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The Effects of Macroeconomic Institutions on Economic Performance in a General Equilibrium Model

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Abstract

This paper analyzes the relation 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 focuses on how macroeconomic institutions may affect output, inflation and taxation when monetary and fiscal policies strategically interact in presence of monopolistic distortions in labor markets. It is shown that, with pre-determined wage setting, fiscal and monetary policy are subject to a time inconsistency problem, and the equilibrium rate of inflation is above the Friedman rule while 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 government size, and negatively related to conservatism. Finally, a regime with commitment is always welfare improving over 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) relation between inflation and government size in the same period.[1] Grilli *et al.*, 1991 and Campillo and Miron, 1997, for instance, find also 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 theoretic model with three players: the central bank (CB), the fiscal authority (FA) and wage setters.

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[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.
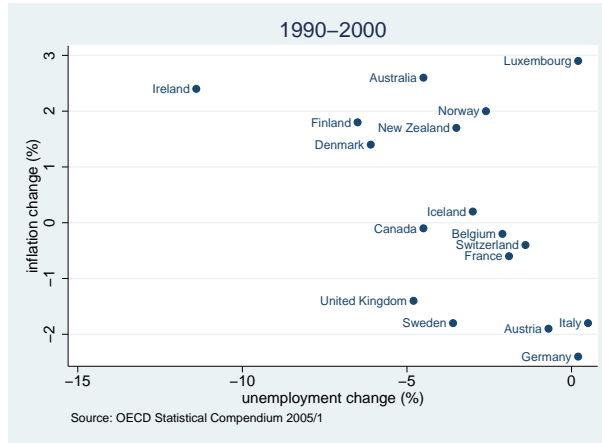
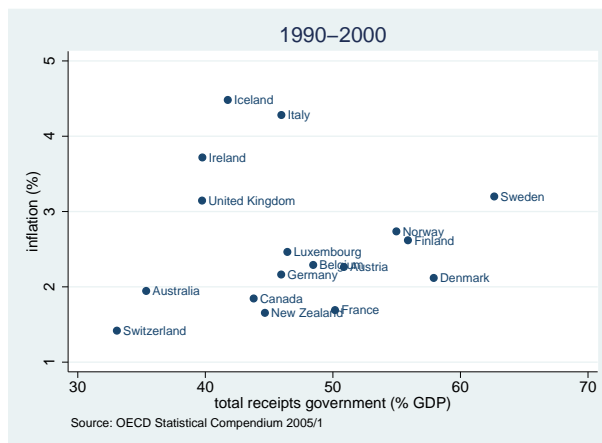Figure 1: Change in inflation and unemployment 1990-2000.

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 suboptimal 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 appointing 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 these works, the connection between macroeconomic institutions, such as government size, and the problem of time consistency of monetary policy has not been modeled explicitly in a fully microfounded 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 microfounded inclusion of inflation as a cost in the policymaker's objective function. Public expenditure enters in the utility function and is financed by means of a distortive tax while labor markets are characterized by monopolistic imperfections and nominal rigidities.[3] In particular, there are three areas in which our model provides insights into the relation between inflation, output and macroeconomic institutions.

Firstly, 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's incentive to inflate. A reduction of unemployment rate has two opposite effects on the equilibrium rate of inflation. On the one hand, it causes an increase of marginal costs of inflating because of lower leisure. However, as unemployment decreases and, as a consequence, output increases, the demand for real money increases as well. This implies that, for a given rate of inflation and tax, the marginal cost of inflating falls, because it is decreasing and convex in real balances. These counterbalancing effects lead to a nonmonotonic relationship between the discretionary level of inflation and the rate of unemployment.

Secondly, the model shows that the discretionary level of inflation is positively related to the weight attached to public expenditure in the utility, i.e. the size of government spending in the economy. In fact, an increase in government size enlarges the gap between efficient and natural output and raises real money demand. Both effects encourage the CB to overinflate. An increase in the degree of CB conservatism, instead, is 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 receive 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 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. Note that 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 the government does not have any incentive to set a lower tax in order to reduce the gap between the efficient and natural output.

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; the effects of the parameters of the economy 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 staggered timing for the acquisition of nominal money within a money-in-the-utility-function framework. 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 and a constant elasticity of substitution among labor types 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 via the index

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

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 family with a continuum of $j \in [0,1]$ members which supply 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

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

and labor demand (3), 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. We assume that $B_0 = 0$; since all households are equal

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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)

in equilibrium, there will be 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 equation (9) is the standard consumption Euler equation linking present and future consumption. The second equation (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 in terms of forgone real balances. We postpone the remaining optimality conditions until we consider the union's problem.

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 utility of the household (7). We assume that government's 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 event of a benevolent monetary authority occurs when $\chi_B = \chi$. Following Svensson (1999)'s terminology, the extreme case of $\chi_B \to \infty$ is a strict inflation targeting, whereas the case of a finite χ_B is called flexible inflation targeting. A conservative CB ($\chi_B > \chi$) will attach a higher weight to real balance compared to a benevolent one.

We 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, we posit that the CB maximizes (12) setting directly the current inflation rate, denoted by $\pi = (P_t - P_{t-1})/P_{t-1}$, and bearing in mind that M_t and P_{t-1} are given at time t.[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

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]

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

In this section we derive the optimal level of output, consumption and government spending and show how it can be supported in equilibrium when wage are fully flexible. This will prove a useful benchmark for judging the role of different macroeconomic institutions, to which we turn later.

3.1 Fully Flexible Wages

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

Plugging the government's budget constraint (11) into the good-market clearing condition (24), we can write the following relation between consumption and disposable income at time t

$$C_t = (1 - \tau_t)Y_t.$$ (15)

Substituting this expression into the unions' first order condition (14) yields

$$W_t = P_t(1 - \tau_t)\frac{\mathcal{M}}{1-\rho}Y_t^{1+\alpha\phi},$$ (16)

which together with equation (6) and (1) produces the following natural level of output

$$\hat{Y} = \left(\frac{1-\rho}{\alpha\mathcal{M}}\right)^{\frac{1}{\alpha(1+\phi)}}.$$ (17)

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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.

[7]As is common in this literature on wage setting (e.g. Lippi, 2003), unions take dividends as given. See equation (49) for a derivation of such a result.

It is apparent that fiscal and monetary policy do not affect output in the case of flexible wages; output remains at its market-clearing level (17), regardless of inflation and tax choice. In such a case maximization of (7) with respect to τ subject to (15) yields the following first-order conditions for the FA

$$\frac{1-\rho}{C_t} = \frac{\rho}{G_t}, \tag{18}$$

while from maximization of (12) with respect to π, the CB first-order condition is

$$\chi_B \left(\frac{M_t}{P_t}\right)^{-\nu} = 0. \tag{19}$$

Now, dividing (15) by (11) and using the optimal condition (18), we obtain that the natural level of private and public consumption are respectively

$$\hat{C} = (1-\rho)\hat{Y}, \tag{20}$$

$$\hat{G} = \rho\hat{Y}, \tag{21}$$

where clearly the FA sets $\tau = \rho$. In other words, the FA would like to equate the marginal utility of consumption to the marginal utility of government spending. Condition (19) requires to equate the (CB) 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

$$\frac{M_t}{P_t} = \left(\frac{P_t}{P_{t-1}}\right)^{-\frac{1}{\nu}} \left(\frac{\beta(1+i_t)\chi C_{t-1}}{i_t(1-\rho)}\right)^{\frac{1}{\nu}} \tag{22}$$

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 requires that

$$i_t = 0 \tag{23}$$

for all t, i.e. the optimal monetary prescription is the Friedman rule. The implication of (23) for the equilibrium rate of inflation is $\pi = \beta - 1 < 0$.[8]

3.2 The Social Planner's Problem

The social planner maximizes the family utility (7) with respect to C_t, G_t and M_t/P_t subject to the technological constraint (1) and the good market clearing condition

$$Y_t = C_t + G_t. \tag{24}$$

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

The optimal allocation coincides with a sequence of static problems so that in any given period 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 of utility of the household of producing an additional unit of good (given by $\alpha Y_t^{\alpha(1+\phi)-1}$) 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 be equal to the social marginal cost of producing real money balances, i.e. zero.

Using the good market clearing condition (24) and the first order conditions (25), we 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 (17) is below the optimal output level (26).*

The departure from the efficient output level is due to two sources of inefficiency. First, the monopolistic power in the labor market implies that there be a wedge, $\mathcal{M} > 1$, between real wages and the marginal rate of substitution. This effect may be eliminated by assuming an extreme labor market regime as perfect competition ($\sigma \to \infty$, $\mathcal{M} = 1$). By contrast, production subsidies, often seen as a remedy to labor market distortions (e.g Alesina and Tabellini, 1987; Dixit and Lambertini, 2003), can not affect such distortions: wages are always set so that (16) holds. Therefore the expectation of a subsidy would trigger a real wage increase that exactly neutralizes the impact on natural output.

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 equation (17)). A remedy to this situation would be a highly centralized/coordinated bargaining systems, where wage negotiations involve also the FA. In this case unions would take into account the macroeconomic constraints such as the government's budget and internalize the consequences of wage claims on government expenditure (e.g. Summers *et al.*, 1993). However, for the remainder of the paper, we keep assuming atomistic wage setting.

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

Our model features two types of wage setting: fully flexible and and pre-determined wages. The former was analyzed in section 3.1, where we noticed that both fiscal and monetary policy could not affect output given by equation (17). Inflation and tax rate were, hence, set according to the Friedman rule and the optimal tax rate ρ, respectively.

Here we assume that nominal wages are set 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, assume that policy makers may or may not act in a coordinated way as in Alesina and Tabellini (1987). In this respect, two possible alternative institutional regimes will be tackled: a discretionary regime and a regime with binding commitments.

4.1 Discretionary Regime

In this regime we 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]

$$\bar{W}_t = P_t^e \frac{1}{\alpha}(1 - \tau_t^e)\hat{Y}^{1-\alpha}, \tag{30}$$

where $\hat{Y}$, P_t^e and τ_t^e denote respectively the natural level of output (17) and the expected price and tax rate. It is convenient to rewrite the above expression in the following way:

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

where $\pi_t^e \equiv (P_t^e - P_{t-1})/P_{t-1}$. Thus, from equations (6), (24) and (15), employment, consumption and government spending are respectively given by

$$N_t = \left[\frac{(1 + \pi_t)(1 - \tau_t)}{(1 + \pi_t^e)(1 - \tau_t^e)}\right]^{\frac{\alpha}{\alpha-1}}\hat{Y}^{\alpha}, \tag{32}$$

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

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

The game is static and is repeated only a finite number of times. Therefore, the only subgame perfect (and hence time-consistent) Nash equilibrium of the repeated game coincides with the

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

[10]This expression is achieved by combining equations (17) and (16).

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., $\hat{Y}(1-\tau)$). Thus,

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

Note that both a surprise inflation and a tax cut cause the nominal as well as the real interest rate to rise. Then, the solution to consumption, output, and nominal interest rate yields equilibrium real balances, which are given by

$$\frac{M_t}{P_t} = \left(\frac{\beta \left[\frac{(1+\pi_t)(1-\tau_t)}{(1+\pi_t^e)(1-\tau_t^e)} \right]^{\frac{1}{\alpha-1}} \chi (1-\tau_t)\hat{Y}}{\left((1+\pi_t) \left[\frac{(1+\pi_t)(1-\tau_t)}{(1+\pi_t^e)(1-\tau_t^e)} \right]^{\frac{1}{\alpha-1}} - \beta \right)(1-\rho)} \right)^{\frac{1}{\nu}} \tag{36}$$

Now, the one-shot Nash equilibrium can be computed as follows. The FA maximizes the household's utility function (7) setting the tax rate at time t, τ_t, subject to the constraint (33), (34), (32). In doing that the rate of inflation and unions' expectations are taken as given. It is convenient to rewrite the FA's first order condition as follows:[11]

$$\underbrace{(1-\rho)\Sigma_{C\tau}}_{marginal\ cost} + \underbrace{\rho\Sigma_{G\tau} - N_t^{1+\phi}\Sigma_{N\tau}}_{marginal\ benefit} = 0, \tag{37}$$

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

$$\Sigma_{C\tau} = \Sigma_{N\tau} \equiv -\frac{\alpha\tau}{(\alpha-1)(1-\tau)} < 0, \quad \Sigma_{G\tau} \equiv \frac{1}{1-\tau} + \Sigma_{N\tau} \equiv \frac{1+\alpha(\tau-1)}{(\alpha-1)(\tau-1)} > 0. \tag{38}$$

A higher tax rate has three effects on household's welfare. First, from equation (32), it is clear that an unexpected tax rise triggers employment to decrease, thereby reducing the cost of providing labor. Second, it lets the FA collect more tax revenue and thus boosting public consumption.[12] Finally, an increase in taxation leads to a reduction in private consumption and, hence, in utility. This implies 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 starts from 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, which in part discourages tax cuts. To see that, we may solve the first order condition (37) for τ, so

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[11]If the government could not affect output, as in the case of flexible wages, the first order condition would imply 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 equation (39) the range of tax rate is $\tau \in \left(\frac{(\alpha-1)\rho}{\alpha}, \frac{\alpha-1}{\alpha} \right)$.

that in a rational expectation equilibrium ($\tau^e = \tau$ and $\pi^e = \pi$) the following expression holds[13]

$$\tau^d = \frac{\rho}{1 + \frac{\alpha}{\alpha-1}\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}. \tag{39}$$

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).

Turning to the CB's maximization problem, we plug equation (31) into the real money balances so that

$$\left(\frac{M_t}{P_t}\right)^{1-\nu} = \left(\frac{M_t(1-\tau_t^e)\hat{Y}^{1-\alpha}}{\alpha\bar{W}_t}\right)^{1-\nu}\left(\frac{1+\pi_t^e}{1+\pi_t}\right)^{1-\nu}. \tag{40}$$

The CB maximizes the utility (12) selecting the inflation rate at time t, π_t, under the constraints (33), (34), (32) and (40). Fiscal stance as well as unions' expectations are taken as given. The solution of the CB's problem yields, in a rational expectation equilibrium (i.e. when $\tau^e = \tau$ and $\pi^e = \pi$), the following reaction function

$$\frac{M_t}{P_t} = \left[\frac{\alpha\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}{(\alpha-1)\chi_B}\right]^{\frac{1}{1-\nu}}. \tag{41}$$

The CB's first-order condition (41) implies that it is optimal for the CB deviates from the Friedman rule (19). 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]

$$\underbrace{(1-\rho)\Sigma_{C\pi} + \rho\Sigma_{G\pi}}_{marginal\ benefit} + \underbrace{\chi_B(m_t)^{1-\nu}\Sigma_{m\pi} - N_t^{1+\phi}\Sigma_{N\pi}}_{marginal\ cost} = 0, \tag{42}$$

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:

$$\Sigma_{C\pi} = \Sigma_{G\pi} \equiv \frac{\pi}{(1+\pi)(\alpha-1)} > 0, \quad \Sigma_{N\pi} \equiv \frac{\pi\alpha}{(1+\pi)(\alpha-1)} > 0, \quad \Sigma_{m\pi} \equiv -\frac{\pi}{1+\pi} < 0. \tag{43}$$

In order to compute the equilibrium rate of inflation and public consumption, we use the first-order conditions of the two policymakers, together with the real money demand (22) and government's budget constraint (11):

$$\pi^d = \underbrace{\beta - 1}_{Friedam\ rule} + \underbrace{\left[\frac{\alpha\left[\tilde{Y}^{\alpha(1+\phi)} - \hat{Y}^{\alpha(1+\phi)}\right]}{(\alpha-1)\chi_B}\right]^{-\frac{\nu}{1-\nu}} \hat{Y}(1-\tau^d)\frac{\beta\chi}{1-\rho}}_{bias} \tag{44}$$

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[13] Where the superscript d stands for discretion.

[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 $\pi_t = \beta - 1$.

$$G^d = \tau^d \hat{Y}. \tag{45}$$

In equilibrium output and government spending are below their efficient levels ($\tilde{Y}$ and $\rho\tilde{Y}$) while inflation is above the Friedman's rule ($\beta - 1$). The discretionary inflation rate is actually formed by two components. The first one is Friedman's rule and the second is the inflation bias. It is apparent from (44) that when output is at its efficient level , the Friedman's rule holds, i.e. inflation rate is set so as to equate the negative of the real interest rate. The presence of monopolistic power in the labor market and externality lead output to be below the efficient level (see section 3.1). For a given tax rate, this creates 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 our model, if public expenditure does not enter in the utility function of households (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 equation (14)). An increase in taxation has a twofold impact on labor. First, it leads a reduction in consumption and, hence, in real wages, whereby the demand of labor increases. Second, it directly reduces the demand of 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's budget is trivially eliminated, but there is still a mark-up over the real competitive wage.[15] Therefore, since output is below the efficient level, the CB has an incentive to deviate from the Friedman's rule.

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

The intuition behind this proposition comes from the effect of χ_B on the CB incentive to create unexpected inflation. Since a more conservative CB (a larger χ_B) undergoes higher costs by lowering real balances, this thwart a reduction of real money balances to a larger extent. In fact, the marginal cost of inflation, through its effect on real balances, is decreasing and convex in real balances. In consequence of that inflation will be lower in equilibrium the higher is 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 government size, the negative impact on output is due to the fact that wage setters do not take the brunt of their wage choice on public consumption. Wages hence reflect such an inefficiency and are positively related to the government size parameter ρ (see equation (16)).

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[15]See section 3.1 for further details.

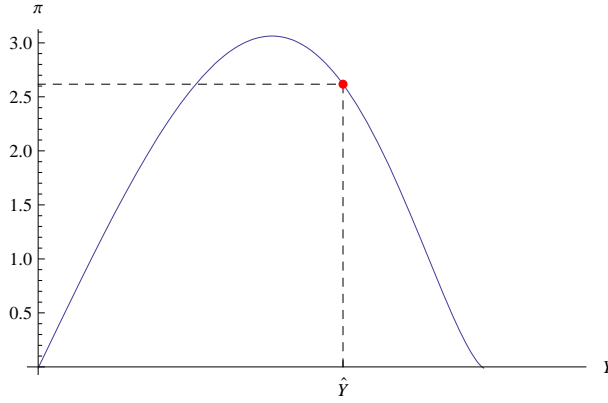[16]The same conclusion is derived in Rogoff (1985).

Figure 3: Discretionary inflation and natural output

The positive relationship between government size and inflation is due to two effects. First, if agents attributes a higher weight to public expenditure, this enlarges the gap between efficient and natural output. This stimulates the CB to inflate because of lower leisure cost. Second, the overall impact of an increase in ρ on money demand is positive. This is due to the fact that a higher ρ reduces the marginal utility of consumption, i.e. it has the same impact of increase in consumption. Hence, the CB undergoes a reduction in the marginal cost of inflation through the increase in real money balances.

From equation (44) we may derive an hump-shaped relationship between inflation rate and natural level of output as shown in Figure 3.[17] An increase in the size of $\hat{Y}$ has two opposite effects on the equilibrium rate of inflation. First, it causes an increase of marginal costs of inflating because of the leisure effect. When $\hat{Y}$ is relatively high, the marginal cost of inflating are high: equation (41) points out that the monetary authority's incentive to systematically overinflate is low because of the "small" discrepancy between efficient and natural output. Such effect dominates when $\hat{Y}$ is relatively high. 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 as well. Hence, the marginal cost of inflating falls, since it is decreasing and convex in real balances. Such an effect dominates for relatively low level of output.

When the level of output $\hat{Y}$ is relatively 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

In this regime we 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 with

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[17]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.

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respect to the workers. Drawing on Alesina and Tabellini (1987), we 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 (33), (34) and (32), 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 rule when it can not affect output:[18]

$$\pi^c = \beta - 1. \tag{46}$$

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:

$$\tau^c = \rho \tag{47}$$

$$G^c = \rho \hat{Y}. \tag{48}$$

Comparing the equilibrium inflation and government spending under a discretionary regime (equations (44), (39) and (45)) and under binding commitment regime (equations (46), (47) and (48)), we may establish the following proposition.

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

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

Blanchard and Wolfers (2000) note that changes in unemployment over time and between countries can only be explained by an interplay of shocks and differences in labor institutions. This paper makes a first step towards integration of disparate pieces of analysis on wage setters, monetary and fiscal policy.

In a microfounded general equilibrium model we have analyzed how macroeconomic institutions may affect output, inflation and taxation when monetary and fiscal policies strategically interact in 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.

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[18]The superscript c stands for commitment equilibrium.

The main 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 nonmonotonically related to the natural output, positively related to government size, and negatively related to conservatism.

An other 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 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 an other 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

$$
\mathcal{L}^{\mathcal{W}} = (1-\rho)\log C_t + \rho \log G_t - \frac{1}{1+\phi}\left[\int_0^1 \left[\left(\frac{W_t(j)}{W_t}\right)^{-\sigma} N_t\right]^{\frac{\sigma-1}{\sigma}} dj\right]^{\frac{\sigma(1+\phi)}{\sigma-1}} + \frac{\chi}{1-\nu}\left(\frac{M_t}{P_t}\right)^{1-\nu} +
$$

$$
+\lambda_t \left(-B_{t+1} - M_{t+1} - P_t C_t + D_t + \int_0^1 W_t(j)\left(\frac{W_t(j)}{W_t}\right)^{-\sigma} N_t dj + P_t T_t + B_t(1+i_t) + M_t\right),
$$

(49)

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

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

$$
-N_t^{1+\phi}\frac{\partial N_t(j)}{\partial W_t(j)}\frac{W_t(j)}{N_t(j)}W_t(j)^{-1} + \frac{(1-\rho)N_t(j)}{P_t C_t}\left(1 + \frac{\partial N_t(j)}{\partial W_t(j)}\frac{W_t(j)}{N_t(j)}\right) = 0
$$

$$
\sigma N_t^\phi + \frac{(1-\rho)W_t}{P_t C_t}(1-\sigma) = 0,
$$

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

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