Monetary Policy in the Euro-Area: An Analysis Using a Stylized New-Keynesian Model

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Abstract

This paper analyses monetary policy in the Euro-Area using a stylized new-Keynesian model. A number of issues are focused upon: (i) optimal monetary policy under commitment and discretion, (ii) a comparison of optimal monetary policies and ad-hoc monetary policies, (iii) the effects of fiscal policies and foreign variables on monetary policy in the model. Using numerical simulations, it is analyzed how these aspects affect monetary policy of the ECB in particular and macro economic fluctuations in the Euro-Area in general.

Keywords: EMU, Fiscal Policy, Monetary Policy
JEL Code: F31, F41, G15

June 2005

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* Bas van Aarle acknowledges the financial support from the Fonds voor Wetenschappelijk Onderzoek Vlaanderen (F.W.O.). We would like to thank seminar participants at the University of Nijmegen and the University of Maastricht for pointing our attention to a number of unclarities in a previous version of our paper.
1. Introduction.

Since its start on January 1th 1999, policymakers, financial market participants and academic researchers alike have shown a strong interest in the effects of the Economic and Monetary Union (EMU). In particular the design, implementation and transmission of the common monetary policy of the European Central Bank (ECB) is often focused upon. One of the debates concerns the credibility of the ECB. Some observers have argued that the ECB practically inherited the reputation and commitment towards low inflation of the Bundesbank. Others have assumed that as a complete new institution, the ECB would lack initially such a possibility to commit its policies vis-à-vis the private sector and that it would need time to earn a reputation. In other words, starting from a regime with discretionary policymaking, it may only gradually establish a policy regime with commitment in its policies. From the academic side, e.g. adopting inflation targeting has been proposed for the ECB to foster credibility. Others have emphasized the need for simple policy rules in the presence of such initial institutional uncertainties and also because of large uncertainties of the actual workings of the Euro-Area (EA) economy (model uncertainty), the lack of consistent data initially (data uncertainty) and the possibility of structural breaks (parameter uncertainty) due to establishment of the EA.

In this paper we analyze the effects of such alternative monetary policy regimes in the EA using a New-Keynesian (NK) model. A number of issues are focused upon in particular: (i) optimal monetary policy under commitment vs. discretion, (ii) a comparison of optimal monetary policies and ad-hoc monetary policy rules, (iii) the effects of fiscal policies and foreign variables on monetary policy. With the use of this model, we illustrate a number of important results on monetary policy in the NK literature and which are assumed to be relevant for actual monetary policymaking in the EA.

The difference between the commitment and discretionary case results from the forward-looking part of the model and is an extension to a dynamic setting of the time-inconsistency problem in the static setting a la Barro-Gordon. Commitment enables the policymaker to smooth the stabilization costs over time: if a macroeconomic shock hits the economy, the policymaker can announce a path of current and future policy actions and credibly implement this strategy. Under commitment the transmission of monetary policy also takes place through the private expectations about current and future monetary policy behavior, the s.c. expectation channel of monetary policy. Under commitment adjustments of interest rates, inflation and output will typically display more inert adjustment and less volatility than under discretion, given this ability to smooth out the adjustment costs over time. Under discretion, such announcements of policy contingent on past commitments are not credible. As a result, policies and inflation are excessively volatile in the short run compared to the commitment case and also welfare losses will be higher with discretionary policymaking due to the existence of a stabilization bias in the short-run. The differences between commitment and discretion will vanish when output and inflation expectations become increasingly backward-looking, since in that case the private sector expectations are less and less affected by policy commitments, or stated differently, optimal policies will suffer less and less from time-inconsistency problems when expectations become less and less forward-looking.
Clarida et al. (1999) demonstrate that in the closed-economy NK model the optimal monetary policy is history dependent under commitment even if expectations are entirely forward-looking. Moreover, commitment gives rise to an improved trade-off between output and inflation variability that a central bank faces in the presence of cost-push shocks. Jensen (2002) shows that in a closed-economy setting without fiscal policy, with purely forward-looking output and inflation expectations and a monetary authority that has no interest rate smoothing objective, the distinction between commitment and discretion is essentially only relevant in the presence of cost-push shocks. There, stabilization of output and inflation is subject to a trade-off between the variability of output and inflation. Demand and potential output do not pose such dilemmas as monetary policy can then always be set –both under commitment and discretion- to perfectly offset demand shocks and to perfectly accommodate potential output shocks. In case monetary policymakers also are concerned about interest rate smoothing, these closed-economy results need to be modified since then the immediate full stabilization of demand and potential output shocks will be costly because of the interest rate variability and hence not be optimal and outcomes under monetary policy with commitment and discretion will differ. Moreover if output and inflation expectations also contain backward looking elements, the above results need to be modified further as the backward-looking components imply persistence of output and price adjustments making immediate full stabilization no longer possible.

We could also assume that the monetary policymaker follows a simple policy rules according to which the policy instrument reacts in a predefined manner to important macroeconomic variables like output and inflation. Taylor rules relate the short-run interest rate setting of the monetary policymaker to deviations of inflation from the inflation target, the output gap and the exchange rate. In addition policy rules may take into consideration an instrument smoothing objective of the policymakers. In case of instrument smoothing policymakers perceive instrument variability as undesirable/costly and thus prefer a gradual adjustment of the policy instruments to rapid changes in policy variables. In the presence of instrument smoothing, the current value of the instrument variable is expressed as a weighted average of its lagged value and an optimal value. Clearly, the inclusion of interest rate smoothing generates history dependence of policy even in a purely forward-looking model. Not all parameter choices of the Taylor rule lead to determinate outcomes: the literature has found that if the feedback to current inflation is reduced, the degree of backward lookingness or the amount of interest rate smoothing is increased, the possibility of indeterminacy and/or instability of the outcomes increases.¹

The presence of active fiscal policies will complicate the management of monetary policies in particular if their effects are contrary to the objectives of the monetary policymakers, e.g. in case of a positive demand shock, the monetary policy will be restrictive to contain inflationary pressure. In those conditions, an expansionary fiscal policy shock will run counter to the monetary policy objectives, evoking a policy conflict between the monetary and fiscal policymakers. Muscatelli et al. (2004) have analysed the interaction of monetary and fiscal policies in a closed economy NK model and applying it to US data.

¹ Uniqueness and stability of the equilibrium in our analysis are governed by the Blanchard and Khan (1980) criterion that the number of unstable eigenvalues must coincide with the number of forward-looking variables.
In an open economy setting, the closed economy results summarized above will partly carry over and will partly need to be modified. The exchange rate becomes an important channel of transmission of monetary policy affecting thereby real and nominal adjustments after macroeconomic shocks. Given the link between interest rates and exchange rates from the UIP hypothesis, monetary policies will affect outcomes both via the interest channel and the exchange rate channel. The transmission via the exchange rate channel will depend on the pass-through of exchange rate fluctuations on domestic inflation and the effect of real exchange rates on net exports. In an open economy setting, optimal monetary policies will therefore depend also on the degree of pass-through in the economy and the sensitiveness of net exports w.r.t. international competitiveness. Leitemo et al. (2002) point to the fact that in the open-economy the distinction between monetary policy commitment and discretion is even more important than in a closed economy: the introduction of another forward-looking variable in form of exchange rate expectations implies additional time-inconsistency problems for the monetary policymaker related to the exchange rate channel of monetary policy.

These insights from the literature on monetary policymaking using NK models, are certainly relevant when studying monetary policy making in the actual EA context as we will try to show. The paper has been structured as follows: Section 2 proposes a stylized NK model. Section 3 discusses the design of monetary policy in this model. Section 4 discusses the simulation results for various shocks using a parametrization based on empirical EA studies. In Section 5 some sensitivity analysis of the outcomes w.r.t. a few crucial model parameters is undertaken. The conclusion summarizes our main results.

2. A NK Model of the EA.

We model the EA economy using a stylized hybrid new Keynesian/NOEM model. The setup of the model is rather standard and e.g. similar to Giordani (2001), Muscatelli et al. (2004) and Svensson (2000). The basic blocs of the model are the aggregate demand and aggregate supply curves, the Uncovered Interest Parity (UIP) condition and the design of monetary and fiscal policies.

The goods market equilibrium, or IS curve, of the EA economy takes the following form:

\[
y_t = \psi_1 y_{t-1} + \psi_2 E_t y_{t+1} - \alpha(i_t - E_t \Delta p_{t+1} - \bar{\pi}) + \eta g_t + \sigma_y y^* - \xi y_t + \delta(e_t + p^*_t - p_t) + u^d_t
\]

where:

- \(y_t\) denotes EA output,
- \(i_t\) the EA short-term nominal interest rate, (the policy instrument of the ECB),
- \(p_t\) the general price level,
- \(g_t\) the fiscal balance (a positive value of \(g\) denotes a fiscal deficit),
- \(e_t\) is the EA exchange rate,
- \(\bar{\pi}\) is the expected inflation,
- \(\psi_1, \psi_2, \alpha, \eta, \sigma_y, \xi, \delta, \) and \(u^d_t\) are parameters.

2 EA variables can be interpreted as weighted averages of individual county variables: thus, aggregate inflation and real output are defined as a weighted average of individual countries: \(\Delta p_t = \sum_j \theta_j \Delta p_{t,j}\), \(y_t = \sum_j \theta_j y_{t,j}\), in which \(\theta_j\), \(\sum_j \theta_j = 1\) measures the relative size (e.g. in terms of trend output) of country \(j\) in the EA economy.

3 Output and output gap in fact can be used interchangeably as long as equilibrium output remains constant. Ehmann and Smets (2003) analyze the case where monetary authorities are uncertain whether supply shocks are the result of cost-push shocks or shocks to equilibrium output. They analyze the implications of such a “signal-extraction problem” facing (optimal) monetary policy. In this paper we will ignore aspects relating to parameter uncertainty, model...
rate (a positive value implying a depreciation); \( \bar{r} \) is the equilibrium real interest rate\(^4\). \( u^d \) is an aggregate demand shock. All variables are given in logarithms and refer to deviations from an initial steady-state.

In this reduced form EA output depends on past output, expected future output, the real interest rate (expressed as a deviation from the equilibrium real interest rate), net government spending, net exports\(^5\) and a demand shock. This IS curves nests several alternative formulations that can be found in the literature: the current output gap can be positively related to past output gaps only (Fuhrer and Moore (1995), Huh and Lansing (2000)), both past and expected future output gaps, Clarida et al., (1999)), or expected future output gaps only (McCallum (2001), Woodford (2001)). The backward-looking component in the IS curve results from “habit formation” in consumption decisions\(^6\). The forward-looking part is produced by rational, intertemporally maximizing agents that apply the principles of optimal “consumption smoothing”. In case consumers are entirely forward looking \((\psi = 0)\), (1) is also sometimes referred to as the “intertemporal IS”.

The euro exchange rate adjusts in such a manner that uncovered interest rate parity holds throughout:

\[
E_t e_{t, t+1} - e_t = i_t - \bar{i}_t + u_t'
\]

where \( u_t' \) represents random exchange rate shocks (risk premium shocks, expectation shocks or other shocks in international financial markets) that cause temporary deviations from UIP.\(^7\)

Inflation dynamics are given by hybrid Phillips-curves which contain elements of both forward and backward-looking price setting. In addition, demand-pull and cost-push factors affect inflation,

\[
\Delta p_t = \omega_1 \Delta p_{t-1} + \omega_2 E_t \Delta p_{t+1} + \gamma (y_t - \bar{y}_t) + \tau \Delta (p^*_t + e_t) + u_t^s
\]

Inflation equals the first difference of the general price level and is assumed to be a function of past inflation, expected future inflation, the output gap, \( y_t - \bar{y}_t \), -reflecting demand pull inflation- and inflation of import prices, \( \Delta (p^*_t + e_t) \), which induces cost-push inflation.\(^8\) \( u_t^s \), are domestic cost push shocks (or “mark-up” shocks) which will be interpreted as supply-shocks in the remainder of the analysis since (3) can also be considered as describing the short-run aggregate supply (AS) curve. In addition, the supply side of the economy can be hit by shocks to potential output viz. productivity shocks.

\(4\) In practice, it may be quite complicated to determine the equilibrium real rate of interest, \( \bar{r} \), as the study on real equilibrium interest rates in the EA by Giammarioli and Valla (2003) shows. Similar to estimating equilibrium output \( \bar{y} \) and equilibrium inflation \( \Delta \bar{p} \) it would be crucial, however, for the monetary authority to get its estimations on this variable right.

\(5\) Net exports are a function of domestic and foreign output and price competitiveness: net exports = \( \sigma y_t' - \zeta y_t' + \delta (e_t' + p^*_t - p_t) \).

\(6\) Leith and Malley (2002), Batini et al. (2003) and McCallum and Nelson (1999) provide micro-foundations for the presence of habit formation in consumption. Empirical evidence is provided that the backward looking component in consumption is substantial.

\(7\) For empirical studies on deviations of UIP see e.g. Jeanne and Rose (2002). McCallum and Nelson (1999) analyze the effects of deviations from UIP on the exchange rate and the current account in a framework that is related to ours.

\(8\) See e.g. Gagnon and Ihrig (2002), Leitemo et al. (2002), Coenen and Wieland (2002) that use similar open economy Phillips curves.
If $\omega = 1$, we obtain the backward-looking Phillips curve, if $\omega = 0$, on the other hand, we obtain the forward-looking New-Keynesian Phillips curve. In the first case, only past economic conditions matter for determining current inflation. In the presence of forward-looking expectations, current price setting depends on expectations about future economic conditions solely. The hybrid Phillips curve assumes that both backward and forward-looking price setting are present, it results if $\omega$ lies in between 0 and 1. The hybrid Phillips curve allows for both a forward-looking component and a backward-looking component, reflecting e.g. learning effects, staggered contracts or other institutional arrangements that affect pricing behavior.

The output gap proxies the effects of demand-pull factors on the general price level. Foreign inflation spillovers affect domestic prices via the price of imported raw-, intermediate and final goods used in the domestic production process. The strength of the foreign inflation and depreciation spillovers, depends not only on the intensity with which foreign goods are absorbed but also on the amount of pass-through in import pricing. Recent empirical research suggests that pass-through is generally non-negligible. Inflation will be affected by changes in the exchange rate through the direct effect via import prices, implying cost-push inflation. Exchange rate changes can also affect inflation indirectly through aggregate demand, since they will affect the relative price between domestic and foreign goods, thereby influencing net exports and domestic output, which in turn will affect prices through demand-pull inflation.

Demand shocks ($u^d$), cost-push shocks ($u^s$), potential output ($\bar{Y}$), fiscal shocks ($u^f$), exchange rate shocks ($u^e$) and foreign output ($u^y*$) shocks are all assumed to follow stationary AR(1) processes $u_t = \rho u_{t-1} + \nu_t$, with $0 \leq \rho < 1$ and $\nu_t$ is white noise, $\nu \sim N(0, \sigma^2)$, all shocks are assumed to be contemporaneously uncorrelated, $E[v_i v_j] = 0, \forall i, j$.

In the model, macroeconomic shocks lead to fluctuations in output and prices. This will affect the interest rate and through (5) the exchange rate. External exchange rate adjustment in the form of changes of the euro exchange rate, $e$, therefore, is a potentially important shock absorber in the EA, in particular in case the shocks are of foreign origin. In fact, whereas a monetary union precludes internal exchange rate adjustments by definition, external exchange rate adjustments may partly take over as a shock absorber. In the context of the EA, one should in other words not only focus on the interest rate channel of its monetary

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9 See e.g. Clarida et al. (1999) for a similar analytical framework and a detailed discussion on the generalised IS (1) and Phillips curves (2). They illustrate how $\psi$ and $\omega$ jointly determine the endogenous inflation and output persistence. Leith and Malley (2002) derive (2) from the overlapping contracts model of Calvo.

10 In empirical applications, more lags of output (in case of the IS curve) and output and inflation (Phillips curve) are often included to improve the empirical fit. Adding these lags will also induce a more persistent and therefore more realistic adjustment to shocks. In empirical studies and monetary policy analysis sometimes concepts of equilibrium and/or core inflation are added to (2), to distinguish short-run fluctuations of inflation from longer term, equilibrium inflation. In our analysis this issue is not dealt with and inflation (as all other variables) is defined in terms of deviations from (possibly non-zero inflation) the steady-state. See Vega and Wynne (2001) and references therein on core inflation in the EA.

11 See e.g. Gagnon and Ihrig (2002) and Anderton (2003). Apart from “pass-through” by importers of foreign price changes, including exchange rate changes, it is sometimes also argued that importers will consider domestic inflation when setting import prices as they seek to react to the pricing of domestic competitors. Such a “pricing to market” could be added to our analysis as well by adding domestic inflation to the RHS of (2).
policy but also the exchange rate channel is important in assessing the transmissions of monetary policy of the ECB.

Macroeconomic stabilization policies are another shock-absorber. The macroeconomic policy regime consists of the monetary and fiscal policy strategies that are implemented in the EA. The monetary and fiscal policy strategies are interacting and their joint implementation affects macroeconomic adjustments. The three direct transmission channels of the interest rate (the interest rate channel of monetary policy) in the model are: (i) a change in nominal interest rates, changes the real interest rate in the short-run, thereby output, (ii) a change of the interest rate affects the rate of exchange rate depreciation through the uncovered interest rate parity condition and (iii) by influencing macro-economic conditions, an interest change may also induce policy responses of the fiscal authorities. The three direct transmission channels of the euro exchange rate (the exchange rate channel of monetary policy) in the model are: (i) a nominal depreciation (viz. higher foreign prices) stimulates net exports in the short-run because of the induced real depreciation, (ii) a nominal depreciation (viz. higher foreign prices) generates a positive spillover on domestic inflation and (iii) a nominal depreciation may elicit a policy response of the monetary authorities. The transmission of fiscal policy takes the form of (i) a direct impact on aggregate demand, (ii) thereby an indirect effect on prices, interest rates and exchange rate, (iii) fiscal policy may elicit, by impacting on macro-economic conditions, policy responses of the monetary authorities.

Concerning fiscal policy we assume that net government spending is determined by a fiscal policy rule. Taylor (2000), developed a framework for simple fiscal policies that relate net government spending to the structural fiscal balance, $\bar{g}$, and the cyclical fiscal stance, as measured by the automatic stabilizers $-\chi_y$, the elasticity of the deficit to cyclical output fluctuations times output. In addition, we allow for the possibility of deficit smoothing and the occurrence of stochastic deficit shocks, $u^g$:

$$g_t = \lambda_g g_{t-1} + (1 - \lambda_g) \left( \bar{g} - \chi_y y_t \right) + u^g_t$$  \hspace{1cm} (4)

where $0 \leq \lambda_g \leq 1$. The parameter $\lambda_g$ captures the degree of fiscal policy inertia/activism: a high value of $\lambda_g$ would mean a very inert—but highly persistent—fiscal policy that could be explained by difficulties to implement changes in tax policies (e.g. pension reforms) and government spending (e.g. healthcare reforms).

The fiscal policy rule (4) enables to represent in the model—at least in a highly stylized way—the various budgetary rules and strategies one may observe in practice. Here, we would like also to relate the fiscal policy rules with the provisions in the Stability and Growth Pact. The budgetary target $\bar{g}$ can be thought e.g. as being the “close-to balance or in surplus medium term objective”, reflecting a preference for long-run sustainability and neutrality. The build-in flexibility in the Stability Pact relies on allowing as much as possible the workings of the automatic stabilizers in the short-run. Finally, the amount of inertia in fiscal policy, summarized by $\lambda_g$, reflects the ability of fiscal policymakers to adjust fiscal policy in the short-run. If $\lambda_g = 0$ fiscal flexibility is the highest and the fiscal balance only driven by the automatic stabilizers. If $\lambda_g$ increases, fiscal flexibility declines implying more persistence in fiscal adjustments. In the limiting case
where $\lambda_g = 1$, fiscal deficits do not adjust at all over time. Ignoring fiscal shocks, this would imply the absence of fiscal stabilization. This element of deficit smoothing seems therefore quite related to the recent discussion on the question if the SGP is not too rigid in some circumstances and should not be amended in any form to become more flexible and e.g. to let automatic stabilizers work freely in a recession.


Concerning the design of monetary policy by the ECB, we will distinguish between two different settings: (i) a setting where the ECB implements an optimal policy, where we need to distinguish between discretion and commitment strategies. (ii) a setting where the ECB implements an ad-hoc policy rule. Following the terminology of Svensson (2000), the first case falls into the category of targeting rules and the second case into the category of instrument rules.

(i) Targeting rules

Targeting rules seek to determine optimal policy responses to economic conditions, given a set of objectives. In the context of the above model, we look at the policy strategies that minimize the following intertemporal quadratic loss function of the ECB:

$$L^E_t = \sum_{t=0}^{\infty} \Gamma^t [\beta (\Delta p_{t+\tau})^2 + \xi (y_{t+\tau} - \bar{y}_{t+\tau})^2 + \nu (\Delta i_{t+\tau})^2 + \kappa (\Delta e_{t+\tau})^2]$$

Strict inflation targeting implies $\beta = 0$, $\xi = \nu = \kappa = 0$, strict output gap targeting $\beta = 0$, $\xi > 0$, $\nu = \kappa = 0$, strict interest targeting $\beta = \xi = 0$, $\nu > 0$, $\kappa = 0$ and strict exchange rate targeting $\beta = \xi = \nu = 0$, $\kappa > 0$. Note that in a setting of perfect capital mobility as expressed by the UIP condition (3), interest rate stability and stability of (the rate of change of) the exchange rate are intrinsically linked. Flexible inflation targeting implies that inflation targeting is an important objective of the CB but that it is also concerned about output and interest rate / exchange rate stability, $\beta > 0$, $\xi > 0$, $\nu > 0$, $\kappa > 0$ which seems to be the most realistic case.

(ii) Instrument rules

From an institutional point of view, the advantage of simple rules is their transparency and their ease to be communicated and monitored by the outside world. It is therefore interesting to confront the monetary policy regimes outlined in (i) with the alternative of simple Taylor rule of the following form:

$$i_t = \lambda_i i_{t-1} + (1 - \lambda_i) \left[ i + \phi_i (\Delta p_t - \Delta \bar{p}) + \chi_i (y_t - \bar{y}) + \mu_i \Delta e_t \right] + u'_t$$
with \( \tilde{i} = \bar{r} + \Delta \tilde{p} \). The feedback on the output gap and inflation are standard in arguments of the Taylor rule. A feedback on the exchange rate has been investigated in some open-economy Taylor rules, and we have followed Taylor (2001) in this specification. Monacelli (1999) shows that, under incomplete exchange rate pass-through, an exchange rate augmented Taylor rule performs better than the standard Taylor rule (be it based on CPI inflation or domestic inflation) in terms of inflation stabilization (but not in terms of output stabilization). The preference for instrument smoothing is measured by the value of \( \lambda \), where \( 0 \leq \lambda \leq 1 \) if \( \lambda \) goes to zero the original Taylor rule, which ignores instrument-smoothing objectives, is obtained.

It is useful to note that the Taylor rule above can be seen as an example out of a broader class of simple policy rules. Along this lines, Söderlind (1999) defines simple policy rules as optimal policies that result from the general optimal policy problem defined under (i) but augmented with restrictions on the coefficients and/or number of state variables to which the policymaker reacts. This definition of the simple rules case as a restricted optimal policy problem is shown by the equivalent structure of both solutions in terms of optimal policy. Depending on the amount of restrictions, the policy rule can be made more or less complicated and in the absence of restrictions the optimal policy under commitment results. In this interpretation the parameters \( \{ \lambda, \phi, \chi, \mu \} \) that the CB operates would be resulting from the solving an optimal monetary policy problem like under (i) but one with a set of additional restrictions.

4. The Effects of Macroeconomic Shocks: A Simulation Analysis.

This section uses simulations to illustrate a number of insights that can be obtained from the model introduced in Section 3. We simulate the effects of demand shocks, cost-push shocks, potential output shocks, fiscal shocks, exchange rate shocks and foreign shocks in the model of the EA. All shocks occur in period 1, are unanticipated and have zero-persistence.

As outlined above, we compare the adjustments under 3 scenarios: (i) optimal monetary policy in case of policy discretion, (ii) optimal monetary policy in case of commitment, (iii) ad-hoc monetary policy. The simulations of the shocks provide (a) impulse response functions that give the dynamics adjustments resulting from the shocks, including the transmission of macroeconomic policies (b) variances and welfare losses resulting from the shocks, allowing us to investigate into more detail aspects of efficiency.

In these simulations we in particular want to obtain insights into: (i) optimal monetary policies of the ECB both under discretion and commitment and in comparison to a monetary policy rule, (ii) the consequences of alternative fiscal policy rules in EMU, (iii) the effects of foreign shocks, the dynamics of the euro exchange rate and EA trade balance, (v) the role of alternative degrees of backward and forward looking in output and inflation.

12 In Taylor (2001) the real rather than the nominal exchange rate features in the policy rule. Like Clarida (2001) we adopt nominal exchange rate targeting here as it seems to be a more realistic and operational target in the monetary policy rule. Given price-stickiness in the model, it should be stressed that this difference may in fact have only minor
Underlying all the simulations in this section is a set of baseline model parameters that is broadly consistent with empirical estimates for the EA (see Table 1) or plausible/convenient as a reference point. This paper in other words does not attempt itself to estimate the model for the EA. The baseline parameters concern: (i) the hybrid IS and Phillips curves: \( \psi_1, \psi_2, \omega_1, \omega_2 \), (ii) other structural parameters: \( \alpha, \eta, \sigma, \zeta, \delta, \gamma, \tau \), (iii) assumptions on variances and autocorrelations of shocks, \( \rho, \sigma^2 \). Note in particular that the empirical studies suggest that the EA economy is characterized by a (i) substantial degree of backward lookingness in output and inflation, (ii) a substantial degree of deficit and interest rate smoothing in the policy rules. In the remainder of the paper we will assume that the monetary and fiscal rules based on the estimates of Table 1 are a relatively accurate representation of policies in the EA and refer to them as the “actual policies”.

Naturally, outcomes may be more or less specific to this set of baseline assumptions. In case of small changes in the parameters, the differences compared to the baseline are typically of a quantitative nature rather than a qualitative nature. If changes get larger, the results can also change qualitatively. In Section 5 we will undertake some sensitivity analysis to try to shed some light on that aspect of the analysis. To some extent our results are likely to be model-specific as well. However, we noted that in several cases larger, estimated EA models yield similar adjustments as in our model in case comparable shocks are studies. E.g. the Dieppe and Henry (2004) Area-Wide Model gives comparable adjustment dynamics as our model in case of a demand shocks, fiscal shocks and productivity shocks. Smets and Wouters (2002) model gives qualitatively similar outcomes in case of exchange rate shocks, a foreign output shocks and productivity shocks.

\[ \text{i) A positive demand shock} \]

Figure 1 displays the adjustments that are produced by a positive demand shock in the EA. Outcomes under discretion, commitment, and the Taylor rule are denoted by _dis, _com and _rul, respectively.

The demand shock increases output in the short-run which will tend to increase inflation. The ECB reacts by raising the interest rate. This causes an initial appreciation after which the exchange rate depreciates according to the UIP condition. The increase of the real interest rate and the real appreciation contribute to a stabilization of output and inflation. The automatic stabilizers of the fiscal policy rule generate a fiscal surplus which also contributes to the stabilization output and inflation. The combination of increased output and a real appreciation cause a current account deficit. It is seen that the monetary policy regime has implications and the more so if the exchange rate feedback is small, of course.

\[ \text{13 While the absence of any own empirical estimations may seem a bit unsatisfying this type of analysis based on calibrated parameters and/or parameters that appears plausible from empirical studies, is quite common in NK papers.} \]
significant impact on the outcomes produced by the demand shock. Compared to discretion, commitment results in a more smooth adjustment of the interest rate and inflation, reflecting the stabilization bias present under discretion as noted in the introduction. The actual monetary policy rule case with strong interest rate smoothing is marked by higher persistence in the adjustments compared to optimal policies under commitment and discretion. Because of the high interest rate and deficit smoothing, macroeconomic policies react too slowly and the policies are moreover too persistent, implying that at some point in time they actually become the source of fluctuations in output and inflation.

Table 2 provides the variances of output, inflation, changes in interest rates and exchange rates and the welfare losses that result in the different regimes and for the type of shocks studied in this section. It is directly seen that commitment reduces in particular inflation variability compared to discretion, contributing to the lower losses under commitment. The Taylor rule case leads to the highest variance of inflation and interest rate changes. The difference in losses between discretion and the Taylor rule based on actual estimates for the EA are relatively small an observation that is also seen in the other examples below.

ii) A positive cost-push shock

Next, we analyse the effects of a non-persistent cost-push shock in Figure 2:

A cost-push shock results in a stagflation: there is a substantial decline in output and a burst in inflation. Given the prevalence of inflation stabilization in its motives, the ECB raises the interest rate. The inflation and initial appreciation erode competitiveness and the current account deteriorates despite the initial decline of output which reduces imports. The prolonged recession and the presence of deficit smoothing imply a substantial fiscal deficit. This implies a policy conflict with the ECB: whereas the ECB follows a restrictive policy, the fiscal policy is expansionary. That in particular cost-push shocks are prone to policy conflicts as monetary and fiscal policies tend to act as policy substitutes rather than complements, has also been note in several empirical studies, see e.g. Muscatelli et al. (2004) for an insightful application to the U.S. case.

The difference in adjustment dynamics between commitment and discretion are considerable and even more substantial than in the previous case. Commitment provides a smoother stabilization of inflation. The Taylor rule induces relatively similar adjustments patterns as policy discretion, although the persistence seems to be somewhat higher. The resulting losses in Table 2 show that commitment leads to the lowest losses and discretion to the highest.

iii) A positive productivity shock

The effects of a temporary productivity shock are provided by Figure 3.

See e.g. Jensen (2002) that follows this line of thought and analysis.
The negative output gap that initially results is the combination of the initial shock to potential output and the resulting increase in actual output. Inflation tends to drop initially, thereby evoking an expansionary monetary policy. The resulting (real) exchange rate depreciation and (real) interest rate decrease stimulate output and inflation. The depreciation also contributes to a current account surplus as it boosts competitiveness. The small fiscal surplus also contributes to stabilizing output. Compared to optimal policies, the monetary policy rule regime is marked by higher persistence in the fluctuations in inflation in particular but also in other variables. The earlier conclusions concerning losses and variances for different monetary policy regimes is also seen here: compared with commitment, discretion tends to result in a short-run stabilization bias which is suboptimal from an efficiency point of view (cf. Table 2).

Interestingly, this example (like the first example concerning demand shocks) illustrates that the conclusion of Jensen (2002) that the distinction between commitment and discretion only matters in case of cost-push shocks needs to be modified in this more general setting of the NK model. The presence of backward-looking output and inflation dynamics, the presence of fiscal policy and the link between interest rates and exchange rates in an open economy context, imply that commitment and discretion result in different outcomes also in case of demand and productivity shocks.

iv) A positive fiscal shock

The workings of a fiscal shock are relatively similar to a demand shock as shown in Figure 4.

[Insert Figure 4 here]

One important difference comes from the fiscal rule itself: the initial shock leads to a dynamic adjustment process in the fiscal deficit itself due to the deficit smoothing mechanism. This is clearly seen in the adjustment of the deficit in Figure 4. The adjustments of other variables are quite similar to the adjustments in Figure 1. The expansionary fiscal policy is counteracted by a restrictive monetary policy in order to combat inflation. In contrast to Figure 1 where the automatic stabilizers result in an anti-cyclical fiscal policy that is supportive of monetary policy, here we observe the opposite. The pro-cyclical fiscal policy is not in line with the restrictive monetary policy that aims at combating inflation. The induced appreciation of the exchange rate reduces the competitiveness so that net exports are crowded out and the current account remains in deficit. Concerning variability of output, inflation and interest rate and welfare losses we reach the same conclusions as in case of the demand shocks.

v) A positive exchange rate shock
As discussed earlier, exchange rate adjustment is an important variable in the dynamic adjustments in this model. Figure 5 displays the effects from a shock to the exchange rate itself.

The initial appreciation shock induces modest but highly cyclical fluctuations in output and inflation. Monetary and fiscal policy are expansionary for most of the time. Monetary policy commitment delivers significant gains in stabilizing inflation and output compared to discretionary monetary policy and rule-based monetary policy.

\[\text{vi) A positive foreign output shock}\]

Since the EA is an open economy, it is interesting to analyze the effects of foreign shocks and how these affect monetary policy of the ECB e.g. Figure 6 shows the adjustments produced by a foreign output shock.

The direction of the effects are very similar to those produced by a demand shock but the size of the effects is considerably smaller given that net exports are only a fraction of total demand. In addition, the foreign output shock leads to current account surplus rather than a deficit. Also the conclusions concerning welfare losses and variability of inflation, output, interest rates and exchange rates in the different regimes are the same as in the case of the demand shock in (i).

### 5. A Robustness /Sensitiveness Check of the Results.

The results obtained above were based on the specific set of baseline parameters that was used. Though their values were made plausible by considering empirical estimations in the literature, it may well be that some values may be inaccurate. It is therefore interesting and useful to check if the outcomes change if we change the baseline parameters. We experimented with the following variations relative to the baseline set of parameters:

(i) the degree of forward-lookingness of the IS and Phillips curves: $\psi_1, \psi_2, \omega_1, \omega_2$.

Clearly, the amount of forward-lookingness in the IS and Phillips curves plays a crucial role in the transmission of shocks and therefore in policymaking. We focus here on the role of forward-lookingness w.r.t. inflation. Figure 7 shows the effects of a cost-push shock in the baseline model for three alternative values of $\omega_1$: (i) $\omega_1 = 0$ implying a forward-looking Phillips curve, (ii) $\omega_1 = 0.5$ implying a hybrid Phillips curve and (iii) $\omega_1 = 1$ implying a backward-looking Phillips curve. Moreover, we show these cases for the
three monetary policy regimes since the effects of changing the amount of forward-lookingness depends among others also on the monetary policy regime.

[Insert Figure 7 here]

With decreasingly forward-looking expectations, the persistence of output, inflation and interest rates fluctuations caused by the cost-push shocks increases substantially. This is the case in all three regimes. Clearly, stabilizing an economy that is more backward-looking, is more costly and time-consuming for the policymakers.

(ii) other structural parameters: \( \alpha, \eta, \sigma, \zeta, \delta, \gamma, \tau \).

As seen from Table 1 there is considerable variation in the estimates of the other parameters of the IS and Phillips curves. Figure 8 shows the effects of a fiscal shocks in the baseline model with commitment but where we vary \( \gamma, \tau \) and \( \alpha \).

[Insert Figure 8 here]

\( \gamma \) measures the output elasticity of inflation in the Phillips curve and by linking demand and supply in the model it is one of the key parameters. With higher values of \( \gamma \) the flexibility of output and prices in the model increases in panel (a). This also reduces the amount of monetary policy activity. A stronger pass-through parameter \( \tau \), implies a stronger effect from exchange rate fluctuations on domestic prices, see panel (b). The fiscal shock leads to an appreciation and interest rate increases as we know from before (see Figure 4), but these effects themselves depend also on \( \tau \) as we see here. The appreciation reduces inflation which restores competitiveness. The effects of varying \( \alpha \) in panel (c) are not as strong as the effects of \( \gamma \) or \( \tau \). This would suggest that the interest rate channel of monetary policy –which is captured by \( \alpha \) - is actually not very strong in this case.

(iii) parameters that characterize monetary and fiscal policy rules \( \lambda, \phi, \chi, \mu, \lambda_g, \chi_g \) and monetary policy preference parameters \( \Gamma, \beta, \xi, \nu, \kappa \).

First, we experimented with alternative fiscal policy rules to assess their effects. In Figure 9 the variance of inflation, output and interest rate changes is plotted as a function of the deficit smoothing parameter \( \lambda_g \) in case of a demand shock (panel (a)) and a cost-push shock (panel (b)).

[Insert Figure 9 here]

Both in case of demand and cost-push shocks, a more inert and persistent fiscal policy increases the variance of inflation and output. In case of demand shocks, less fiscal flexibility raises the variance of interest rate,
whereas the variance of interest rate is lowered in case of cost-push shocks. This suggests that from the perspective of the monetary policymaker, fiscal flexibility is preferred in case of demand shocks, but in case of cost-push shocks constraints on fiscal flexibility are needed. This outcome is robust across the three monetary policy regimes.

Next, we varied the preferences of the ECB under commitment and discretion. Table 3 gives the effects of changing the preferences w.r.t. output stabilization, $\xi$, and interest rate smoothing, $\nu$, for the case of demand shocks. The effects are straightforward: (except for a few corner cases with either $\xi$ or $\nu$ equal to zero or one) (a) the variance of inflation increases if the preferences for interest rate smoothing increase and it decreases with a higher preference for output stability. (b) The variance of the output gap increases if interest rate smoothing increases and it decreases with preferences for higher output stability. (c) Interest rate variability decreases with higher preferences for interest rate stability and it increases with higher preferences for output stability. Moreover, these effects conclusions hold both in case of commitment and discretion.

(iv) assumptions on variances and autocorrelations of shocks, $\sigma^2_i, \rho^j_i$. The effects of increasing or decreasing the variance of shocks are straightforward: this will lead to proportional changes in the variances of inflation, output etc. In addition, in the baseline equal variances of all shocks were assumed and it was seen that e.g. in terms of variability of output, cost-push shocks imply the highest variability of output and foreign output shocks the lowest. Increasing e.g. the variability of foreign output shocks will, ceteris paribus, increases the relative importance of foreign output shocks -and decreases the relative importance of the other type of shocks- in explaining the variability of output. Finally, the baseline set of parameters assumes that all shocks are uncorrelated with each other and are uncorrelated over time. The last assumption was not only done because of absence of empirical estimations but also for expositional reasons: increasing the degree of persistence of shocks has strong effects on all adjustments. The increased persistence of shocks will add to the internal persistence of the model produced in particular by the backward-lookingnes in inflation and output and the policy regime (commitment vs discretion or rule based). In case of persistent shocks it will be impossible to distinguish how much of the persistence of variables is due to the persistence of shocks and how much of the persistence is intrinsic to the model. On the other hand, in case of non-persistent shocks we know that the entire persistence of variables is due to the intrinsic dynamics of the model.

Conclusions

The design of monetary policy by the ECB is likely to have important impacts in the EA. Conversely, monetary policy in the EA is affected by many factors. In this paper, we focused on the role of the monetary policy regime: given the structural parameters of the EA economy, the effects were shown to be strongly
conditional upon the monetary policy regime: whether monetary policy was implemented under commitment, discretion or a rule-based framework was seen to have important consequences.

In addition, we highlighted the role of fiscal policy and external factors. Fiscal policies matter for the monetary policymaker: in particular the degree of deficit smoothing and their cyclical component have a strong influence. Moreover, in an open economy like the EA, exchange rate adjustment and foreign shocks are of fundamental importance and may substantially change adjustment dynamics compared to a closed economy setting. This has clearly implications for the monetary policy: not only the interest rate channel will determine outcomes, but also the exchange rate channel of monetary policy.

We analyzed the effects of a series of macroeconomic shocks to assess their impact on monetary policy. As to be expected, commitment strategies yield the best outcomes. In particular, inflation stabilization is fostered under commitment. Optimal policies under discretion suffer from a short-run stabilization bias compared to commitment. Results based on empirical estimates of the Taylor rule are also inferior necessary to commitment. Compared to discretion, its performance was in most cases not much worse or even slightly outperforming the optimal discretionary policy. The difference between the monetary policy regimes is a function of many mechanisms. In particular, the degree of backward lookingness in output and inflation and the amount of deficit smoothing were shown to be important in this respect.

Extensions of the analysis could go into several directions: in particular one could envisage: (i) a further working out of the simple rules regimes allowing for various other simple rules e.g. (ii) The model can be extended to include the possibility that the monetary authorities are facing parameter uncertainty and data uncertainty since these have been shown in the literature to have important consequences for monetary policy. (iii) enriching the effects of monetary and fiscal policy, one could think of including the LM curve to analyze monetary targeting and fiscal effects on the supply side of the economy.

Appendix

The model (1)-(4) can be written in state-space form:

\[
\begin{bmatrix}
X_{t+1} \\
x_{t+1}
\end{bmatrix} = A \begin{bmatrix}
X_t \\
x_t
\end{bmatrix} + Bi + CV_{t+1}
\]  \hspace{1cm} (A.1)

where \(X_t = \begin{bmatrix} y_{t-1} \Delta \rho_{t-1} \epsilon_{t-1} \rho_{t-1} \rho_{t} \hat{u}_{t-1} - y_{t} \hat{u}_{t} \hat{u}_{t} \hat{y}_{t} \hat{y}_{t} \hat{p}_{t} \hat{p}_{t} \hat{i}_{t} \hat{i}_{t} \hat{g}_{t} \hat{p}_{t} \end{bmatrix}\) is a 15*1 vector of predetermined variables in the model, \(x_t = \begin{bmatrix} y_t \Delta \rho_t \epsilon_t \end{bmatrix}\) a 3*1 vector of forward-looking variables, \(i_t = \begin{bmatrix} i_t \end{bmatrix}\) a 1*1 vector of instruments and \(v_t = \begin{bmatrix} v_t^d \hat{v}_t \hat{v}_t^d v_t^d v_t^{d^2} \hat{v}_t \hat{v}_t^d v_t^{d^2} \hat{v}_t \hat{v}_t^{d^2} \end{bmatrix}\) a 8*1 vector of macroeconomic shocks.

The objective function of the policymaker (6) can be rewritten as;

\[
\min L_t^k = E_t \sum_{\tau=0}^{\infty} \Gamma^\tau Y_{t+\tau} W Y_{t+\tau} \hspace{1cm} \text{s.t. (A.1)}
\]  \hspace{1cm} (A.2)
where $Y = D X + C t$ is a 4*1 vector of target variables and $W = \begin{bmatrix} \beta & 0 & 0 & 0 \\ 0 & \xi & 0 & 0 \\ 0 & 0 & \nu & 0 \\ 0 & 0 & 0 & \kappa \end{bmatrix}$.
The model (A.1)-(A.2) is a standard linear stochastic regulator problem with rational expectations and forward-looking variables. Optimal policies can be determined (a) under a regime of policy commitment, (b) under policy discretion (see e.g. Oudiz and Sachs (1985), Backus and Driffill (1986), and Söderlind (1999), Jensen (2002) for the detailed working out of the optima; policies under commitment and discretion cases).

In the discretion case, the policymaker reoptimizes each period by taking the process by which private agents form their expectations as given, where the expectations are consistent with actual policies. The optimal reaction function and forward-looking variables will be linear functions of the predetermined variables. The dynamics of the economy are then described by:

\[ X_{t+1} = M_{11}X_t + v_{t+1}, \]
\[ x_t = HX_t, \]
\[ i_t = FX_t, \]
\[ Y_t = (C_1 + C_2H + C_3F)X_t \]

where \( M = (I - F)^{-1}(A + BF) \) and \( M = \begin{bmatrix} M_{11} & M_{21} \\ M_{12} & M_{22} \end{bmatrix}, \)
\( C = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} \)

are partitioned according to \( X_t \) and \( x_t \).

Standard solution algorithms (see Söderlind (1999)) are used to determine \( H \) and \( F \) and derive the adjustment dynamics and variance-covariance matrices under discretion.

In the commitment case, the policymaker optimises at the beginning of the planning period. The policymaker acts as a Stackelberg leader w.r.t. the private sector, taking into the equations of motion of the forward-looking variables (i.e. the expectations of the private agents) as additional constraints. It adopts this optimal policy and sticks to it during the entire planning period. The optimal reaction function and the forward-looking variables depend not only on the predetermined variables but also depend on the shadow prices of the forward-looking variables. The latter measure the costs from reneging upon the committed policy. The optimal reaction function commitment solution is determined by a decomposition of the stable eigenvalues from the first-order conditions of the optimization problem (A.2) subject to the transition equation (A.1), see e.g. Söderlind (1999) for the different optimization procedures.

In the simple policy rule regime, the rule is inserted as \( i_t = QX_t \) into the dynamic system (A.3) instead of the optimal policy, see again Söderlind (1999) on the simple rule regime.
References


Peersman and Smets (1999),


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**Table 1**

Estimations of the IS and Phillips curves, Taylor rules and macroeconomic shocks characteristics for the euro-area. ^a Germany.
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Table 2
Variance analysis and losses from various shocks.
Figure 1
A Demand Shock
Figure 2
A Cost-Push Shock
Figure 3
A Potential Output Shock
Figure 4
A Fiscal Shock
Figure 5
An Exchange Rate Shock
Figure 6
A Foreign Output Shock
Figure 7
Effects of backward-looking inflation expectations (cost-push shocks).
Figure 8

Sensitivity w.r.t. $\gamma$, $\tau$ and $\alpha$, fiscal shocks, commitment.
Variance of inflation as a function of $\lambda_g$

Variance of output gap as a function of $\lambda_g$

Variance of interest rate changes as a function of $\lambda_g$

(a) demand shocks

(b) cost-push shocks

Figure 9
Effects of deficit smoothing
### Table 3
Effects of varying $\xi$ and $\nu$

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