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

Vincenzo Cuciniello*

Ecole Polytechnique Fédérale de Lausanne
University of Siena

November 2008

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.

---

*Address: EPFL, ODY 2 17 (Odyssea), Station 5, CH-1015 Lausanne (Switzerland), telephone: +41 21 693 00 68, e-mail: *vincenzo.cuciniello@epfl.ch*. I am particularly grateful to Luisa Lambertini and Alberto Dalmazzo for detailed comments on an earlier version of this paper. I also benefited from the comments of workshop participants on “Central banks, fiscal policies and unionized labor markets: the role of different institutions” at the University of Rome “La Sapienza” (February 2008). Financial support by the Chair of International Finance (CFI) is gratefully acknowledged. The first version of this paper was written while I was a postdoctoral fellow at the CFI at EPFL. I thank the CFI for the stimulating research environment. I alone am responsible for any error.

[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.

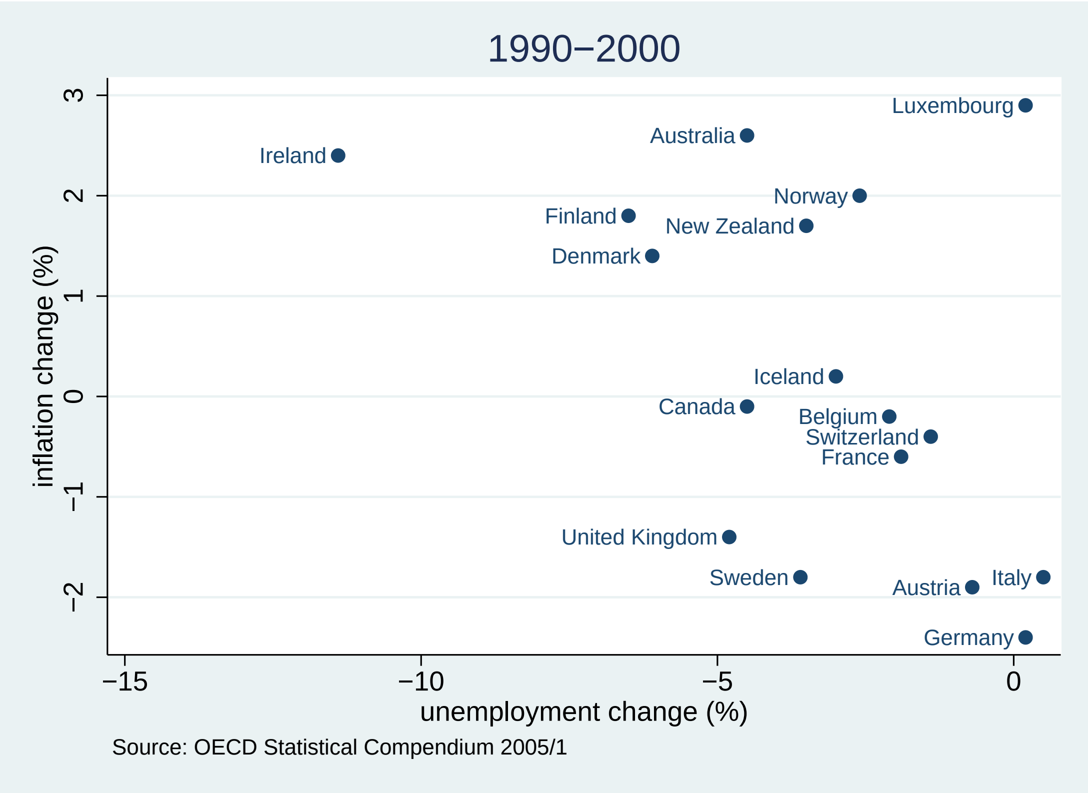

Figure 1: Change in inflation and unemployment 1990-2000.

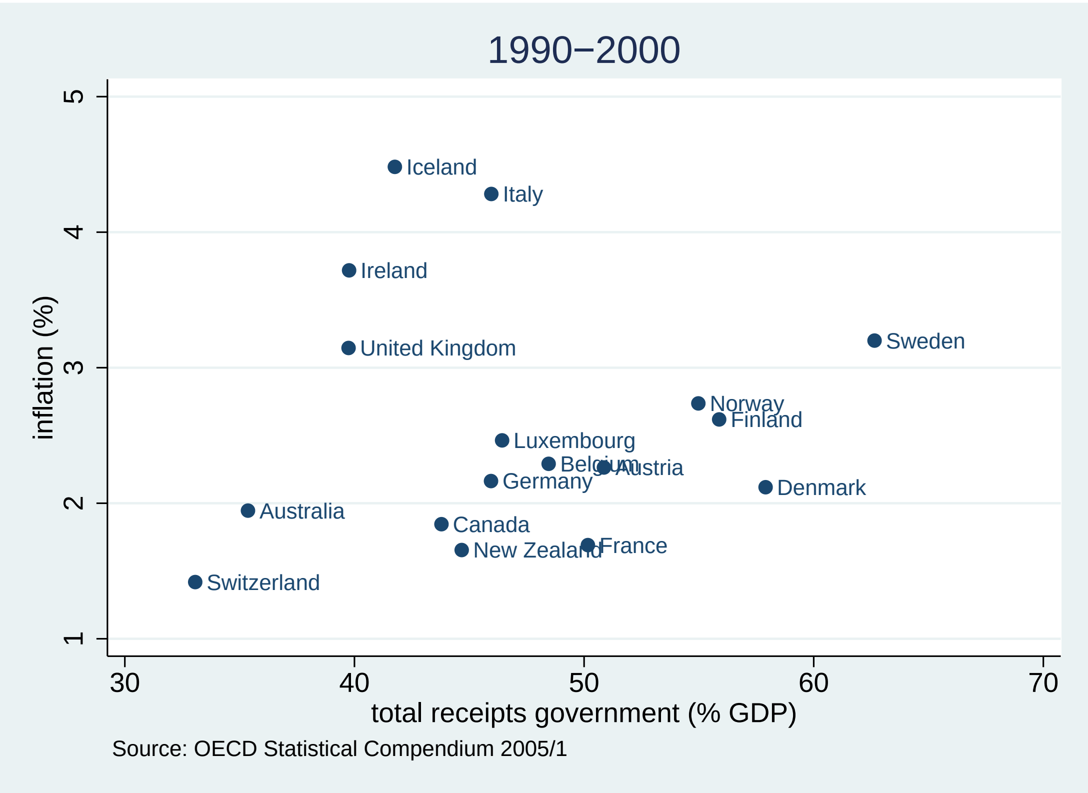

Figure 2: Inflation and total receipts government 1990-2000.

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.

[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 predetermined 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.

[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

[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]

[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

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

[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

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

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

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

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.

[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.

[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

[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.

[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).

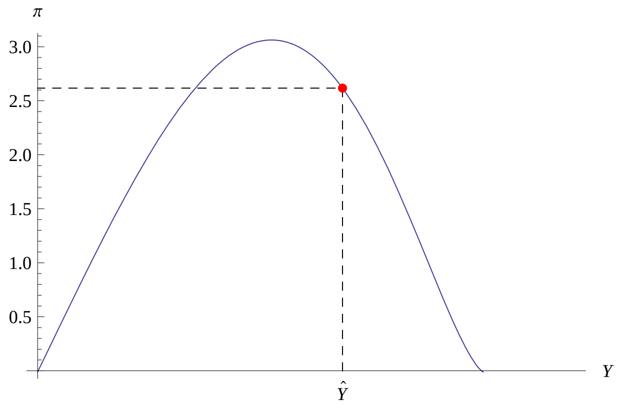

Figure 3: Discretionary inflation and natural output

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

[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 $\quad \pi^c < \pi^d; \qquad \tau^c > \tau^d; \qquad G^c > G^d.$

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

[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

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

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.

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

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

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

■

References

Alesina, A. (1989), Politics and business cycles in industrial democracies, *Economic Policy*, 8, pp. 55-98.

Alesina, A. and G. Tabellini (1987), Rules and Discretion with Noncoordinated Monetary and Fiscal Policies, *Economic Inquiry*, pp. 619-630.

Barro, R. and D. Gordon (1983), A Positive Theory of Monetary Policy in a Natural Rate Model, *Journal of Political Economy*, 91, pp. 589-610.

Blanchard, Olivier and Francesco Giavazzi (2003), Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets, *The Quarterly Journal of Economics*, 118(3), pp. 879-907.

Campillo, M. and J.A. Miron (1997), Why does inflation differ across countries? in: Romer, C.D., Romer, D.H. (Eds.), *Reducing Inflation: Motivation and Strategy*, Chigago: University of Chicago Press.

Cukierman, A., S. Webb and B. Neyapti (1992), Measuring the independence of central banks and its effect on policy outcomes, *World Bank Economic Review*, 6, pp. 353-398.

Dixit, A. and L. Lambertini (2003), Interactions of Commitment and Discretion in Monetary and Fiscal Policies, *American Economic Review*, 93(5), pp. 1522-1542, December.

Grilli, V., D. Masciandaro and G. Tabellini (1991), Political and monetary institutions and public financial policies in the industrial countries, *Economic Policy*, 13, pp. 341-392.

Kidland, F. and E. Prescott (1977), Rules Rather Than Discretion: The Inconsistency of Optimal Plans, *Journal of Political Economy*, 85, pp. 473-491.

Mélitz, Jacques (1997), Some Cross-Country Evidence about Debt, Deficits, and the Behaviour of Monetary and Fiscal Authorities, *CEPR Discussion Paper*, 1653.

Neiss, Katharine S. (1999), Discretionary Inflation in a General Equilibrium Model, *Journal of Money, Credit and Banking*, 31(3), pp. 357-374.

Nickell, Stephen, Luca Nunziata and Wolfgang Ochel (2005), Unemployment in the OECD since the 1960s. What Do We Know?, *The Economic Journal*, 115(January), pp. 1-27.

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

Summers, Lawrence, Jonathan Gruber and Rodrigo Vergara (1993), Taxation and the Structure of Labor Markets: The Case of Corporatism, *The Quarterly Journal of Economics*, 108(2), pp. 385-411.

Svensson, L.E.O. (1999), Inflation Targeting as a Monetary Policy Rule, *Journal of Monetary Economics*, 43, pp. 607-654.