On (Sub)Optimal Monetary Policy Rules under Untied Fiscal Hands

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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 (1997). 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 (2002)'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.

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Keywords: interest rate smoothing, monetary policy rules, fiscal shocks.

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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 contribution to this issue, Woodford (1997) 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 (1997)'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 policy rules, namely inflation targeting and nominal income growth targeting. We perform simulations of optimal policy on a simple variant of Woodford (1997)'s model developed by Natalucci and Pandimiglio (2000). It is intuitively appealing that a ranking among alternative policy regimes depends on their endogenous properties. Among others, Jensen (2002) 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.

In the traditional 'Ricardian' analysis of fiscal policy, government deficits have no impact on nominal variables. Households are assumed to formulate consumption decisions so as to insulate aggregate saving from fiscal shocks. The model employed here is instead grounded on the so-called 'fiscal theory of price level determination'. The introduction of price rigidities in the context of typically 'Ricardian' assumption - rational expectations, lump-sum taxation and frictionless markets (Woodford, 1997) - amplifies the impact of fiscal policy on the demand side of the economy. In other words, fiscal shocks do shift the intertemporal budget constraint of households through the wealth effect of public debt, and affect both inflation and the output gap at the aggregate level.

Once a debt shock takes place, the underlying adjustment mechanism at work to bring the economy back to equilibrium depends on the sign of the initial reaction of the monetary authority. Inflation targeters prefer a ‘tougher’ stance at the beginning of the simulation, in the sense that they put stronger efforts in eliminating the roots of instability. In order to offset consumption swings, they promote faster reductions of public debt by allowing the real interest rate to fall below zero. The paper shows that this strategy 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.

Strikingly, our numerical results demonstrate that the difference in the macroeconomic outcomes of the two policy strategies do not originate from the extent of interest rate smoothing, that is a sluggish adjustment of real interest rates. 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 when public debt instability contributes to macroeconomic fluctuations. The intuition behind this reasoning is that there are several channels through which monetary policy can limit public debt swings. We stress the role of real interest expenditures, seignorage revenues, and the reduction of nominal debt through inflation. The endogenous properties of our monetary policy rules interact with these factors under the quest for stability. The ‘aggressiveness’ of inflation targeting referred to above is beneficial for it immediately prevents an unstable public debt from turning into unstable inflation. The endogenous money supply rule plays a stronger role in a growing economy, namely when public debt changes keep on boosting aggregate demand throughout the adjustment path. But, in this case, also the inflation rate keep on displaying a positive sign.

Jensen (2002) compares inflation and nominal income targeting by using a ‘New-Keynesian’ macromodel with nominal rigidities calibrated to fit US data. Differently from our framework, any scope for fiscal shocks is neglected. Jensen (2002)’s simulations indicate that discretionary inflation targeting leads to an excessive stability of output, but too volatile inflation relative to the commitment solution. This is the so-called ’stabilization bias’ of inflation targeters. Bringing about a larger interest rate inertia, nominal income growth targeting under discretion produces more stable inflation and more volatile output than inflation targeting, thus bringing the discretionary equilibrium closer to the commitment one. We demonstrate that the inclusion of public debt reverses this outcome. Owing to a milder interest rate stance towards the removal of instability, the volatility of inflation is exacerbated under nominal income targeting with respect to inflation targeting. Puzzingly, the 'stabilization bias' of monetary policy manifests itself in an alternative way when public debt matters for aggregate demand. The hidden inertia of nominal income targeting acknowledged in Jensen (2002) turns out to be destabilizing in our model, for it implies moderate changes of the real interest rates. And their offsetting power on real debt swings is shown to be relatively low.

The empirical relevance of the scenarios described in this paper is magnified in a common currency area, where monetary policy can exert different effects at the 'regional' - i.e. national - 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 paper is structured as follows. Section 2 describes the log-linearized version of our Woodford (1997)-type model. The formalization of the monetary policy regimes under investigation is discussed in section 3, where the technical steps involved in the evaluation of targeting rules are also discussed. 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, and appendix B deals with the unconditional covariance matrix of the target variables under discretion.

2 A microfounded model with sticky prices

The amended model *à la* Woodford is characterized by a measure of identical infinitely-lived households. Each of them acts as 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 (1997). 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:

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

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

A clarification on the notation is due at this point of the discussion. The variables bearing a hat are expressed as log-deviations from the steady state.

The IS relationship of equation 1 derives from the intertemporal consumption Euler equation of the representative household. It is noteworthy that the solution to the consumption/saving decision problem assumes the existence of one-period risk-free government bills as the only interest-bearing financial asset. 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 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. Although arising as a convolution of several deep parameters, the term λ bears the intuitive interpretation of trade-off measure between output and inflation. Interestingly such a trade-off is determined mainly by the degree of price rigidity. For instance, when all the prices are assumed to be fixed, λ is equal to zero, and the inflation rate does not vary as a function of output deviations from trend. With perfectly flexible prices, λ is infinitely large.

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 log-linearized 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,

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

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

The evolution of 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 (1999). 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.

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, 2002).

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 (2002), and Walsh (2002) 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 (2002) 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 general need for safeguarding financial markets stability. In our context, there is the ad-hoc concern of preventing serially-correlated shocks from having a destabilizing impact well beyond reasonability.

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 - $\widehat{r}_t^n$ in our model - is denoted by i_t. Further details on the representation of the model can be found in appendix A.

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 of equation 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

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

3.2 The solution algorithm

At this point, the problem is expressed as a dynamic program with expectational terms. The solution strategy for the commitment case follows Söderlind (1999) in expressing the first-order conditions as a Vector-Autoregressive System - VAR(1) - of rational expectation equations. The method developed by Klein (2000) is then 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 of 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 function to solve for stable coefficients (see Söderlind, 1999).

The optimal rules for the policy instrument are computed as

$$i_t^c = -F^c \left[\begin{array}{c} x_{1t} \\ \rho_{2t} \end{array} \right], \quad i_t^d = -F^d x_{1t}.$$

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. The policy stance is decided once for all over the period. 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. In other words, the central bank does not internalize the impact of monetary policy over agents' expectations - the so-called "maximization within the period". The policymaker revises its actions every period, and 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):

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

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

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 by including the optimized coefficients into its analytical expression:

$$J_t^{opt} = x'_{1t} V_t x_{1t} + \upsilon_t,$$

where

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

and V is a symmetric matrix to be determined.

The results of this paper have been obtained by modifying the Matlab routines provided by Paul Söderlind. The code is available from the author upon request.

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.

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 (1997).

The coefficient values in table 2 are taken from Woodford (1997). The 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 (2002). Such a configuration relies on earlier studies by Jensen (2002) 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 (1997) 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).

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

Table 4: Baseline weights of target variables.

Differently from Jensen (2002), 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).

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. The aim is to provide the ground for key insights against which the effects of deviations from baseline parameters can be assessed.

The reader should also be aware that two different measure of interest rate inertia will be introduced for the rest of the paper. In particular, while commenting on the figures, we will still refer to 'inertia' in terms of *ex-ante* real interest rates as in the previous section. That is a more appealing measure of the impact of monetary policy on output. On the contrary, the numerical results reported in the forthcoming tables refers to inertia as the period-to-period change in the nominal interest rate. There we conform to the standard practice in studies of sluggish interest rate behavior.

The impulse-response functions are traced by simulating the model under alternative configurations of the disturbance vector 21 on page 25. 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, output swings are stabilized almost completely in the short run, albeit not at long horizons. Positive real interest rates generate an upsurge in real public debt, thus boosting households' consumption via the wealth channel. In the end, this produces a persistent - and declining - deviation of inflation from steady state.

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

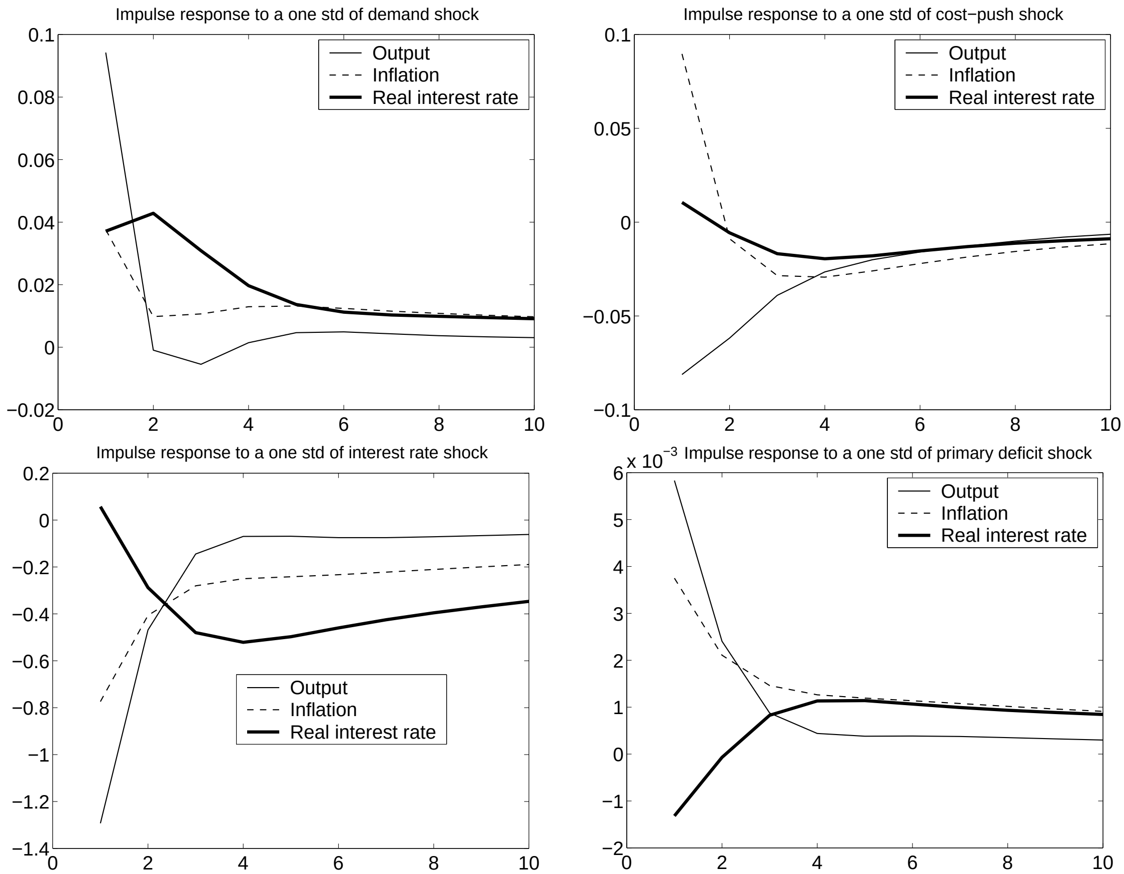


Figure 1: Impulse-response functions under commitment, inflation targeting.

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 from discriminating between inflation targeting and income growth targeting. Like in Jensen (2002), 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

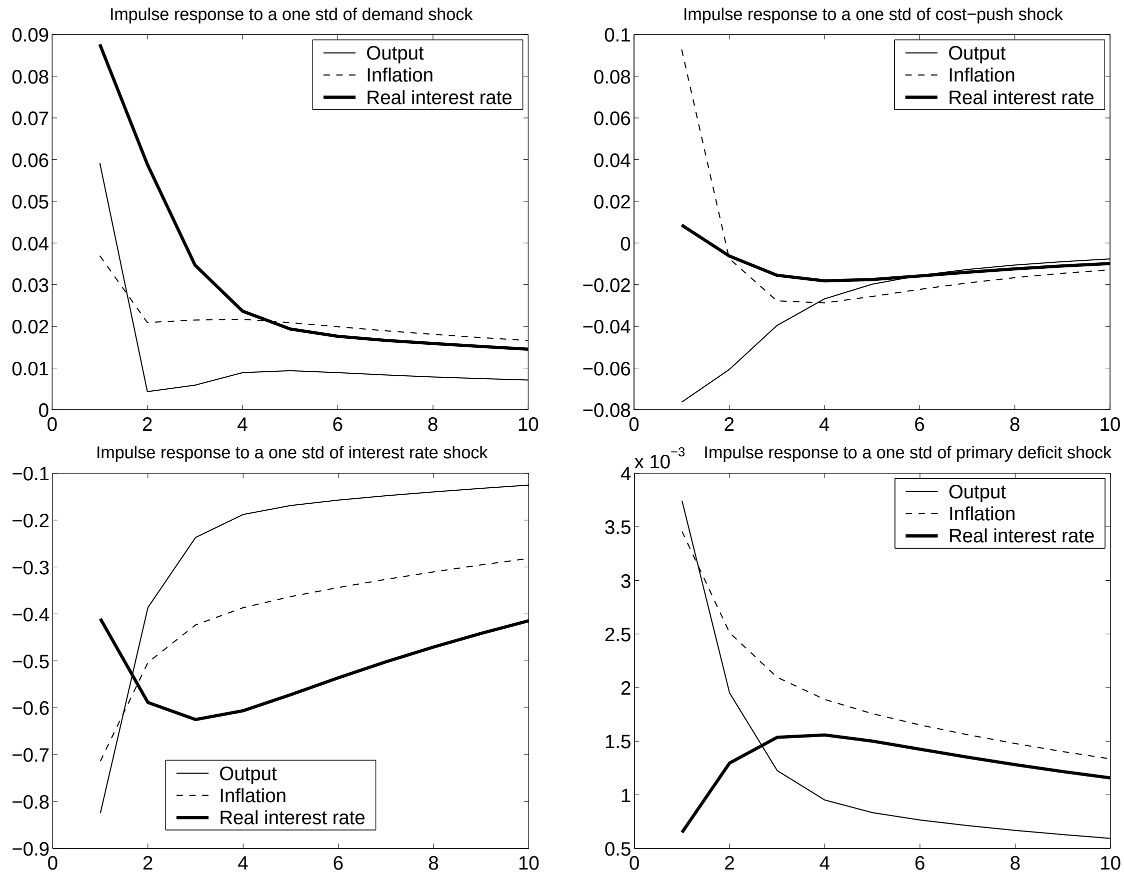


Figure 2: Impulse-response functions under commitment, nominal income growth targeting.

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 (2002)'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 (1997), 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, the reader should notice that 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, 1997). 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 does not internalize 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

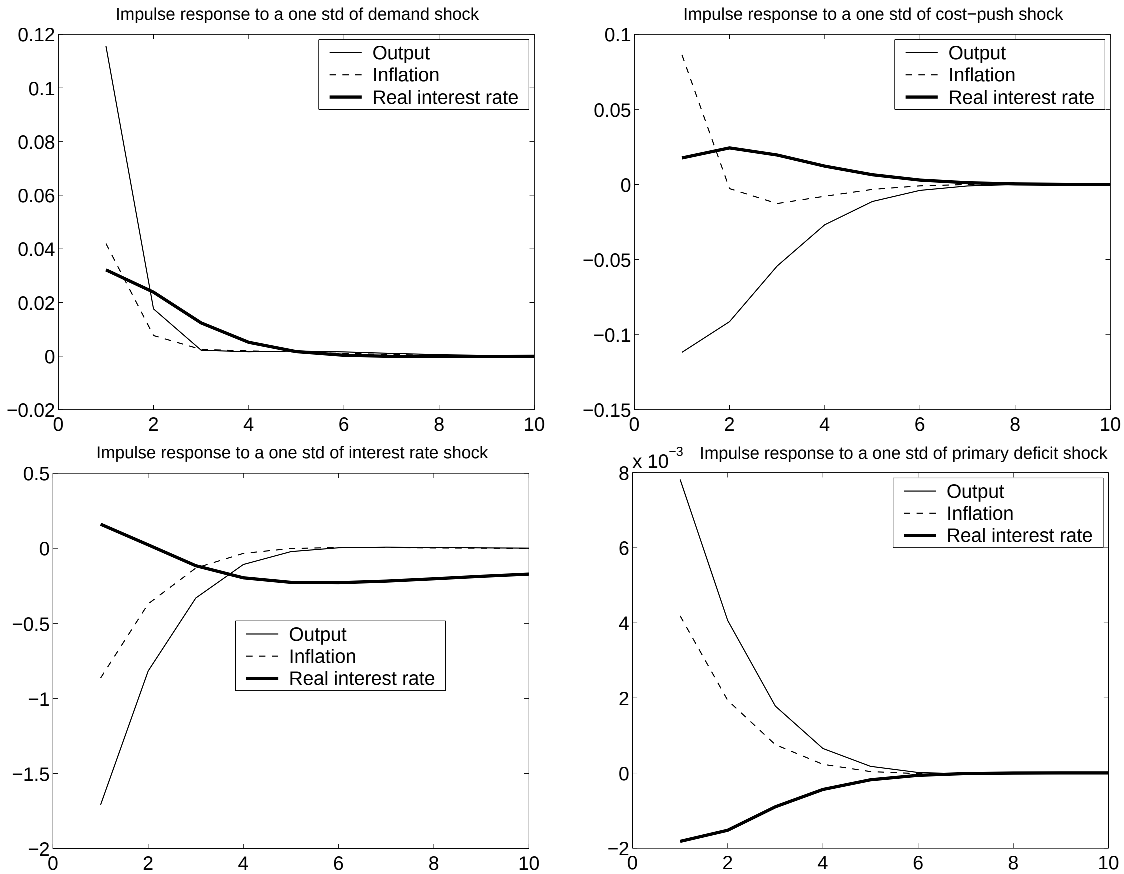


Figure 3: Impulse-response functions under discretion, inflation targeting.

replicate the inertial behavior that characterizes them under commitment. Thus, we extend the recent findings by Jensen (2002), 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 18 reports some descriptive statistics under baseline parameters. Two

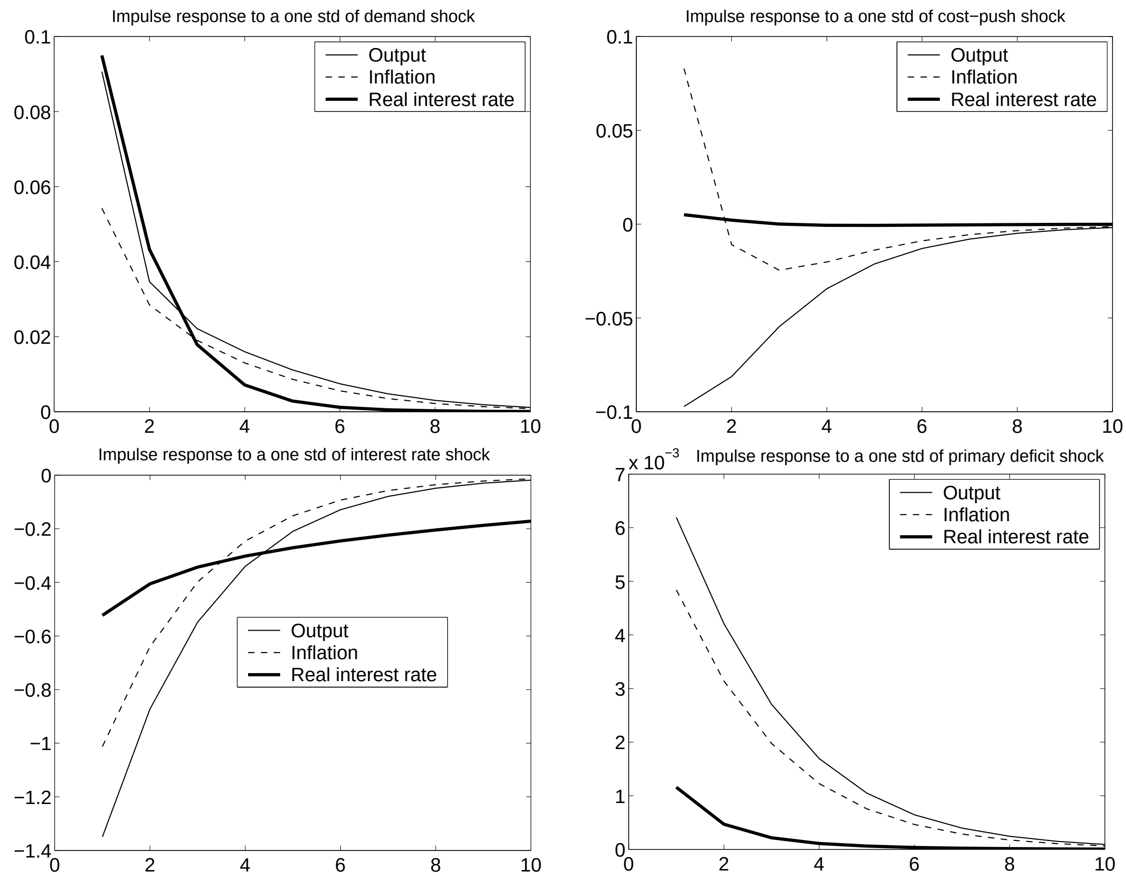


Figure 4: Impulse-response functions under discretion, nominal income growth targeting.

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 (2002). Our indicator provides for an exact measure of the variance of the real interest rate, whereas Jensen (2002) 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

	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.

are at odds with Jensen (2002), 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 (1997)'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 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.

	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 ($\lambda = 0.9$).

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 22 shows that this occurs at the cost of larger output swings than under inflation targeting. Again, such 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 23). But that does not imply raising interest rates any further. Jensen (2002) 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

	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 ($\beta = 0.7$).

forces.

	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 ($\gamma = 0.7$).

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 targeting turns out lower than under inflation targeting (see table 8). Figure 6(a) on page 23 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

	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 ($^{(1)}$ $\phi_{y,IT} = \phi_{y,NIT} = 2$, $^{(2)}$ $\phi_{y,IT} \equiv \phi_{y,NIT} = 0.125$).

	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 ($\phi_{i,IT} \equiv \phi_{i,NIT} = 0$).

confirmed.

The main properties of inflation targeting hold even when the central bank's loss function excludes an explicit objective of interest rate smoothing (see table 10). On the other hand, nominal income growth targeting exhibits its main virtue of sluggish adjustment of nominal interest rates, as accounted for by Jensen (2002). The well-established finding on the predominant aggressiveness of inflation targeting is also supported by the dynamic path of the key macroeconomic aggregates following a fiscal shock (see figure 7 on page 24). 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 brings evidence in favor of inflation targeting as a superior monetary policy strategy in a second-best world. By running simulations on a microfounded model *à la* Woodford (1997), we demonstrate that the alleged aggressiveness of inflation targeters need not gener-

	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 ($\lambda = 0.1$).

ate 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.

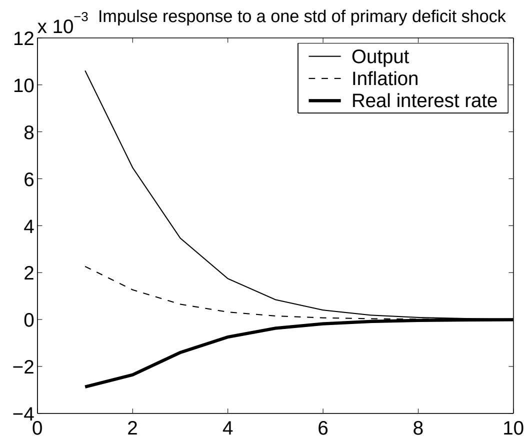
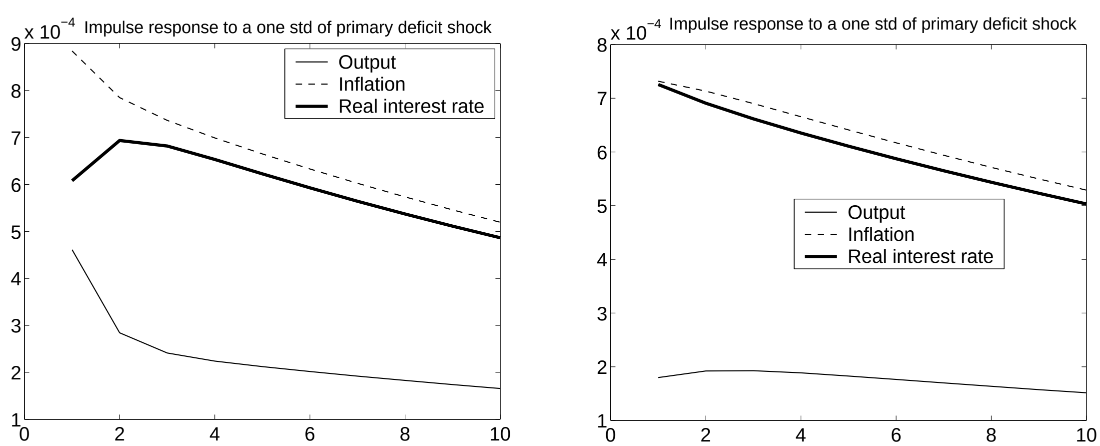


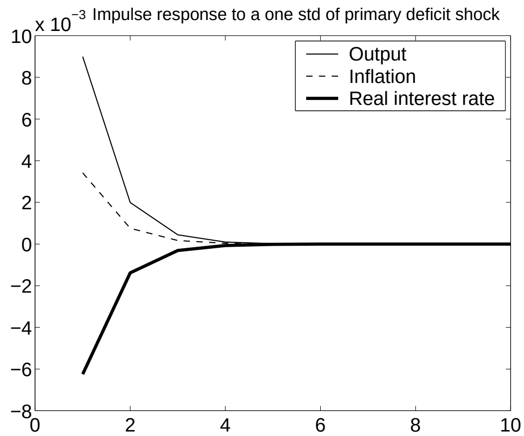
Figure 5: Effects of lower inflation elasticity to output gap ($\lambda = 0.1$) under nominal income growth targeting.



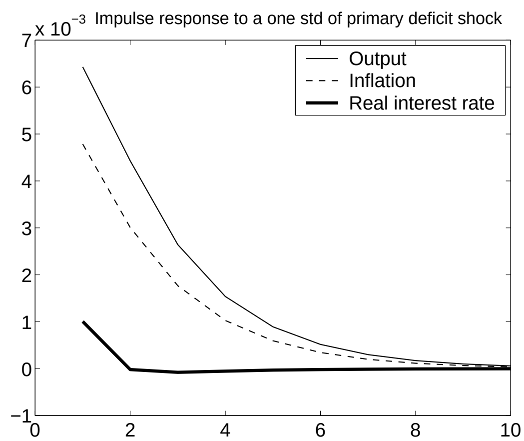
(a) Inflation targeting

(b) Nominal income growth targeting

Figure 6: Effects of higher public debt elasticity to seignorage ($\gamma = 0.7$).



(a) Inflation targeting



(b) Nominal income growth targeting

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

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

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

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

$$\begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = Ax_t + Bi_t + \xi_{t+1}, \tag{17}$$

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

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

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

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

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

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:

$$A_0 \equiv \left[\begin{array}{cccccc} \mathbf{I}_{4\times 4} & \mathbf{0}_{3\times 2} & & \mathbf{0}_{4\times 4} & & \\ & 0 & \gamma & & & \\ \mathbf{0}_{4\times 4} & \mathbf{I}_{4\times 4} & \mathbf{0}_{4\times 2} & & & \\ \mathbf{0}_{2\times 8} & & & & 1 & 1 \\ & & & & 0 & \beta \end{array}\right], \tag{23}$$

$$A_1 \equiv \left[\begin{array}{ccccccc} \Xi_{3\times 3} & & & \mathbf{0}_{3\times 7} & & & \\ \mathbf{0}_{1\times 3} & & \frac{1}{\beta} & \frac{1}{\beta}-1 & \gamma & \mathbf{0}_{2\times 3} & -\left(\gamma+\frac{1}{\beta}\right) \\ \mathbf{0}_{4\times 4} & & & \rho_d & 0 & & 0 \\ & & & \mathbf{0}_{3\times 4} & & \frac{1}{\varepsilon} & 0 \\ & & & & & \mathbf{0}_{1\times 2} & \\ & & & & & 1 & 0 \\ -\mathbf{I}_{2\times 2} & 1 & \mathbf{0}_{2\times 5} & & & 1 & 0 \\ & 0 & & & & -\lambda & 1 \end{array}\right]. \tag{24}$$

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

$$\Xi_{3\times 3} \equiv \left[\begin{array}{ccc} \rho_y & 0 & 0 \\ 0 & \rho_\pi & 0 \\ 0 & 0 & \rho_r \end{array}\right].$$

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

$$C_x^{\mathrm{IT}} \equiv \left[\begin{array}{ccc} \mathbf{0}_{2\times 8} & \mathbf{I}_{2\times 2} & \\ \mathbf{0}_{1\times 6} & -1 & \mathbf{0}_{1\times 3} \end{array}\right], \quad C_i^{\mathrm{IT}} \equiv \left[\begin{array}{c} \mathbf{0}_{2\times 1} \\ 1 \end{array}\right]. \tag{25}$$

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

$$C_x^{\mathrm{NIT}} \equiv \left[\begin{array}{ccccc} \mathbf{0}_{3\times 6} & \mathbf{0}_{1\times 2} & & 1 & 0 \\ & 0 & -1 & 1 & 1 \\ & -1 & \mathbf{0}_{1\times 3} & & \end{array}\right], \quad C_i^{\mathrm{NIT}} = C_i^{\mathrm{IT}}. \tag{27}$$

B Unconditional covariances under discretionary policy

In order to evaluate the quantitative performance of our policy rules, we need to calculate the unconditional covariance matrix of the target variables. After a stable decision is computed, we express the first line of the constraint 17 as

$$x_{1t+1} = \Gamma_d x_{1t} + \epsilon_{t+1}, \tag{28}$$

with

$$\Gamma_d \equiv \left(A_{11} + A_{12}N - B_1 F\right).$$

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

$$\text{vec}\left(\Sigma_{x_{1t}}\right) = \left[I_{n_1^2} - \Gamma_d \otimes \Gamma_d\right]^{-1} \text{vec}\left(\Sigma_\epsilon\right). \tag{29}$$

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

$$z_t = \left[C_{x_1} + C_{x_2}N + C_i F\right] x_{1t}. \tag{30}$$

The covariance matrix of the goal variables is then given by

$$\Sigma_z = C_d \Sigma_{x_{1t}} C_d', \tag{31}$$

where

$$C_d \equiv \left[C_{x_1} + C_{x_2}N + C_i F\right]. \tag{32}$$

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

$$\Sigma_{x_{2t}} = N \Sigma_{x_{1t}} N'. \tag{33}$$

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

Calvo, Guillermo, and Mervin King (eds.), *The Debt Burden and Its Consequences for Monetary Policy*, London, MacMillan, 1997

Clarida, Richard, Jordi Galì, and Mark Gertler, "The Science of Monetary Policy: A New Keynesian Perspective", *Journal of Economic Literature*, Vol. 37, No. 4, 1661-1707, 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, 195-222, October 1999

Jensen, Henrik, "Targeting Nominal Income Growth or Inflation?", forthcoming on the *American Economic Review*, 2002

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, 1405-1423 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*, Vol. 87, No. 1, 98-114, March 1997

Svensson, Lars E. O., “Inflation Targeting as a Monetary Policy Rules”, *Journal of Monetary Economics*, Vol. 56, No. 2, 45-73, June 1999

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. (ed.), *Monetary Policy Rules*, Chicago University Press, 1999

Walsh, Carl E., “The Output Gap and Optimal Monetary Policy”, forthcoming on the *American Economic Review*, 2002

Woodford, Michael, “Control of the Public Debt: A Requirement for Price Stability?”, in Calvo and King (1997)