Optimal Monetary Policy: Does the Government Agree?*

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Abstract

This paper studies a non-cooperative policy game between monetary and fiscal policy in a closed one-sector production economy with nominal rigidities. Lack of commitment on the fiscal side induces disagreement between the central bank and the government about the optimal stabilization plan. Such a disagreement is responsible for inefficient public spending fluctuations and undermines the stabilization objectives pursued by the monetary authority.

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1 Introduction

Optimal monetary and fiscal policy over the business cycle are commonly investigated under the assumption that a single authority chooses all policy instruments so as to maximize welfare. As a representative sample, see Galí and Monacelli (2008), Beetsma and Jensen (2005), Schmitt-Grohé and Uribe (2004), Schmitt-Grohé and Uribe (2007), Leith and Von Thadden (2008), Leith and Wren-Lewis (2006). Also, since Rotemberg and Woodford (1997), Clarida, Galí and Gertler (1999) and Galí (2003), the literature has emphasized the stabilization gains from monetary commitment, even in the absence of an inflation bias due to steady state distortions. The result is derived entirely abstracting from fiscal policy.

Here, we reassess optimal monetary and fiscal policy prescriptions, as well as gains from monetary commitment, when the central bank never reneges on early promises while governments cannot commit to future actions. The question is relevant to the extent that the tenure of governments is limited in time and governments' objectives are not as clearly established as for inflation targeting central bankers.

We show that as long as policy makers do not share the same ability to credibly commit to future policy, lack of coordination yields misuse of the policy instruments and imposes a negative externality on the committed authority. This is because policy makers do not agree on the optimal stance required to efficiently stabilize cyclical fluctuations. The resulting inefficiency is exclusively due to disagreement, rather than arising from the lack of commitment on the fiscal side. In fact, discretion per se does not generate any misuse of the fiscal instrument with respect to commitment, as long as the central bank acts in a discretionary fashion too. In this case, inflation and the output gap are more volatile than they should optimally be. Still, the government agrees on the policy implemented by the monetary authority and decides to set public expenditure in such a way to guarantee the efficient provision of public goods. In contrast, optimal monetary policy under fiscal discretion produces inefficiently high volatility of public spending, so that we interpret this outcome as the sole consequence of disagreement.

The reason why the monetary and the fiscal policy maker do not agree on the optimal stabilization plan, though sharing the same objective function, follows from the time inconsistency of optimal plans as first emphasized by Kydland and Prescott (1977). The central bank would like to smoothen the impact of shocks over the cycle and transfer part of their burden to the future. In the event of a bad shock generating a short-run stabilization trade-off, committing to future deflation and recession allows to reduce current inflation at a lower cost in terms of output. This expectation channel improves current stabilization trade-offs. However, governments evaluate the monetary policy tightening as more recessionary than the central bank does. They choose indeed sequentially and overlook the benefits of the current tightening in terms of past outcomes. As a consequence of that, they over-expand public spending to correct the policy stance and to bring it in line with their plan. Therefore, fiscal discretion generates from the viewpoint of the central bank an endogenous cost push shock, making impossible to achieve the optimal stabilization plan under commitment and full coordination.

The result has some interesting implications for optimal monetary policy, as well as for the evaluation of gains from monetary commitment. First, public spending explicitly appears in the optimal monetary targeting rule. In fact, if the central bank internalizes the misbehavior of the government, she chooses to deviate from the rule that would be implemented under commitment and perfect coordination. This is because the central bank is willing to accept higher volatility of inflation and/or output to give governments the incentive to contain the volatility of expenditure. The way the trade-off between output, inflation and government expenditure stabilization is resolved depends on the persistence of the shock. If the shock is purely transitory, it is more worthy to use the expectation channel to smoothen the shock. In addition, fiscal over-reaction is less persistent and then less harmful. Therefore, monetary policy disregards fiscal misbehavior and gives up on fiscal gap stabilization, while focusing on inflation. In contrast, when the shock is persistent, smoothing the shock is less of an issue and fiscal over-expansion is strong and long lasting. It follows that the central bank gives up on inflation and contains the fiscal gap by over-stabilizing output and pleasing the government. The result distinguishes the model outlined here from the standard New-Keynesian (NK henceforth), where public spending is not explicitly targeted and it is relevant to monetary policy only to the extent that it generates inefficient movements of inflation and output. In addition, and as in Dixit and Lambertini (2003a,b), fiscal discretion reduces the gains associated to monetary commitment, relative to discretion. In particular, under our baseline parametrization, the welfare gain is half of the one that would be observed under commitment of all policy makers.

Since the seminal paper by Sargent and Wallace (1981), the literature on policy games between monetary and fiscal policy is still rather scant. Our contribution is closely related to Adam and Billi (2008a,b, 2006), who consider the case of sequential policymaking and mainly focus on the desirability to install a conservative central banker, as suggested by Rogoff (1985) to eliminate the steady state biases associated to discretion. Our paper can be regarded as complementary to theirs, even though the focus is different. In fact, we study the dynamics of optimal monetary policy under fiscal discretion and the way shocks are stabilized under such a regime (which Adam and Billi (2006) call optimal inflation regime). In contrast, they compare the dynamics under sequential policy-making, with and without assuming a conservative central banker, with the standard Ramsey problem under perfect coordination. They also compute the steady state inflation rate in the case of steady state distortions, under the optimal inflation regime. However, they do not characterize the dynamics and hence they do not establish a relation with the stabilization bias issue, as we do here along the lines of Galí (2008) or Woodford (2003).

The model is clearly oversimplified. For instance, the analysis is confined to the case of balanced budget and lump sum taxation; a richer fiscal policy problem may allow to gain additional insights. However, we believe that in this case simplicity is a virtue rather than a flaw: in this simple environment, it is possible to clearly distinguish the inefficiency due to disagreement from the classical and well known sub-optimality associated to discretionary policy.

2 The Private Sector Equilibrium

Consider a closed production economy populated by infinitely many households and firms interacting on goods, labor and asset markets. Goods markets are imperfectly competitive and prices are set in staggered contracts with random duration. Labor markets are monopolistically competitive and the wage mark-up is assumed to fluctuate exogenously around its mean value to create a meaningful policy trade-off between output and inflation stabilization. Financial markets are complete.

Monetary policy is in charge to set the nominal interest rate, while fiscal policy is responsible for choosing government expenditure and taxes. It is assumed for simplicity that static distortions due to imperfect competition are undone by means of subsidies to production, while lump-sum taxes are available and free to adjust so as to balance the government budget constraint at all times.

It is described next the private sector equilibrium conditional on monetary and fiscal policy instruments.

2.1 Households

Each household i consumes a continuum of private and public goods and sells differentiated labor services to firms. Preferences are described by a utility function defined over private consumption, public expenditure and leisure

$$U_0^i = E_0 \sum_{t=0}^{\infty} \beta^t \left((1-\chi) log C_t^i + \chi log G_t - \frac{(N_t^i)^{1+\varphi}}{1+\varphi} \right) \tag{2.1}$$

where C_t^i is is a CES aggregator of the quantity consumed of each variety $j \in [0,1]$ denoted by $C_t^i(j)$

$$C_t^i = \left[\int_0^1 C_t^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{2.2}$$

and $\epsilon_p > 1$ is the elasticity of substitution between varieties. The aggregate price[1] is defined as

$$P_t = \left[\int_0^1 P_t(j)^{1-\epsilon_p} dj \right]^{\frac{1}{1-\epsilon_p}} \tag{2.3}$$

[1]The price index has the property that the minimum cost of a consumption bundle C_t is $P_t C_t$.

Given optimal intra-temporal allocation of expenditure across varieties, the period budget constraint reads as

$$P_t^i C_t^i + E_t \left\{ Q_{t,t+1} D_{t+1}^i \right\} \leq D_t^i + (1+\tau^w) W_t^i N_t^i + T_t^i \tag{2.4}$$

$W_t^i N_t^i$ is nominal labor income, τ_w is a proportional subsidy to labor income and T_t^i are lump-sum taxes. In addition, households hold a portfolio including state contingent assets and shares in domestic firms. D_{t+1}^i denotes the nominal payoff of the portfolio in $t+1$, $Q_{t,t+1}$ is the one-period ahead stochastic discount factor and it is such that $E_t\{Q_{t,t+1}\}R_t = 1$, where R_t is the risk-free nominal interest rate factor.

2.2 Firms

Consider a continuum of firms indexed by j on the unit interval $[0,1]$, each producing a variety with a constant return to scale technology

$$Y_t(j) = A_t N_{t,j} \tag{2.5}$$

and productivity denoted by A_t. Prices are staggered à la Calvo, then in every period firms face a constant probability $1-\theta$ of changing the price. The effective labor input is a CES aggregator of the quantity hired of each differentiated labor service

$$N_{t,j} = \left[\int_0^1 N_{t,j}(i)^{\frac{\epsilon_w - 1}{\epsilon_w}} di \right]^{\frac{\epsilon_w}{\epsilon_w - 1}} \tag{2.6}$$

The parameter $\epsilon_w > 1$ is representing the elasticity of substitution among labor types. Firms do not have power in the labor market, then they take wages as given. The aggregate wage is defined as[2]

$$W_t = \left[\int_0^1 W_t(i)^{1-\epsilon_w} di \right]^{\frac{1}{1-\epsilon_w}} \tag{2.7}$$

2.3 Government Expenditure

Define aggregate government expenditure as

$$G_t = \left[\int_0^1 G_t(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{2.8}$$

where $G_t^i(j)$ is the quantity of public consumption of variety j. Given G_t, optimal intra-temporal allocation across varieties implies the following condition

$$G_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\epsilon_p} G_t \tag{2.9}$$

that pins down public consumption of each variety, given prices and aggregate government expenditure.

[2] As for the price index, the aggregate wage has the property that the minimum cost of a unit of composite labor input N_t is $W_t N_t$.

2.4 Market Clearing

Define aggregate output Y_t as

$$Y_t = \left[\int_0^1 Y_t^i(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{2.10}$$

and total demand of variety j by integrating $C_t^i(j)$ across households

$$C_t(j) = \int_0^1 C_t^i(j) di \tag{2.11}$$

then, the clearing of all goods markets, $Y_t(j) = C_t(j) + G_t(j)$ for all j, implies

$$Y_t = C_t + G_t \tag{2.12}$$

Finally, it can be shown that the aggregate production function is given by

$$Y_t Z_t = A_t N_t \tag{2.13}$$

where Z_t defined as

$$Z_t = \int_0^1 \frac{Y_t(j)}{Y_t} dj \tag{2.14}$$

represents a measure of relative price dispersion[3] and N_t is the aggregate labor input

$$N_t = \left[\int_0^1 N_{t,j}^{\frac{\epsilon_p - 1}{\epsilon_p}} di \right]^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{2.15}$$

2.5 The Pareto Optimum

Pareto efficiency requires the marginal rate of substitution between leisure and private consumption and between leisure and public consumption to equalize the corresponding marginal rate of transformation, this implying

$$A_t = N_t^{\varphi} \frac{C_t}{1 - \chi} = N_t^{\varphi} \frac{G_t}{\chi} \tag{2.16}$$

where household index i has been dropped because of symmetry. The goods market clearing condition and the aggregate production function are used to recover the efficient allocation

$$\overline{N}_t = 1; \quad \overline{Y}_t = A_t; \quad \overline{C}_t = (1 - \chi) A_t; \quad \overline{G}_t = \chi A_t \tag{2.17}$$

[3]It can be proved that $log(Z)$ is a function of the cross sectional variance of relative prices and it is of second order.

2.6 Equilibrium Dynamics

The solution to households and firms problems determines the first order conditions describing the private sector equilibrium as a function of policy. Given that they are standard in the NK literature, they are not reported here and we directly refer to their first order approximation. However, note that though households optimization would require[4]

$$C_t(N_t)^\varphi = (1-\chi)\frac{W_t}{P_t} \tag{2.18}$$

equation (2.18) is augmented to include a random shock μ_t^w

$$exp\{\mu_t^w\}C_t(N_t)^\varphi = (1-\chi)\frac{W_t}{P_t} \tag{2.19}$$

in order to introduce a tension between inflation and output gap stabilization. The assumption could be rationalized by any real or nominal friction in the wage contracting process[5].

As efficiency will constitute the benchmark for welfare analysis, we compute the approximation by log-linearizing around the efficient deterministic steady state[6]. Let output, government expenditure and fiscal gaps be respectively defined as

$$\tilde{y}_t = y_t - \overline{y}_t; \qquad \tilde{g}_t = g_t - \overline{g}_t; \qquad \tilde{f}_t = \tilde{g}_t - \tilde{y}_t; \tag{2.20}$$

$\tilde{f}_t$ can be interpreted as the percentage deviation from efficiency of government expenditure, as a fraction of GDP. One can show that inflation and output gap are fully described by the following equations

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \lambda(1+\varphi)\tilde{y}_t - \lambda\frac{\chi}{1-\chi}\tilde{f}_t + \lambda\mu_t^w \tag{2.21}$$

$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} + \frac{\chi}{1-\chi}\tilde{f}_t - \frac{\chi}{1-\chi}\tilde{f}_{t+1} - (r_t - E_t\{\pi_{t+1}\} - rr_t) \tag{2.22}$$

where rr_t is a function of TFP shocks

$$rr_t = \rho + E_t\{\Delta a_{t+1}\} \tag{2.23}$$

and λ is a convolution of deep parameters

$$\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$$

[4]Equation (2.18) already takes into account that a subsidy is optimally set to offset workers' monopolistic power.

[5]See Clarida et al. (1999), Galí (2003) and Woodford (2003)

[6]The steady state of the solution to the policy problem will coincide with the steady state of the Pareto efficient allocation if the government is allowed to appropriately choose a subsidy to production. This result holds because lump-sum taxes are available

3 The Optimal Policy under Coordination

We first characterize coordination as a benchmark, where the two authorities operate under the same regime, be it commitment or discretion[7]. A second order approximation to the utility function around the efficient steady-state yields the following welfare function

$$W = -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{\epsilon_p}{\lambda} \pi_t^2 + (1+\varphi) \tilde{y}_t^2 + \frac{\chi}{1-\chi} \tilde{f}_t^2 \right) \tag{3.1}$$

which is assumed to be the objective function of both policymakers. The expected loss of utility resulting from departing from the efficient outcome, as a fraction of steady state consumption, is approximately equal to

$$\frac{1}{2} \left(\frac{\epsilon_p}{\lambda} Var\{\pi_t\} + (1+\varphi) Var\{\tilde{y}_t\} + \frac{\chi}{1-\chi} Var\{\tilde{f}_t\} \right) \tag{3.2}$$

The optimal policy under commitment is a state contingent plan $\{\pi_t, \tilde{y}_t, \tilde{f}_t, r_t\}_{t=0}^{\infty}$ maximizing (3.1) subject to (2.21) and (2.22)[8]. The optimal policy mix implies

$$\epsilon_p \pi_t + \Delta \tilde{y}_t = 0 \tag{3.3}$$

$$\tilde{g}_t = 0 \tag{3.4}$$

(3.3) and (3.4) define the second best, i.e. the constrained efficient allocation. (3.4) states that average public spending is always set at its efficient level. This condition is labelled in the rest of the paper as neutral fiscal stance, as fiscal policy does not take care of stabilization issues and only ensures efficient public goods provision.

Under discretion, policy makers re-optimize in every period. The problem does not involve endogenous state variables. As a consequence, future variables are functions of future exogenous states only and a discretionary government that cannot manipulate private beliefs take expectations as given. Therefore, the optimization problem reduces to a sequence of static problems where period losses

$$\frac{\epsilon_p}{\lambda} \pi_t^2 + (1+\varphi) \tilde{y}_t^2 + \frac{\chi}{1-\chi} \tilde{f}_t^2 \tag{3.5}$$

are minimized subject to (2.21) and (2.22). The resulting policy mix requires

$$\epsilon_p \pi_t + \tilde{y}_t = 0 \tag{3.6}$$

while equation (3.4) still holds. By comparing commitment and discretion, a first result emerges.

[7]Under both regimes it is indifferent whether monetary and fiscal policy are chosen by a single authority or by two independent authorities taking as given the policy instrument of the other.

[8]The IS equation, (2.22), can be implemented ex-post, by choosing the interest rate consistently with optimal inflation, output and fiscal gaps

Result 3.1 *If monetary and fiscal policy operate under the same regime, the optimal fiscal policy stance is neutral*[9].

Hence, we can conclude that discretion on the part of the government *per se* does not generate inefficient fluctuations of public spending, at least *as long as* monetary policy is also conducted in a discretionary fashion. We do not claim any generality of the result: the optimal fiscal stance under discretion may not be neutral in another environment. Still, it is crucial for the interpretation of what follows. Note also that, as emphasized above, coordination does not play any role in the result.

4 Optimal Monetary Policy under Fiscal Discretion

We turn now to the case where monetary and fiscal policy are conducted by two independent authorities, sharing the same objectives. However, only the latter is able to credibly commit to future policies, while the fiscal policy maker chooses the fiscal gap sequentially, i.e. she solves the policy problem in each period in order to determine the current instrument only[10].

As in Dixit and Lambertini (2003a), we model strategic interaction as a Stackelberg game. The committed authority, the central bank in our case, is assumed to be the leader, while fiscal policy is the follower. As such, the latter takes the interest rate as given. The model is solved by backward induction: after computing the fiscal rule of the government, the central bank determines her optimal state contingent plan, taking into account the fiscal policy reaction function. It is important to emphasize that in each time period government expenditure and the nominal interest rate are set simultaneously, so that the leadership structure concerns the choice of the policy rule, rather than the choice of the instruments. Also, we restrict the government to play open loop strategies[11], i.e. the whole interest rate path is taken as given. Then, fiscal policy does not internalize that the monetary authority can condition the current play on the past fiscal play. Nevertheless, all players hold rational beliefs at equilibrium. Hence, we use the same equilibrium concept as is Adam and Billi (2008a, 2006).

[9] It can be easily proved that in such a case the Lagrange multiplier attached to the IS equation in the fiscal policy problem is equal to zero. This is because, despite the lack of coordination there is no disagreement between the two authorities so that monetary policy does not impose any binding constraint on fiscal policy.

[10] It is well known that this is equivalent to let the government choose a state contingent plan $\{g_{t+j}\}_{j=0}^{\infty}$ in every period t from $t = 0$ onwards, but ruling out as an equilibrium whatever plan that is not credible.

[11] Many contributions have analyzed dynamic policy games to tackle the issue of international cooperation. For a discussion and the use of open loop strategies, see Benigno (2002), Benigno and Benigno (2006), Canzoneri and Gray (1985), Canzoneri and Henderson (1992), Clarida, Galí and Gertler (2002), Coenen, Lombardo, Smets and Straub (2008) and Liu and Pappa (2008).

The government maximizes (3.1) subject to (2.21) and (2.22), given the interest rate, the exogenous stochastic processes and expectations about future variables. Optimal fiscal policy under discretion requires

$$\tilde{g}_t = -\varphi(\tilde{y}_t + \epsilon_p \pi_t) \tag{4.1}$$

The central bank selects at time zero a state contingent plan $\{\pi_t, \tilde{y}_t, \tilde{f}_t, r_t\}_{t=0}^{\infty}$ maximizing (3.1) subject to (2.21), (2.22) and the fiscal reaction function (4.1). The targeting rule of the central bank reads as

$$\epsilon_p \pi_t + \Delta \tilde{y}_t = \chi(1 + \varphi \epsilon_p \lambda)\tilde{g}_t - \chi \tilde{g}_{t-1} \tag{4.2}$$

By comparing the optimal policy under fiscal discretion with the case of perfect coordination we can state the following.

Result 4.1 *The fiscal stance is not neutral if and only if the central bank deviates from the discretionary solution.*

This is the central result of the paper. The conclusion immediately follows from the discretionary monetary policy rule (3.6) and the discretionary fiscal policy rule under non-coordination (4.1). It implies that inefficient fluctuations in public spending are not due to discretion, but to the asymmetry of the policy regime. Equivalently, the government expenditure gap *entirely* arises because the policy makers do not agree on the monetary policy stance. The nature of the disagreement is due to a time inconsistency problem. The central bank would like to implement the commitment solution in each period. In fact, in case a bad (good) shock hits, it is welfare improving to smoothen its impact on output and inflation over time. By committing to future deflation (inflation), current inflation falls (rises), given output, through the effect on expected inflation, and part of the impact of the current shock is transferred to the future. This expectation channel improves the trade-off between inflation and output gap stabilization. However, the government does not take into account the benefits of the current tightening in terms of past outcomes, since she moves sequentially. This is clear when noticing that lagged output appears in the monetary targeting rule under commitment (3.3), but not in the fiscal policy rule (4.1). Then, fiscal policy tries to bring the policy stance in line with her own cost-benefit evaluation, by expanding public expenditure above the level merely required by Pareto efficiency. As a consequence, the central bank has to trade-off deviations from second best inflation and output against deviation of public expenditure from its first best level. Hence, discretionary fiscal policy worsens the conventional trade-off between inflation and output gap stabilization faced by the monetary authority.

By looking at the monetary and fiscal policy rules a few additional conclusions can be drawn

- Optimal monetary policy involves the targeting of fiscal gap deviations from the full commitment (second best) level. In particular, coherently with the reaction function of the government, higher deviations call for higher inflation or higher output gap. This allows the central bank to contain government over-reaction. Moreover, if the government does not deviate from the commitment solution, the monetary policy rule (4.2) converges to (3.3).

- As in the standard case, optimal monetary policy under fiscal discretion is inertial: the lagged fiscal gap appears in the targeting rule. Then, for given future fiscal gaps, the central bank commits to tighten future monetary policy in the event of an increase of the current fiscal gap above its second best level. This improves the current trade-off between inflation and fiscal gap stabilization by reducing expected future inflation.
- In the absence of cost-push shocks, the full commitment solution can be implemented even in the case of fiscal discretion. In fact, $\tilde{\pi}_t = \tilde{y}_t = \tilde{g}_t = 0$ is feasible and satisfies all first order conditions. Keeping inflation and output at their natural level eliminates any incentive of over-expansion on the part of the government. This is because, absent any short-run stabilization trade-off, the efficient allocation is feasible and time inconsistency is not an issue.

5 Impulse Responses, Second Moments and Welfare

Impulse responses confirm the intuition grasped by looking at the targeting policy rules. A committed central bank could still set the nominal interest rate so as to eliminate completely government over-reaction, i.e. $\tilde{g}_t = 0$. However, though feasible, this is not optimal and a combination of positive inflation, output and fiscal gap variability is preferred.

Figures 1 and 2 display the response of inflation, output, fiscal and government expenditure gaps, under the two regimes of commitment on the part of both authorities and discretionary fiscal policy with monetary commitment. Structural parameters are the same as in Galí and Monacelli (2008) and they are reported in Table 1. φ is set equal to 3, implying a labor supply elasticity of 1/3. The elasticity of substitution among goods and labor types, ϵ_p and ϵ_w are equal to 6, which is consistent with average mark-ups of 20 percent. θ and β are respectively set to 0.75 and 0.99. The steady-state share of government spending in output, $\gamma = \chi$, is parameterized to 0.25, the average of final government consumption for the Euro Area. TFP shocks are omitted as they would not change the results nor add any insight. Wage mark-up shocks are assumed to follow an autoregressive process

$$\mu_{t+1}^w = \rho_u \mu_t^w + \varepsilon_{t+1,u}$$

where ρ_u is set alternatively to 0 or to 0.95. The standard deviation of $\varepsilon_{t+1,u}$ is chosen in such a way that the standard deviation of the cost-push term appearing in the Phillips curve, $\lambda\mu_t^w$, is equal to one percent. The normalization makes the analysis directly comparable to Galí (2003).

Figures 1 and 2 respectively report the case of a wage mark-up shock with correlation equal to 0.95 and 0. The shock makes impossible to simultaneously stabilize inflation and output gap. Hence, because of the concavity of the welfare function, it is optimal to temporarily accept both some positive inflation and a negative output gap. In addition, in the case of commitment and perfect coordination, the fiscal stance remains neutral. In fact, government expenditure does not deviate from its first best level and the fiscal gap fluctuates one to one with the output gap. Instead, under fiscal discretion the government expenditure gap responds to the shock, this generating inefficient movements of the fiscal gap. This is the direct consequence of the policy disagreement. Inefficient fluctuations in the fiscal gap translate through aggregate demand into inefficient fluctuations of inflation and output. As it has been emphasized above, the central bank has to give up to some extent the active use of the expectation channel to contain fiscal misbehavior, which explains the difference between the response under fiscal discretion and full commitment. Equilibrium fluctuations represent the maximum deviation from full commitment that the monetary authority is willing to accept so as to reduce inefficient public spending variability. Finally, although the fiscal rule targets contemporaneous variables, monetary policy induces inertia by suitably choosing her policy instrument. This is evident from Figure 2. Since the cost-push shock is serially uncorrelated, persistence must be entirely generated by policy. The inertia induced by optimal monetary policy is a well established result, since Woodford (2003) and Galí (2008).

Tables 2 and 3 report the standard deviation of the output gap, inflation and the fiscal gap under both regimes. Keeping in mind that the variance of the shock has been normalized, second moments show that the solution to the trade-offs depends on ρ_u. If the shock is purely transitory, it is more worthy to use the expectation channel to smoothen the shock. In addition, fiscal over-reaction is less persistent and then less harmful. Therefore, monetary policy gives up on fiscal gap stabilization and focuses on inflation. In contrast, when the shock is persistent, smoothing the shock is less of an issue and fiscal over-expansion is strong and long lasting. It follows that the central bank gives up on inflation and contains the fiscal gap by over-stabilizing output, relative to the full commitment solution, and pleasing the government.

Table 4 reports welfare losses measured in consumption equivalents, i.e. the fraction of the efficient steady-state consumption that households would be willing to give up in order to switch from the actual policy to the first best. Again, the two columns consider respectively the cases of a wage mark-up shock with serial correlation equal to 0.95 and 0. The first three rows report welfare. The fourth one displays the change in welfare resulting from implementing a full commitment regime, starting from discretion on the part of all policymakers. Row 5 shows the change in welfare resulting from implementing monetary commitment under fiscal discretion, starting from discretion on the part of all policymakers. Finally, the last row computes the fraction of the gains from monetary commitment, as traditionally considered in the monetary policy literature, surviving to fiscal discretion. It is possible to see that gains are half of the ones obtained when the fiscal authority is also committing. Finally, in absolute terms and under all regimes considered, welfare is much lower when the shock is serially correlated. Again, this is because the central bank gives up on inflation relative to government expenditure stabilization. As it is well known, the inflation costs implied by the Calvo model are the highest, relatively to the cost generated by inefficient fluctuations of all other variables. Hence, differences in welfare are largely explained by differences in inflation volatility.

6 Conclusion

This paper considers a non-cooperative game between monetary and fiscal policy, where the government cannot commit to future policies and the central bank commits to set optimally the nominal interest rate, by taking into account potential fiscal misbehavior. It is shown that in this setting public spending is more volatile than optimal. The outcome is not due to discretion per se. Rather, it is the consequence of disagreement between the central bank and the government. The implication for monetary policy is that fiscal misbehavior undermines the achievement of the stabilization goals of the monetary authority.

Two possible applications of our findings are worth exploring.

On the one hand, it is not obvious that government expenditure is the proper instrument to deal with asymmetric shocks in currency areas as a substitute to the nominal exchange rate. In a companion paper, Gnocchi (2009) places the mechanism outlined here in a currency area model and shows that, contrary to previous findings, using government expenditure for stabilization purposes rather than limiting it to the efficient provision of public goods is welfare reducing for plausible calibrations of the stochastic processes driving the shocks.

On the other hand, a richer fiscal policy problem may allow to gain additional insights. As of now, the analysis is confined to the case of balanced budget and lump sum taxation. However, distortionary taxation and debt are likely to make harsher the time inconsistency problem. Interestingly, non-cooperation and lack of fiscal commitment may provide a rationale for budget rules, as long as inefficient volatility of public spending translates into inefficient volatility of debt through tax smoothing. Those rules are widely implemented in the US, the UK and the EU. The effectiveness and the optimality of budget rules have been the subject of an extensive discussion in fiscal policy literature. Alesina and Tabellini (1990), Andres and Domenech (2006), Diaz Gimenez, Giovannetti, Marimon and Teles (2008), Canova and Pappa (2006), Galí and Perotti (2003) and Fatas and Mihov (2006) is just a sample. However, none of those contributions focuses on the problems that disagreement between monetary and fiscal authorities may create and relate them to fiscal institutions. This is a question left to future research.

A Fiscal Policy

Fiscal policy chooses in each period t the fiscal gap f_t so as to minimize the period loss function subject to (2.21) and (2.22), given expectations about future variables, the nominal interest rate and exogenous stochastic processes. First order conditions with respect to inflation, output gap and fiscal gap are respectively given by

$$\frac{\epsilon_p}{\lambda}\pi_t + \psi_{\pi,t} = 0 \tag{A.1}$$

$$(1+\varphi)\tilde{y}_t - \lambda(1+\varphi)\psi_{\pi,t} + \psi_{r,t} = 0 \tag{A.2}$$

$$\frac{\chi}{1-\chi}\tilde{f}_t + \lambda\frac{\chi}{1-\chi}\psi_{\pi,t} - \frac{\chi}{1-\chi}\psi_{r,t} = 0 \tag{A.3}$$

together with the constraints (2.21) and (2.22), where $\psi_{\pi,t}$ and $\psi_{r,t}$ are the lagrange multipliers respectively associated to (2.21) and (2.22). The system can be equivalently rewritten as

$$\frac{\epsilon_p}{\lambda}\pi_t + \psi_{\pi,t} = 0 \tag{A.4}$$

$$(1+\varphi)\tilde{y}_t - \lambda(1+\varphi)\psi_{\pi,t} + \psi_{r,t} = 0 \tag{A.5}$$

$$\tilde{f}_t = -\tilde{y}_t - \varphi(\tilde{y}_t + \epsilon_p\pi_t) \tag{A.6}$$

From (A.6), the fiscal policy rule reported in the text, (4.2), can be obtained by applying the definition of f_t. The first two equations, given the equilibrium, serve the only purpose to determine lagrange multipliers.

B Monetary Policy

The central bank chooses at time zero a state contingent path for $\left\{\pi_t, \tilde{y}_t, \tilde{f}_t, r_t\right\}_{t=0}^{\infty}$ in order to maximize (3.1) subject to (2.21) and (A.6).The first order conditions with respect to inflation, output gap and fiscal gap are respectively given by

$$\frac{\epsilon_p}{\lambda}\pi_t + \Delta\xi_{\pi,t} + \varphi\epsilon_p\xi_{f,t} = 0 \tag{B.1}$$

$$(1+\varphi)\tilde{y}_t - \lambda(1+\varphi)\xi_{\pi,t} + (1+\varphi)\xi_{f,t} = 0 \tag{B.2}$$

$$\frac{\chi}{1-\chi}\tilde{f}_t + \lambda\frac{\chi}{1-\chi}\xi_{\pi,t} + \xi_{f,t} = 0 \tag{B.3}$$

where $\xi_{\pi,t}$, $\xi_{f,t}$ are the lagrange multipliers respectively associated to (2.21) and (A.6). (B.2) and (B.3) allow to express lagrange multipliers as functions of output and fiscal gaps

$$\xi_{\pi,t} = \frac{1-\chi}{\lambda}\tilde{y}_t - \frac{\chi}{\lambda}\tilde{f}_t \tag{B.4}$$

$$\xi_{f,t} = -\chi(\tilde{y}_t + \tilde{f}_t) \tag{B.5}$$

Substituting back into (B.1) and applying the definition of f_t yields the monetary policy rule (4.1) in the text.

Table 1: **Parametrization**

Parameter	**Value**
φ	3
$\epsilon_p = \epsilon_w$	6
θ	0.75
β	0.99
$\gamma = \chi$	0.25

Table 2: **Percentage standard Deviations in the case of serially uncorrelated cost-push shocks**

$\rho = 0$	**Output Gap**	**Fiscal Gap**	**Inflation**
Discretionary Fiscal	1.69	2.51	0.29
Full Commitment	1.56	1.56	0.31

Table 3: **Percentage standard Deviations in the case of serially correlated cost-push shocks**

$\rho = 0.95$	**Output Gap**	**Fiscal Gap**	**Inflation**
Discretionary Fiscal	2.37	5.55	0.23
Full Commitment	2.60	2.60	0.10

Table 4: **Welfare Analysis**. Welfare losses are measured in consumption equivalents under all regimes, i.e. it is the percentage of efficient steady state consumption that households would be willing to give up in order to switch from the actual regime to the efficient allocation.

	$\rho = 0.95$	$\rho = 0$
Full Commitment	0.15	0.08
Full Discretion	0.21	0.10
Fiscal Discretion and Monetary Commitment	0.18	0.09
(1) Gains from Monetary Commitment, Fiscal Commitment	0.06	0.02
(2) Gains from Monetary Commitment, Fiscal Discretion	0.03	0.01
Ratio of (2) to (1)	0.5	0.5

Figure 1: **Impulse responses to a cost-push shock.** Serial correlation has been set to 0.95. Parameters are calibrated as in Table 1.

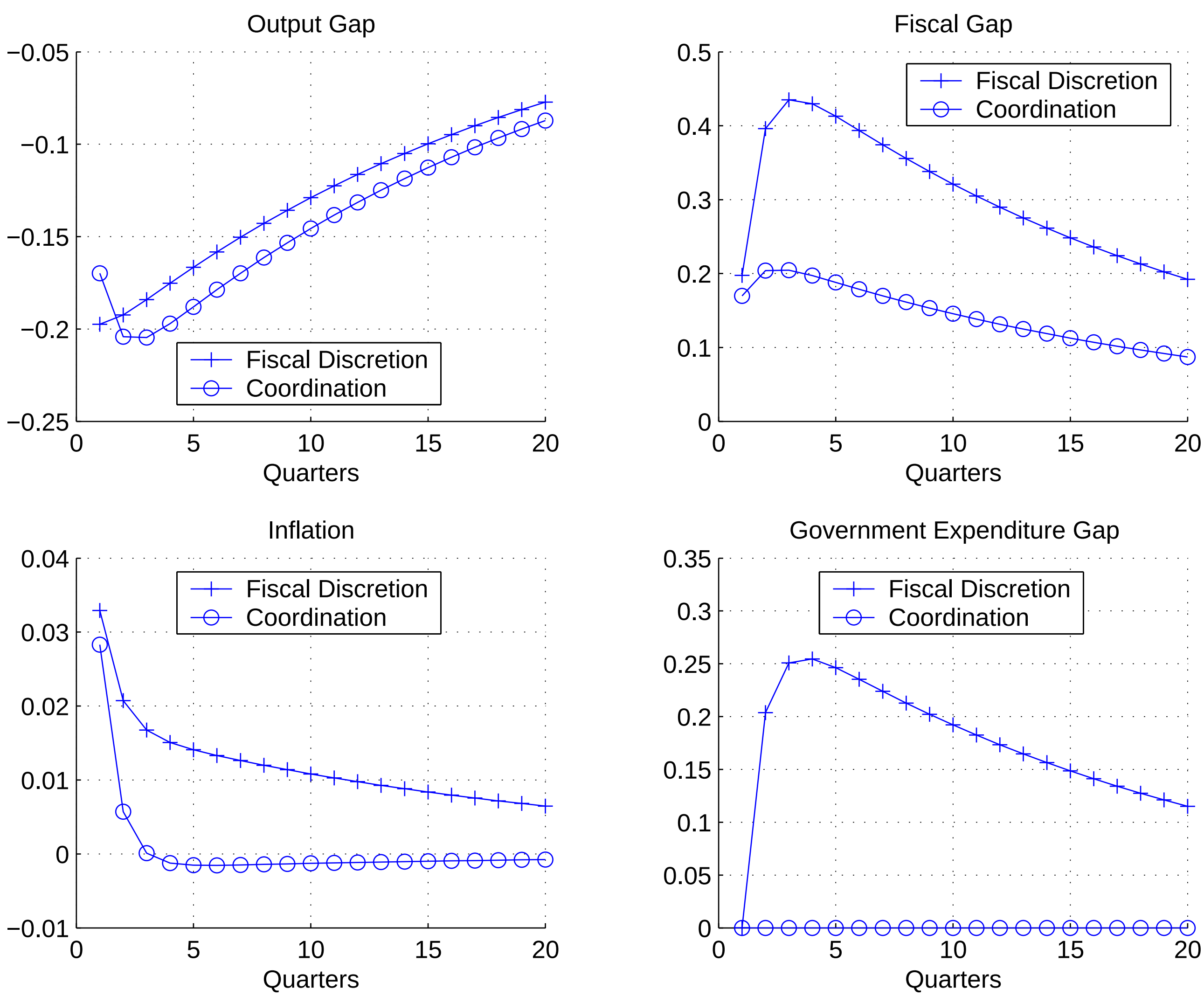
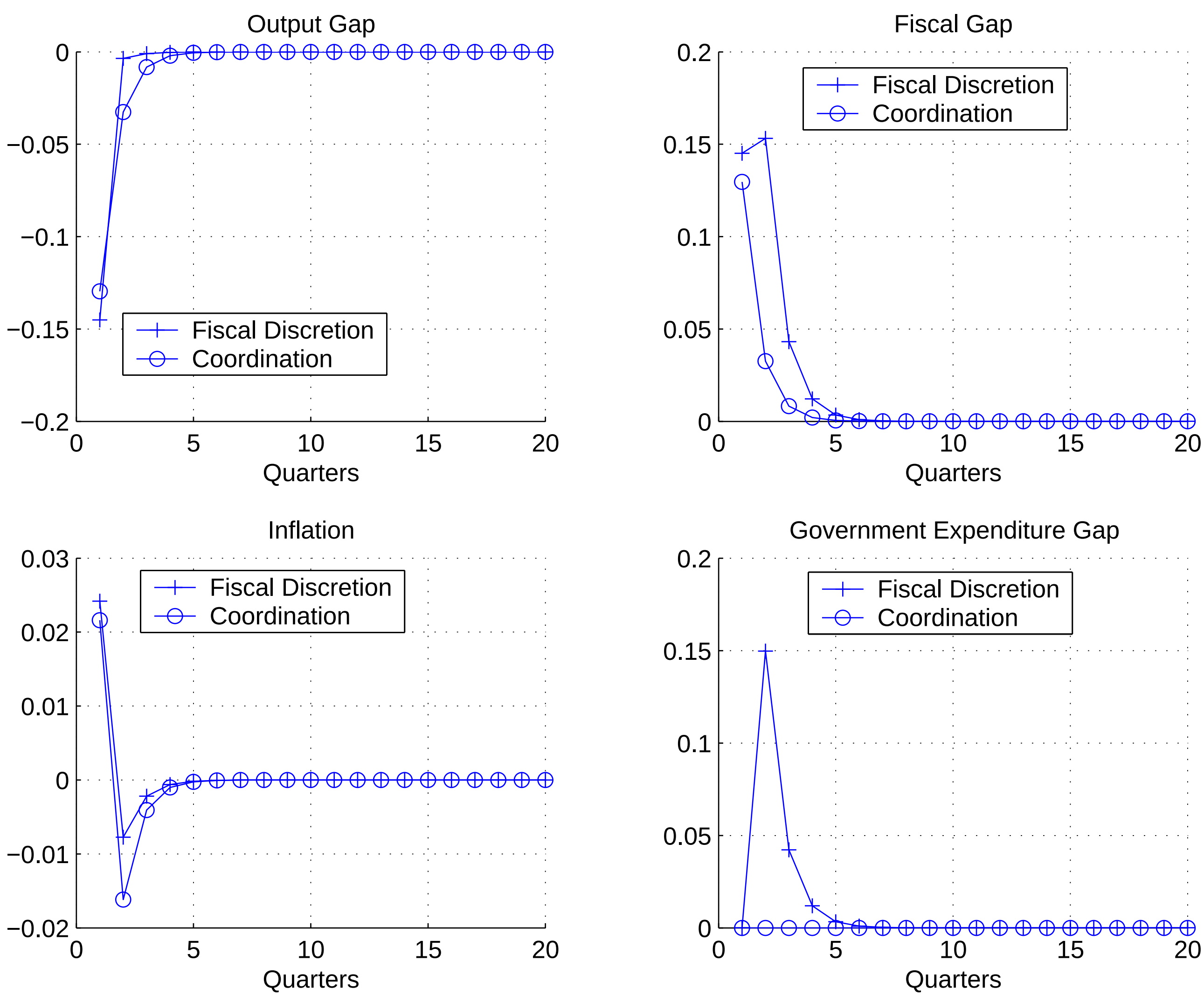


Figure 2: **Impulse responses to a cost-push shock.** Serial correlation has been set to 0. Parameters are calibrated as in Table 1.



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