as to equate a mark-up over the marginal rate of substitution between consumption and leisure.

3 Natural and Efficient Allocation under Flexible Wage Setting

This section derives the optimal level of output, consumption and government spending and shows how they can be supported in equilibrium when wage are fully flexible. This will prove a useful benchmark for evaluating the role of different macroeconomic institutions, to which I turn later.

3.1 Fully Flexible Wages

This model features two types of wage setting: fully flexible and pre-determined. I now describe the natural level of output and evaluate how the optimal fiscal and monetary policies are performed under the assumption of flexible wages. I will introduce nominal wage stickiness later on.

Before assessing the optimal fiscal policy, it is convenient to plug the government budget constraint (11) into the following good-market clearing condition

$$Y_t = C_t + G_t, \tag{15}$$

so as to obtain a relation between consumption and disposable income at time t as follows

$$C_t = (1 - \tau_t)Y_t. \tag{16}$$

The optimal level of government size is then the solution of the maximization of (7) with respect to τ subject to (16). The first-order condition of the FA's problem yields

$$\frac{1 - \rho}{C_t} = \frac{\rho}{G_t}; \tag{17}$$

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[7]See eq. (50) for a derivation of such a result.

i.e., the FA equates the marginal utility of private consumption to the marginal utility of public consumption. Dividing (16) by (11) and using the optimal condition (17), the natural levels of private and public consumption are respectively given by

$$C = (1 - \rho)Y \tag{18}$$

$$G = \rho Y, \tag{19}$$

where clearly ρ denotes the government size level in the economy (G/Y).

Next, substituting expression (16) into the unions' first order condition (14) yields

$$W_t = P_t(1 - \tau_t)\frac{\mathcal{M}}{1 - \rho}Y_t^{1+\alpha\phi}, \tag{20}$$

which together with eq. (6) and (1) implies the following natural level of output

$$\hat{Y} = \left(\frac{1 - \rho}{\alpha\mathcal{M}}\right)^{\frac{1}{\alpha(1+\phi)}}. \tag{21}$$

The impact of a change in government size and labor market distortions on the natural level of output above can be summarized in the following proposition.

Proposition 1 *In an economy in which agents perceive utility from government spending and wages are flexible, the output level is lower, the higher the government size and the mark-up set by the unions.*

Proof. From eq. (21), it is apparent that the natural level of output is decreasing in the degree of monopolistic distortion in the labor market ($\mathcal{M}$) and in the level of government size (ρ) as stated in Proposition 1. ∎

As for optimal monetary policy, from maximization of (12) with respect to π, the CB first-order condition yields

$$\chi_B\left(\frac{M_t}{P_t}\right)^{-\nu} = 0. \tag{22}$$

Condition (22) requires the CB to equate the marginal utility of real balances to the *social* marginal cost of producing real money balances, which is zero. However, a comparison with real money demand

$$\frac{M_t}{P_t} = \left(\frac{P_t}{P_{t-1}}\right)^{-\frac{1}{\nu}}\left(\frac{\beta(1 + i_t)\chi C_{t-1}}{i_t(1 - \rho)}\right)^{\frac{1}{\nu}}, \tag{23}$$

suggests that, from the viewpoint of each individual, the *private* marginal cost of holding real balances at time t is not zero and coincides with the opportunity cost of holding money $i_t/(1+i_t)$. Thus, the CB first-order condition implies that

$$i_t = 0 \tag{24}$$

for all t, i.e. the optimal monetary prescription is the Friedman rule. The implication of (24)

for the equilibrium rate of inflation is $\pi = \beta - 1 < 0$.[8]

3.2 The Social Planner's Problem

The social planner maximizes the household's utility (7) with respect to C_t, G_t and M_t/P_t subject to the technological (1) and the resource constraints (15).

The optimal allocation coincides with a sequence of static problems so that, in any given period t, the following conditions hold:

$$\frac{1-\rho}{C_t} = \frac{\rho}{G_t} = \alpha Y_t^{\alpha(1+\phi)-1}, \qquad \chi\left(\frac{M_t}{P_t}\right)^{-\nu} = 0. \tag{25}$$

The first relation states that the marginal loss in utility of the household producing an additional unit of good ($\alpha Y_t^{\alpha(1+\phi)-1}$) must be equal, at the margin, to the utility gain originated by the two possible uses of that additional output: consumption and government spending. The second relation requires the (social) marginal utility of real balances to be equal to the social marginal cost of producing real money balances, i.e. zero.

Using the good market clearing condition (15) and the first order conditions (25), I obtain the optimal level of output, consumption, government spending and inflation as follows:

$$\tilde{Y} = (1/\alpha)^{\frac{1}{\alpha(1+\phi)}} \tag{26}$$

$$\tilde{C} = (1-\rho)\tilde{Y} \tag{27}$$

$$\tilde{G} = \rho\tilde{Y} \tag{28}$$

$$\pi = \beta - 1 < 0. \tag{29}$$

It is worth noticing that the main difference with the decentralized case in section (3.1) concerns the equilibrium level of output.

Remark 1 *The natural output level (21) is below the optimal output level (26).*

The difference between the natural output level obtained under flexible prices (21) and the efficient output level derived in this section 26) is due to two sources of inefficiency. First, the monopolistic power in the labor market implies the existence of a wedge, $\mathcal{M} > 1$, between real wages and the marginal rate of substitution. This distortion may be eliminated either by assuming an extreme labor market regime as perfect competition ($\sigma \to \infty$, $\mathcal{M} = 1$) or production subsidies. In the latter case the optimal allocation can be supported as an equilibrium in the

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[8]This can be immediately derived from the Euler equation (9).

presence of flexible prices. In fact, from eqs. (6), (14), and (1)

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\begin{aligned}
Y_t &= \left(\frac{\alpha W_t}{P_t(1 - \tau_t)} \right)^{\frac{1}{1-\alpha}} \\
&= \left(\frac{\alpha \mathcal{M} N_t^\phi C_t}{(1 - \tau_t)(1 - \rho)} \right)^{\frac{1}{1-\alpha}} \\
&= \left(\frac{\alpha \mathcal{M} N_t^\phi Y_t}{(1 - \tau_t)} \right)^{\frac{1}{1-\alpha}},
\end{aligned}
\tag{30}
$$

in order for the equilibrium allocation under flexible prices to correspond to the Pareto efficient allocation the τ must be set at a level

$$
\mathcal{M} = 1 - \tau_t,
$$

so that a production subsidy is a remedy for labor market distortions (e.g. Alesina and Tabellini, 1987; Dixit and Lambertini, 2003). More specifically, if the above condition is satisfied, the flexible price equilibrium yields the level of employment and output that is optimal from the social planner's perspective, i.e. $Y_t = (\alpha)^{\alpha(1+\phi)}$ for all t.

Second, trade unions neglect the effects of their actions on the public consumption, which is taken as given in the maximization problem. This explains why, even with $\mathcal{M} = 1$, wages are set above the optimal level by the factor $1 - \rho$ (see eq. (21)). A remedy for this outcome would be a highly centralized/coordinated bargaining systems with wage negotiations involving the FA. In this case, unions would take into account the macroeconomic constraints such as the government budget and would internalize the consequences of their wage claims on government expenditure (see e.g. Summers *et al.*, 1993). However, for the remainder of the paper, I will keep assuming atomistic wage setting.

4 Strategic Interaction between Fiscal and Monetary Authorities under Pre-determined Wages

When wages are flexible, both fiscal and monetary policy cannot affect output (21), and inflation and tax rate are respectively set according to the Friedman rule and the optimal tax rate ρ (see section 3.1).

In this section I assume that nominal wages are pre-determined and chosen before inflation and tax rate are known. In such a case there is scope for fiscal and monetary policy to affect the output in the "short run".[9] Moreover, policy makers may act either in a coordinated or uncoordinated way as in Alesina and Tabellini (1987). In this respect, two possible alternative institutional regimes will be tackled: a discretionary uncoordinated regime and a regime with binding commitments.

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[9]In this model the short run coincides with the period in which wages cannot be modified. When wages are pre-determined, the employment level is then determined only by the labor demand.

4.1 Discretionary Regime

Under a discretionary regime I exclude any possibility of commitments by the policymakers. The three agents (unions, CB and FA) act as Nash player, taking everybody's else current strategy as given.

Nominal wages are set equal to the level expected to produce the real wage that equates labor supply (14) and labor demand (6) as follows:[10]

$$\bar{W}_t = P_t^e \frac{1}{\alpha} (1 - \tau_t^e) \hat{Y}^{1-\alpha}, \tag{31}$$

where $\hat{Y}$, P_t^e and τ_t^e denote respectively the natural level of output (21) and the expected price and tax rate. It is convenient to rewrite the above expression in the following way:

$$\frac{\bar{W}_t}{P_t} = \frac{(1 + \pi_t^e)}{(1 + \pi_t)} (1 - \tau_t^e) \frac{1}{\alpha} \hat{Y}^{1-\alpha}, \tag{32}$$

where $\pi_t^e \equiv (P_t^e - P_{t-1})/P_{t-1}$. Thus, from equations (6), (15) and (16), employment, consumption and government spending are respectively given by

$$N_t = \left[\frac{(1 + \pi_t)(1 - \tau_t)}{(1 + \pi_t^e)(1 - \tau_t^e)} \right]^{\frac{\alpha}{\alpha-1}} \hat{Y}^\alpha, \tag{33}$$

$$C_t = \left[\frac{(1 + \pi_t)(1 - \tau_t)}{(1 + \pi_t^e)(1 - \tau_t^e)} \right]^{\frac{1}{\alpha-1}} (1 - \tau_t)\hat{Y}, \tag{34}$$

$$G_t = \left[\frac{(1 + \pi_t)(1 - \tau_t)}{(1 + \pi_t^e)(1 - \tau_t^e)} \right]^{\frac{1}{\alpha-1}} \tau_t \hat{Y}. \tag{35}$$

The game is static and repeated only a finite number of times. In such a case the only subgame perfect (and hence time-consistent) Nash equilibrium of the repeated game coincides with the unique Nash equilibrium of the one-shot game. Assuming that the economy is at the Nash equilibrium at time $t - 1$, the nominal interest rate at time t is found by associating the Euler equation (9) and the equilibrium level of consumption at time $t - 1$ (i.e., $\hat{Y}(1 - \tau)$) as follows:

$$1 + i_t = \frac{1 + \pi_t}{\beta} \left[\frac{(1 + \pi_t)(1 - \tau_t)}{(1 + \pi_t^e)(1 - \tau_t^e)} \right]^{\frac{1}{\alpha-1}}. \tag{36}$$

Note that both a surprise inflation and a tax cut cause the nominal as well as the real interest rate to rise. Substituting the above expressions into the real money balances (10) yields

$$\frac{M_t}{P_t} = \left(\frac{\beta \left[\frac{(1+\pi_t)(1-\tau_t)}{(1+\pi_t^e)(1-\tau_t^e)} \right]^{\frac{1}{\alpha-1}} \chi(1 - \tau_t)\hat{Y}}{\left((1 + \pi_t) \left[\frac{(1+\pi_t)(1-\tau_t)}{(1+\pi_t^e)(1-\tau_t^e)} \right]^{\frac{1}{\alpha-1}} - \beta \right)(1 - \rho)} \right)^{\frac{1}{\nu}} \tag{37}$$

Now, I turn to the one-shot Nash equilibrium.

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[10]This expression is achieved by combining equations (21) and (20).

The FA maximizes the household's utility function (7) by setting the tax rate at time t, τ_t, subject to eqs. (34), (35), (33). In doing that, the rate of inflation and unions' expectations are taken as given. It is convenient to rewrite the FA first order condition as follows:[11]

$$\underbrace{(1-\rho)\Sigma_{C\tau}}_{marginal\ cost} + \underbrace{\rho\Sigma_{G\tau} - N_t^{1+\phi}\Sigma_{N\tau}}_{marginal\ benefit} = 0, \tag{38}$$

where Σ_{xz} denotes the elasticity of variable x to variable z, and for all $\tau \in \left(\frac{(\alpha-1)\rho}{\alpha}, \frac{\alpha-1}{\alpha}\right)$

$$\Sigma_{C\tau} = \Sigma_{N\tau} \equiv -\frac{\alpha\tau}{(\alpha-1)(1-\tau)} < 0, \quad \Sigma_{G\tau} \equiv \frac{1}{1-\tau} + \Sigma_{N\tau} \equiv \frac{1+\alpha(\tau-1)}{(\alpha-1)(\tau-1)} > 0. \tag{39}$$

A higher tax rate has three effects on household's welfare. First, from eq. (33), it is clear that an unexpected tax rise triggers employment to decrease, thereby reducing the cost of providing labor services. Second, it lets the FA collect more tax revenue and boost public consumption.[12] Finally, an increase in taxation leads to a reduction in private consumption and, hence, in utility. In this respect, the FA has to equate the *sum* of marginal utilities originated from larger public spending and leisure to the marginal disutility due to less private consumption.

Since the economy exhibits a level of output below the efficient one, the marginal utility of an additional unit of consumption is larger than the marginal disutility of producing it. Thus, the FA has an incentive to set a lower tax rate. However, in such a process the FA undergoes a reduction in marginal utility stemming from less resources available for public spending. This in part discourages tax cuts. To see that, I may solve the first order condition (38) for τ, so that in a rational expectation equilibrium ($\tau^e = \tau$ and $\pi^e = \pi$) the following reaction function holds:[13]

$$\tau^d = \frac{\rho}{1 + \frac{\alpha}{\alpha-1}\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}. \tag{40}$$

Clearly, as long as natural output is below the optimal employment level, the FA will choose a tax rate lower than the socially efficient one, ρ (see section 3).

In order to solve the CB maximization problem, I plug eq. (32) into real money balances:

$$\left(\frac{M_t}{P_t}\right)^{1-\nu} = \left(\frac{M_t(1-\tau_t^e)\hat{Y}^{1-\alpha}}{\alpha\bar{W}_t}\right)^{1-\nu}\left(\frac{1+\pi_t^e}{1+\pi_t}\right)^{1-\nu}. \tag{41}$$

The CB maximizes the utility (12) selecting the inflation rate at time t, π_t, under the constraints (34), (35), (33) and (41). Fiscal stance as well as unions' expectations are taken as given. The solution of the CB problem yields, in a rational expectation equilibrium (i.e. when $\tau^e = \tau$ and

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[11]If the government cannot affect output, as in the case of flexible wages, the first order condition implies that $\frac{\rho}{\tau} = \frac{1-\rho}{1-\tau}$ which is clearly solved for $\tau = \rho$.

[12]In order to have a positive elasticity between government revenue and tax rate, i.e. to be on the efficient side of the Laffer curve, the condition $\tau < \frac{\alpha-1}{\alpha}$ must hold. Thus, from eq. (40) the range of tax rate values has to be such that $\tau \in \left(\frac{(\alpha-1)\rho}{\alpha}, \frac{\alpha-1}{\alpha}\right)$.

[13]Where the superscript d stands for discretion.

$\pi^e = \pi$), the following reaction function

$$\frac{M_t}{P_t} = \left[\frac{\alpha\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}{(\alpha-1)\chi_B}\right]^{\frac{1}{1-\nu}}. \tag{42}$$

The CB first-order condition (42) implies that it is optimal for the CB deviates from the Friedman rule (22). The monetary authority, in fact, has an incentive to raise prices up to the point where the *sum* of marginal benefits due to more public and private consumption equate the *sum* of marginal costs due to less leisure and real balances:[14]

$$\underbrace{(1-\rho)\Sigma_{C\pi} + \rho\Sigma_{G\pi}}_{marginal\ benefit} + \underbrace{\chi_B(m_t)^{1-\nu}\Sigma_{m\pi} - N_t^{1+\phi}\Sigma_{N\pi}}_{marginal\ cost} = 0, \tag{43}$$

where $\Sigma_{C\pi}$, $\Sigma_{G\pi}$, $\Sigma_{N\pi}$ and $\Sigma_{m\pi}$ are the elasticity of consumption, government spending, employment and real money ($m \equiv M/P$) to inflation rate π defined as follows:

$$\Sigma_{C\pi} = \Sigma_{G\pi} \equiv \frac{\pi}{(1+\pi)(\alpha-1)} > 0, \quad \Sigma_{N\pi} \equiv \frac{\pi\alpha}{(1+\pi)(\alpha-1)} > 0, \quad \Sigma_{m\pi} \equiv -\frac{\pi}{1+\pi} < 0. \tag{44}$$

The equilibrium rate of inflation and public consumption is computed by combining the first-order conditions of the two policymakers, together with the real money demand (23) and the government budget constraint (11):

$$\pi^d = \underbrace{\beta-1}_{Friedam\ rule} + \underbrace{\left[\frac{\alpha\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}{(\alpha-1)\chi_B}\right]^{-\frac{\nu}{1-\nu}} \hat{Y}(1-\tau^d)\frac{\beta\chi}{1-\rho}}_{bias} \tag{45}$$

$$G^d = \tau^d\hat{Y}. \tag{46}$$

In equilibrium output and government spending are below their efficient level, while inflation is above the Friedman rule ($\beta - 1$). The discretionary inflation rate is actually formed by two components. The first one is the Friedman rule and the second is a positive inflation bias. It is apparent from (45) that when output is at its efficient level, the Friedman rule holds, i.e. inflation rate is set in order to equate the negative of the real interest rate. As seen above, the presence of monopolistic power in the labor market leads output to be below the efficient level (see section 3.1). It turns out that, for a given tax rate, there is an incentive for the CB to inflate when wages are sticky. Similarly, the FA is induced to boost the economy by setting a tax rate below the efficient level ρ.

These results are in line with Alesina and Tabellini (1987). Nevertheless, they find that, in absence of government spending in the objective functions of the policymakers, inflation and output are at their target levels. This is due to the fact that the FA subsidizes firms so as to eliminate the distortion in the labor market. By contrast, in this model, if public expenditure

---

[14]If the CB could not affect output, the first order condition would be given by $\chi_B\Sigma_{m\pi}\left[\frac{\beta\chi C_t}{(1-\rho)(1+\pi_t-\beta)}\right]^{\frac{1-\nu}{\nu}} = 0$ which is clearly solved by conforming with the Friedman rule $\pi_t = \beta - 1$.

does not enter in the household's utility function (i.e. when $\rho = 0$) inflation and output are still different from their efficient values.

The reason is that in equilibrium unions set their real wage as a constant mark-up over the marginal rate of substitution between consumption and leisure (see eq. (14)). An increase in tax rate has a twofold impact on labor. On the one hand, it leads a reduction in consumption and in real wages, thereby raising the demand for labor. On the other hand, it directly reduces the demand for labor by dampening sales revenue. The two effects exactly offset each other so that the natural level of output turns out to be policy invariant. When ρ is equal to zero, the distortion in wage setting related to the externality on the FA budget is trivially eliminated, but there is still a mark-up over the real competitive wage.[15]

Proposition 2 *In a Nash game between the two policy makers: i) an increase in χ_B reduces inflation without any repercussion on output; ii) an increase in ρ reduces output and raises inflation.*

Proof. See Appendix. ∎

The intuition behind this result hinges upon the effect of χ_B on the CB incentive to create unexpected inflation. More specifically, the marginal cost of inflation, through its effect on real balances, is decreasing and convex in real balances. Since a more conservative CB (higher χ_B) undergoes higher costs by lowering real balances, this discourages a reduction in real money balances to a larger extent. As a consequence, inflation will be lower in equilibrium, the higher χ_B. Moreover, this result implies that, given the natural level of output, society would be made better off by having appointed a CB more averse to inflation than society itself.[16]

As to the role of ρ, it is worth noticing that the negative effect of ρ on output in Proposition 2 is mainly due to the fact that wage setters do not internalize the repercussions of their wage claims on public consumption (see eq. (20)). It follows that natural output reflects such an inefficiency and is lower the higher the parameter ρ. The impact of ρ on inflation is instead related to the relation between government size and inflation itself. Specifically, a rise in ρ triggers an increase in the government size (G/Y) because of the positive relationship between ρ and τ^d.[17] Thus, from Proposition 2 I can infer a positive relationship between government size (via ρ) and inflation. Intuitively, this is due to two effects. First, when agents attribute higher weight to public expenditure (higher ρ), the gap between efficient and natural output increases (see eqs. (21) and (26)), thereby inducing the CB to inflate. Second, the overall impact of an increase in ρ on money demand is positive (see eq. (23)). Therefore, a higher ρ reduces the marginal utility of consumption and the CB undergoes a reduction in the marginal cost of inflation because of the increase in real money balances. Both effects lead to an expansionary monetary policy. A rise in government size, in other words, reduces the marginal cost of inflation faced by the CB by lowering the leisure cost and by increasing the demand for real money balances.

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[15]See section 3.1 for further details.

[16]The same conclusion is derived in Rogoff (1985).

[17]The government size in fact coincides with the tax rate in eq. (40) through the binding government budget constraint (11).
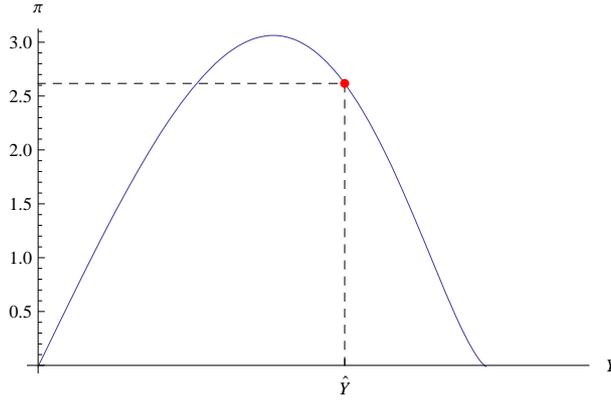
Figure 3: Discretionary inflation and natural output

From eq. (45) I may derive a hump-shaped relationship between inflation rate and natural level of output as shown in Figure 3.[18] An increase in the size of $\hat{Y}$ has two opposite effects on the equilibrium rate of inflation. First, it causes an increase in the marginal costs of inflating because of the leisure effect. The higher $\hat{Y}$ is, the higher the marginal cost of inflating. Second, as $\hat{Y}$ increases, the market-clearing level of output rises and, for a given rate of inflation and tax, the equilibrium demand for real balances rises, thereby inducing the CB to increase inflation. The latter effect dominates when output is relatively low, while the former prevails when output is relatively high.

So long as the level of output $\hat{Y}$ is close to the efficient one, $\tilde{Y}$, the curve in Figure 3 seems at odds with the Phillips curve relationship between inflation and unemployment. However, during the 1990s, many OECD countries had declining rates of inflation, while their unemployment rates were also falling. The analysis so far may hence give a justification for such seemingly contradictory developments.

4.2 Regime with Binding Commitments

Under this regime I assume that both CB and FA enter in a binding commitment before nominal wages are set. In other words, the CB and FA act simultaneously as Stackelberg leader, while workers are Stackelberg followers. Drawing on Alesina and Tabellini (1987), I compute the equilibrium with commitment simply by imposing the requirement that $\pi = \pi^e$ and $\tau = \tau^e$ before taking the CB and FA first-order conditions, rather than subsequently as in section 4.1. In such a way the CB and FA anticipate that in equilibrium unexpected inflation and taxes are ruled out.

From equations (34), (35) and (33), it is apparent that the CB may only affect the real balances by setting the inflation rate. As analyzed in section 3.1, the CB obeys the Friedman

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[18]Parameter values used to draw the figure are the following: $\rho = 0.5$, $\nu = 4$, $\sigma = 6$, $\alpha = 0.65^{-1}$, $\chi = 0.015$, $\phi = 0.5$, $\beta = 0.99$, $\chi_B = 0.02$. These values yield a level of $\hat{Y} = 0.57$, $\mathcal{M} = 1.2$, $\tau = 0.24$ and $\pi = 2.62$ percent.

rule when it cannot influence output:[19]

$$\pi^c = \beta - 1. \tag{47}$$

The FA, instead, equates the marginal utility of consumption to the marginal utility of public expenditure, as in the case of flexible wage setting. The optimal tax rate and level of public expenditure are hence given by:

$$\tau^c = \rho \tag{48}$$

$$G^c = \rho \hat{Y}. \tag{49}$$

Proposition 3 $\pi^c < \pi^d; \qquad \tau^c > \tau^d; \qquad G^c > G^d.$

Proof. This follows directly from the comparison of eq. (47) to (45) and of eq. (48) to (40). Note that, from the expressions of government spending under the two regimes (46) and (49), I have that $\tau^c > \tau^d \Rightarrow G^c > G^d$. ■

This result shows that commitments are always better than discretion. In fact, in the regime with commitments the inflation rate is lower than in the case of discretion. Hence, in terms of real balances agents are better off. Moreover, since under commitments the marginal utility of consumption and government spending are equal, the overall impact on welfare of switching regime from discretion to commitment is positive.

5 Concluding remarks

This paper makes a first step towards integration of disparate pieces of analysis on wage setters, monetary and fiscal policy. In a micro-founded general equilibrium model, I have analyzed how macroeconomic institutions may affect output, inflation and taxation when monetary and fiscal policies strategically interact in the presence of monopolistic distortions in the labor markets. A main message from the paper is that, with pre-determined wage setting, fiscal and monetary policy are subject to a time inconsistency problem. As a result, in the absence of a commitment on the part of CB and FA, the equilibrium rate of inflation is above the Friedman rule and the equilibrium tax rate below the efficient level. In fact, labor market distortions lead output to be below the optimal level, and both policymakers attempt an expansionary policy in order to reduce such a gap.

The determinants of the size of the inflation bias are the degree of monopoly power of unions, the share of government spending in national income, and the degree of CB conservatism. An important finding of this analysis is that the discretionary rate of inflation is non-monotonically related to the natural output, positively related to government size, and negatively related to CB conservatism.

Another set of results concerns the consequences of switching from a regime with discretion to a regime with commitment. The regime with commitment is shown to be welfare improving over the discretionary regime. The move from a discretionary regime to a regime with commitments

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[19]The superscript c stands for commitment equilibrium.

yields a higher level of government spending and taxation, and an equilibrium rate of inflation equal to the Friedman rule.

This paper can be fruitfully extended by incorporating public expenditures financed also by means of money creation controlled by the CB. This would generate another channel of interaction between fiscal and monetary policy as, for example, in Alesina and Tabellini (1987).

Appendix

Proof of optimal setting of wage j**.** To derive the j-th union first-order condition with respect to the wage $W_t(j)$, it is convenient to reproduce the Lagrangian relevant to this purpose

$$
\mathcal{L}^{\mathcal{W}} = (1-\rho)\log C_t + \rho \log G_t - \frac{1}{1+\phi}\left[\int_0^1\left[\left(\frac{W_t(j)}{W_t}\right)^{-\sigma}N_t\right]^{\frac{\sigma-1}{\sigma}}dj\right]^{\frac{\sigma(1+\phi)}{\sigma-1}} + \frac{\chi}{1-\nu}\left(\frac{M_t}{P_t}\right)^{1-\nu} +
$$
$$
+\lambda_t\left(-B_{t+1} - M_{t+1} - P_tC_t + D_t + \int_0^1 W_t(j)\left(\frac{W_t(j)}{W_t}\right)^{-\sigma}N_t dj + P_tT_t + B_t(1+i_t) + M_t\right),
$$
(50)

where the conditional labor demand (3) has been plugged in. The first-order condition with respect to $W_t(j)$ is given by

$$
-N_t^\phi\left(N_t(j)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma-1}{\sigma}-1}N_t(j)^{\frac{\sigma-1}{\sigma}-1}\frac{\partial N_t(j)}{\partial W_t(j)} + \lambda_t\left[N_t(j) + W_t(j)\frac{\partial N_t(j)}{\partial W_t(j)}\right] = 0
$$
$$
-N_t^{1+\phi}\frac{\partial N_t(j)}{\partial W_t(j)}\frac{W_t(j)}{N_t(j)}W_t(j)^{-1} + \frac{(1-\rho)N_t(j)}{P_tC_t}\left(1 + \frac{\partial N_t(j)}{\partial W_t(j)}\frac{W_t(j)}{N_t(j)}\right) = 0
$$
$$
\sigma N_t^\phi + \frac{(1-\rho)W_t}{P_tC_t}(1-\sigma) = 0,
$$

where in the last equation I drop the j index because of symmetry between workers in equilibrium. ∎

Proof of Proposition 2. From eqs. (45) and (21), it is apparent that $\partial \pi^d/\partial \chi_B < 0$ and $\partial \hat{Y}/\partial \chi_B = 0$. This proves the first part of Proposition 2. In order to prove the second part of Proposition 2, first notice that the natural level of output (21) is a decreasing function of ρ, i.e.

$$
\frac{\partial \hat{Y}}{\partial \rho} = -\frac{\hat{Y}}{\alpha(1+\phi)(1-\rho)} < 0.
$$
(51)

As to the impact of ρ on discretionary inflation (45), using the previous result and eq. (40), I

have that

$$
\begin{aligned}
\frac{\partial \pi^d}{\partial \rho} &= bias \cdot \left[\frac{1}{1-\rho} + \frac{\alpha^2 \nu (1+\phi) \partial \hat{Y}/\partial \rho}{(\nu-1)(\alpha - \hat{Y}^{-\alpha(1+\phi)})\hat{Y}} + \frac{\partial[(1-\tau^d)\hat{Y}]/\partial \rho}{(1-\tau^d)\hat{Y}} \right] \\
&= bias \cdot \left[\frac{1}{1-\rho} + \frac{\nu}{(\nu-1)(\mathcal{M}+\rho-1)} - \frac{\mathcal{M}(\alpha-1)(\mathcal{M}\alpha-1)}{(\mathcal{M}(\alpha(1-\rho)+\rho)+\rho-1)(\mathcal{M}\alpha+\rho-1)} \right. \\
&\quad \left. - \frac{1}{\alpha(1-\rho)(1+\phi)} \right] \\
&= bias \cdot \left[\frac{\nu}{\nu-1} \frac{1}{\mathcal{M}+\rho-1} - \frac{1}{\alpha\mathcal{M}+\rho-1} \right. \\
&\quad \left. + \frac{1-\rho+\mathcal{M}(\alpha\rho-\rho+\alpha\phi)}{\alpha(1-\rho)[(1-\rho)(\alpha\mathcal{M}-\mathcal{M}-1)+\mathcal{M}](1+\phi)} \right] > 0. \tag{52}
\end{aligned}
$$

∎

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The welfare effect of switching from a floating exchange rate regime to a monetary union with non-atomistic wage setters[*]

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Abstract

How does a switch from national monetary policies (NMP) to a monetary union (MU) affect welfare? I address this question in a two-country general equilibrium model with large wage setters. The analysis shows that the unions' perception of the terms of trade movement is substantially different under either monetary regime. In a MU each union anticipates its wage claim not causing any terms-of-trade movements, while under NMP it leads to an improvement in the terms of trade. In contrast with recent studies, the formation of a MU is hence welfare improving by eliminating the incentive to strategically use the terms of trade. Finally, the paper extends Lippi's (2003) findings about the real effects of a conservative central bank (CB) and centralized wage setting into a flexible exchange rate regime with two independent CBs.

Keywords: Central bank conservatism, centralized wage setting, open-economy macro, monetary regime

JEL: E42, E58, F33, F41, J51

1 Introduction

Strategic monetary policy models with non-atomistic wage setting highlight that the establishment of a monetary union (MU) reduces the extent to which each union internalizes the inflationary repercussions of its wage demands (Soskice and Iversen, 1998; Cukierman and Lippi, 2001; Cavallari, 2004). In particular, a monetary regime change, as for example the creation at the beginning of 1999 of the Economic and Monetary Union (EMU) in Europe, alters *per se* the perceived labor demand faced by the unions and, therefore, employment. Intuitively, when nominal wage contracts are signed, the common central bank (CB) has an incentive to contract so as to reduce inflation. Unions internalize the general equilibrium

consequences of their choices anticipating that labor demand is positively related to the economy's pro-duction scale which, in turn, depends on monetary policy. Thus, since monetary policy response toward wages hinges on the inflationary cost of wage hikes, a lower internalization of such costs on the part of unions leads them to perceive a more expansive monetary policy and, therefore, a less elastic labor demand. In this respect, two strategic mechanisms have been explored in the literature.[1]

The first effect focuses on the imperfect substitutability between the demand for labor types, and is hence labeled "substitution effect". Cukierman and Lippi (2001) show that, in a MU, unions internalizes less the repercussions of their own actions on the aggregate wages, i.e. on other unions' wages, through a steeper aggregate labor demand. It turns out that the switch from national monetary policies (NMP) to a MU is likely to raise unemployment because each individual union perceives to improve its relative wage to a larger extent. The second effect, instead, studies the direct impact of a wage claim on aggregate labor demand, and is labeled "output effect". Soskice and Iversen (1998) argue that the establishment of a MU regime has negative effects on economic performance because each union anticipates that its wage demand has a limited effect on the union-wide inflation level and, hence, on the monetary wage response policies.

Either effect, singularly considered, indicates that the formation of a MU raises the monopolistic power of unions and the equilibrium unemployment level. However, when they are both nested within a model, the real effects of moving from NMP to a MU regime can be ambiguous. In this respect, Cavallari (2004) uses an open economy version of Lippi (2003), featuring both substitution and output effects, and shows that the formation of a MU is not necessarily detrimental. Intuitively, the lower perception on the part of unions of the inflationary consequences of their wage claims due to the MU regime leads, on the one hand, to a higher impact on aggregate real wage (i.e. on aggregate output), but, on the other hand, to a higher real wage relative to the other unions (i.e. a higher relative wage). Thus, the output and substitution effects entail two opposite incentives to nominal wage demands. In particular, Cavallari (2004) finds that a common monetary policy can be desirable when the output effect prevails on the substitution effect.[2]

A shortcoming of this literature is that the argument on the MU regime hinges only on strategic interaction between wage setters and a single monetary authority without considering the possibility for domestic unions of affecting the foreign labor market via an adverse "beggar-thy-neighbor" effect. The main reason is that Cukierman and Lippi's (2001) and Soskice and Iversen's (1998) findings under NMP are derived in a closed economy setup. Cavallari (2004), instead, allows for a two-country open economy setup under NMP, but domestic unions do not internalize the impact of their wage demand on the foreign monetary policy and, therefore, on the foreign labor market.

This paper adds to the above literature in two respects. First, it investigate in a micro-founded model a third channel through which a monetary regime shift can affect welfare: the unions' strategic use of

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[1] Grüner and Hefeker (1999) consider a single monopoly union in each country which is inflation averse *per se*. A MU regime has real effects in their model through this channel. In the paper, however, I will focus on standard unions' preferences without allowing for money illusion.

[2] See Cukierman (2004) for a recent survey on this issue.

the terms of trade.[3] As noted by Corsetti and Pesenti (2001), under non-cooperative NMP, monetary authorities have an incentive to contract their money supply in order to improve the terms of trade. I show that under NMP not only have CBs an incentive to improve the terms of trade, but unions are also induced to strategically move the terms of trade. Since both domestic and foreign monetary policies are common knowledge for wage setters, a domestic wage increase improves the terms of trade through the asymmetric monetary policy responses toward domestic wages in the two countries. Thus, increasing the purchasing power of domestic residents, a terms of trade improvement leads also to a more aggressive wage demand. But this effect only operates under NMP. In a MU, in fact, the common CB internalizes the externalities stemming from the terms of trade, and unions perceive wage hikes as not producing any terms-of-trade modification because of the symmetric wage response policy in the two countries. As a result, the formation of a MU regime leads to wage moderation relative to NMP because of the disappearance of the terms-of-trade effect.[4]

Second, it extends Lippi's (2003) closed-economy analysis of the welfare effects of a conservative CB and centralized wage setting to a flexible exchange rate regime with two independent CBs. By nesting the three channels described above within an open-economy framework, this model identifies a different condition determining the sign of the impact of conservatism and centralization in wage setting on employment and welfare. More specifically, under a NMP regime, this condition is modified so as to allow for the strategic impact of wage setting on the terms of trade, while under a MU regime it coincides with the Lippi's requirement. Intuitively, from a strategic viewpoint, a common CB has the same effect on wage setting of a national monetary policy operating in a closed economy, whereby an individual union perceives to affect neither the terms of trade nor the exchange rate. Therefore, the only effects operating in a MU regime are the substitution and output effects.

The paper is organized as follows. The model is presented in Section 2, and Section 3 discusses the efficient allocation and the macroeconomic interdependencies under the two alternative monetary regimes. Section 4 presents the monetary policies under either regime, and Section 5 studies the wage setting. Section 6 details the welfare results of a switch from NMP to a MU regime, while Section 7 focuses on the real effects of CB conservatism and centralized wage setting. Section 8 concludes.

2 Economic setup

Building on Lippi (2003), I analyze the strategic interactions between monetary policy and non-atomistic wage-setting decisions in a micro-founded framework. I extend his model to a two-country general equilibrium model with nominal rigidities and monopolistic competition in line with the new open economy macroeconomics literature (e.g. Corsetti and Pesenti, 2001; Benigno, 2002).

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[3]In a first generation of game-theoretic models *à la* Canzoneri and Henderson (1988), Jensen (1993) shows that the real exchange rate appreciation drives a wedge between the consumption and production real wage, thereby inducing unions to be more aggressive in their wage requests.

[4]There is evidence that inflationary pressures stemming from the labor markets have remained moderate since the formation of the EMU in Europe (European Commision, 2007).

The economy consists of two equally-sized countries, Home (H) and Foreign (F). Each country is specialized in the production of a single traded good, and inhabited by a continuum of agents (with population size normalized to 1) and a finite number of unions. I assume no impediments or costs to trade across borders. Production of the Home (Foreign) good requires a continuum of differentiated labor inputs indexed by $[0, 1]$ and supplied by Home (Foreign) agents.

Wages are contractually fixed for one period (contract period). The assumption of sticky wages allows monetary policy to affect real variables at least in the contract period. Specifically, I assume that at the beginning of the contract period, monopolistic unions simultaneously set nominal wages in their country of origin. Next, monetary policy is conducted under non-cooperative NMP or in a MU regime. The prevailing monetary regime is always known to unions when setting their wages. Finally, firms hire labor.

2.1 Firms

Let Y and Y^* denote output per capita in the Home and Foreign country respectively.[5] Technology is described by the following production functions in the two countries:

$$Y = L^\alpha \quad ; \quad Y^* = (L^*)^\alpha \quad 0 < \alpha < 1, \tag{1}$$

where labor indexes L and L^* are Dixit-Stiglitz aggregators defined over the quantities hired of each differentiated labor type

$$L = \left[\int_0^1 L(j)^{\frac{\sigma-1}{\sigma}} \mathrm{d}j \right]^{\frac{\sigma}{\sigma-1}} \quad ; \quad L^* = \left[\int_0^1 L^*(j^*)^{\frac{\sigma-1}{\sigma}} \mathrm{d}j^* \right]^{\frac{\sigma}{\sigma-1}} \quad \sigma > 1. \tag{2}$$

Domestic firms act competitively, while each economic agent is a monopolistic supplier of one type of labor input.[6] For a given level of production, the demand for labor type j solves the dual problem of minimizing total cost, $\int_0^1 W(j)L(j)\mathrm{d}j$, subject to the employment index (2):

$$L(j) = \left[\frac{W(j)}{W} \right]^{-\sigma} L \quad ; \quad L(j^*) = \left[\frac{W^*(j^*)}{W^*} \right]^{-\sigma} L^*, \tag{3}$$

where $W(j)$ denotes the nominal wage of labor type j and W is the nominal wage index defined as

$$W = \left[\int_0^1 W(j)^{1-\sigma} \mathrm{d}j \right]^{\frac{1}{1-\sigma}} \quad ; \quad W^* = \left[\int_0^1 W^*(j^*)^{1-\sigma} \mathrm{d}j^* \right]^{\frac{1}{1-\sigma}}. \tag{4}$$

These wage indexes have the property that the minimum cost of employing an array of labor types $L(j)$ is given by WL. Therefore, from profit maximization, aggregate labor demands are given by

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[5]Henceforth, Foreign variables will be indicated by "*".

[6]The paper results are not affected by the assumption of monopolistic competition in the product market. Proof available upon request.

$$L = \left[\frac{1}{\alpha} \frac{W}{P_H} \right]^{-\frac{1}{1-\alpha}} \quad ; \quad L^* = \left[\frac{1}{\alpha} \frac{W^*}{P_F^*} \right]^{-\frac{1}{1-\alpha}}. \tag{5}$$

2.2 Households

Utility of a representative Home agent $j \in [0,1]$ is defined over consumption (C), labor (L), and real money balances (M/P):

$$U(j) = \log C(j) - \frac{k}{2} [\log L(j)]^2 + \log \left(\frac{M(j)}{P} \right) \qquad k > \alpha, \tag{6}$$

where k is a positive preference parameter.[7] For any person j the overall consumption index, C, is a Cobb-Douglas aggregator over the two available types of goods, i.e. the Home and Foreign goods:

$$C = 2C_H^{1/2} C_F^{1/2}. \tag{7}$$

C_H and C_F are consumption of the Home-produced traded good and of the Foreign-produced traded good respectively. The consumption-based price index expressed in domestic currency is defined as

$$P = P_H^{1/2} P_F^{1/2}, \tag{8}$$

where P_H and P_F are the prices of Home and Foreign goods in Home currency. Foreign agents are modeled in an analogous way.

In the absence of of market segmentation across countries, the law of one price holds:

$$P_F = E P_F^* \quad ; \quad P_H^* = P_H / E, \tag{9}$$

where E is the nominal exchange rate (domestic currency per unit of foreign currency), and P_H^* and P_F^* are the prices of Home and Foreign goods in Foreign currency.

The Home commodity demand functions resulting from cost minimization imply

$$P_H C_H = P_F C_F = \frac{1}{2} PC, \tag{10}$$

i.e. one half of household expenditure is spent on each tradeable good.

---

[7]In order to have a utility function decreasing and concave in equilibrium leisure, the assumption $k > \alpha$ must hold (see eqs. (24) and (53)).

2.3 Asset markets and budget constraints

Each j-th individual owns equal shares of all domestic firms and of an initial stock of the domestic currency. Markets are complete domestically and international equity trade is forbidden.[8]

A typical Home agent j maximizes (6) with respect to $C(j)$ and $M(j)$ subject to the budget constraint

$$\frac{M(j)}{P} + C(j) = \frac{M_0(j)}{P} + T + D(j) + \frac{W(j)L(j)}{P}, \tag{11}$$

where T denotes per capita real transfers from the Home government, $\frac{W(j)L(j)}{P}$ represents real labor income, $D(j)$ expresses real domestic profits, and $M_0(j)$ are initial nominal money holdings. Foreign individuals face an analogous problem.

The first-order condition for individual j's nominal money balances, $M(j)$, is given by:

$$\frac{1}{C(j)} = \left(\frac{M(j)}{P}\right)^{-1}. \tag{12}$$

Since money has value only for the current period, individuals equate the marginal utility from holding it to the opportunity cost of acquiring it. Notice that in such a model, money market equilibrium is equivalent to binding cash in advance constraints.[9]

Governments in each country rebate all seignorage revenue in lump-sum transfers to households:

$$T = \frac{M}{P} - \frac{M_0}{P} \qquad ; \qquad T^* = \frac{M^*}{P^*} - \frac{M_0^*}{P^*}. \tag{13}$$

2.4 Market clearing, exchange rate determination, and terms of trade

The first order conditions are identical for all agents within a given country. Thus, I drop the agent indexation. The product market equilibrium requires that

$$P_H Y_H = \frac{1}{2}PC + \frac{1}{2}EP^*C^* \qquad ; \qquad P_F Y_F^* = \frac{1}{2}PC + \frac{1}{2}EP^*C^*, \tag{14}$$

which, in turn, implies the following result

$$\frac{P_H}{P_F} = \frac{Y_F^*}{Y_H}. \tag{15}$$

Now, using eq. (13) together with the household's budget constraints (11) leads to

$$PC = P_H Y_H \qquad ; \qquad EP^*C^* = PC^* = P_F Y_F^*, \tag{16}$$

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[8]Note that, given the Cobb-Douglas preferences over traded goods (7) and the separability of individuals' utility functions, international equity trade would not affect equilibrium allocation (see eq. (17)). This implies that current accounts would be zero in an inter-temporal version of the model as well.

[9]In a dynamic version of the model, interest rates would appear in eq. (12); see for instance Obstfeld and Rogoff (1998).

from which

$$C^* = C \tag{17}$$

follows.[10]

The exchange rate is simply given by the ratio of national nominal expenditure

$$E = \frac{PC}{P^*C^*}. \tag{18}$$

This result stems directly from the characteristics of current account balance and constant expenditure shares exhibited by the model.

Under a NMP regime, the exchange rate is free to float. Thus, from the money demand (12), I may rewrite the exchange rate as the ratio of money supply in the two countries

$$E = \frac{M}{M^*}. \tag{19}$$

Conversely, in a MU, the exchange rate E is always equal to 1, and the following identities hold:

$$P_F = P_F^* \quad ; \quad P_H^* = P_H \quad ; \quad P = P^* \quad ; \quad M = M^*. \tag{20}$$

Furthermore, the terms of trade are defined in the Home country as

$$TOT \equiv \frac{EP_F^*}{P_H}. \tag{21}$$

A decrease in TOT constitutes a real appreciation of the domestic currency, i.e. an improvement in the Home terms of trade.

The rest of the paper will show how terms-of-trade adjustments play a key role in determining the welfare impact of a monetary regime change. However, before analyzing monetary policy under the two regimes, it is convenient to derive a benchmark policy, i.e. the social planner's problem, and then to assess the macroeconomic interdependencies operating in the model.

3 The efficient allocation and the reduced form

In this section I derive the efficient allocation and the reduced-form of the model. The former is a useful benchmark for the analysis of optimal policy in the presence of monopolistic distortions, while the latter shows macroeconomic interdependence in the two economies.

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[10]The equality stems from the fact the weights in the consumption index (7) are the same as country size. Were they different, consumption levels would be proportional but not equal.

3.1 Efficient allocation

The efficient allocation is obtained by appointing a central institution (social planner) that maximizes an objective function represented by a weighted average of the welfare of the single countries. Benigno (2002) shows that with an elasticity of intertemporal substitution in consumption equal to one (i.e., log preferences in consumption), the optimal weight of preferences of the social planner coincides with a population-weighted average of welfare of the single countries. Thus, the world's optimal allocation in any given period implies the solution of the following social planner's problem:

$$\max_{C_z, C_z^*, L, L^*, \frac{M}{P}, \frac{M^*}{P^*}} \frac{1}{2} \int_0^1 U(j) \mathrm{d}j + \frac{1}{2} \int_0^1 U^*(j^*) \mathrm{d}j^* \qquad z \in [H, F],$$

subject to the feasibility constraint

$$Y = C_H + C_F \qquad ; \qquad Y^* = C_H^* + C_F^*$$

and the technological constraint

$$Y = L^\alpha \qquad ; \qquad Y^* = (L^*)^\alpha.$$

The optimal conditions for the social planner's problem are:

$$\frac{1}{2C_H} = \frac{1}{2C_F} = \frac{k \log L}{\alpha Y}$$

$$\frac{1}{2C_H^*} = \frac{1}{2C_F^*} = \frac{k \log L^*}{\alpha Y^*}$$

$$\left(\frac{M}{P}\right)^{-1} = \left(\frac{M^*}{P^*}\right)^{-1} = 0,$$

i.e. the planner would like to equate the marginal utility of consumption of each tradeable good to the marginal loss of utility of producing an additional unit of the tradeable good. The last condition, instead, requires to equate the (social) marginal utility of real balances to the social marginal cost of producing real money balances, which is zero.

From the resource and technological constraint, it is easy to obtain the following solutions to the social planner's problem:

$$C_H = C_F = C/2 \quad ; \quad C_H^* = C_F^* = C^*/2 \tag{22}$$

$$Y = L^\alpha = C \quad ; \quad Y^* = (L^*)^\alpha = C^* \tag{23}$$

$$\log L = \alpha/k \quad ; \quad \log L^* = \alpha/k. \tag{24}$$

3.2 Reduced form

I now demonstrate a critical insight of the model: the monetary authority's incentive to undertake expansionary policies depends on the international monetary system. In what follows, I will denote natural logarithm of any variable X by the corresponding lower-case letter; thus $x \equiv \log X$. Without loss of generality, I normalize the previous period nominal wage, money supply, and general price level to unity, so that the log of these variables can be considered as an approximation of their percentage increase.

Table 1: Reduced form of the model: NMP regime ($e = m - m^*$)

$l = m - w$	$l^* = m^* - w^*$	(25)
$p_H = (1-\alpha)m + \alpha w$	$p_F^* = (1-\alpha)m^* + \alpha w^*$	(26)
$p = \dfrac{1}{2}[(2-\alpha)m + \alpha(w+w^* - m^*)]$	$p^* = \dfrac{1}{2}[(2-\alpha)m^* + \alpha(w+w^* - m)]$	(27)
$c_H = \alpha(m-w)$	$c_F^* = \alpha(m^* - w^*)$	(28)
$c_F = \alpha(m^* - w^*)$	$c_H^* = \alpha(m-w)$	(29)
$c = \dfrac{\alpha}{2}(m+m^* - w - w^*)$	$c^* = \dfrac{\alpha}{2}(m+m^* - w - w^*)$	(30)
$tot = \alpha(m - m^* - w + w^*)$	$e = m - m^*$	(31)

Table 2: Reduced form of the model: MU regime ($e = 0$)

$l = \dfrac{m^W}{2} - w$	$l^* = \dfrac{m^W}{2} - w^*$	(32)
$p_H = (1-\alpha)\dfrac{m^W}{2} + \alpha w$	$p_F^* = (1-\alpha)\dfrac{m^W}{2} + \alpha w^*$	(33)
$p = \dfrac{1-\alpha}{2}m^W + \dfrac{\alpha}{2}(w+w^*)$	$p^* = \dfrac{1-\alpha}{2}m^W + \dfrac{\alpha}{2}(w+w^*)$	(34)
$c_H = \alpha\left(\dfrac{m^W}{2} - w\right)$	$c_F^* = \alpha\left(\dfrac{m^W}{2} - w^*\right)$	(35)
$c_F = \alpha\left(\dfrac{m^W}{2} - w^*\right)$	$c_H^* = \alpha\left(\dfrac{m^W}{2} - w\right)$	(36)
$c = \dfrac{\alpha}{2}(m^W - w - w^*)$	$c^* = \dfrac{\alpha}{2}(m^W - w - w^*)$	(37)
$tot = \alpha(w^* - w)$	$m^* = m = \dfrac{m^W}{2}$	(38)

The reduced form of the model, apart from constant additive terms, is presented in Table 1 and 2

under NMP and MU respectively.[11] Consider a domestic monetary expansion under NMP.

A rise in m leads to an increase in per capita demand, $p + c$, and a proportionate increase in expenditure of the goods that Home agents consume (see eqs. (10) and (12)). For a given level of wages, p_H increases by $1 - \alpha$. It follows that c_H have to rise (eq. (28)). At the same time, the nominal exchange rate depreciates in proportion to money supply (eq. 19); so, $p_F (= e + p_F^*)$ increases by a unit and there is no impact on c_F (eq. 29). c_F is hence determined by the foreign money supply, m^*.[12]

As observed by Canzoneri, Cumby, and Diba (2005), macroeconomic interdependence is rather limited in new open economy macroeconomics models exhibiting balanced current account, constant expenditure shares and log utility of money:

> "Domestic monetary policy controls consumption and output of the domestically produced goods, while foreign monetary policy controls consumption of the imported tradeable good",
> p. 371.

In a MU, conversely, the common CB sets the union-wide money growth $m^W = m + m^*$. From eqs. (35) and (36) it appears that not only may the common monetary policy control consumption (and output) of domestically produced goods, but also affects the consumption of the imported tradeable goods. In fact, a rise in $m^W/2$ leads to an increase in aggregate demand, $p + c$, and a proportionate increase in expenditure of Home and Foreign goods. But, with a permanently fixed exchange rate, $p_F = p_F^*$, and producer prices p_H and p_F increase by $1 - \alpha$. It turns out that both c_H and c_F have to rise by α.

It is worth noticing that an expansionary monetary policy under NMP worsens the terms of trade (31), while in a MU the common CB perceives its policy as not affecting the terms of trade (38).

In the following section, I assess optimal monetary policies under the two regimes, and next I turn to the question of how monetary regimes affect wage setting. The model is solved by backward induction.

4 Monetary policy

I draw on Lippi (2003) and assume that the monetary authority aims at maximizing a targeting rule by setting the growth rate of money supply after wages have been negotiated. Under a NMP regime, each monetary authority maximizes the following targeting rule, taking the other's action as given, i.e. the Home CB solves

$$\max_{m} \Omega^{NMP} = \int_0^1 \left[U(j) - \log\left(\frac{M(j)}{P}\right) \right] dj - \frac{\beta}{2} p^2 \quad \texttt{s.to} \ (30), (25), (27) \ \texttt{and} \ \partial m^*/\partial m = 0, \quad (39)$$

where the parameter β is the degree of CB conservatism (Rogoff, 1985). If the level of conservatism is zero, the CB is a benevolent planner that cares only about agents' welfare. Following Obstfeld and Rogoff (1998) and Corsetti and Pesenti (2001), the monetary authority ignores the real balances part of

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[11] The reduced forms of the model are obtained by using eqs. (5), (7)-(10), (14)-(17) and (21).

[12] Note that an increase in m^* has two opposing effect on p_F: increase p_F^* by $(1 - \alpha)$ and depreciate e by unity. Hence, the latter effect is always larger.

the utility function; thus, I abstract from the traditional considerations that lie behind the Friedman rule of zero nominal interest rate.[13] A symmetric problem is solved by the Foreign CB.

The first-order condition of (39) yields

$$p = \frac{k(\tilde{l}-l)-\alpha/2}{(1-\alpha/2)\beta},$$

(40)

where $\tilde{l} \equiv \alpha/k$ is the efficient employment level (eq. 24). Since employment l is sub-optimally low owing to monopolistic distortions in labor markets, the monetary authority has an incentive to raise inflation so as to reduce the discrepancy between efficient and natural output. This is the standard Blanchard-Kiyotaki result (captured by the term $\tilde{l}-l$ in eq. (40)), whereby a positive monetary shock unambiguously improves domestic welfare in a closed economy (Blanchard and Kiyotaki, 1987).

Nevertheless, as noted by Corsetti and Pesenti (2001), in an open economy this effect is not sufficient to prevent a deflationary monetary policy.[14] Intuitively, money contraction reduces both consumption and output. But it also improves the terms of trade, thereby increasing consumption and reducing output further. It turns out that the reduction in the disutility of supplying labor services more than offsets the reduction in the utility from lower consumption, because the "burden" of production is shifted to the other country through the improved terms of trade. Such an effect is captured by the negative term on the R.H.S. of eq. (40).

Solving eq. (40) for money supply yields Home policy in terms of Foreign policy, Home wages, and Foreign wages. The Nash equilibrium policies are derived by combining this reaction function with the corresponding one in the Foreign country (see Appendix A).

Now, in order to evaluate how wage setters perceive to affect employment, I plug the Nash equilibrium monetary reaction function into (25) as follows:

$$l = \varepsilon_H^{NMP} w + \varepsilon_F^{NMP} w^*,$$

(41)

$$l^* = \varepsilon_{F^*}^{NMP} w^* + \varepsilon_{H^*}^{NMP} w,$$

(42)

where

$$\varepsilon_H^{NMP} = \varepsilon_{F^*}^{NMP} < \varepsilon_F^{NMP} = \varepsilon_{H^*}^{NMP} < 0.$$

(43)

In a MU regime the CB aims at solving the following problem

$$\max_{m^W} \Omega^{MU} = \frac{1}{2} \int_0^1 \left[U(j) - \log\left(\frac{M(j)}{P}\right) \right] dj + \frac{1}{2} \int_0^1 \left[U(j^*) - \log\left(\frac{M(j^*)}{P^*}\right) \right] dj^* - \frac{\beta}{2} p^2$$

$$\texttt{s.to}\ (37), (32),\ \texttt{and}\ (34),$$

(44)

---

[13]Neiss (1999) for example assesses the validity of the Friedman rule and the welfare effect of real money balances in the presence of predetermined wage setting; an extension of her model to the case of non-atomistic wage setters is in Acocella, Di Bartolomeo, and Tirelli (2008).

[14]For an empirical evidence that relatively open countries experience lower inflation see Romer (1993), Lane (1997), and Campillo and Miron (1997).

by controlling the growth rate of union-wide money supply m^W. The first-order condition of (44) is given by

$$p = \frac{k}{\beta(1-\alpha)/2}(\tilde{l}-l), \tag{45}$$

where I used the equality condition between Home and Foreign employment in the MU regime.[15] The common CB equates marginal benefits of raising union-wide employment (R.H.S. of eq. (45)) to marginal costs of its inflationary policy (L.H.S. of eq. (45)). The following proposition summarizes the result of a change in the monetary regime.

Proposition 1 *A switch from NMP to a MU entails a more inflationary monetary policy.*

The proof is straightforward.

Comparing eqs. (45) and (40), it appears that eq. (45) is always above eq. (40) in the (l, p) space. More specifically, moving to a MU induces an upwards shift *and* a clockwise rotation of the domestic monetary reaction function. The first effect is due to the disappearance of the terms-of-trade externality. Maximizing the union-wide utility, the common CB in fact internalizes the impossibility of improving the terms of trade in both countries (see eq. (38)). The second effect is instead due to the disappearance of exchange rate movements in the MU regime. Under NMP, an expansionary monetary policy leads to a rise in domestically produced traded good and a depreciation of the exchange rate. Both effects raises inflation. In a MU, instead, the inflationary cost stemming from exchange rate movements are ruled out and, *ceteris paribus*, the common CB faces lower marginal costs from an expansionary policy.

Before the formation of the EMU, monetary policy in Germany hinged on interactions between German labor unions and the monetary policy of the Bundesbank. According to Proposition 1, did the ECB obtain autonomy and conservatism equal to the Bundesbank, the ECB monetary-policy stance on the German economy would have been more expansionary relative to the Bundesbank, thereby triggering higher inflation. In this respect, Proposition 1 also provides a rationale for having appointed a more conservative ECB (Piga, 2000).

Before turning to the subgame-perfect solution, I write the corresponding values of employment substituting the money supply solutions of problem (44) into eq. (32) as follows (see Appendix B for the elasticities values):

$$l = \varepsilon_H^{MU} w = \varepsilon_F^{MU} w^*, \tag{46}$$

$$l^* = \varepsilon_{F^*}^{MU} w^* = \varepsilon_{H^*}^{MU} w, \tag{47}$$

where

$$\varepsilon_H^{MU} = \varepsilon_{H^*}^{MU} = \varepsilon_F^{MU} = \varepsilon_{F^*}^{MU} < 0. \tag{48}$$

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[15]From Table 2, in fact, I obtain in a MU regime that $p + c = w + l = p^* + c^* = w^* + l^*$, which can be solved by setting $w = w^*$ and $l = l^*$.

5 Wage setting

Home workers are organized in $n > 1$ labor unions. I assume that all labor types are unionized and equally distributed among unions. Therefore, each union u has mass $1/n(= \int_{j \in u} dj)$. In such a setup, both the degree of wage centralization and the unions' ability to internalize the consequences of their actions are proportional to the union's size: the smaller the number of unions, the more they internalize the impact of their wage settlement on aggregate wage. In fact, controlling the growth of the nominal wage u, each union u anticipates that

$$\frac{\partial w}{\partial w_u} = \frac{1}{n} \left(\frac{w_u}{w} \right)^{-\sigma} \tag{49}$$

taking other unions' wages both at Home and abroad as given.

Eq. (49) is key to understand the model results. As long as n is finite, an increase in the union's wage affects aggregate wage which, in turn, reduces aggregate employment by eqs. (41)-(42) or (46)-(47). In addition, a rise in w_u reduces also employment through the elasticity of substitution among labor types σ, since firms substitute the u-th labor variety for the other labor types. In a symmetric equilibrium ($w_u = w$), the elasticities of Home labor demand to nominal wage of union u ($\partial l_u / \partial w_u$) under NMP and MU are respectively

$$\varepsilon_h^{NMP} = -\sigma \left(1 - \frac{1}{n} \right) + \frac{1}{n} \varepsilon_H^{NMP} \quad ; \quad \varepsilon_h^{MU} = -\sigma \left(1 - \frac{1}{n} \right) + \frac{1}{n} \varepsilon_H^{MU}. \tag{50}$$

Eq. (50) defines the elasticity of domestic labor demand perceived by the u-th union as a weighted average of the elasticity of substitution between labor types and the elasticity of domestic aggregate labor demand. It turns out that, with atomistic wage setters ($n \to \infty$), eq. (50) is simply formed by the elasticity of substitution, and unions do not take into account the impact of their wage claims on aggregate employment. The weight of the elasticity of aggregate labor demand in eq. (50) is instead increasing in the union's size (lower n). With a single all-encompassing union ($n = 1$) each labor-type service receives the same wage, thereby preventing any substitution effect between labor types from operating.

The domestic monetary response to domestic wages has been recently investigated in the literature (e.g. Lippi, 2002, 2003; Cavallari, 2004; Coricelli, Cukierman, and Dalmazzo, 2004; Gnocchi, 2006), while the *foreign* monetary response to domestic wages has been ignored by these studies. However, since in an open economy both Home and Foreign monetary policies are common knowledge for the u-th union, a large union internalizes the impact of its wage demands on Foreign labor markets as well. Thus, from eqs. (42) and (47), a change in w_u affect Foreign employment as follows:

$$\varepsilon_{h^*}^{NMP} = \frac{1}{n} \varepsilon_{H^*}^{NMP} \quad ; \quad \varepsilon_{h^*}^{MU} = \frac{1}{n} \varepsilon_{H^*}^{MU}. \tag{51}$$

Intuitively, an increase in the Home nominal wage u leads to higher inflation in the Foreign country because of the rise in p_H. As a result, for a given exchange rate, the corresponding (optimal) Foreign monetary policy balances the burden of the welfare loss between employment and inflation by moving

employment and inflation into the opposite direction (see eqs. (40) and (45)) so that Foreign employment falls in the wake of Home wage claims.

I assume that the representative Home union u acts benevolently by maximizing the utility of its members (of mass $1/n$) and disregarding liquidity effects. Therefore, it solves the following problem in either regime:[16]

$$\max_{w_u} V_u = n \int_{j \in u} \left[U(j) - \log \left(\frac{M(j)}{P} \right) \right] \mathrm{d}j \qquad \texttt{s.to} \ (11), (1), (50), (51), \tag{52}$$
$$\partial w_{u^*}/\partial w_u = 0, \text{ and } \partial w_{j \notin u}/\partial w_u = 0.$$

Equilibrium employment under the two monetary regimes is derived from the first-order condition of (52) evaluated at the symmetric equilibrium $w_u = w$ (see Appendix C) as follows:

$$l^r = \tilde{l} \left(1 - \frac{1}{\eta^r} \right), \qquad r \in (NMP, MU) \tag{53}$$

where $\eta^r \equiv -\mathrm{d}\log L_u^r / \mathrm{d}\log(W_u/P^r) > 1$ is the real consumption wage elasticity (in absolute value) of the perceived demand for labor type $j \in u$ in regime r. It is apparent that, as long as η is finite, equilibrium employment is below the efficient level $\tilde{l}$ in either regime. More specifically, a lower labor demand elasticity implies that, for a given level of employment, nominal wage hikes yield higher marginal benefits in terms of consumption, thereby reducing wage restraints. In other words, η is a measure of the monopolistic power of unions. Rewriting eq. (53)

$$\frac{1}{\eta^r} = \frac{1 - s_h^r}{\varepsilon_h^r} = \frac{\tilde{l} - l^r}{\tilde{l}}, \qquad r \in (NMP, MU) \tag{54}$$

where $s_h^r \equiv \partial \log P^r / \partial \log W(u)$ is the elasticity of CPI to nominal wage u, the elasticity of labor demand to *real* wages measures the percentage deviation of natural employment from efficient employment. The lower η, the higher is the perceived real wage obtained by unions in the wake of *nominal* wage claims.

To understand expression (54), note that the term $s_h \in (0, 1)$ in the numerator reduces the monopolistic distortion in the labor market. An increase in the wage u raises the general price level, which in turn reduces the real wages of union members. Similarly, an increase in labor demand elasticity to nominal wage ε_h implies that, for a given increase in w_u, the reduction in employment and hence in labor income is more considerable. It turns out that an increase in ε_h and s_h leads to lower wage demands.

Now, from eqs. (40), (45) and (53) the equilibrium rate of inflation in either regime is given by:

$$p^{NMP} = \frac{\alpha(1/\eta^{NMP} - 1/2)}{\beta(1 - \alpha/2)}, \tag{55}$$

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[16]The benevolent union hypothesis is in line with the trade union behavior surveyed by Oswald (1985), whose objective function usually includes real wages and unemployment.

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$$p^{MU} = \frac{\alpha/\eta^{MU}}{\beta(1-\alpha)/2}. \tag{56}$$

The key implication of these two expressions is that in a MU, eq. (56) features an *inflation bias* while, a NMP regime may trigger a *deflation bias* (eq. (55)). It follows that, for a given degree of CB conservatism, equilibrium inflation is lower under a NMP regime than in a MU . Intuitively, under a floating exchange rate, monetary authorities are induced to resort to surprise monetary contractions because they perceive to affect the terms of trade. Conversely, the MU economy as a whole is not affected by the terms of trade externality and exchange rate movements, thereby leading the common CB to a more expansionary monetary policy (see Section 4).

The next sections will show how different institutions, in particular centralized wage setting, CB conservatism, and monetary regime, cause workers to modify their wage claims.

6 The effect of the monetary regime

This section assesses the role of moving from NMP to a MU regime *per se*.

In order to disentangle the strategic mechanisms operating in η^r, it is convenient to rewrite the elasticities of labor demand to real wages under the two monetary regimes as follows:

$$\eta^{NMP} = \left[\underbrace{\left(1 - \frac{\varepsilon_H^{NMP}}{n\varepsilon_h^{NMP}}\right)\frac{1}{\sigma}}_{substitution\ effect} + \underbrace{(1-\alpha)\frac{\varepsilon_H^{NMP}}{n\varepsilon_h^{NMP}}}_{output\ effect} + \underbrace{\left(\frac{\alpha}{2}\frac{\varepsilon_H^{NMP} - \varepsilon_{H^*}^{NMP}}{\varepsilon_H^{NMP}}\right)\frac{\varepsilon_H^{NMP}}{n\varepsilon_h^{NMP}}}_{terms-of-trade\ effect} \right]^{-1} \tag{57}$$

$$\eta^{MU} = \left[\underbrace{\left(1 - \frac{\varepsilon_H^{MU}}{n\varepsilon_h^{MU}}\right)\frac{1}{\sigma}}_{substitution\ effect} + \underbrace{(1-\alpha)\frac{\varepsilon_H^{MU}}{n\varepsilon_h^{MU}}}_{output\ effect} \right]^{-1}. \tag{58}$$

The incentive to set a higher nominal wage w_u depends on three effects.

First, since other unions' policy is taken as given, the u-th union perceives to increase its wage relative to the other unions' wage. More specifically, for a unit increase in the u-th union's wage, the increase in its wage relative to the other unions' wages is higher, the lower the impact on aggregate wage. However, the aggregate wage adjusts according to the aggregate labor elasticity which, in turn, is increasing in the tightness of monetary policy responses toward wages. Thus, the more accommodating the monetary policy, the more aggressive wage demands are, since wage setters perceive the possibility of achieving higher wage deviations from the other unions' wages. This effect is captured by the first term in eqs. (57) and (58), and, drawing on Lippi's (2003) terminology, is labeled "substitution effect".

Note that, as long as the direct effect of w_u on w ($1/n$) is less than one, the union has an incentive to exploit its monopolistic power on the labor services market. In the extreme case of a single all-encompassing union ($n = 1$), ε_h^r is equal to ε_H^r, and the substitution effect disappears. A wage rise, in this

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case, leads to an equal proportional increase in aggregate wage without any possibility for the union of increasing its relative wage.

Second, the *u*-th union anticipates that its real production wage (i.e., $w_u - p_H$) increases in the wake of a nominal wage rise through the reduction in aggregate output. This effect is captured by the second term in eqs. (57) and (58), and, drawing on Lippi's (2003) terminology, is labeled "output effect". Specifically, from eq. (5), a nominal wage rise is perceived to increase the real production wage by the elasticity of aggregate employment to real production wage $(1 - \alpha)^{-1}$.

In a closed economy, the producer price index coincides with the consumer price index. Therefore, in Lippi (2003) the output and substitution effects are the sole effects taken into account by unions in their wage setting process. In this model, eqs. (57) and (58) reveals that both η^{MU} and η^{NMP} are constituted by the output and substitution effect. But η^{NMP} is further reduced by a third effect: the improvement in the terms of trade.[17]

Proposition 2 *When monetary policy is performed*

  i. *under a NMP regime, a domestic union expects an improvement in the terms of trade as a result of a nominal wage rise.*

 ii. *in a MU, a domestic union does not perceive that it can affect the terms of trade.*

In order to prove this proposition, it is helpful to investigate how w_u affects the terms of trade. From eqs. (31) and (38), it turns out that

$$\frac{\partial tot^{NMP}}{\partial w_u} = \frac{\alpha}{n}(\varepsilon_H^{NMP} - \varepsilon_{H^*}^{NMP}) < 0, \qquad \frac{\partial tot^{MU}}{\partial w_u} = \frac{\alpha}{n}(\varepsilon_H^{MU} - \varepsilon_{H^*}^{MU}) = 0. \tag{59}$$

Each Home union anticipates that a wage rise may change the terms of trade through the difference between the elasticity of (aggregate) domestic and foreign employment. I label that mechanism the "terms-of-trade effect". Such an effect is present only under a NMP regime (see eq. (57)) because the Home employment elasticity to Home wage (ε_H^{NMP}) is (in absolute value) larger than the Foreign employment elasticity to Home wage ($\varepsilon_{H^*}^{NMP}$). In such a case, a Home wage hike entails an improvement in the Home terms of trade which, in turn, reduces the consumer price index. As a result, the real consumption wage ($w_u - p$) rises because of the terms of trade appreciation, encouraging nominal wage demands.[18]

Conversely, in a MU, both Home and Foreign labor demand elasticities to Home wages are equal (see eq. (48)), and the terms-of-trade effect is prevented from operating. A common CB in fact internalizes the terms-of-trade externality and, maximizing the union-wide utility, reacts symmetrically to inflationary

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[17]Among the first to highlight such effect, in a first generation of game-theoretic models *à la* Canzoneri and Henderson (1988), is Jensen (1993) who shows that the real exchange rate appreciation drives a wedge between the consumption and production real wage, thereby inducing unions to be more aggressive in their wage requests.

[18]Cavallari (2004) omits such a wedge between the real consumption wage elasticity and the real production wage elasticity of perceived labor demand under either regime. Thus, her results hinge only on the output and substitution effects.

wage claims in the two countries. Intuitively, since Home and Foreign inflation are equal in a MU (see Table 2), a domestic nominal wage increase has the same effect on inflation at Home and abroad ($p = p^*$), thereby triggering a symmetric monetary reaction. Moreover, as noted in footnote 15, in a MU labor unions anticipate that both employment and wages are equalized between countries because of the full risk-sharing condition. Therefore, the real consumption wage elasticity of the perceived labor demand equates to the real production wage elasticity (58) as in a closed-economy framework.

What is then the direct effect of a MU on the labor demand elasticity η? To answer this question, I first assume that wage setting is highly centralized, i.e. $n = 1$. In such a case, the wage bargaining system is fully centralized,[19] and the substitution effect is absent in η. It turns out that

Proposition 3 *When labor markets are characterized by nationally defined systems of collective bargaining, a move from a NMP regime to a MU is always welfare improving.*

The proof is straightforward.

Comparing eqs. (57) and (58), and noticing that the labor type demand elasticity (ε_h) coincides with the aggregate labor demand elasticity to wage (ε_H) when $n = 1$, the following relation holds:

$$\eta^{NMP}\big|_{n=1} = \left[1 - \alpha + \frac{\alpha}{2}\left(\frac{\varepsilon_H^{NMP} - \varepsilon_{H^*}^{NMP}}{\varepsilon_H^{NMP}}\right)\right]^{-1}, \qquad \eta^{MU}\big|_{n=1} = [1 - \alpha]^{-1}, \tag{60}$$

where $\frac{\varepsilon_H^{NMP} - \varepsilon_{H^*}^{NMP}}{\varepsilon_H^{NMP}} > 0$. Moreover, since the equilibrium level of employment (53) is equal in the two countries, welfare can be rewritten in equilibrium as:

$$u = \alpha l - \frac{k}{2}l^2 = u^*,$$

which is clearing increasing in l as long as employment is below its efficient level $\tilde{l}$.

Before analyzing the more general case of $n > 1$, it would be interesting to assess the "relative size" of all effects entering in η. The α parameter in the model measures the aggregate labor share, whose values are usually in the interval $0.55 - 0.65$ (e.g. Kongsamut, Rebelo, and Xie, 2001). This implies $\eta^{NMP}\big|_{n=1} \in (1.38, 1.93)$ and $\eta^{MU}\big|_{n=1} \in (2.22, 2.86)$. Now, microeconomic evidence and calibrated models suggest values for the elasticity of substitution not smaller than 2.5 and not greater than 21 (e.g. Griffin, 1992; Christiano, Eichenbaum, and Evans, 2005). In accordance with this, the following proposition holds.

Proposition 4 *For any $\sigma \geq \eta^{NMP}\big|_{n=1}$ and $n > 1$,*

$$\eta^{MU} > \eta^{NMP},$$

i.e. the move from NMP to MU increases both employment and welfare.

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[19]Wage determination in most OECD countries is dominated by nationally defined systems of collective bargaining (e.g. Nickell, Nunziata, and Ochel, 2005).

The formation of a MU may have two contrasting effects on real labor demand elasticity. First, the disappearance of exchange rate movements and the impossibility of strategically improving the terms of trade induce the CB to a more accommodating monetary policy (see Section 4). This in part reduces the labor demand elasticity to a real production wage perceived by unions, and increases wage aggressiveness relative to NMP.[20] Secondly, the incentive to a strategic use of the terms of trade (i.e., the terms-of-trade effect) causes unions to demand a higher wage under NMP relative to a MU regime. From Proposition 4, it turns out that the incentive to set higher wages is nevertheless discouraged in a MU since the terms-of-trade channel prevails over the aggregate output channel.

It is worth noticing that such the results in this section are in sharp contrast with most of the predictions about the effects of a switch from NMP to the MU regime which do not consider the role of terms-of-trade effect (e.g. Cukierman and Lippi, 2001; Soskice and Iversen, 1998; Cavallari, 2004). In addition, Proposition 4 can account for the wage-growth trend in Europe, which has remained under control since the formation of EMU (European Commision, 2007).

7 The effect of centralization in wage setting and CB conservatism

This section assesses the real effects of the wage-bargaining system and CB conservatism.

To this purpose, it is convenient to rewrite the real wage elasticity $1/\eta^r$ as follows:

$$\frac{1}{\eta^r} = \frac{1}{\sigma}\left(1 - \frac{\varepsilon_H^r}{n\varepsilon_h^r}\right) + \frac{1}{\eta^r|_{n=1}}\frac{\varepsilon_H^r}{n\varepsilon_h^r}, \tag{61}$$

which is a weighted average measuring the monopolistic distortion in the labor market, whereby the higher $1/\eta^r$, the more monopolistic power unions have.

Note that the "weight" entering in the labor demand elasticity η^r is given by

$$\frac{\varepsilon_H^r}{n\varepsilon_h^r} = \frac{1}{1 + \frac{\sigma(n-1)}{\varepsilon_H^r}}. \tag{62}$$

From the above expression is hence apparent that n and ε_H^r have two opposing effect on the weight attached to the elasticity of labor demand to real wage. More specifically, an increase in the number of unions reduces eq. (62), while an increase in aggregate labor demand elasticity raises it.

7.1 Collective bargaining coverage

How does the collective bargaining coverage system affect welfare?

Proposition 5 *An increase in the number of unions, i.e. a more decentralized wage setting, raises (reduces) welfare and reduces (raises) inflation under the regime $r \in (NMP, MU)$ if $\sigma > \eta^r|_{n=1}$ $\left(\sigma < \eta^r|_{n=1}\right)$.*

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[20]It is possible to show that ε_H^{NMP} is greater than ε_H^{MU} only for a range of value of the degree of CB conservatism given by: $0 < \beta < \bar{\beta}$. Conversely, for a sufficiently high degree of conservatism $\beta > \bar{\beta} > 0$, the aggregate employment elasticity to nominal wage is higher in a MU.

The intuition for this ambiguous result stems from eq. (61). Since $1/\eta^r$ is a linear combination of $1/\sigma$ and $1/\eta^r|_{n=1}$, an increase in n puts more weight on the substitution effect operating in the labor demand elasticity, so that employment increases and inflation diminishes only if $\sigma > \eta^r|_{n=1}$ (see eqs. (53), (40), (45), and (61)). Opposite effects occur if $\sigma < \eta^r|_{n=1}$.[21] Furthermore, since employment is inefficiently low, an increase in labor demand elasticity is accompanied by an increase in welfare as well. It follows that, an improvement in economic performance and welfare hinges on complementarity between labor market distortions and centralization of wage setting. More specifically, labor markets featuring sizeable (low) monopolistic distortions has to be associated with centralized (decentralized) wage bargaining.

This result differs from Coricelli, Cukierman, and Dalmazzo (2004). They find that a larger number of unions in a MU always worsens economic performance at Home. The explanation of such a different prediction is due to the absence of a substitution effect in their model. As labor services are not substitutable in production, the output effect is always larger than the substitution effect which, in turn, implies that economic performance is unambiguously decreasing in the decentralization of wage bargaining.

It is worth noticing that the condition in Proposition 5 referring to a MU exactly reproduces Lippi's (2003) finding. This coincidence is due to the fact that unions perceive their wages as not having any impact on the terms of trade (see eq. (59)). In other words, the strategic interactions operating in η^{MU} are isomorphic to the closed-economy ones. By contrast, under NMP, Home and Foreign monetary authorities do not internalize the impact of their policies on the other country and causes their desired response toward a domestic wage increase to be asymmetrical. Thus, not only substitution and output effect matter, but also the terms of trade effect accounts for unions' wage demands under NMP.

7.2 CB conservatism

How does the degree of CB conservatism affect welfare?

Proposition 6 *As long as $n \in (1, \infty)$, an increase in CB conservatism raises (reduces) welfare under the regime $r \in (NMP, MU)$ if $\sigma < \eta^r|_{n=1}$ $(\sigma > \eta^r|_{n=1})$.*

A higher degree of CB inflation aversion implies that monetary policy accommodates wage hikes to a lesser extent, thus leading to higher (in absolute value) aggregate labor demand elasticities (ε_H^r). This has two opposing effect on η.

As noted above, the monopolistic distortion in the labor market is simply a weighted average of the strategic effects $1/\sigma$ and $1/\eta^r|_{n=1}$, where the weights are given respectively by $\left(1 - \frac{\varepsilon_H^{NMP}}{n\varepsilon_h^{NMP}}\right)$ and $\left(\frac{\varepsilon_H^{NMP}}{n\varepsilon_h^{NMP}}\right)$.

Now, an increase in β causes a rise in ε_H^r, thereby increasing the weight attached to the $1/\eta^r|_{n=1}$ component (see eq. (62)). As a result, if $\sigma < \eta^r|_{n=1}$, a more conservative CB is beneficial in terms of

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[21]Notice that, for given values of σ and $\eta^r|_{n=1}$, Proposition 5 entails a monotonic relation between the degree of centralization in wage setting and economic performance. This is in contrast with the U-shape curve *à la* Calmfors and Driffill (1988). The main reason for the absence of a Calmfors-Driffill curve in models with constant elasticity of substitution between labor types is provided by Guzzo and Velasco (1999).

welfare because it reduces labor market distortions. Conversely, if $\left(\sigma > \eta^r\big|_{n=1}\right)$, the society would be better off by appointing a less conservative CB. Such a complementarity between labor market distortions and the degree of conservatism may then explain the appointment of a more conservative CB on the grounds of monopolistic distortions in European labor markets.

The ambiguous result in Proposition 6 is in contrast with Coricelli, Cukierman, and Dalmazzo (2004) where a more conservative CB always boosts employment in a MU. As previously highlighted, their result hinges on the fact that the production function does not exhibit any substitution effect. In other words, their prediction is replicated in this model when the substitution effect is relatively low, so that conservatism has an increasing effect on employment in a MU.

Finally, as noted in the previous section, Proposition 6 extends the Lippi's (2003) findings in two respects. First, the strategic effects operating in an open economy under NMP and flexible exchange rate include not only the substitution and output effects, but also the terms-of-trade effect. Second, a MU regime replicates his results because of the absence of a terms-of-trade effect.

8 Conclusions

I have considered the impact of a switch from a floating exchange rate regime to a monetary union (MU) in a monetary policy game based on a simple microfounded general equilibrium model. The analysis has shown that the impact of wage demands on the terms of trade is perceived by unions as being substantially different under national monetary policies (NMP) and in a MU. In particular, under NMP the asymmetric responses of domestic and foreign monetary policies to domestic wage hikes lead unions to anticipate an improvement in the terms of trade, thereby reducing wage restraints. Intuitively, for a given labor demand elasticity, the improvement in the terms of trade in the wake of a nominal wage increase let unions achieve a higher real consumption wage. Conversely, in a MU each union anticipates its wage demands not affecting the terms-of-trade because of the symmetric monetary wage responses in both countries. The lack of such a terms-of-trade effect in a MU induces to larger wage restraints, thereby raising both employment and welfare.[22]

Moreover, the paper highlights how the two monetary regimes modify the impact of a centralized system of wage bargaining and central bank (CB) conservatism on welfare. In general, in order to improve economic performance, a higher (lower) degree of conservatism and centralized wage setting are to be associated with sizeable (lower) distortions in the labor markets. More specifically, the sign of the effect of CB conservatism and of a centralized system of wage bargaining on employment and welfare depends instead on the unions' incentive to move the terms of trade under NMP. In this respect the Lippi's (2003) result, whereby conservatism of monetary policy and centralized wage setting affect equilibrium employment only through the output and substitution effect, is modified under NMP so as to allow for the terms-of-trade effect. Conversely, his results are replicated in a MU.

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[22]This result is in line with the nominal wage moderation experienced in Europe since the formation of the EMU (European Commision, 2007).

Appendixes

A   Derivation of monetary policies under a NMP regime

Solving (39) and the corresponding Foreign CB problem explicitly for money supplies yields, apart from constant additive terms, the following CB reaction functions:

$$m = \frac{k - \beta(1-\theta)\theta}{k + \beta\theta^2}w + \frac{\beta(1-\theta)\theta}{k + \beta\theta^2}[m^* - w^*],$$

$$m^* = \frac{k - \beta(1-\theta)\theta}{k + \beta\theta^2}w^* + \frac{\beta(1-\theta)\theta}{k + \beta\theta^2}[m - w],$$

where $\theta \equiv 1 - \alpha/2 \in (1/2, 1)$. The Nash equilibrium is hence obtained in the point where these curves intersect:

$$m = \frac{k^2 - \beta^2(1-\theta)\theta^2 + k\beta\theta(1-\alpha)}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}w - \frac{\beta^2(1-\theta)\theta^2}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}w^*,$$

$$m^* = \frac{k^2 - \beta^2(1-\theta)\theta^2 + k\beta\theta(1-\alpha)}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}w^* - \frac{\beta^2(1-\theta)\theta^2}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}w.$$

In order to find the aggregate employment elasticities, I plug the Nash solution of money supplies into (25) as follows:

$$l = -\underbrace{\frac{\beta\theta(k+\beta\theta^2)}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}}_{\varepsilon_H^{NMP}}w - \underbrace{\frac{\beta^2(1-\theta)\theta^2}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}}_{\varepsilon_F^{NMP}}w^*,$$

$$l^* = -\underbrace{\frac{\beta\theta(k+\beta\theta^2)}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}}_{\varepsilon_{F^*}^{NMP}}w^* - \underbrace{\frac{\beta^2(1-\theta)\theta^2}{(k+\beta\theta)[k+\beta\theta(1-\alpha)]}}_{\varepsilon_{H^*}^{NMP}}w.$$

B   Derivation of monetary policies under a MU regime

Solving (44) yields, apart from constant additive terms, the following CB reaction function:

$$m^W = \frac{(w + w^*)(k - (1-\alpha)\alpha\beta)}{k + (1-\alpha)^2\beta}.$$

Thus, using the relations obtained in footnote 15, aggregate employment elasticities are found by plugging the above solution into (32) as follows:

$$l = -\underbrace{\frac{\beta(1-\alpha)}{k + \beta(1-\alpha)^2}}_{\varepsilon_H^{MU}}w - \underbrace{\frac{\beta(1-\alpha)}{k + \beta(1-\alpha)^2}}_{\varepsilon_F^{MU}}w^*,$$

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$$l^* = -\underbrace{\frac{\beta(1-\alpha)}{k+\beta(1-\alpha)^2}}_{\varepsilon_{F*}^{MU}} w^* = -\underbrace{\frac{\beta(1-\alpha)}{k+\beta(1-\alpha)^2}}_{\varepsilon_{H*}^{MU}} w.$$

C Derivation of union's first-order condition

The *u*-th union first-order condition is obtained by solving (52)

$$-nk\int_{j\in u}\log L(j)\frac{\partial \log L(j)}{\partial \log W(j)}\mathrm{d}j+\frac{W(j)L(j)}{PC(j)}\left[1+\frac{\partial L(j)}{\partial W(j)}\frac{\partial W(j)}{\partial \log W(j)}\frac{1}{L(j)}-\frac{\partial P}{\partial W(j)}\frac{\partial W(j)}{\partial \log W(j)}\frac{1}{P}\right]=0. \tag{63}$$

From firms profit maximization, it turns out that in a symmetric equilibrium $WL/(PC) = \alpha$. Thus, I may write (63) as follows:

$$\alpha(1+\varepsilon_h - s_h) = k\log L\varepsilon_h, \tag{64}$$

where $s_h \equiv \partial \log P/\partial \log W(j)$. Using the definition of η into (64) yields eq. (53) in the text.

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International monetary policy cooperation revisited: conservatism and non-atomistic wage setting

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Abstract

This paper presents a benchmark model of policy coordination in line with the New Open Economy Macroeconomics literature. I extent the analysis on non-cooperative toward cooperative solutions by incorporating non-atomistic wage setters and conservative central banks. It turns out that previous results on international monetary policy cooperation are modified such that cooperation is welfare improving. The finding in the model relies on unions' perceptions about affecting monetary policy. It is shown that under cooperation wage setters perceive a tighter monetary policy, thereby inducing stronger wage restraint.

Keywords: monetary policy games, international policy coordination, central bank conservatism, monopoly unions

JEL classification: E58, F41, F42, J51

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"In most countries in the OECD, the majority of workers have their wages set by collective bargaining between employers and trade unions at the plant, firm, industry or aggregate level ... there is some evidence that trade union power in wage setting has a significant impact on unemployment." (Nickell, Nunziata, and Ochel, 2005, p. 6)

1 Introduction

The importance of interdependencies between the stabilization rule of a conservative central bank (CB) and benevolent wage setters[1] was originally emphasized in Soskice and Iversen (1998, 2000) and Bratsiotis and Martin (1999), and recently reinvestigated in the literature (e.g. Coricelli, Cukierman, and Dalmazzo, 2004, Gnocchi, 2006).

However, the issue of international monetary policy coordination and non-atomistic wage setting relies on linear versions of the Rogoff (1985a) model due to Canzoneri and Henderson (1988). In this respect, Jensen (1993) presents a two-country model of strategic wage setting and monetary policy regimes. He found that, in a world with flexible prices and exchange rates, international monetary policy cooperation is counterproductive.

The key point of this literature is that the rate of accommodation in monetary policy affects the behavior of wage setters. In particular, the degree of accommodation of the money supply to changes in the price level (conservatism) increases the elasticity of the labor demand curve, thereby worsening the trade-off between employment and wages faced by workers, and leading to lower rate of equilibrium unemployment; see Cukierman (2004) for a recent survey.

The main reason why a cooperative regime is disadvantageous in Jensen (1993) is that monetary authorities are shown to increase the domestically generated inflation bias (as e.g. Rogoff, 1985a). Since non-atomistic wage setters anticipate a more expansive monetary policy in the wake of wage rises, they will set higher wages and hence a greater equilibrium unemployment. Intuitively, wage demands are positively related to the slope of the perceived labor demand curve. A more expansionary monetary policy in turn induces unions to perceive a steeper curve because unions can attain higher real consumer wages at a smaller employment loss.

This paper examines macroeconomic interdependence and the need for policy coordination in a tractable micro-founded model in line with the New Open Economy Macroeconomics (NOEM) literature (e.g. Obstfeld and Rogoff, 2002, Corsetti and Pesenti, 2005, Devereux and Engel, 2003, Canzoneri, Cumby, and Diba, 2005). According to Canzoneri, Cumby, and Diba (2005), the main characteristics of a benchmark model for the study of macroeconomic interdependence are: "(1) a balanced current account, (2) log utility of consumption, (3) constant expenditure shares (on components of the composite consumption good), and (4) a log specification for the utility of money" (Canzoneri, Cumby, and Diba, 2005, p. 364).

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[1]An other strand of literature, following Cubitt (1992), examines strategic interactions between monetary policy and wage setting under the assumption that unions are also concerned about inflation. I do not pursue this literature here.

In order to obtain gains from coordination, however, some assumptions of the simple framework have been relaxed in literature. Corsetti and Pesenti (2005) and Devereux and Engel (2003), for example, consider the case where the law of one price does not hold closely, i.e. the degree of exchange-rate pass-through to import prices may be different from one. Obstfeld and Rogoff (2002) focus on a more general specification of the representative household's utility function. Canzoneri, Cumby, and Diba (2005) introduce imperfectly correlated sectoral shocks, and conclude that sizable welfare gains from coordination can be generated in such a case in the standard Obstfeld and Rogoff's (2002) setup.

A novel feature of this model is the introduction of non-atomistic wage setters and conservative CBs in an otherwise standard NOEM model. The central question addressed is whether non-atomistic wage setting and CB conservatism can generate welfare benefit of monetary cooperation in a simple symmetric benchmark model *à la* Canzoneri, Cumby, and Diba (2005).

The main finding of the paper is that the introducing of strategic interactions between non-atomistic wage setters and conservative monetary authorities produces welfare gains in a cooperative monetary regime also in a benchmark model. This is in sharp contrast with Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005), and Devereux and Engel (2003) where welfare gains from coordination cannot be generated in the standard symmetric Obstfeld and Rogoff (2002) set-up.

The reason for this result stems from a tighter monetary policy *perceived* by wage setters under the cooperative monetary regime. As in Rogoff (1985a) and Benigno (2002), cooperation reduces the incentive to contract money supply. In this paper it is mainly due to two effects. Under a non-cooperative regime, the CB has the incentive to strategically improve the terms of trade and disregards foreign inflation. Both effects lead to a less expansive monetary policy than under cooperation. Nevertheless, in terms of equilibrium employment, it is relevant how unions perceive the monetary wage response policies under either regime. Since a cooperative monetary authority incurs an additional cost from domestic wage rise via the change in inflation abroad, it is demonstrated that under cooperation monetary responses are perceived as being more stringent. This discourages wage demands to a larger extent because unions anticipate a less marginal benefit from their wage claims.

Moreover, such a result is in contrast with the classical contributions to this issue (e.g. Jensen, 1993, 1997). Jensen (1997) shows that there can be beneficial effects from monetary cooperation only in presence of inflation averse wage setters. Interestingly, in this model, it is not necessary to assume inflation aversion *per se*. The inflationary costs of the CB perceived by the unions in the wake of wage rises are in fact sufficient to dampen wage claims under the cooperative regime.

The rest of the paper is organized as follows: Section 2 presents the benchmark model. In Section 3, I analyze the efficient allocation and the macroeconomic interdependence exhibited by the model. Section 4 and 5 discuss the monetary policy and wage setting under the two monetary regimes respectively. Section 6 summarizes.

2 The model

I analyze the role of monetary policy coordination using a simple micro-founded general equilibrium model in the vein of the NOEM literature. However, I extend the model by introducing non-atomistic wage setters and CB conservatism.

The economy consists of two countries, Home (H) and Foreign (F), each inhabited by a continuum of agents with population size normalized to 1. Home agents are indexed by j.[2] Each country is specialized in the production of a single traded good. There are no impediments or costs to trade across borders. For each type of goods, H and F, there exists a continuum of brands.

The model features (1) a balanced current account, (2) log utility of consumption, (3) constant expenditure shares on the goods entering in the consumption bundle in each country, and (4) log utility of money. These are the key points of a prototypical second generation model for the study of macroeconomic interdependence, as underlined in Canzoneri, Cumby, and Diba (2005).

I consider a no commitment game that has the following timing. First, each firm sets the price of the particular brand whose is the sole producer. Next, nominal wages are set simultaneously by a large monopolistic union in its country of origin. Finally, monetary policy is conducted in each country by an independent monetary authority under a non-cooperative or cooperative regime. The prevailing regime is always known to unions when setting their wages.

Intuitively, the timing structure of the model entails prices being stickier than other nominal variables. Specifically, prices are stickier than wages, while monetary policy is more flexible than wages and prices. These characteristics are in line with the NOEM models featuring some form of nominal inertia (see Corsetti and Pesenti, 2001, 2005, Obstfeld and Rogoff, 2000, 2002).

2.1 Households

Utility of a representative Home agent j is given by

$$U(j) = \log C(j) - \frac{k}{2} \left[\log L(j)\right]^2 + \log\left(\frac{M(j)}{P}\right), \tag{1}$$

where k is a positive preference parameter and $L(j)$ is a measure of hours worked. $C(j)$ is a Cobb-Douglas aggregate of the two available types of goods:

$$C(j) = 2C_H(j)^{1/2} C_F(j)^{1/2}; \tag{2}$$

$C_H(j)$ and $C_F(j)$ are the j-th individual consumption basket of the Home good and Foreign good respectively given by:

$$C_H(j) = \left[\int_0^1 C_H(j,z)^{(\theta-1)/\theta} \mathrm{d}z\right]^{\theta/(\theta-1)} \quad ; \quad C_F(j) = \left[\int_0^1 C_F(j,z)^{(\theta-1)/\theta} \mathrm{d}z\right]^{\theta/(\theta-1)},$$

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[2]Henceforth, economic variables in the Foreign country will be indexed by "*".

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where z is an index of brands, and $\theta > 1$ is the elasticity of substitution between brands. Isomorphic preferences on the two goods hold in the Foreign country.

The consumption-based price indexes expressed in domestic and foreign currency are

$$P = P_H^{1/2}P_F^{1/2} \qquad ; \qquad P^* = P_H^{*1/2}P_F^{*1/2}, \tag{3}$$

where

$$P_H = \left[\int_0^1 P_H(z)^{1-\theta}\mathrm{d}z\right]^{1/(1-\theta)} \qquad ; \qquad P_F = \left[\int_0^1 P_F(z)^{1-\theta}\mathrm{d}z\right]^{1/(1-\theta)}.$$

A formula parallel to the one above holds for the Foreign-denominated prices of Home and Foreign goods, P_H^* and P_F^*, respectively.

Throughout the paper, I assume that firms set prices in the sellers' local currency and the law-of-one-price holds, so that the cost of imported goods in the home consumption basket is simply the price of traded goods charged by foreign exporting firms, adjusted by the nominal exchange rate:

$$P_F(z) = EP_F^*(z) \qquad ; \qquad P_H^*(z) = P_H(z)/E, \tag{4}$$

where E is the nominal exchange rate (domestic currency per unit of foreign currency), and $P_H^*(z)$ and $P_F^*(z)$ are the prices of Home and Foreign brand z expressed in Foreign currency. Since agents' preferences are identical in the two countries, combining the law of one price with (3) leads to the consumption-based purchasing power parity (PPP):

$$EP^* = P. \tag{5}$$

A typical Home agent j maximizes (1) with respect to $C(j)$ and $M(j)$ subject to the budget constraint

$$M(j) + PC(j) + T(j) = M_0(j) + W(j)L(j) + D(j), \tag{6}$$

where $T(j)$ is a lump-sum tax and $M_0(j)$ is initial nominal money holdings. The household's income consists of her wage income, $W(j)L(j)$, and dividends, $D(j)$, received from all domestic firms.[3] Throughout the paper, I assume that the profits are entirely paid to shareholders as dividends. Foreign individuals face an analogous problem.

The household j's demands for a typical Home and Foreign brand are derived from cost minimization as follows:

$$C_H(j,z) = \frac{1}{2}\left[\frac{P_H(z)}{P_H}\right]^{-\theta}\left[\frac{P_H}{P}\right]^{-1}C(j) \tag{7}$$

$$C_F(j,z) = \frac{1}{2}\left[\frac{P_F(z)}{P_F}\right]^{-\theta}\left[\frac{P_F}{P}\right]^{-1}C(j), \tag{8}$$

---

[3]Given the Cobb-Douglas preferences in consumption (2) and the separability of individuals' utility functions, the foreign equity trade is redundant. Moreover, the equilibrium holdings of international traded bonds would be zero at any time in an intertemporal version of our model (see Corsetti and Pesenti, 2001).

with isomorphic demands by Foreigners. Note that, in a symmetric equilibrium ($P_H(z) = P_H$ and $P_F(z) = P_F$), eqs. (7) and (8) exhibit the constant expenditure shares discussed above.

The first-order conditions for Home and Foreign households' nominal money balances are:

$$\frac{1}{C(j)} = \left(\frac{M(j)}{P}\right)^{-1} \quad ; \quad \frac{1}{C^*(j^*)} = \left(\frac{M^*(j^*)}{P^*}\right)^{-1}. \tag{9}$$

The implication of monopolistic wage setting on labor supply will be discussed below.

2.2 Firms

From the consumption allocation derived in the previous section and aggregating across the Home and Foreign households, the demands faced by the various firms in the two countries are given by:

$$Y_H(z) = \frac{1}{2}\left[\frac{P_H(z)}{P_H}\right]^{-\theta}\left[\frac{P_H}{P}\right]^{-1}(C+C^*) \tag{10}$$

$$Y_F^*(z) = \frac{1}{2}\left[\frac{P_F^*(z)}{P_F^*}\right]^{-\theta}\left[\frac{P_F^*}{P^*}\right]^{-1}(C+C^*). \tag{11}$$

Technology is described by the following production functions:

$$Y_H(z) = L(z) \quad ; \quad Y_F^*(z) = L^*(z), \tag{12}$$

for all $z \in [0,1]$, i.e. all firms use a linear technology.

The Home-currency profits of representative firms are hence as follows:

$$D_H(z) = \frac{1}{2}(P_H(z) - W)\left[\frac{P_H(z)}{P_H}\right]^{-\theta}\left[\frac{P_H}{P}\right]^{-1}(C+C^*), \tag{13}$$

while the Foreign-currency profits of Foreign firms are:

$$D_F^*(z) = \frac{1}{2}(P_F^*(z) - W^*)\left[\frac{P_F^*(z)}{P_F^*}\right]^{-\theta}\left[\frac{P_F^*}{P^*}\right]^{-1}(C+C^*). \tag{14}$$

Thus, each domestic firms z maximizes its profits by setting the relevant brand price, $P_H(z)$, subject to the demand constraint. The optimal price leads firms to charge a markup over the wage cost:

$$P_H(z) = P_H = \frac{\theta}{\theta-1}W \quad ; \quad P_F^*(z) = P_F^* = \frac{\theta}{\theta-1}W^*, \tag{15}$$

where I dropped the index z since the equilibrium is symmetric across firms within a given country.

2.3 Market clearing, exchange rate determination, and terms of trade

Governments in each country rebate all seignorage revenue in lump-sum transfers to households:

$$-T = \frac{M}{P} - \frac{M_0}{P} \qquad -T^* = \frac{M^*}{P^*} - \frac{M_0^*}{P^*}. \tag{16}$$

The first order conditions are identical for the agents within a given country. Thus, I drop the j index. The product market equilibrium requires that

$$P_H Y_H = 1/2(PC + EP^*C^*) \qquad ; \qquad P_F Y_F^* = 1/2(PC + EP^*C^*), \tag{17}$$

which implies the following result

$$\frac{P_H}{P_F} = \frac{Y_F^*}{Y_H}. \tag{18}$$

Now, using the government budget constraint (16) together with the individual budget constraints (6) yields balanced current accounts

$$PC = P_H Y_H \qquad ; \qquad EP^*C^* = PC^* = P_F Y_F^*, \tag{19}$$

from which Home and Foreign consumption need move together:

$$C = C^*. \tag{20}$$

Eqs. (18) and (19) imply that the exchange rate is equal to the ratio of national nominal expenditure

$$E = \frac{PC}{P^*C^*}. \tag{21}$$

This result stems directly from the characteristics of current account balance and constant expenditure shares exhibited by the model. Substituting the money demand (9) into the above expression, the exchange rate can be rewritten as the ratio of money supply in the two countries

$$E = \frac{M}{M^*}. \tag{22}$$

The terms of trade are defined in the Home country as

$$TOT \equiv \frac{EP_F^*}{P_H}. \tag{23}$$

A decrease in the terms of trade constitutes a real appreciation of the domestic currency, i.e. an improvement in the Home terms of trade.

3 The efficient allocation and the reduced form

In this section I derive the efficient allocation and the reduced-form of the model. The former is a useful benchmark for the analysis of optimal policy in the presence of nominal rigidities, while the latter shows macroeconomic interdependence in the two economies.

3.1 Efficient allocation

In order to describe the world's optimal allocation in any given period, I consider the solution of the following social planner's problem (see e.g. Galí and Monacelli, 2008):

$$\max_{C_u, C_u^*, L, L^*, \frac{M}{P}, \frac{M^*}{P^*}} \frac{1}{2} \int_0^1 U(j) \mathrm{d}j + \frac{1}{2} \int_0^1 U^*(j^*) \mathrm{d}j^* \qquad u \in [H, F],$$

subject to the feasibility constraint

$$Y_H = C_H + C_F \qquad ; \qquad Y_F^* = C_H^* + C_F^*$$

and the technological constraint

$$Y_H = L \qquad ; \qquad Y_F^* = L^*.$$

The optimal conditions for the social planner's problem are:

$$\frac{1}{2C_H} = \frac{1}{2C_F} = \frac{k \log L}{L}$$

$$\frac{1}{2C_H^*} = \frac{1}{2C_F^*} = \frac{k \log L^*}{L^*}$$

$$\left(\frac{M}{P}\right)^{-1} = \left(\frac{M^*}{P^*}\right)^{-1} = 0,$$

i.e. the planner would like to equate the marginal rate of substitution between consumption and leisure to the marginal product of labor. The last condition, instead, requires to equate the (social) marginal utility of real balances to the social marginal cost of producing real money balances, which is zero.

From the resource and technological constraint, it is easy to obtain the following solutions to the social planner's problem:

$$C_H = C_F = C/2 \quad ; \quad C_H^* = C_F^* = C^*/2 \tag{24}$$

$$Y_H = L = C \quad ; \quad Y_F^* = L^* = C^* \tag{25}$$

$$\log L = 1/k \quad ; \quad \log L^* = 1/k. \tag{26}$$

3.2 Reduced form

In what follows, I will denote natural logarithm of any variable X by the corresponding lower-case letter; thus $x \equiv \log X$. Without loss of generality, I normalize the previous period nominal wage, money supply, and general price level to unity, so that the log of these variables can be considered as an approximation of their percentage increase. It is assumed throughout the paper that the strategic choice variable of Home (Foreign) union and CB are respectively the nominal wage growth w (w^*) and the nominal money growth m (m^*).

Table 1: Reduced form of the model

$$l = m - w \qquad\qquad l^* = m^* - w^* \tag{27}$$

$$p_H = w \qquad\qquad p_F^* = w^* \tag{28}$$

$$p = 1/2(m - m^* + p_F^* + p_H) \qquad\qquad p^* = 1/2(m^* - m + p_F^* + p_H) \tag{29}$$

$$c_H = m - p_H \qquad\qquad c_F^* = m^* - p_F^* \tag{30}$$

$$c_F = m^* - p_F^* \qquad\qquad c_H^* = m - p_H \tag{31}$$

$$c = 1/2(m + m^* - p_F^* - p_H) \qquad\qquad c^* = 1/2(m + m^* - p_F^* - p_H) \tag{32}$$

$$tot = m - m^* + p_F^* - p_H \qquad\qquad e = m - m^* \tag{33}$$

The reduced form of the model (apart from constant terms) is summarized in Table 1 (see Appendix A for details).

A Home monetary expansion ($m > 0$) depreciates the exchange rate. This effect worsens the terms of trade (33), thereby shifting the demand toward the good produced in the Home country (see (31) and (30)). As noted in Canzoneri, Cumby, and Diba (2005), exchange rate adjustments render foreign supply side unaffected by domestic monetary policy. Given domestic wages and prices, an increase in m leads to both a nominal ($p + c$) and real (c) consumption rise (see eqs. (7)). Conversely, the nominal exchange rate depreciation has no impact on c_F (eq. 31). c_F and l^* are hence insulated from Home shocks.

In the following section, I will assess how optimal policies are performed under the two different policy regimes, and next I turn to the question of how monetary regimes affect domestic wage setting.

I assume a sequential game consisting of *three* stages under a cooperative and a non-cooperative monetary regime.

All firms set their brand price in the first stage as derived in section 2.2. Next labor unions choose their own wages simultaneously, anticipating the subsequent moves of the two monetary authorities and taking prices set by firms as given. In the third stage, the two CBs choose simultaneously their monetary policies under a cooperative or non-cooperative monetary regime, taking as given wages and prices from

the previous stages.[4]

In this context I analyze the optimal stabilization policy of discretionary monetary policy disturbances, as in Benigno (2002). In either regime, unions exactly anticipate the optimal policies of the two monetary authorities. There is no cooperation between unions as well as no cooperation between unions and CBs. The CBs, instead, may act non-cooperatively or cooperatively. The model is solved by backward induction.

4 Monetary policy

4.1 Non-cooperative regime

As money growth is chosen after observing prices and wages, the monetary authority will take prices and wages as given. Drawing on Lippi (2003), I assume that the two independent monetary authorities aim at maximizing a targeting rule by setting the growth rate of money supply after wages have been negotiated. In doing that, each CB takes the money supply in the other country as given. However, following the example of recent literature on monetary policy evaluation, I ignore the money term in the utility function (e.g. Canzoneri, Cumby, and Diba, 2005, Devereux and Engel, 2003, Obstfeld and Rogoff, 2000).

Thus, the problem of the Home CB is given by:

$$\max_{m} \Omega = \int_0^1 \left[U(j) - \log\left(\frac{M(j)}{P}\right) \right] dj - \frac{\beta}{2} p^2 \quad \texttt{s.to } (32), (27), (29), \texttt{and } \partial m^*/\partial m = 0, \quad (34)$$

while the Foreign CB solves the following problem:

$$\max_{m^*} \Omega^* = \int_0^1 \left[U^*(j^*) - \log\left(\frac{M^*(j^*)}{P^*}\right) \right] dj^* - \frac{\beta}{2} p^{*2} \quad \texttt{s.to } (32), (27), (29) \texttt{and } \partial m/\partial m^* = 0. \quad (35)$$

The $\beta > 0$ parameter captures the CB degree of conservatism in the Home and Foreign country (Rogoff, 1985b).[5] By assuming symmetric targeting rule for the two CBs, I focus on countries with similar characteristics as in the spirit of the NOEM literature.

The first-order condition of (34) yields

$$p = \frac{k(\tilde{l} - l) - 1/2}{\beta/2}, \quad (36)$$

where $\tilde{l} \equiv 1/k$ is the efficient employment level given by eq. (26). Similarly, the solution to (35) yields

$$p^* = \frac{k(\tilde{l} - l^*) - 1/2}{\beta/2}. \quad (37)$$

---

[4]Following the literature on strategic interaction between wage setting and monetary policy, I assume a Stackelberg game between CB (follower) and unions (leader) (see Cukierman, 2004).

[5]One could think of the quadratic costs of inflation entering in (35) and (34) as representing an inflation aversion specific to the CB stemming from an explicit statutory or implicit goal of price stability (e.g. Betts and Devereux, 2000).

Table 2: Aggregate labor demand elasticities to wages under a non-cooperative regime

$$l = -\underbrace{\frac{k\beta}{2k(2k+\beta)}}_{\varepsilon_H^C}w + \underbrace{\frac{k\beta}{2k(2k+\beta)}}_{\varepsilon_F^C}w^* \qquad l^* = \underbrace{\frac{k\beta}{2k(2k+\beta)}}_{\varepsilon_{H^*}^C}w - \underbrace{\frac{k\beta}{2k(2k+\beta)}}_{\varepsilon_{F^*}^C}w^* \qquad (38)$$

$$p = \underbrace{\frac{k}{2k+\beta}}_{s_H^{NC}}w - \underbrace{\frac{k}{2k+\beta}}_{s_F^{NC}}w^* \qquad p^* = -\underbrace{\frac{k}{2k+\beta}}_{s_{H^*}^{NC}}w + \underbrace{\frac{k}{2k+\beta}}_{s_{F^*}^{NC}}w^* \qquad (39)$$

Thus, the optimal monetary policy hinges on equating marginal benefit of an inflationary monetary policy to marginal cost, respectively given by the terms on the R.H.S. and L.H.S. of eqs. (36) and (37). For a given (explicit) marginal cost of inflation ($\beta/2p$), an expansionary monetary policy has two opposing effects. First, as long as employment l is below the efficient level $\tilde{l}$, the monetary authority has an incentive to raise inflation so as to shrink the discrepancy between efficient and natural output. This is the standard Blanchard-Kiyotaki result in which a positive monetary shock unambiguously improves domestic welfare (Blanchard and Kiyotaki, 1987). Second, as found in Corsetti and Pesenti (2001), in an open economy the CB has an incentive to strategically improve its terms of trade, (see eq. (33)), thereby implementing a too contractive monetary policy. Specifically,

> "[t]he reduction in the utility derived from consumption is more than compensated by the reduction in the disutility of producing effort, because the 'burden' of production is shifted to the other country through the improved terms of trade" Benigno (2002, p. 185).

Such an effect is captured by the negative term on the R.H.S. of eqs. (36) and (37). It turns out that the inflationary bias equilibrium does not necessary arise in this model.

The Nash equilibrium is derived by combining the Home CB reaction function (36) with the Foreign CB reaction function (37). Solving eq. (36) for money supply yields Home policy in terms of Home and Foreign wages.

Table 2 presents the elasticities of aggregate labor demand and prices to nominal wages after plugging the Nash equilibrium monetary reaction function into (27) and (29), disregarding constant terms and preset prices. These are, in other words, the "perceived" elasticities by unions in the two countries.

A domestic wage increase reduces employment, thereby inducing the domestic CB to ease its policy so as to boost employment. From eq. (36), a domestic wage rise will trigger the following monetary reaction:

$$-k\frac{\partial l}{\partial w} = \frac{\beta}{4}\frac{\partial e}{\partial w} \qquad (40)$$

In words, if the CB does not care about inflation ($\beta = 0$), the rise in money supply will be equal to the

wage increase so as to redress the employment level (i.e. $\frac{\partial m}{\partial w} = 1$). In such a case a unit wage rise is perceived as not having any effect on aggregate employment (see eqs. (40) and (38)). Inflation, instead, is expected to raise because of the exchange rate depreciation.

When the CB cares about inflation ($\beta > 0$), the domestic monetary authority desired response toward a domestic wage increase is less expansive. Thus, the perceived labor demand elasticity will be greater than zero in absolute terms. Moreover, in the extreme case of $\beta \to \infty$, an increase in nominal wages will not cause any change in the perceived exchange rate and, hence, in the general price level. The optimal monetary policy in the wake of a wage increase will simply imply $\frac{\partial m}{\partial w} = \frac{\partial m^*}{\partial w}$ (see eq. (40)).

It is worth noticing that a domestic wage rise is perceived to raise foreign employment via the terms of trade effect. In fact, a domestic monetary expansion leads to an exchange depreciation which, in turn, move consumption toward foreign good. The same mechanism explains why wage rises have opposite impact on price expressions (39).

4.2   Cooperative regime

Under a cooperative regime, the CBs solve the following problem

$$
\begin{aligned}
\max_{m,m^*} 1/2\Omega + 1/2\Omega^* \quad = \quad & 1/2\left[\int_0^1 \left[U(j) - \log\left(\frac{M(j)}{P}\right)\right]\mathrm{d}j - \frac{\beta}{2}p^2\right] \\
& + 1/2\left[\int_0^1 \left[U(j^*) - \log\left(\frac{M(j^*)}{P^*}\right)\right]\mathrm{d}j^* - \frac{\beta}{2}(p^*)^2\right] \\
& \texttt{s.to}\ (32),(27),\ (29) \quad\quad\quad\quad\quad\quad\quad\quad (41) \\
& \texttt{and}\ \partial m^*/\partial m = 0,\ \partial m/\partial m^* = 0 \quad\quad\quad (42)
\end{aligned}
$$

The corresponding first-order conditions in terms of prices and employment are given by

$$
p = p^* + \frac{k}{\beta/2}(\tilde{l} - l), \tag{43}
$$

$$
p^* = p + \frac{k}{\beta/2}(\tilde{l} - l^*). \tag{44}
$$

Result 1 *Monetary policy is more expansive under a cooperative regime.*

The optimal monetary policy requires equating marginal benefit of inflating (terms on R.H.S. of eqs. (43) and (44)) to marginal cost (terms on L.H.S. of eqs. (43) and (44)). It is apparent that a move from a non-cooperative to a cooperative regime raises marginal benefits of the CB for a given level of inflation. In fact, comparing eqs. (36) and (43), the domestic CB will implement a more expansive monetary policy under a cooperative regime because of the higher marginal benefit. A symmetrical reasoning can be applied to the Foreign country.

A more expansionary monetary policy under a cooperative regime is consistent with literature on international policy coordination (e.g. Benigno, 2002, Rogoff, 1985a). Intuitively, under cooperation, the

monetary authorities realize that they cannot affect the terms of trade, but can reduce inflation abroad. The latter aspect is neglected in Benigno (2002) because of the benevolent CB assumption ($\beta = 0$).

The sizeable global money expansion under cooperation (Result 1) might be expected to induce a domestic CB to respond more expansively toward a domestic wage increase. However, a novel feature of the model is summarized in the following result.

Result 2

    i. Non-cooperative wage response policies in both countries are more expansive than cooperative ones.

    ii. Labor demand elasticity to nominal wages are higher under a cooperative monetary regime.

How is monetary policy perceived by wage setters under a cooperative regime? A domestic wage rise has the following impact on the optimal monetary policy:

$$-k\frac{\partial l}{\partial w} = \frac{\beta}{2}\frac{\partial e}{\partial w}. \tag{45}$$

Comparing eqs. (40) and (45), it is apparent that, for a given labor demand elasticity, the cooperative monetary response will be more costly in terms of exchange rate depreciation and, hence, inflation. Intuitively, under the non-cooperative regime a domestic monetary authority does not internalize the impact of exchange rate depreciation on foreign inflation. Conversely, in the cooperative regime, a depreciation of the exchange rate is perceived as increasing domestic inflation at home and reducing marginal benefit via lower inflation abroad. These two effects are equal in size; therefore, the increase in marginal cost in the wake of wage demands is larger under a cooperative monetary regime and explains the first part of Result 2.

As to the second part of Result 2, it is worth noticing that the elasticity of domestic labor demand perceived by unions is increasing (in absolute value) in the tightening of domestic domestic monetary response to wage. Since cooperative wage response policies are more stringent, Result 2 states that with cooperative monetary policies, a domestic nominal wage increase reduces employment mostly in the domestic country.

Thus, solving eq. (44) and (43) for money supplies and plugging the solutions into (27) and (29), I may rewrite (perceived) aggregate labor demand and inflation in a cooperative equilibrium as presented in Table 3.

As noted above, if the CB does not care about inflation ($\beta = 0$), the rise in money supply will be equal to the wage increase so as to redress the employment level as in the case of non-cooperative regime. In such a case unions do not perceive to affect employment, and the cooperative solution coincides with the competitive allocation as in Benigno (2002). Conversely, if the CB cares about inflation ($\beta > 0$), the CB will accommodate to a lesser extent, and the perceived labor demand elasticity by unions will be different from zero (see Table 3). In the extreme case of $\beta \to \infty$, the CB will only care about inflation, and the

13

Table 3: Aggregate labor demand elasticities to wages under a cooperative regime

$$l = \underbrace{-\frac{\beta}{2(k+\beta)}}_{\varepsilon_H^C} w + \underbrace{\frac{\beta}{2(k+\beta)}}_{\varepsilon_F^C} w^* \qquad l^* = \underbrace{\frac{\beta}{2(k+\beta)}}_{\varepsilon_{H^*}^C} w - \underbrace{\frac{\beta}{2(k+\beta)}}_{\varepsilon_{F^*}^C} w^* \qquad (46)$$

$$p = \underbrace{\frac{k}{2(k+\beta)}}_{s_H^C} w - \underbrace{\frac{k}{2(k+\beta)}}_{s_F^C} w^* \qquad p^* = \underbrace{-\frac{k}{2(k+\beta)}}_{s_{H^*}^C} w + \underbrace{\frac{k}{2(k+\beta)}}_{s_{F^*}^C} w^* \qquad (47)$$

optimal monetary policy would be such that $p = p^*$, i.e. $m = m^*$. Note that in the two extreme cases of CB conservatism, both the cooperative and non-cooperative monetary policies perceived by unions coincide.

5 Wage setting and gains from monetary policy cooperation

I now turn to the issue of wage determination. In each country workers are organized in a monopolistic labor union.[6] In setting the growth of the nominal wage, each union anticipates that it will affect aggregate employment under either regime according to expressions derived in Tables 2 and 3.

I assume that each union acts benevolently, i.e. it maximizes the utility of its members disregarding real balances. Thus, the Home union aims at solving the following problem in either regime:[7]

$$\max_w V = \int_0^1 \left[U(j) - \log\left(\frac{M(j)}{P}\right) \right] dj \qquad \text{s.to } (32), (38) \text{ or } (46),$$
$$\text{and } \partial w^*/\partial w = 0. \qquad (48)$$

Employment in the two monetary regimes is derived from the first-order condition (see Appendix B):

$$l^r = \tilde{l}\left(1 - \frac{1}{\eta^r}\right), \qquad r \in (NC, C) \qquad (49)$$

where $\eta^r \equiv -\varepsilon_H^r/(1 - s_H^r)$ is the real consumer wage elasticity (in absolute value) of the perceived

---

[6]One could think of a single union as a small number of unions coordinating their wage policies effectively enough to act as a single union. But the main results of the paper are not being invalidated by considering intermediate degrees of centralization as for example in Lippi (2003). I do not pursue this issue here.

[7]The benevolent union hypothesis is in line with the trade union behavior surveyed by Oswald (1985), whose objective function usually includes real wages and unemployment.

demand for labor in regime r. It is apparent that equilibrium employment is below the efficient level $\tilde{l}$ in either regime as long as η is finite. In particular, the higher real wage elasticity, the higher the marginal benefit of wage restraint, thereby boosting equilibrium employment.

In other words, η is a measure of the monopolistic distortions in the labor market, whereby a lower labor demand elasticity implies that nominal wage hikes have smaller consequences in terms of employment inducing higher wage demands. Conversely, a larger value of η implies more severe repercussions in real terms form wage claims, thereby curbing monopolistic power in the labor market. Moreover, eqs. (36) and (43) point out how inflation is related to labor market performance.

Now, in order to assess the effect of the monetary regime on welfare, it is sufficient to compare the two real wage elasticities to labor demands:

$$\eta^{NC} = \frac{\beta}{2(k+\beta)} \qquad ; \qquad \eta^C = \frac{\beta}{k+2\beta}. \qquad (50)$$

It turns out that not only do CBs act differently across monetary regimes, but also wage setters do. The perception of a more restrictive monetary policy under a cooperative regime leads unions to moderate their wage demands. They in fact anticipate that a harsher monetary response curbs the possibility of achieving higher consumption, i.e. higher marginal benefits, thereby inducing wage restraint. Moreover, the higher the degree of conservatism, β, the higher is the real wage elasticity.

Result 3 *The move from a non-cooperative to a cooperative monetary regime is welfare improving as long as $0 < \beta < \infty$.*

For a given level of CB conservatism β, eqs. (49) and (50) reveal that employment is higher in a cooperative regime. This suggests that monetary cooperation may have some benefits in a benchmark model via its impact on labor market distortions. Since $\eta^C > \eta^{NC}$, the equilibrium level of employment is higher under a cooperative regime. In order to find the equilibrium level of consumption, I substitute the firms' first order conditions (15) into eq. (32) as follows:

$$c = 1/2(m - w + m^* - w^*) = 1/2(l + l^*) = c^*,$$

where the second equality stems from using eq. (27). Since the equilibrium level of employment is equal across countries, welfare can be rewritten in equilibrium as:

$$u = l - \frac{k}{2}l^2 = u^*,$$

which is clearing increasing in l as long as employment is below its efficient level $\tilde{l}$.

As noted in the previous section, with a floating exchange rate, cooperative monetary authorities are perceived by unions to resort to less expansion because of the impact of money supply on inflation abroad. Therefore, introducing a conservative CB into a NOEM model modifies the optimal monetary policies under the two regimes.

The real effect of conservatism on real wage elasticity is in line with the literature on the strategic interaction between international monetary policies and large unions (Soskice and Iversen, 1998, 2000, Bratsiotis and Martin, 1999). This literature highlights that policies that ensure low inflation also create lower rates of equilibrium unemployment.

The paper result is interesting when viewed alongside the results of Jensen (1993, 1997) and other works on cooperation and CB conservatism. The traditional approach to international monetary policy coordination in presence of large unions is built in Jensen (1993, 1997). The main conclusion of his analysis is that, if wage setters do not care about inflation, policymakers cooperation is counterproductive. In order to obtain positive effects on economic performance from monetary cooperation, wage setters should also be inflation averse (Jensen, 1997).

According to Result 3, an international monetary policy cooperation is instead beneficial in presence of a conservative CB and non-atomistic wage setting without resorting to inflation aversion *per se*. Here, in a micro-founded setting, the introduction of nominal rigidities cause unions to anticipate a more restrictive monetary policy under a cooperative regime. A cooperative monetary authority, in fact, incurs an additional cost from wage claims, and this discourages wage demands to a larger extent.

Therefore, in contrast to Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005), and Devereux and Engel (2003), I conclude that welfare gains from coordination can be generated in the standard benchmark model by introducing a standard policy game between non-atomistic wage setters and conservative monetary authorities.

6   Conclusion

I have developed a tractable two-countries model suitable for international monetary policy coordination analysis. As an extension, I have introduced non-atomistic wage setting and conservatism in monetary policy in an otherwise standard NOEM model with nominal rigidities. The main goal has been to assess the prediction of the traditional international policy coordination literature.

The paper has shown in a micro-founded framework that, in contrast to the traditional approach to international monetary policy coordination and non-atomistic wage setting, coordinated policies are welfare improving. The explanation hinges on the interaction between monopolistic unions and monetary policies under a non-cooperative and cooperative monetary regime. A cooperative monetary authority is perceived by wage setters as implementing a tighter response toward domestic wage hikes. Such an effect discourages wage claims and increases employment in the economy.

A   Derivation of the reduced form

In a symmetric equilibrium with flexible prices, indexed by the subscript 0, all prices in a given currency are identical

$$P_0 = \frac{\theta}{\theta - 1} W_0,$$

purchasing power parity holds

$$P_0 = E_0 P_0^*,$$

the aggregate outputs, labor worked, and consumption are equalized in both countries

$$Y_0 = Y_0^* = L_0 = L_0^* = C_0,$$

and profits are

$$\frac{D_0}{P_0 C_0} = \frac{D_0^*}{P_0^* C_0^*} = \frac{1}{\theta}.$$

From the above results, after taking into account the government's budget constraint, eq. (6) may be log-linearized around a flexible equilibrium as follows:

$$\hat{p} + \hat{c} = \frac{\theta - 1}{\theta}(\hat{w} + \hat{l}) + \frac{\hat{d}}{\theta} \quad ; \quad \hat{p}^* + \hat{c}^* = \frac{\theta - 1}{\theta}(\hat{w}^* + \hat{l}^*) + \frac{\hat{d}^*}{\theta}, \tag{A.1}$$

where a hat "ˆ" stands for log-difference from the flexible equilibrium, i.e. $\hat{x} = x - x_0$.

The monetary authority takes prices and wages as given. However, following Lippi (2003), I assume that the CBs do not take profits d as given. Therefore, from eq. (13), the Home and Foreign CBs anticipate that

$$d = m \quad ; \quad d^* = m^*. \tag{A.2}$$

The reduced form of the model in Table 1 is obtained combining eqs. (3), (22), (12), (15), (A.1), (23), and (A.2), and disregarding constant terms.

B Derivation of the union's first-order condition

From eqs. (A.1) and (27), consumption may be rewritten as

$$c = w + l - p. \tag{B.1}$$

The first-order condition of the problem (48) is obtained substituting (B.1) into the utility function and using the elasticities given in Tables 2 and 3 as follows:

$$1 + \varepsilon_H^r - s_H^r - k\varepsilon_H^r l = 0 \qquad r \in [NC, C]. \tag{B.2}$$

Eq. (49) in the text is obtained by dividing the above expression by $1 - s_H^r$ and using the real wage definition $\eta^r \equiv -d \log L^r / d \log(W/P^r)$.

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