Taylor rules for monetary policy in a closed economy

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Abstract

This paper studies monetary stabilization policies in a DSGE model with Calvo type nominal fixities and imperfect competition. We model Monetary policy to follow alternative Taylor-type rules. We find that the monetary authority can guarantee the joint stabilization of inflation and output through the baseline Taylor rule (Taylor 1993) with strong enough reaction to inflation and no reaction to the output gap. Moreover, we find that the joint stabilization of inflation and output requires neither the estimation of unobservable variables nor the optimal choice of reaction coefficients. Given that reaction coefficients always guarantee Blanchard-Kahn conditions a good monetary policy can be implemented through an operational Taylor type rule which responds to observed targets already known with certainty at the time of monetary policy action.

Keywords: Taylor Rules, Countercyclical Monetary Policy

JEL Classifications: E52, E58

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1 Introduction

In recent years Taylor-type rules have considered a widespread acknowledgement for the analysis of practical policy issues as well as for the assessment of several theoretical open debates. In this paper, we study monetary policy stabilization issues in a DSGE model with nominal fixities (Calvo-type) and imperfect competition. Following recent empirical literature such as Smets & Wouters (2003) and Rabanal & Tuesta (2010) who find that the reaction function of Central Banks can be summarized by Taylor-type rules and recent theoretical models such as Schmitt-Grohé & Uribe (2007) who show that simple Taylor rules can implement optimal policy of Ramsey type, we model the monetary authority to follow simple Taylor-type rules. Our scope is to analyze the effects of alternative monetary stabilization policies so we keep fiscal policy simple and we assume that the monetary authority worries about inflation and output. Our measure of stabilization is the unconditional second moment of inflation and output. In this model, it was proved that the monetary authority can avoid the trade-off between inflation and output stabilization, so the goal of the monetary authority is to stabilize jointly inflation and output. We focus on three key monetary policy issues: i) We ask whether monetary policy should react or not to the output gap. Several authors argue against countercyclical monetary policy mainly because the "best" operating target for the output is unobservable and often misspecified. Thus, a strong countercyclical reaction to a misspecified operating target for output causes intrinsic volatility in the economy which can be avoided. ii) We ask which is the "best" operating target for output, given that monetary policy responds countercyclically. We find that this is the natural level of output, i.e. the output that will prevail under flexible prices. However, we find that countercyclical monetary policy generates a trade-off between the goals of monetary policy (stabilization of inflation and output) under all the operating targets we examine and mentioned in the relevant literature except from the natural output. iii) We study if a monetary policy with good stabilization properties can be implemented through an operational Taylor rule. Several authors argue that simplicity and operationality are crucial for the successful implementation of monetary policy. Such a rule is of interest because it requires minimal information from the part of the policy maker, as the policy instrument (the nominal interest rate in our case) can be set as a function of easily observed macroeconomic indicators and it makes the communication of the monetary policy targets to the public simple. Moreover, Orphanides (2000) points out that not only are the expectation of inflation and the natural output measured with statistical errors but also current inflation and output can be measured with serious errors from real time data. Based on this critique, we use the "difference rule", proposed by Schmit-Grohe & Uribe (2007), in which the
policy instrument is set as a function of variables already known with certainty when monetary policy takes action and we relax their optimal choice of reaction coefficients to find if an operational Taylor rule suffices to stabilize the economy. Hopefully, we find that this rule can replicate and in some cases overperform all Taylor rules we examine and actually it can yield results very close to the strict inflation targeting policy which is near optimal in this model.

The remainder of the paper is organized in five sections. Section 2 presents the model, the decentralized equilibrium and policy. Section 3 presents the calibration and the long-run solution of the model. Section 4 discusses alternative monetary policies and the key results of the paper and section 5 concludes. In technical appendix you can find the analytical derivation of the model equilibrium described in Section 2, computational issues and some additional results (graphs and tables).

2 The Model

2.1 Households

There is a representative household indexed by $j$. Household $j$ yields utility from a consumption index $C_t(j)$, real money balances $m_t(j)$ and disutility from hours worked $N_t(j)$:

$$
\sum_{t=0}^{\infty} \beta^t U(C_t(j), m_t(j), N_t(j))
$$

The functional form of utility is given by $U_t(j) = \frac{[C_t(j)]^{1-\sigma}}{1-\sigma} + \frac{[m_t(j)]^{1-\nu}}{1-\nu} - \frac{N_t(j)^{1+\phi}}{1+\phi}$. Household $j$ maximizes (1) by facing each period its nominal budget constraint:

$$
P_t C_t(j) + P^t X_t(j) + B_t(j) + M_t(j) = R_t + \delta B_{t-1}(j) + M_{t-1}(j) + W_t N_t(j) + R^k_t K_{t-1}(j) - T^l_t(j) + \Omega_t(j)
$$

$B_{t-1}$ are private nominal bonds, $R_{t-1}$ is the gross nominal interest rate, $\Omega_t(j)$ are nominal profits, $T^l_t(j)$ are government lump-sum taxes, $M_{t-1}$ are money holdings, $K_{t-1}$ is capital, $W_t$ and $R^k_t$ are nominal wage and the return on capital respectively. Capital accumulates according to:

$$
K_t(j) = (1 - \delta) K_{t-1}(j) + X_t(j)
$$

$\delta$ is a constant depreciation rate. Finally, $C_t(j)$ and $X_t(j)$ are consumption and investment

2

3
Dixit-Stiglitz (1977) aggregators over all differentiated goods \( i \in [0, 1] \):

\[
C_t(j) = \left( \int_0^1 [C_t(i, j)]^{\frac{\varepsilon}{1 - \varepsilon}} \, di \right)^{\frac{1}{\varepsilon - 1}} \quad (4)
\]

\[
X_t(j) = \left( \int_0^1 [X_t(i, j)]^{\frac{\varepsilon}{1 - \varepsilon}} \, di \right)^{\frac{1}{\varepsilon - 1}} \quad (5)
\]

\( \varepsilon \) is the elasticity of substitution among the differentiated goods \( i \). Household allocates its consumption among goods \( i \) by maximizing (4) subject to a given expenditure \( Z_t(j) \equiv \int_0^1 P_t(i) \, C_t(i, j) \). As in Schmitt-Grohé & Uribe (2007) we assume that household solves an identical problem in order to allocate its investment among differentiated goods \( i \) (see appendix). Solving these problems we obtain the demand for good \( i \):

\[
X_t(i, j) + C_t(i, j) = \left[ \frac{P_t(i)}{P_t} \right]^{-\varepsilon} (X_t(j) + C_t(j)) \quad (6)
\]

where \( P_t = \left( \int_0^1 P_t(i)^{1-\varepsilon} \, di \right)^{\frac{1}{1-\varepsilon}} \) is the aggregate price level. Household \( j \) first order conditions from the utility maximization problem are:

\[
\frac{1}{R_t} = \beta E_t \frac{C_{t+1}(j)^{-\sigma} \, P_t}{C_t(j)^{-\sigma} \, P_{t+1}} \quad (7)
\]

\[
C_t(j)^{-\sigma} = \beta E_t \left[ (1 - \delta) + r_{t+1}^k \right] C_{t+1}(j)^{-\sigma} \quad (8)
\]

\[
\frac{[m_t(j)]^{-\nu}}{C_t(j)^{-\sigma}} = \frac{R_t - 1}{R_t} \quad (9)
\]

\[
\frac{N_t(j)^b}{C_t(j)^{-\sigma}} = w_t \quad (10)
\]

and the trasversality condition.

### 2.2 Government

Government solves an identical problem with household \( j \) to allocate its expenditure among differentiated goods \( i \):

\[
G_t = \left( \int_0^1 G_t(i)^{\frac{\varepsilon}{1 - \varepsilon}} \, di \right)^{\frac{1}{\varepsilon - 1}} \quad (11)
\]
Thus, demand for good $i$ from government is given by:

$$G_t(i) = \left[ \frac{P_t(i)}{P_t} \right]^{-\varepsilon} G_t$$

(12)

Government finances government expenditures by seignorage revenues and lump-sum taxes so the government budget constraint in nominal terms is given by:

$$T_t + M_t = M_{t-1} + P_t G_t$$

(13)

Policy follows simple policy rules analyzed in next section.

2.3 Monetary Policy

We assume that the Central Bank follows simple Taylor-type feedback rules following recent literature (see Clarida, Gali & Gertler 2001, Schmitt-Grohe & Uribe 2007, Gali 2008). We consider Taylor type rules and compare them to the baseline Taylor rule:

$$\log \frac{R_t}{R} = \phi_x \log \frac{\Pi_t}{\Pi_t^t} + \phi_y \log \frac{Y_t}{Y_t^t}$$

(14)

where $\Pi_t^t, Y_t^t$ are the operating targets set by the Central Bank. We consider alternative operating targets for the stabilization of the economy.

2.4 Fiscal Policy

We focus on monetary policy issues so we keep fiscal policy simple. Thus, the fiscal authority sets the government spending output ratio ($s_g^t \equiv \frac{G_t}{Y_t}$) equal to its steady-state value for all periods:

$$s_g^t = s^g$$

(15)

2.5 Firms

We assume a continuum of monopolistic firms $i \in [0, 1]$. Every period $t$ each firm $i$ faces a Calvo type nominal fixity. Thus, it faces an exogenous probability $\theta$ that cannot set its price, so when it sets its new price $P_t^* (i)$ at period $t$ anticipates that may keep it fixed with probability $\theta^{k_1}$ for the next $k$ periods. Firm $i$ maximizes the sum of expected profits for the next $k$ periods:

\footnote{In the appendix we solve firm $i$'s profit maximization problem with indexation to trend inflation, so the fraction of firms $\theta$ which cannot reoptimize update their prices to steady-state inflation, see Ascani (2004) for a relevant discussion.}
\[
\max_{P_t^i} \sum_{k=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k} \left( P_t^i(i) Y_{t+k}(i) - \Psi_{t+k}(Y_{t+k}(i)) \right) \right\}
\]

subject to:

\[
Y_{t+k}(i) = \left[ \frac{P_t^i(i)}{P_{t+k}} \right]^{-\varepsilon} Y_{t+k}^d
\]

where \( Y_t^d = C_t + X_t + G_t \) is aggregate demand, \( Q_{t,t+k} \) is the stochastic discount factor and \( \Psi_t(\cdot) \) is the minimum cost function derived in the appendix. We assume perfect competition in factor markets and an identical Cobb-Douglas production function \( Y_t(i) = A_t K_t^a(i) N_t^{1-a}(i) \) for all firms \( i \).

The solution of the profit maximization problem is given by the price setting rule:

\[
\sum_{k=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k} \left[ \frac{P_t^i(i)}{P_{t+k}} \right]^{-\varepsilon} Y_{t+k}^d \left( P_t^i(i) - \frac{\varepsilon}{\varepsilon - 1} \Psi_{t+k}' \right) \right\} = 0
\]  

(17)

We prove in the appendix that the marginal cost is only a function of the factor inputs prices because of the constant returns to scale technology, so the nominal marginal cost is identical across all firm \( i \)'s:

\[
\Psi_{t+k}' = MC_{t+k}(i) = MC_{t+k}^n
\]

Firms' behaviour can be summarized by equation (17) and the demand for labour and capital:

[Demand for Labour]:

\[
w_t = MC_t(1 - a) A_t K_t^a(i)^a N_t(i)^{-a}
\]  

(18)

[Demand for Capital]:

\[
r_t^K = MC_t a A_t K_t^a(i)^{a-1} N_t(i)^{1-a}
\]  

(19)

### 2.6 Aggregation and Price Dispersion

Yun (1996) shows that in order to obtain a relation for aggregate output in terms of the aggregate factor inputs, we need to denote two auxiliary indices. Thus, we aggregate (16) across \( i \):

\[
\int_0^1 Y_t(i) \, di = \int_0^1 \left\{ \left[ \frac{P_t(i)}{P_t} \right]^{-\varepsilon} Y_t^d \right\} \, di
\]  

(20)
In (20) we denote the auxiliary indices $Y^t = \int_0^1 Y_t(i) di = A_t K^a_t N_{1-a}^t$ and $P^t = \left( \int_0^1 P_t(i)^{-\varepsilon} di \right)^{-\frac{1}{\varepsilon}}$. Imposing the equilibrium condition $Y^t = Y^s_t = Y^d_t$ we get a relation between the auxiliary and the consistent aggregate output index:

$$Y_t = \frac{1}{\left[ \frac{P^t}{P^t} \right]} Y^t = \frac{1}{\left[ \frac{P^t}{P^t} \right]} A_t K^a_t N_{1-a}^t$$

(21)

Ascari (2004) finds that price dispersion results a loss of output when steady-state gross inflation is higher than unity. Also, he shows that a first order approximation of this model around a positive inflation steady-state may yield implausible dynamic behaviour for the endogenous variables. To avoid a counterfactual dynamic behaviour of this model Yun (1996) assumes that the fraction of firms which cannot reoptimize in period $t$ update their price to steady-state inflation. In appendix, we solve the profit maximization problem of firm $i$ under indexation to trend/steady-state inflation, however our results holds independent of the indexation to trend inflation.

### 2.7 Decentralized Equilibrium:

A decentralized equilibrium is a vector of prices $P_t = \left[ P_t \ \ R_t^h \ \ W_t \ \ R_t \right]'$, a vector of allocations for households $H_t = \left[ K_t^h \ \ N_t^s \ \ C_t \ \ M_t^d \right]'$, a vector of allocations for firms $F_t = \left[ Y_t \ \ K_t^d \ \ N_t^d \right]'$, and a vector of allocation for government $\left[ M_t^g \ \ G_t \right]'$ such that:

a) Household chooses $H_t$ in order to maximize its utility subject to their budget constraint (2) given the vector of prices $P_t$, their initial nominal wealth $R_{-1} B_{-1} + M_{-1}$, capital initial endowment $K_{-1}$ and policy.

b) The fraction of monopolistic firms $1 - \theta$ choose a new price $P_t^*$ in period $t$ in order to maximize a sequence of profits subject to a sequence of demands for their differentiated products (16), given the vector of prices $P_t$ and their technology. The other fraction $\theta$ cannot reset their prices so they set their previous period price (or they update their prices each period with steady state inflation level $\Pi$, we solve for either case in appendix).

c) Monetary authority satisfies every period its budget constraint (13) by setting its instruments (see below).

e) The vector of prices $P_t$ is such that all markets clear:

[Goods Market]:

$$Y_t = G_t + X_t + C_t$$
[Labour Market]:

\[ N_t^s = N_t^d \]

[Capital Market]:

\[ K_t^s = K_t^d \]

[Bonds Market]:

\[ B_t = 0 \]

[Money Market]:

\[ M_t^s = M_t^d \]

When monetary authority uses as its instrument the nominal interest rate it commits to satisfy the money demand which arises at any given level of the nominal interest rate. The decentralized equilibrium given policy can be summarized by 13 equations and 13 endogenous variables\(^2\):

\[
\begin{bmatrix}
Y_t & C_t & N_t & X_t & \Pi_t & \tau_t^K & MC_t & w_t & K_t & m_t & \Delta_t & \Theta_t & \tau_t \n\end{bmatrix}'
\]

and one exogenous variable \([A_t]'\):

Households:

\[
\frac{1}{R_t} = \beta E_t \left\{ \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{1}{\Pi_{t+1}} \right\}
\]

(22)

\[
C_t^{-\sigma} = \beta E_t \left[ (1 - \delta) + \tau_t^K \right] C_{t+1}^{-\sigma}
\]

(23)

\[
w_t = \frac{N_t^\phi}{C_t^{-\sigma}}
\]

(24)

\[
\frac{m_t^{-\nu}}{C_t^{-\sigma}} = \frac{R_t - 1}{R_t}
\]

(25)

Firms:

\(^2\)In appendix we transform the nominal variables in ratios following Schmitt-Grohe & Uribe (2007). We define three new variables, gross inflation \(\Pi_t \equiv \frac{\rho_t}{\pi_t - 1}\), price dispersion \(\Delta_t \equiv \left[ \frac{\nu_t}{\pi_t} \right]^{-\epsilon}\) and an auxiliary variable \(\Theta_t \equiv \frac{\nu_t}{\pi_t}\).
where
\[
\sum_{k=0}^{\infty} \theta^k E_t \left[ Q_{t,t+k} \left[ \frac{\Theta_t}{\prod_{i=1}^{k} \Pi_{t+i}} \right] \right]^{-\varepsilon} Y_{t+k} \left( \Theta_t \Pi_t - \frac{\varepsilon}{\varepsilon - 1} MC_{t+k} \prod_{i=0}^{k} \Pi_{t+i} \right) = 0
\]
(26)

or with indexation
\[
\sum_{k=0}^{\infty} \theta^k E_t Q_{t,t+k} \left[ \frac{\Pi^k}{P_{t+k}} \right]^{-\varepsilon} D_{t+k} \left[ \Pi^k \Theta_t \left( \frac{1}{\prod_{i=1}^{k} \Pi_{t+i}} \right) - \frac{\varepsilon}{\varepsilon - 1} MC_{t+k} \right] = 0
\]

\[w_t = MC_t (1 - a) A_t K_t^a N_t^{-a}\]  (27)

\[r_t^k = MC_t a A_t K_t^{a-1} N_t^{-a}\]  (28)

Constraints & Indices:

\[Y_t = C_t + X_t + s_t^g Y_t\]  (29)

\[Y_t \frac{1}{\Delta_t} A_t K_t^a N_t^{1-a}\]  (30)

\[K_t = (1 - \delta) K_{t-1} + X_t\]  (31)

\[\Pi_t^{1-\varepsilon} = \theta + (1 - \theta) (\Pi_t \Theta_t)^{1-\varepsilon}\]  (32)

or with indexation

\[\Pi_t^{1-\varepsilon} = \theta (\Pi)^{1-\varepsilon} + (1 - \theta) (\Pi_t \Theta_t)^{1-\varepsilon}\]

\[\Delta_t = \theta \Delta_{t-1} \Pi_t^\varepsilon + (1 - \theta) \Theta_t^{-\varepsilon}\]  (33)

or with indexation

\[\Delta_t = \theta (\Pi)^{-\varepsilon} \Delta_{t-1} \Pi_t^\varepsilon + (1 - \theta) \Theta_t^{-\varepsilon}\]
\[
\tau_t + m_t = \frac{m^{t-1}}{\Pi_t} + s_t^g Y_t
\]  
(34)

Monetary policy sets the nominal interest rate \([R_t]\)' according to (14) and fiscal policy sets the government output ratio \(s_t^g = s^g\) constant and equal to its steady-state value.

3 Calibration & Long-Run Solution

In this study we aim to discuss monetary policy issues for Euro area. We consider Euro area as a closed economy, so we calibrate the structural parameters of our model by mainly following Andrés & Domenech (2006) who study a similar model for Euro area.

<table>
<thead>
<tr>
<th>Structural Parameters</th>
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<tbody>
<tr>
<td>Description</td>
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<tr>
<td>Time Preference</td>
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<tr>
<td>Risk Aversion Coef.</td>
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<td>Depreciation Rate</td>
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<td>Price Rigidity Parameter</td>
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<td>Price Elasticity of Demand</td>
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<td>Share of Capital</td>
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<td>Elasticity of Real Money Balances</td>
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<td>Labour Elasticity</td>
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Table 1

Monetary policy sets the long-run nominal interest rate \(R = 1.01237\) such that steady state inflation is \(\Pi = 1.02^{0.25}\). We assume that the government spending to output ratio is \(s^g \equiv \frac{G}{Y} = 0.2\), a value very close to the Euro-zone average. Table 2 shows the steady-state values of the endogenous variables:
Steady-State Values  
(Quarterly)  

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<th>r(^k)</th>
<th>MC</th>
<th>w</th>
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<tr>
<td>Y</td>
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<td>0.6189</td>
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Table 2

We simulate the model around this steady-state using standard methods (i.e. Klein 1998). We assume that the economy fluctuates around this steady-state due to productivity shocks which follow an AR(1) process:

\[
\log(A_t) = \rho^a \log(A_{t-1}) + \epsilon_t^a
\]

with standard deviation \(\sigma_{\epsilon^a} = 0.0062\) and persistence \(\rho^a = 0.8\).

4 Policy Results

Following recent monetary literature ([5],[7],[8],[12],[13] and [14]) we seek for Taylor-type rules which satisfy two criteria. First, the Taylor rule should be implementable such that the monetary authority always guarantees a unique locally stable equilibrium (see appendix-stability), all the Taylor rules and reaction coefficients are chosen so as to always satisfy this criterion. Second, we prefer taylor-type rules which are simple and operational. A simple Taylor rule sets the nominal interest rate as a function of a small number of easily observed macroeconomic indicators. Moreover, the operational targets/macroeconomic indicators should require the minimal information from the part of policy maker (see Schmitt-Grohe and Uribe 2007).

4.1 Baseline Taylor Rule: React to the output gap or not?

We define as the baseline Taylor rule, the reaction function (14) when the operating targets for inflation and output are set equal to their steady-state values \((Y_t^s = Y, \Pi_t^s = \Pi)\). This means a yearly inflation rate equal to 2% which is consistent with ECB long-run inflation target. In this benchmark case we ask whether the monetary authority should follow a countercyclical monetary stance. We examine this simple case of the Taylor rule because: i) it is the proposal made by Taylor 1993, ii) it is realistic and simple because the Central Bank reacts to a long-run operating target for the output and does not need to adjust each period its target, iii) other measures which are examined in next section are unobservable and require too
much information in order to be implemented. We find that countercyclical monetary policy generates a trade off between inflation and output stabilization, so it stabilizes output but at the cost of large inflation volatility (this is important, as Woodford (2003) shows, because inflation volatility deteriorates welfare). If monetary policy switches on the countercyclical reaction to the baseline rule (14) equal to $\phi_y = 0.5$ which is a value consistent with empirical estimates for ECB, see Gerlach & Schnabel (2000), the standard deviation of output will be reduced from 0.0163 to 0.0093 but inflation volatility will increase from 0.0005 to 0.0071 (see Table 1 in the appendix). In this model policy intervention is justified by the presence of two frictions, i.e. staggered prices and imperfect competition. In the baseline Taylor rule, monetary policy should react only to deviations of the actual inflation from its target in order to replicate the flexible price equilibrium, while should not respond to the output gap because it generates inflation volatility. The message from this exercise is that monetary policy should focus on undoing the distortion which arises from the staggered price mechanism and avoid countercyclical reaction to the output gap.

### 4.2 Alternative Operating Targets for Output

In this section we examine alternative operating targets for output. There are several operating targets proposed in the related literature, in this section we show that the result of the previous section holds for the majority of the operating targets proposed in the literature and that the "best" operating target is the natural output (defined below), however the gains are not quantitatively significant. So, we compare the second moments of inflation and output when the operating target for output is respectively the natural output which is the output that will prevail under flexible prices and imperfect competition (first row in Table 3), the efficient level of output which is the output that will prevail under flexible prices and perfect competition (second row), last period output so monetary policy responds to the growth rate (third row) and the baseline case i.e. steady-state output. We set the countercyclical policy response $(\phi_y)$ equal to 0.5, which is the value proposed by Taylor and also it is very close to the actual empirical estimates for Euro area\(^3\). A summary of results are presented at Table 3. In terms of the joint stabilization of inflation and output it is better to react to the natural output, while the worst scenario is when the Central Bank reacts to steady-state output. Moreover, the efficient level of output destabilizes inflation and leads to a burst of mean inflation. This is

\(^3\)However, empirical findings are not clear for the actual countercyclical reaction of the ECB with $\phi_y$ varies within the range from 0 to 3, depending on the specification and the data available to the econometrician. So we examine the whole set for the policy parameter space $\phi_y, \phi_a \in (0, 3)$. In the appendix you can find a figure illustrating that the stabilization ordering of the operating targets for output remains the same for the whole policy space as for $\phi_y = 0.5$. 

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an expected result, because the efficient level of output is always higher than the the distorted level of output so the nominal interest is always lower than its steady-state value and mean inflation is very large.

Table 3: Alternative Operating Targets

<table>
<thead>
<tr>
<th>Definition</th>
<th>$\phi_y = 0.5$</th>
<th>Standard Deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Output $Y_t^T \equiv Y_t^n$</td>
<td>$std(Y_t) = 0.0160$</td>
<td>$std(\Pi_t) = 0.0004$</td>
</tr>
<tr>
<td>Efficient Output $Y_t^T \equiv Y_t^{eff}$</td>
<td>$std(Y_t) = 0.0161$</td>
<td>$std(\Pi_t) = 0.0007$</td>
</tr>
<tr>
<td>Last Period Output $Y_t^T \equiv Y_{t-1}$</td>
<td>$std(Y_t) = 0.0124$</td>
<td>$std(\Pi_t) = 0.0018$</td>
</tr>
<tr>
<td>Long-Run Output $Y_t^T \equiv \bar{Y}$</td>
<td>$std(Y_t) = 0.0093$</td>
<td>$std(\Pi_t) = 0.0071$</td>
</tr>
</tbody>
</table>

Notes: In the case where the operating target is the efficient level of output the mean inflation is extremely large ($\Pi = 1.2305$).

Thus, efficient countercyclical monetary policy requires a lot of information and does not offer quantitatively important stabilization of the economy. While when the operating targets are set equal to easily observed measures of output (long-run or previous period output) the losses in terms of higher volatility of inflation are quantitatively larger.

4.3 Strict Inflation Targeting

The analysis in sections (4.1) and (4.2) yields two important results concerning countercyclical monetary policy. First, countercyclical monetary policy increases significantly the volatility of inflation for several operating targets for output. Second, the correct choice of the operating target for output requires too much information\(^4\) from the part of the policy maker while it only achieves small improvement in the joint stabilization of output and inflation. In our setup, it is better not to responding to the output gap. So, the polar case of strict inflation targeting is interesting because it is simple and easy to communicate to the public as well as in this setup guarantees the best stabilization results. In order to achieve the strict inflation targeting case through the Taylor rule we set $\phi_\pi \to \infty$ and $\phi_y = 0$. Thus, actual inflation is always equal to

\(^4\)For a Central Bank to respond to the natural output needs a structural model and estimation from real time data.
its target while the standard deviation of output falls to 0.0157. Thus, strict inflation targeting not only achieves zero volatility of inflation but also the minimum volatility of output among the policies we examined.

4.4 Operational Taylor rule

In this section we examine the stabilization properties of an operational Taylor-type rule. Recent leading academic papers as Orphanides 2001, McCallum 1999 and McCallum & Nelson 1999 dispute the ability of policy makers to observe the operating targets suggested by the theoretical models i.e. natural or steady state output. In addition, they show that policy institutions may estimate with statistically significant errors current inflation and output from real time data. Below, we analyse the performance of an operational Taylor rule proposed by Schmitt-Grohé & Uribe (2007), in which the nominal interest rate is set as a function of previous periods growth rates:

$$\log \left( \frac{R_t}{R_{t-1}} \right) = \rho \log \left( \frac{R_{t-1}}{R_{t-2}} \right) + \phi_\pi \log \left( \frac{\Pi_{t-1}}{\Pi} \right) + \phi_y \left( \frac{Y_{t-1}}{Y_{t-2}} \right) \quad (36)$$

Taylor rule (36) requires information that is already known in period $t$ with certainty. We simulate the model when the policy reaction coefficients are chosen optimally as in Schmitt-Grohé and Uribe (2007)

$$\rho = 0.77, \phi_\pi = 0.75 & \phi_y = 0.02.$$ However, an operational Taylor rule should require minimal information from the part of the policy maker. Thus, we relax optimality assumption and choose some standard values for the reaction coefficients which guarantee local stability (see the figure in appendix). In Table 4 we observe that rule (36) performs better than all the Taylor rules that we examine and very close to the case of strict inflation targeting. Additionally, the Central Bank does not need to choose optimally the reaction coefficients in order to achieve the joint stabilization of inflation and output.
Table 4: Operational versus Theoretical Taylor

<table>
<thead>
<tr>
<th></th>
<th>SGU 2007 (Optimal)</th>
<th>SGU 2007 (Standard)</th>
<th>Theoretical Taylor</th>
</tr>
</thead>
<tbody>
<tr>
<td>std ($Y_t$) = 0.0156</td>
<td>std ($Y_t$) = 0.0151</td>
<td>std ($Y_t$) = 0.0160</td>
<td></td>
</tr>
<tr>
<td>std ($\Pi_t$) = 0.0001</td>
<td>std ($\Pi_t$) = 0.0004</td>
<td>std ($\Pi_t$) = 0.0004</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Standard means $\rho = 0, \phi_\pi = 1.5 & \phi_y = 0.1$.
As theoretical Taylor rule we define

- equation (14) when the operating target
- for output is the natural output and the
reaction coefficients $\phi_\pi = 1.5$ & $\phi_y = 0.5$

5 Conclusions

In this paper we aim to study the stabilization properties of monetary policy in a closed economy. We examine monetary policies which can be implemented by Taylor type rules. Monetary policy goal is the joint stabilization of inflation and output from their policy targets. Our criterion to evaluate alternative monetary policies is the volatility of inflation and output. Our main conclusions are: Firstly, monetary policy can guarantee the joint stabilization of inflation and output through the baseline Taylor rule with a strong enough reaction to inflation and no reaction to the output gap. Secondly, a countercyclical monetary stance to almost all alternative operating targets for output that we examine, generates a trade-off between output and inflation stabilization except the case where the monetary authority reacts to deviations from the natural output (i.e. the output that will prevail under flexible prices). This result confirms the proposal that monetary authority should focus on inflation targeting. Thirdly, we find that the joint stabilization of inflation and output requires neither the estimation of unobservable variables nor the optimal choice of reaction coefficients. Given that reaction coefficients always guarantee Blanchard-Kahn conditions a good monetary policy can be implemented through simple and operational Taylor type rules that respond to easily observed targets already known at the time of monetary policy action.

References


