Università degli Studi di Ancona
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On (Sub)Optimal Monetary Policy Rules under Untied Fiscal Hands*

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Abstract

We examine the interplay between monetary and fiscal policies in a context where disturbances to the public deficit process are a primary source of macroeconomic instability. We perform simulations of optimal targeting rules on a sticky-price model *à la* Woodford (1996). Our investigation compares the dynamic adjustment path under inflation targeting with that arising from nominal income growth targeting. When fiscal shocks enter the picture, inflation targeting is a superior strategy. In opposition to Jensen (1999)'s results, we show that an inflation targeter is capable of bringing about the required degree of interest rate inertia. This does not occur at the cost of additional nominal instability. (**JEL**: E52, E63)

1 Introduction

The Stability and Growth Pact is often called upon to guarantee a smooth startup of the common monetary policy in the EMU. In a path-breaking con-

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tribution to this issue, Woodford (1996) shows that fiscal shocks can have a significant impact on the dynamic behavior of nominal variables. The key intuition leading to such a result is that fiscal policy need not follow a Ricardian path, since profligate governments may not comply with the intertemporal budget constraint. Thus, a misalignment between the level of outstanding public debt on the one side, and the present value of future government surpluses on the other shifts households consumption profiles, and generates price instability.

A missing point in Woodford (1996)'s study regards the role of alternative monetary policy rules in a second-best world, that is when monetary institutions are incapable of perfectly stabilizing fiscal shocks. The pertinence of this issue applies with special strength to the EMU itself. A huge literature has recently emerged on the so-called 'expansionary fiscal contraction hypothesis', namely the proposition that public deficit reductions need not exert a negative effect on economic activity (see Perotti, 1996). The composition of fiscal adjustments is often referred to as the key instrument capable of preventing output from falling after a deficit cut. Should the Stability Pact be enforced tightly, fiscal shocks would partially retain their impact on nominal variables. The body of literature mentioned earlier stresses that strategies of fiscal retrenchments based on revenue increases are associated with inflationary outcomes.

Our analysis focuses on two well-known targeting rules, namely inflation targeting and nominal income growth targeting. We perform simulations of optimal policy on a simple variant of Woodford (1996)'s model developed by Natalucci and Pandimiglio (2000). It is intuitively appealing that a ranking among alternative policy regimes depends on their endogenous properties. Jensen (1999) argues that the degree of aggressiveness brought about by our reference policy rules makes income growth targeting a superior strategy with respect to inflation targeting. We challenge this view by showing that, when fiscal shocks enter the picture, the traditional approach to the evaluation of monetary policy inertia is a misleading criterion on which assessing the relative performance of policy rules.

A positive disturbance to the primary deficit process raises both inflation

and the output gap. The underlying adjustment mechanism at work depends on the sign of the initial reaction of the monetary authority. Since inflation targeters prefer a tougher stance at the beginning of the simulation, they allow the real interest rate to fall below zero. This ensures a fast convergence toward the steady state at no cost of additional macroeconomic instability. On the other hand, monetary policy under nominal income growth targeting contemplates a different shape of the adjustment path, as interest rates bear a positive sign after the shock has taken place. The long-term equilibrium is achieved more gradually than under inflation targeting. Our numerical results demonstrate that this outcome does not originate from larger interest rate smoothing. Rather, the explaining factor we account for consists in the quality of the monetary policy response. Central banks need not rely merely on the quantitative aspect of policy changes.

The empirical relevance of the scenario just outlined is magnified in a common currency area, where monetary policy can exert different effects at the 'regional' level. Member countries of a monetary union may have diverging rates of inflation. Obviously, persistent inflation differentials cannot be supported unless serious distortions to the allocation of resources are tolerated. In the short run, inflation can be interpreted as a beneficial factor inducing international adjustment - the so-called Balassa-Samuelson effect. Acknowledging the case for divergent inflation rates also means accounting for different national real rates of interest within a monetary union.

The organization of this paper is as follows. Section 2 describes the reduced-form solution of our Woodford (1996)-type model. The formalization of the monetary policy regimes under investigation is discussed in section 3, while section 3.1 presents the technical steps involved in the evaluation of targeting rules. Section 4.1 outlines the main methodological aspects of our study. In particular, section 4.2 defines the calibration properties of the model. Optimal policy under commitment is scrutinized in section 5. The more realistic case of discretionary monetary policy is considered in section 6.1. In section 6.2, we perform a sensitivity analysis of the results under discretion. Section 7 draws up some concluding remarks. Three methodological appendixes are also included. Appendix A formulates the state-space representation of the model. Appendix B summarizes the procedures involved in the numerical solution of the rational expectations equations. Finally, appendix C describes the representation of steady-state covariance matrices.

A clarification on the notation is needed. The variables bearing a hat are expressed as log-deviations from the steady state.

2 A microfounded model with sticky prices

The amended model *à la* Woodford is characterized by a measure of identical infinitely-lived economic agents defined over $[0,1]$. Each household is the monopolistic supplier of a single differentiated good. The intertemporal utility function of households has a logarithmic form in terms of consumption and public expenditure, and a power form with respect to real money and the private supply of production goods. These functional assumptions by Natalucci and Pandimiglio (2000) satisfy the general conditions for model solution laid down by Woodford (1996). On the supply side, a random fraction of agents is assigned a fixed probability of changing the current-period price.

The microfounded model is solved by log-linearizing the variables around their steady states. After including stochastic shocks in the resulting equations, we obtain:

$$\widehat{y}_t = -\widehat{r}_t{}^r + E_t\widehat{y}_{t+1} + u_t^y, \tag{1}$$

$$\widehat{\pi}_t = \lambda\widehat{y}_t + \beta E_t\widehat{\pi}_{t+1} + u_t^\pi. \tag{2}$$

Equation 1 postulates an IS relationship. The elasticity of the output gap $\widehat{y}_t$ to the *ex-ante* real interest rate $\widehat{r}_t{}^r$ corresponds to the intertemporal elasticity of substitution of consumption. Owing to the logarithmic utility function of the relevant term, such elasticity turns out with a positive unit value. Equation 2 represents, instead, an expectations-augmented Phillips curve with steady-state inflation $\pi_t \equiv \frac{P_t}{P_{t-1}}$. The parameter β is the subjective discount factor entering households' utility. The term λ has no straightforward interpretation, since it is a non-linear function of the supply elasticity of households, the household's elasticity of consumption substitution, and the probability of a given price to be hold constant.

We assume that the stochastic disturbances u_t^y and u_t^π follow exogenous first-order autoregressive - AR(1) henceforth - processes:

$$u_{t+1}^y = \rho_y u_t^y + \epsilon_{t+1}^y, \quad u_{t+1}^\pi = \rho_\pi u_t^\pi + \epsilon_{t+1}^\pi, \tag{3}$$

with $0 \leq [\rho_t,\ \rho_\pi] < 1$. Both ϵ_{t+1}^y and ϵ_{t+1}^π are white noise processes with null means and finite variances σ_y^2 and σ_π^2, respectively. The shock persistence in both $\widehat{y}_t$ and $\widehat{\pi}_t$ accounts for the well-documented serial correlation in the impact - both real and nominal - of monetary policy (see Söderlind, 2001). Clarida et al. (1999) also show that persistent cost disturbances represent a key factor in the choice of the optimal monetary policy arrangement.

The log-deviation of the real interest rate with respect to its long-term value can be expressed as

$$\widehat{r}_t{}^r = \widehat{r}_t{}^n + u_t^r - E_t\widehat{\pi}_{t+1}. \tag{4}$$

The term $\widehat{r}_t{}^n$ represents the monetary policy instrument used by the central bank - i.e. systematic policy -, while u_t^r indicates a stochastic policy shock. Again, we assume that the random disturbance generates from an AR(1) process

$$u_{t+1}^r = \rho_r u_t^r + \epsilon_{t+1}^r, \tag{5}$$

where ϵ_{t+1}^r is drawn from a standardized normal distribution with variance σ_r^2.

The LM curve can be derived as

$$\widehat{m}_t = \frac{1}{\varepsilon}\widehat{y}_t - \psi\widehat{r}_t{}^n. \tag{6}$$

The term ε arises from the ratio between the elasticity of money demand with respect to the opportunity cost of holding money, and the intertemporal elasticity of consumption substitution. On the other hand,

$$\psi \equiv \frac{1}{\varepsilon r^n},$$

where $r^n = \frac{1}{\beta}$ is the steady-state nominal rate of interest. Hence, ψ can he interpreted as the rate of time preference, trading off consumers' impatience for current consumption with the propensity to hold cash.

The evolution of the real public debt is determined by

$$\widehat{b}_{t+1} = \widehat{r}_t{}^n + \frac{1}{\beta}\left(\widehat{b}_t - \widehat{\pi}_t\right) + \left(\frac{1}{\beta} - 1\right)\widehat{D}_t + \gamma\left(\widehat{m}_{t-1} - \widehat{m}_t - \widehat{\pi}_t\right). \tag{7}$$

The parameter $\gamma \equiv \frac{m}{\beta b}$ measures the share of money holdings in financial wealth, with $m = \frac{M_t}{P_t}$ and $b = \frac{B_t}{P_{t-1}}$ as money balances and real debt in the long run.

To close the model, the real primary deficit D_t has the law of motion

$$\widehat{D}_t = \rho_d \widehat{D}_{t-1} + u_t^d, \tag{8}$$

where u_t^d is a white noise with variance σ_d^2. The parameter ρ_d captures the persistence of primary deficit. In order to rule out any explosive behavior of the deficit process, we impose the restriction that $|\rho_d| < 1$. The reader should note that equation 8 implies that neither the current level of public debt, nor the interest rate exert any impact on the evolution of the fiscal deficit.

3 Monetary policy regimes

We study the conduct of interest rate policy according to two monetary regimes, namely inflation targeting and nominal income growth targeting. Our definition of targeting rules draws on the theoretical framework developed by Svensson (1998). In other words, we interpret the setup of monetary policy as a function of some predetermined goals to be achieved by the policymaker. This process takes the form of minimizing the state-independent loss functions reported in table 1.

Regime	Loss function
IT	$\phi_\pi\left(\widehat{\pi}_t - \overline{\pi}\right)^2 + \phi_{y,IT}\,\widehat{y}_t^2 + \phi_{i,IT}\,\left(r_t^n - r_{t-1}^n\right)^2$
NIT	$\phi_g\left(\widehat{g}_t - \overline{g}\right)^2 + \phi_{y,NIT}\,\widehat{y}_t^2 + \phi_{i,NIT}\,\left(r_t^n - r_{t-1}^n\right)^2$

Table 1: Single-period loss functions for alternative monetary policy regimes. Source: author's definition.

The baseline definition of nominal income growth relies on the following expression:

$$\widehat{g}_t \equiv \widehat{\pi}_t + \widehat{y}_t - \widehat{y}_{t-1}.$$

Assuming a constant level of trend output, we obtain that $\widehat{g}_t$ is a mere indicator of nominal GDP growth. In the more realistic case of a time-varying level of trend output, $\widehat{g}_t$ represents *"nominal income growth relative to real trend output growth"* (Jensen, 1999).

We consider only flexible monetary policy rules. Thus, each loss function contains additional targets with respect to the ones strictly involved in its formulation. Although the case for a flexible inflation targeting is well established in the literature, a flexible version of nominal income growth targeting might appear theoretically groundless. Indeed, this formalization is employed both in Jensen (1999), and Walsh (2001) with the reasoning that it does not disregard the underlying logic of the monetary policy strategy.

Both loss functions in table 1 include an objective of interest rate smoothing. Jensen (1999) demonstrates that monetary policy under 'standard' income growth targeting generates endogenous inertia in the interest rate adjustment. The introduction of an explicit target of interest rate smoothing can then be motivated with the primary need for safeguarding financial markets stability.

It is worth pointing out that we assume null target values for our main goal variables, that is

$$\overline{\pi} \equiv \overline{g} = 0. \tag{9}$$

The relation 9 is inherently coherent, since targeting $\widehat{g}$ at zero implies aiming at a nominal GDP growth equal to trend output growth. In turn, this behavior is consistent with a null target rate of inflation. A final remark is needed. Table 1 is based on the assumption of a target output gap equal to zero. This prevents the model from exhibiting an inflationary bias *à la* Barro and Gordon (1983).

3.1 Central bank preferences and optimal monetary policy

Following Söderlind (1999), we re-write the model in state-space form:

$$\begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = Ax_t + Bi_t + \xi_{t+1}, \tag{10}$$

with $x_t' \equiv (x_{1t}', x_{2t}')'$. Predetermined state variables are collected into x_{1t}, while x_{2t} includes forward-looking variables. The vector of disturbances to the predetermined variables is indicated as ξ_{t+1}. The monetary policy instrument - r_t^n in our model - is denoted by i_t.

The central bank's problem consists in minimizing the intertemporal loss function

$$E_t \sum_{\tau=0}^{+\infty} \delta^\tau L_{t+\tau} \tag{11}$$

subject to the constraint 10, with $0 < \delta < 1$ as the society's discount factor. Each period loss function from table 1 is cast into the matrix form

$$L_t = z_t' K z_t, \tag{12}$$

where K is a weighing matrix of preference parameters. The goal variables are collected into z_t. They are linked both to the state variables, and the nominal interest rate through the transition equation

$$z_t = C_x x_t + C_i i_t. \tag{13}$$

The optimal rules for the policy instrument are computed as

$$i_t^c = -F^c \begin{bmatrix} x_{1t} \\ \rho_{2t} \end{bmatrix}, \quad i_t^d = -F^d x_{1t}.$$

F^ι with $\iota = c, d$ are coefficient matrices. In the commitment case, the central bank acts as a Stackelberg leader by internalizing the effects of its actions on the private sector's expectations. As a result, the optimal interest rate - i_t^c - depends on both the Lagrange multipliers - ρ_{2t} - associated to the forward-looking variables, and the predetermined variables. Discretionary policy - i_t^d -

takes, instead, the expectations of agents as given. The state of the economy collapses to the predetermined variables only.

A key point is worth stressing. Both the primary deficit and the public debt enter the vector x_{1t}. One might thus be tempted to think of the resulting monetary policy stance as non-autonomous with respect to the needs of government solvency. In opposition to this view, we notice that the loss functions of the central bank do not include any fiscal variable. Rather, the surrounding economic environment is subject to fiscal profligacy.

As δ approaches unity, the value of the expression 11 becomes proportional to the second moments of the variables entering the central bank's loss function (see Rudebusch and Svensson, 1999):

$$EL_{IT} = \phi_\pi \text{Var}[\widehat{\pi}_t] + \phi_{y,IT}\text{Var}[\widehat{y}_t] + \phi_{i,IT}\text{Var}[\Delta r_t^n], \tag{14}$$

$$EL_{NIT} = \phi_g \text{Var}[\widehat{g}_t] + \phi_{y,NIT}\text{Var}[\widehat{y}_t] + \phi_{i,NIT}\text{Var}[\Delta r_t^n]. \tag{15}$$

After the model has been solved, the unconditional variances of the goal variables can be used to evaluate equation 14 and 15. Instead, we calculate the exact value of each loss function hy inclnding the optimized coefficients into its analytical expression:

$$J_t^{opt} = x_{1t}' V_t x_{1t} + v_t,$$

where

$$v_t = \delta \text{ trace}(V_{t+1}\Sigma) + \delta E_t v_{t+1},$$

and V is a symmetric matrix to be determined.

Appendix A formulates the state-space representation of the model under each monetary policy regime. The numerical algorithms employed for solving the dynamic systems are reviewed briefly in appendix B. The solutions have been obtained by modifying the Matlab routines provided by Paul Söderlind.

4 Methodological issues

4.1 Methodology

We are interested in investigating the monetary policy implications of an autarchic fiscal policymaker. In doing so, we take the commitment solutions as a preliminary ground on which assessing the main properties of our model. Then, we turn our attention to the more realistic scenario of optimal monetary policy under discretion. We concentrate on the welfare impact of parameter deviations from their baseline setup when primary deficit shocks occur. Since we assume that the central bank's loss function corresponds to the one of the society, we compare its equilibrium values under alternative monetary regimes.

The variances of all the white noise terms in the model, and the correlation coefficients of the AR disturbances defined in 3 account for uncertainty on the state of the economy. An example of this methodological application can be found in Leitemo and Söderström (2001), who discuss the impact of exchange rate uncertainty on the optimal design of interest rate rules. Hence, by studying how the optimal monetary policy regime changes as a function of these parameters, we also analyze the robustness properties of the various policy rules in a framework including fiscal shocks.

The reader should notice that only non-restricted rules for the determination of optimal policy are considered in solving the model. Despite their relevance in day-to-day policymaking, we provide no account for Taylor-type rules.

4.2 Calibration

We assign the parameter values as they are already defined in the current literature. Our aim is not to provide for either a rigorous calibration of the model, or empirical estimates capable of capturing the dynamic properties of any economic time series. The underlying criterion of our calibration strategy is simply to avoid unreasonable settings. Thus, the numerical results of the following analysis should be interpreted as merely indicative.

The coefficient values in table 2 are taken from Woodford (1996). The

λ	β	ε	ψ	γ	δ
0.3	0.95	1	0.95	0.1	0.99

Table 2: Baseline parameter configuration of the stochastic equations. Source: Woodford (1996).

compound term λ follows from econometric studies based on US data. Both the discount factor β, and the rate of time preferences ψ are consistent with current rates of return. Assuming that both the intertemporal elasticity of consumption substitution, and the money-demand elasticity to the opportunity cost of holding money are equal to one, we get a unit value for ε too. The parameter γ is calibrated on the relative size of the US monetary base. Finally, the society's discount factor δ has been assigned a value that guarantees the safe numerical convergence of our model solutions.

ρ_y	σ_y^2	ρ_π	σ_π^2	ρ_r	σ_r^2	ρ_d	σ_d^2
0.3	0.015	0.3	0.015	0.92	0.13	0.6	0.01

Table 3: Baseline parameters entering the shock terms. Sources: various authors.

The source for the settings of the shock disturbances of both the output and the inflation equations is Walsh (2001). Such a configuration relies on earlier studies by Jensen (1999) and McCallum and Nelson (1999). The stochastic properties of the monetary policy shocks are identified by Rudebusch (2001). He estimates a Taylor rule on US data allowing for first-order serial correlation. As for the evolution of the deficit process, we choose the value already assigned by Woodford (1996) to the autocorrelation coefficient ρ_d. We also assume that the stochastic disturbance u_t^d is drawn from a standardized normal distribution (see table 3).

Differently from Jensen (1999), the weights on the target variables of each period loss function are not optimized. Instead, they have been assigned the standard values used by both Rudebusch and Svensson (1999) and Rudebusch (2001).

$\phi_{y,IT}$	$\phi_{i,IT}$	$\phi_{y,NIT}$	$\phi_{i,NIT}$	ϕ_{π}	ϕ_{g}
1	0.5	1	0.5	1	1

Table 4: Baseline weights of target variables. Source: author's definition.

5 Impulse responses under commitment

This section illustrates the main features of the monetary regimes in a context where the central bank can commit to a certain path of policies once for all. This is clearly an unrealistic case, since it neglects the policymaker's time-inconsistency problem. Nonetheless, it provides the ground for key insights against which the effects of deviations from baseline parameters can be assessed.

The impulse-response functions are traced by simulating the model under alternative configurations of the disturbance vector 21 on page 28. We consider each type of shock separately from the others.

The upper-left panel of figure 1 plots the dynamic response of selected variables to a demand shock under inflation targeting. Notwithstanding positive inflation expectations, the *ex-ante* real interest rate increases steadily after the shock has taken place. As a result, the output swing is stabilized almost completely. The inflation rate displays a high degree of persistence, mainly due to the forward-looking structure of its driving process.

Remarkable differences emerge between the dynamic path of adjustment outlined earlier and the one arising from nominal income growth targeting (see figure 2 on page 14). The initial response of the central bank is tougher when income growth determines monetary policy. The inertial behavior of the real interest rate prevents the output gap from becoming negative. Furthermore, the convergence towards the stationary solution of the model is achieved at a slower pace than under inflation targeting.

When the economy is subject to persistent cost-push shocks, the output gap-inflation tradeoff of the central bank worsens. It is striking that the upper-right panels of figures 1 and 2 show no divergences among the resulting optimal paths. Thus, there are virtually no gains in terms of economic performance

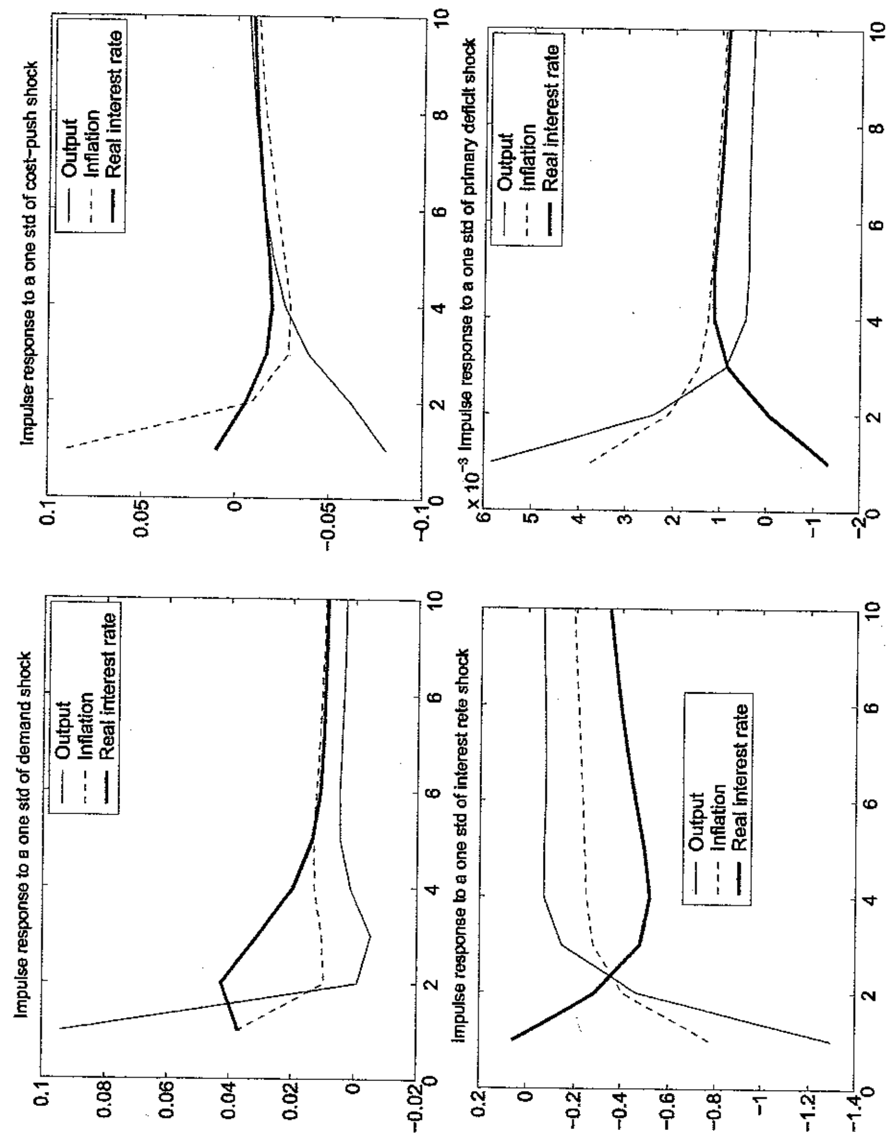


Figure 1: Impulse-response functions under commitment, inflation targeting. Source: author's elaborations.

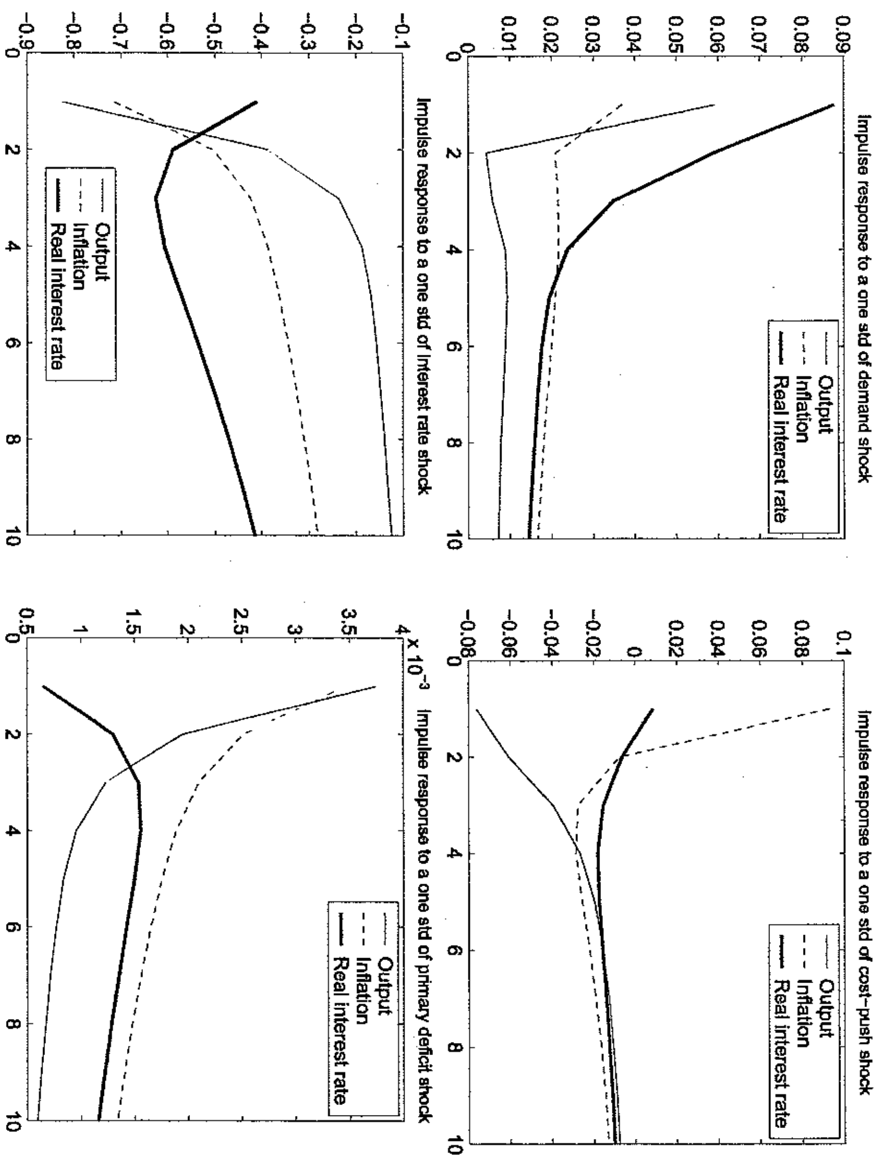


Figure 2: Impulse-response functions under commitment, nominal income growth targeting. Source: author's elaborations.

from discriminating between inflation targeting and income growth targeting. Like in Jensen (1999), optimal policy is characterized by a high degree of persistence. The real interest rate steps on a declining trajectory, and acquires negative values. This outcome should be entirely attributed to the assumed parameter structures of the policymaker's loss functions, implying strong preferences for output gap stabilization under both policy regimes.

The dynamic impact of a stochastic monetary policy shock is depicted in the lower-left panels of figures 1 and 2. Although the adjustment paths move along common trajectories, a few noticeable differences can be stressed. A central bank committed to an inflation target imparts a more severe downturn to the output gap at the beginning of the simulation. On the other hand, a slightly higher degree of monetary policy inertia emerges under income growth targeting with respect to inflation targeting. The existence of a sluggish interest rate adjustment in both regimes can be interpreted under the light of Jensen (1999)'s results. A persistent negative output gap keeps inflation expectations low, thus improving the output gap-inflation tradeoff.

Differently from the case of a cost-push disturbance, primary deficit shocks generate an upswing both in output and inflation (see the lower-right panels of figures 1 and 2). Thus, we replicate the main analytical finding of Woodford (1996), namely that fiscal policy can exert non-Ricardian effects despite all the standard assumptions underlying rational expectations equilibria. What makes the difference with respect to conventional microfounded models is the positive wealth impact on household's consumption of an increase in public debt. At both unchanged prices and interest rates, a misalignment between the present value of outstanding government liabilities and the present value of public primary surpluses takes place. As a result, only when compliance with the government's intertemporal budget constraint is restored, can the economy return to its stationary equilibrium.

Three different adjustment channels can be exploited to hamper deviations from the steady state (see Woodford, 1996). Falling real interest rates ease the financial burden due to debt servicing costs. Increased inflationary pressures reduce the real value of outstanding debt. Furthermore, in the context of a growing economy, seignorage revenues are generated by the endogenous money supply rule.

It is striking that the first mechanism outlined earlier plays a stronger role under inflation targeting than under income growth targeting, as the real rate of interest becomes negative after the shock is realized. The inflation rate is then characterized by a steeper initial drop. At the end of the simulation period, a central bank caring about GDP growth generates higher real interest rates with respect to an inflation targeter. Again, inertial behavior emerges clearly as the predominant property of a monetary policy strategy centered around nominal income growth. This translates into a larger role for seignorage-based adjustment.

6 Optimal policy under discretion

In order to point out the main qualitative differences between targeting regimes, we now turn our attention to the case when the representative central bank faces the time-inconsistency problem. Forward-looking variables depend solely on the current state of the economy. The monetary authority is also assumed to minimize its loss function "*within the period*" (Jensen, 1999), thus not internalizing the effects of its policy actions.

6.1 Results under baseline parameters

Figures 3 and 4 show the impulse responses of selected variables under discretionary inflation targeting and income growth targeting, respectively. Once we compare such plots with the corresponding ones under commitment, we immediately notice that both regimes do not replicate the inertial behavior that characterizes them under commitment. Thus, we extend the recent findings by Jensen (1999), who concentrates on the role of cost-push shocks for the choice of the optimal monetary arrangement.

The interest rate adjustment produced by nominal income growth targeting tends to be more sluggish than the one displayed by inflation targeting. This general consideration finds less clear cut evidence in the case of a sudden drop in the government primary surplus. The opposite signs of the initial

impulse responses of the interest rate in the two regimes determine the quality of the adjustment in the following periods. Under income growth targeting, equilibrium is restored mainly through endogenous money supply changes, whereas it is the interest rate channel that plays a key role under inflation targeting.

Table 5 on page 20 reports some descriptive statistics under baseline parameters. Two preliminary aspects are worth emphasizing. It should be stressed that the society's losses are normalized by 100, thus implying substantial welfare drops in level. This aspect is clearly related to the fact that we are studying the available options for monetary policy in a second-best world, i.e. in a setting where factors leading to suboptimal economic outcomes prevail. On the same ground, we evaluate the variability of the interest rate in a different fashion from Jensen (1999). Our indicator provides for an exact measure of the variance of the real interest rate, whereas Jensen (1999) calculates the simulated standard deviation of such a variable.

Strikingly, inflation targeting over-performs with respect to nominal income growth targeting. Although it generates wider output gap fluctuations, inflation targeting succeeds in achieving both more stable inflation, and smaller interest rate variability. These conclusions are at odds with Jensen (1999), who obtains opposite results. Two factors can be considered for explaining our puzzling results. One can assert that the inclusion of an interest rate smoothing objective in the context of inflation targeting greatly affects the ranking among alternative policies. Indeed, we argue in favor of a deeper rationale.

Woodford (1996)'s model encompasses the traditional adjustment mechanisms based on the labor market performance. Public debt plays a central role in determining the convergence of the model towards its long-term equilibrium. As a result, the impact of changes of key variables on the debt path shapes the optimal response by the monetary authority.

Given multiple persistent shocks, the optimality of inflation targeting consists in imparting a stronger policy shock at the beginning of the simulation period. This abates inflationary expectations, and guarantees a faster achievement of stationary solutions. Such a process takes place more forward in time

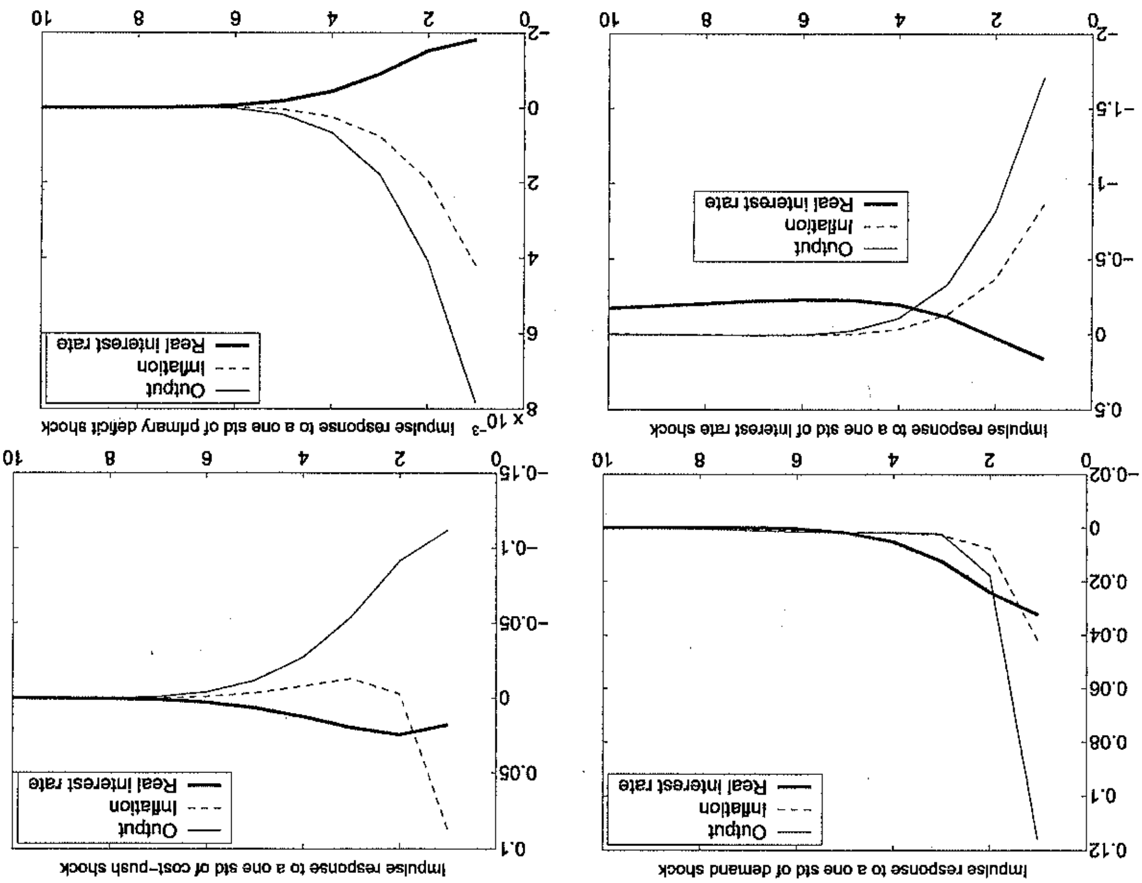


Figure 3: Impulse-response functions under discretion, inflation targeting. Source: author's elaborations.

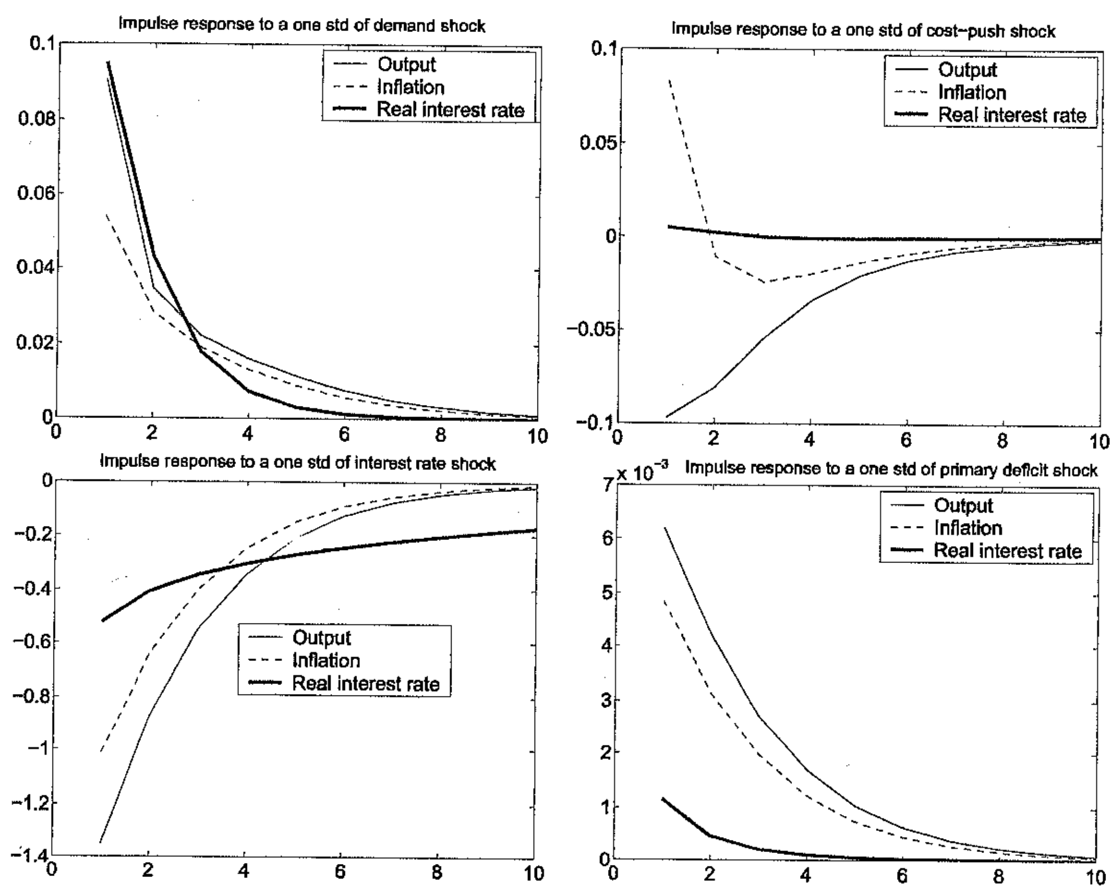


Figure 4: Impulse-response functions under discretion, nominal income growth targeting. Source: author's elaborations.

	IT	NIT
Society's loss (/100)	4.6319	8.7810
S.d. of π_t	0.9542	1.3052
S.d. of y_t	1.9345	1.7607
S.d. of Δi_t	1.3871	2.0317

Table 5: Analytical results under baseline discretionary policy. Source: author's elaborations.

under income growth targeting, since the central bank prefers a milder stance at the beginning of the experiment.

When dealing with disturbances to the deficit process, inflation targeters let the real interest rate fall below zero both under commitment and under discretion. This prevents inflation from worsening any further. The key point is that the initial sign of the monetary policy response determines the following variation of macroeconomics variables. The emerging negative correlation between the rate of inflation and the real rate of interest reflects the aggressiveness of monetary policy under inflation targeting. But such an aggressiveness does not come at the cost of additional variability of either rates, since it relies on the quality of the impact rather than on quantitative aspects.

6.2 Deviations from baseline parameters

The virtues of inflation targeting *vis-à-vis* income growth targeting are confirmed by the battery of sensitivity tests that follows. The baseline results of the simulations are robust with respect to variations of the inflation elasticity to the output gap. With a higher elasticity, the ranking among volatilities of different variables remains unchanged (see table 6). On the other hand, when a lower inflation sensitivity to business cycle fluctuations is at stake, nominal income growth targeting is capable of generating a smoother path of interest rates. Additional evidence from table 11 on page 24 shows that this occurs at the cost of larger output swings than under inflation targeting. Again, such

	IT	NIT
Society's loss (/100)	3.2686	6.1898
S.d. of π_t	1.3934	1.6438
S.d. of y_t	1.1602	0.9460
S.d. of Δi_t	1.4847	2.2935

Table 6: Deviation from baseline: higher inflation elasticity to the output gap ($\lambda = 0.9$). Source: author's elaborations.

puzzling results can be explained by referring to the impact of primary deficit shocks on optimal policy. A central banker caring about nominal growth subscribes to a more aggressive stance than under baseline parameters (see figure 5 on page 26). But that does not imply raising interest rates any further. Jensen (1999) offers a counter-intuitive motivation by noticing that *"any regime will perform equally bad in terms of stabilizing inflation (...) when the trade-off reaches the limit where the output gap has virtually no effect on inflation".*

Changes in the degree of forward-looking adjustment of the inflation process affect the persistence of disturbances through two channels. A supply-side impact arises from the incorporation of a portion of current inflation into the nominal contracts negotiated in each period. The endogenous persistence of shocks is also a function of the parameters determining the evolution of the public debt. At a reduced degree of inflation forward lookingness, the emerging pattern of behavior of macroeconomic variables is different from the one of a lower-than-baseline inflation elasticity to the output gap (see table 7). The variance of inflation is strongly reduced. On the other hand, output variability becomes larger than inflation variability in both policy regimes. The alleged parameter shift plays in favor of a stronger net impact of deficit shocks, i.e. the debt-induced effect is larger than the supply-side impact. Unsurprisingly, a rational central banker puts a counterweight against these destabilizing forces.

An increase in the elasticity of public debt to seignorage revenues leads to a dramatic change of the qualitative aspects of monetary policy setting. Although the ranking among monetary policy regimes is the same as under baseline, it is intriguing that the variance of inflation under income growth tar-

	IT	NIT
Society's loss (/100)	0.6102	1.4739
S.d. of π_t	0.2565	0.3142
S.d. of y_t	0.7206	0.7359
S.d. of Δi_t	1.5545	1.5937

Table 7: Deviation from baseline: lower degree of forward-looking inflation adjustment ($\beta = 0.7$). Source: author's elaboration.

	IT	NIT
Society's loss (/100)	0.1551	0.1664
S.d. of π_t	0.2681	0.2669
S.d. of y_t	0.1641	0.1115
S.d. of Δi_t	2.1185	2.2070

Table 8: Deviation from baseline: higher public debt elasticity to seignorage revenues ($\gamma = 0.7$). Source: author's elaboration.

geting turns out lower than under inflation targeting (see table 8). Figure 7(a) on page 26 shows that a central bank caring mainly about inflation exploits the inflation channel, rather than the interest rate one, in order to bring about the required reduction of public debt. The money-based adjustment operating under GDP growth targeting is strengthened in the current framework. We stress this aspect in order to understand better the development induced by the assumed parameter shift. A given reduction of inflation can be bought at the cost of a smaller money supply increase, i.e. via a more gradual drop of the public debt level. Thus, the endogenous inertia characterizing income growth targeting results in lower inflation variability than under alternative regimes.

We now move our attention to the role of the preference parameters of the monetary authority. Table 9 shows the numerical effects of variations of the weight assigned to the output objective in each policy regime. The robustness of our baseline results is strikingly confirmed.

The main properties of inflation targeting hold even when the central bank's

	IT[(1)]	NIT[(1)]	IT[(2)]	NIT[(2)]
Society's loss (/100)	8.1262	11.8739	1.3673	6.1408
S.d. of π_t	0.9863	1.2884	0.8847	1.3074
S.d. of y_t	1.9014	1.7649	2.0268	1.7684
S.d. of Δi_t	1.4000	1.9852	1.4726	2.0227

Table 9: Deviation from baseline: different weights on the output objective ($^{(1)}$ $\phi_{y,IT} = \phi_{y,NIT} = 2$, $^{(2)}$ $\phi_{y,IT} \equiv \phi_{y,NIT} = 0.125$). Source: author's elaborations.

	IT	NIT
Society's loss (/100)	4.4058	8.9126
S.d. of π_t	0.7532	1.2932
S.d. of y_t	1.9711	1.8074
S.d. of Δi_t	2.0089	1.9333

Table 10: Deviation from baseline: no weight on interest rate smoothing objective ($\phi_{i,IT} \equiv \phi_{i,NIT} = 0$). Source: author's elaborations.

loss function does not include the interest rate (see table 10). On the other hand, nominal income growth targeting exhibits its main virtue of interest rate smoothing, as accounted for by Jensen (1999). The well-established finding on the predominant aggressiveness of inflation targeting is also supported by the dynamic adjustment path of the key macroeconomic aggregates following a fiscal shock (see figure 7 on page 27). All in all, the available evidence points to the conclusion that deficit disturbances play a key role in our analysis. Endogenous interest rate smoothing does shape heavily the conduct of monetary policy, although it is not able to generate sensible results by itself.

7 Conclusion

This paper rules out in favor of inflation targetiug as a superior monetary policy strategy in a second-best world. By running simulations on a micro-founded model *à la* Woodford (1996), we show that the alleged aggressiveness

	IT	NIT
Society's loss (/100)	7.8605	15.8995
S.d. of π_t	0.4123	0.5736
S.d. of y_t	2.6908	2.7654
S.d. of Δi_t	2.1333	1.3947

Table 11: Deviation from baseline: lower inflation elasticity to output gap ($\lambda = 0.1$). Source: author's elaborations.

of inflation targeters need not generate a suboptimal degree of interest rate inertia. When fiscal shocks are a source of nominal instability, the proposition of Ricardian equivalence does not hold any longer. A policy of falling rates of interest is then required to let the government comply with its intertemporal budget constraint. Since a central bank caring about nominal income growth aims at a slow convergence towards steady-state output, it fails to bring about the appropriate degree of aggressiveness. As a result, macroeconomic fluctuations are exacerbated rather than dampened.

We acknowledge that our study might be extended in several ways. The inclusion of optimized coefficients in the targeting rules would provide a more solid ground on which assessing alternative findings. Furthermore, a careful analysis of such parameters along the lines developed by Leitemo and Söderström (2001) might reveal additional robustness properties of our work.

A further point of investigation regards the introduction of different functional forms with respect to the ones assessed in the sensitivity analysis. In particular, Rudebusch (2000) finds that inertia in inflation adjustment plays a key role in determining the ranking among policy rules. A new inflation process may thus be considered:

$$\widehat{\pi}_t = \lambda \widehat{y}_t + \beta E_t \widehat{\pi}_{t+1} + (1-\beta)\widehat{\pi}_{t-1} + u_t^{\pi}.$$

The empirical relevance of the specification outlined above is subject to controversy. For instance, Galì and Gertler (1999) find strong evidence in favor of a purely forward-looking inflation equation. On the other hand, the position widely held in the literature consists in endorsing the more theoretically-

attractive form with sluggish adjustment (Jensen, 1999).

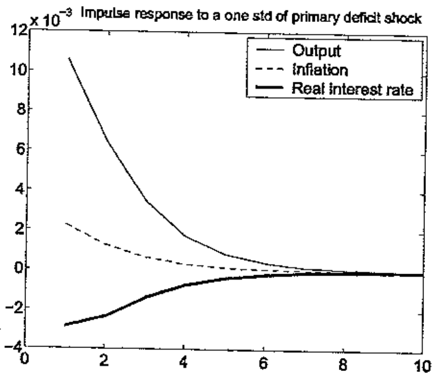
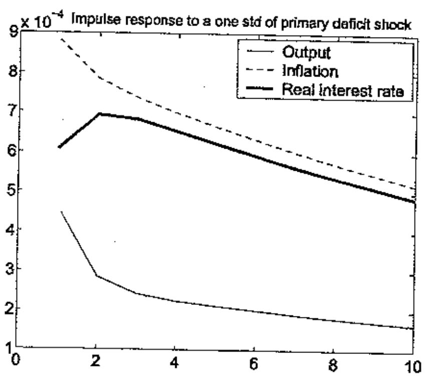
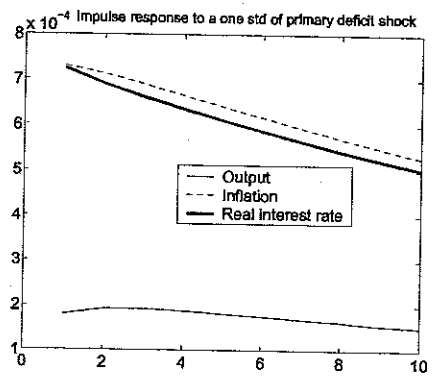


Figure 5: Effects of lower inflation elasticity to output gap ($\lambda = 0.1$) under nominal income growth targeting. Source: author's elaborations.

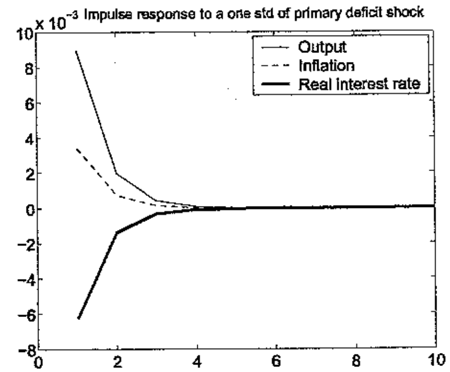


(a) Inflation targeting

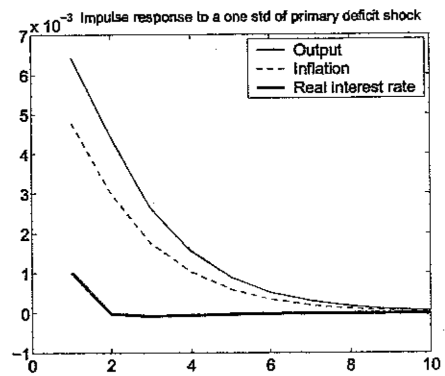


(b) Nominal income growth targeting

Figure 6: Effects of higher public debt elasticity to seignorage ($\gamma = 0.7$). Source: author's elaborations.



(a) Inflation targeting



(b) Nominal income growth targeting

Figure 7: Effects of no interest rate-smoothing objective ($\phi_{i,NIT} \equiv \phi_{i,IT} = 0$). Source: author's elaborations.

A State-space representation of the model

Recall the general expression for state-space representation of monetary policy models from Söderlind (1999):

$$A_0 \begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = A_1 \begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} + B_1 i_t + \widetilde{\xi}_{t+1}, \tag{16}$$

with

$$\widetilde{\xi}_{t+1} \equiv \begin{bmatrix} \epsilon_{t+1} \\ 0 \end{bmatrix}.$$

By multiplying A_0^{-1} to both the sides of equation 16, we obtain the compact notation:

$$\begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = A x_t + B i_t + \xi_{t+1}, \tag{17}$$

where $A = A_0^{-1} A_1$, $B = A_0^{-1} B_1$, and $\xi_{t+1} = A_0^{-1} \widetilde{\xi}_{t+1}$. From this definition of the structural disturbance vector, it follows that

$$\mathrm{Cov}\left(\xi_t\right) \equiv \Sigma = A_0^{-1} \mathrm{Cov}(\widetilde{\xi}_t) A_0^{-1\prime}.$$

The target variables are traditionally expressed as a linear combination of both x_t and u_t:

$$z_t = C_x x_t + C_i i_t. \tag{18}$$

We define the vectors of state variables under policy regimes as

$$x_{1t} \equiv \left[u_t^y,\ u_t^\pi,\ u_t^r,\ \widehat{b}_t,\ \widehat{D}_t,\ \widehat{m}_{t-1},\ r_{t-1}^n,\ \widehat{y}_{t-1}\right]', \tag{19}$$

$$x_{2t} \equiv \left[\widehat{y}_t,\ \widehat{\pi}_t\right]', \tag{20}$$

while the disturbance vector is given by

$$\widetilde{\xi}_{t+1} \equiv \left[\epsilon_{t+1}^y,\ \epsilon_{t+1}^\pi,\ \epsilon_{t+1}^r,\ 0,\ u_{t+1}^d,\ \mathbf{0}_{5\times1}'\right]'. \tag{21}$$

The formulation of x_{1t} exploits the recursive property of the deficit process 8 on page 6. The coefficient vector of the monetary policy instrument is represented by

$$B_1 \equiv \left[\mathbf{0}_{3\times1}',\ 1,\ 0,\ -\psi,\ 1,\ 0,\ 1,\ 0\right]', \tag{22}$$

where $\mathbf{0}_{a\times b}$ is a null vector with dimension in the subscript. The remaining matrices can be written as:

$$A_0 \equiv \begin{bmatrix} \mathbf{I}_{4\times4} & \mathbf{0}_{3\times2} & & \mathbf{0}_{4\times4} & & \\ & 0 & \gamma & & & \\ \mathbf{0}_{4\times4} & \mathbf{I}_{4\times4} & \mathbf{0}_{4\times2} & & & \\ \mathbf{0}_{2\times8} & & & & \mathbf{I}_{1\times2} & \\ & & & & 0 & \beta \end{bmatrix}, \tag{23}$$

$$A_1 \equiv \begin{bmatrix} \Xi_{3\times3} & & & & \mathbf{0}_{3\times7} & & & \\ \mathbf{0}_{1\times3} & & & \frac{1}{\beta} & \frac{1}{\beta}-1 & \gamma & \mathbf{0}_{2\times3} & -\left(\gamma+\frac{1}{\beta}\right) \\ \mathbf{0}_{4\times4} & & & & \rho_d & 0 & & 0 \\ & & & & \mathbf{0}_{3\times4} & & \frac{1}{\epsilon} & 0 \\ & & & & & & \mathbf{0}_{1\times2} & \\ & & & & & & 1 & 0 \\ -\mathbf{I}_{2\times2} & 1 & \mathbf{0}_{2\times5} & & & & 1 & 0 \\ & 0 & & & & & -\lambda & 1 \end{bmatrix}. \tag{24}$$

The object $\mathbf{I}_{c\times d}$ is an identity matrix of suitable dimensions, while $\Xi_{3\times3}$ is defined as

$$\Xi_{3\times3} \equiv \begin{bmatrix} \rho_y & 0 & 0 \\ 0 & \rho_\pi & 0 \\ 0 & 0 & \rho_r \end{bmatrix}.$$

Define $\Delta r_t^n \equiv r_t^n - r_{t-1}^n$. Assuming $z_t^{\mathrm{IT}} \equiv [\widehat{y}_t,\ \widehat{\pi}_t,\ \Delta r_t^n]'$, we have that

$$C_x^{\mathrm{IT}} \equiv \begin{bmatrix} \mathbf{0}_{2\times8} & \mathbf{I}_{2\times2} & \\ \mathbf{0}_{1\times6} & -1 & \mathbf{0}_{1\times3} \end{bmatrix}, \quad C_i^{\mathrm{IT}} \equiv \begin{bmatrix} \mathbf{0}_{2\times1} \\ 1 \end{bmatrix}. \tag{25}$$

The state space form of the model under nominal income growth targeting follows from marginal changes with respect to the one under inflation targeting. It is straightforward to notice that no modifications of the state variables defined earlier are needed. As a result, the coefficients matrices are unchanged. Only the transition equation 18 is characterized in a different fashion. The vector of target variables is re-written as

$$z_t^{\mathrm{NIT}} \equiv [\widehat{y}_t,\ \widehat{g}_t,\ \Delta r_t^n]', \tag{26}$$

and

$$C_x^{\text{NIT}} \equiv \begin{bmatrix} 0_{3\times 6} & 0_{1\times 2} & & 1 & 0 \\ & 0 & -1 & 1 & 1 \\ & -1 & 0_{1\times 3} & & \end{bmatrix}, \quad C_i^{\text{NIT}} = C_i^{\text{IT}}. \tag{27}$$

C Essential numerical algorithms

At time 0, the central bank minimizes the intertemporal loss function

$$J_0 = \sum_{\tau=0}^{+\infty} \delta^\tau L_{t+\tau} \tag{28}$$

for each period loss function in table 1 on page 6. Such functions can also be expressed as

$$L_t = z_t' K z_t, \tag{29}$$

where K is a diagonal weighing matrix of preference parameters.

By substituting the relation 18 into equation 29, and solving out, we obtain

$$\begin{aligned} L_t &= \begin{bmatrix} x_t' & i_t' \end{bmatrix} \begin{bmatrix} C_x' \\ C_i' \end{bmatrix} K \begin{bmatrix} C_x & C_i \end{bmatrix} \begin{bmatrix} x_t \\ i_t \end{bmatrix} \\ &= x_t' C_x' K C_x x_t + x_t' C_x' K C_i i_t + i_t' C_i' K C_x x_t + i_t' C_i' K C_i i_t \\ &\equiv x_t' Q x_t + x_t' U i_t + i_t' U x_t + i_t' R i_t \\ &\equiv x_t' Q x_t + 2 x_t' U i_t + i_t' R i_t \end{aligned} \tag{30}$$

with

$$Q \equiv C_x' K C_x,$$

$$U \equiv C_x' K C_i,$$

$$R \equiv C_i' K C_i.$$

The constraints to the optimization problem can be written in compact notation as

$$x_{t+1} = A x_t + B i_t + \xi_{t+1}, \quad \text{and } x_{10} \text{ given.} \tag{31}$$

The vector of innovations has the form

$$\xi_{t+1} = \left[\epsilon_{t+1}', \ (x_{2t+1} - E_t x_{2t+1})'\right]',$$

with the second term on the right-hand side denoting the shocks to the forward looking variables.

The solution strategy for the commitment case consists in expressing the first-order conditions as a Vector-Autoregressive System - VAR(1) - of rational expectations equations. The method developed by Klein (2000) can then be applied to the resulting model. The generalized Schur decomposition is used to isolate the block of stable roots from that of unstable and nearly-stable roots. Finally, the standard saddle-path condition by Blanchard and Kahn (1980) for the uniqueness of solutions is imposed. After the steady-state coefficient matrix of the VAR(1) system has been found, it is straightforward to compute the optimal interest rate rule as a function of the state variables.

No closed-form solution exists for the model with discretionary policy. Hence, numerical iteration is applied on a recursive representation of the value loss function to solve for stable coefficients. The reader can refer to Söderlind (1999) for a rigorous outliue of the mathematical procedure.

D Covariance matrices under alternative regimes

In order to evaluate the quantitative performance of our policy rules, we need to calculate the unconditional covariance matrix of the target variables. Although they are not used in this paper, we include also the computations for the commitment case. The following discussion is based on appendix B.3 of Leitemo and Söderström (2001).

D.1 Commitment

After applying the generalized Schur decomposition to the system of rational expectation equations, Söderlind (1999) obtains the following equilibrium relations:

$$\begin{bmatrix} x_{2t} \\ i_t \\ \mu_{1t} \end{bmatrix} = \underbrace{Z_{\varphi\theta} Z_{k\theta}^{-1}}_{\Omega_c} \begin{bmatrix} x_{1t} \\ \mu_{2t} \end{bmatrix}, \tag{32}$$

$$\begin{bmatrix} x_{1t+1} \\ \mu_{2t+1} \end{bmatrix} = \underbrace{Z_{k0} S_{\theta\theta}^{-1} T_{\theta\theta} Z_{k\theta}^{-1}}_{\Gamma_c} \begin{bmatrix} x_{1t} \\ \mu_{2t} \end{bmatrix} + \begin{bmatrix} \epsilon_{t+1} \\ \mathbf{0}_{n_2 \times 1} \end{bmatrix}, \tag{33}$$

where $\mu_{\iota t}$, $\iota = 1, 2$ indicates the vector of Lagrange multipliers.

We re-define the vectors

$$k_t \equiv \begin{bmatrix} x_{1t} \\ \mu_{2t} \end{bmatrix}, \quad \varphi_t \equiv \begin{bmatrix} x_{2t} \\ i_t \\ \mu_{1t} \end{bmatrix}. \tag{34}$$

Under commitment, the covariance matrix of k_t can then be written as

$$\Sigma_k = \Gamma_c \Sigma_k \Gamma_c' + \Sigma_{\epsilon_k}, \tag{35}$$

and

$$\Sigma_{\epsilon_k} = \begin{bmatrix} \Sigma_{\epsilon_1} & \mathbf{0}_{n_1 \times n_2} \\ \mathbf{0}_{n_1 \times n_2} & \mathbf{0}_{n_1 \times n_2} \end{bmatrix}. \tag{36}$$

A suitable expression for Σ_k can be found by applying the vec operator to equation 35:

$$\operatorname{vec}(\Sigma_k) = [I_{n^2} - \Gamma_c \otimes \Gamma_c]^{-1} \operatorname{vec}(\Sigma_{\epsilon_k}). \tag{37}$$

After re-shuffling the laws of motion of k_t and φ_t, Leitemo and Söderström (2001) obtain the following expression:

$$\Pi \equiv \begin{bmatrix} k_t \\ \varphi_t \end{bmatrix} = \begin{bmatrix} I_n \\ \Omega_c \end{bmatrix} k_t. \tag{38}$$

The covariance matrix of Π is

$$\Sigma_\Pi = \begin{bmatrix} I_n \\ \Omega_c \end{bmatrix} \Sigma_k \begin{bmatrix} I_n \\ \Omega_c \end{bmatrix}'. \tag{39}$$

The final step consists in isolating the covariance matrix Σ_{xi} of the target variables from Σ_Π, so as to calculate

$$\Sigma_z = C \Sigma_{xi} C', \tag{40}$$

such that the coefficients matrix of z_t in equation 18 is re-arranged as

$$C = [C_x, \; C_i]. \tag{41}$$

D.2 Discretion

After a stable decision is computed, we express the first line of the constraint 17 as

$$x_{1t+1} = \underbrace{(A_{11} + A_{12}N - B_1 F)}_{\Gamma_d} x_{1t} + \epsilon_{t+1}. \tag{42}$$

The covariance matrix of x_{1t} under discretionary monetary policy is easily found by applying the vec operator:

$$\operatorname{vec}(\Sigma_{x_{1t}}) = \left[I_{n_1^2} - \Gamma_d \otimes \Gamma_d\right]^{-1} \operatorname{vec}(\Sigma_\epsilon). \tag{43}$$

After including the converged values of x_{2t} and i_t into the definition of the target variables, we obtain

$$z_t = [C_{x_1} + C_{x_2} N + C_i F] \, x_{1t}. \tag{44}$$

The covariance matrix of the goal variables is then given by

$$\Sigma_z = C_d \Sigma_{x_{1t}} C_d', \tag{45}$$

where

$$C_d \equiv [C_{x_1} + C_{x_2} N + C_i F]. \tag{46}$$

The reader should notice that the variance of the inflation rate under nominal income growth targeting does not enter any of the covariance matrices outlined earlier. It can instead be obtained from the converged relation between forward-looking and predetermined variables as

$$\Sigma_{x_{2t}} = N \Sigma_{x_{1t}} N'. \tag{47}$$

References

Barro, Robert, and D. B. Gordon, "Rules, Discretion, and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics*, Vol. 12, 101-121, 1983

Blanchard, Olivier J., and C. M. Kahn, "The Solution to Linear Difference Models under Rational Expectations", *Econometrica*, Vol. 48, No. 5, 1305-1313, July 1980

Clarida, Richard, Jordi Galì, and Mark Gertler, "The Science of Monetary Policy: A New Keynesian Perspective", *Journal of Economic Literature*, Vol. 37, No. 4, December 1999

Currie, David, and Paul Levine, *Rules, Reputation and Macroeconomic Policy Coordination*, Cambridge University Presss, 1993

Galì, Jordi, and Mark Gertler, "Inflation Dynamics: A Structural Econometric Analysis", *Journal of Monetary Economics*, Vol. 44, No. 2, October 1999

Jensen, Henrik, "Targeting Nominal Income Growth or Inflation?", *CEPR Working Paper*, No. 2341, London, December 1999

Klein, Paul, "Using the Generalized Schur Decomposition to Solve a Multivariate Linear Rational Expectations Model", *Journal of Economic Dynamics and Control*, Vol. 24, No. 10, September 2000

Leeper, Eric M., "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies", *Journal of Monetary Economics*, Vol. 27, No. 2, 129-147, 1991

Leitemo, Kai, and Ulf Söderström, "Simple Monetary Policy Rules and Exchange Rate Uncertainty", *Working Paper*, No. 122, Sveriges Riksbank, June 2001

McCallum, Bennett T, and Edward Nelson, "Performance of Operational Policy Rules in an Estimated Semi-Classical Structural Model", in Taylor (1999)

Natalucci, Fabio Massimo, and Alessandro Pandimiglio, "Fiscal Policy and Macroeconomic Stability: Forward Looking vs. Backward Looking Monetary Policy Rules", *ISE Working Paper*, No. 114, Luiss University, Rome, April 2000

Perotti, Roberto, "Fiscal Consolidation in Europe: Composition Matters", *American Economic Review, AEA Papers and Proceedings*, Vol. 86, No. 2, 105-110, May 1996

Rudebusch, Glenn D., "Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty", *Working Paper*, No. 3, Federal Reserve Bank of San Francisco, October 2000

Rudebusch, Glenn D., "Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia", *Working Paper*, No. 2, Federal Reserve Bank of San Francisco, January 2001

Rudebusch, Glenn D., and Lars E. O. Svensson, "Policy Rules for Inflation Targeting", in Taylor (1999)

Sims, Christopher A., "The Precarious Fiscal Foundations of EMU", *Staff Report*, No. 34, De Nederlandsche Bank, December 1998

Svensson, Lars E. O., "Optimal Inflation Targets, 'Conservative' Central Banks, and Linear Inflation Contracts", *American Economic Review, AEA Papers and Proceedings*, Vol. 87, No. 1, 98-114, March 1997

Svensson, Lars E. O., "Inflation Targeting as a Monetary Policy Rules", *NBER Working Paper*, No. 6790, November 1998

Söderlind, Paul, "Solution and Estimation of RE Macromodels with Optimal Policy", *European Economic Review*, Vol. 43, No. 2, 813-823, 1999

Söderlind, Paul, "Lecture Notes on the Effects of Monetary Policy", *unpublished manuscript*, Stockholm School of Economics, May 2001

Taylor, John B., *Monetary Policy Rules*, Chicago University Press, 1999

Walsh, Carl E., "The Output Gap and Optimal Monetary Policy", *unpublished manuscript*, University of California at Santa Cruz, March 2001

Woodford, Michael, "Control of the Public Debt: A Requirement for Price Stability?", *NBER Working Paper*, No. 5684, July 1996

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