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Monetary-Fiscal Mix and Inflation Performance: Evidence from the U.S. *

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Abstract

There has been a lot of interest recently in developing small scale rule-based empirical macro models for the analysis of monetary policy. These models, based on the conventional view that inflation stabilization should be a concern of monetary policy only, have typically neglected the role of fiscal policy. We start with the evidence that a baseline VAR-augmented Taylor rule can deliver recurrent mispredictions of inflation in the U.S. before 1987. We then show that a fiscal feed-back rule, in which the primary deficit reacts to both the output gap and the government debt, can well characterize the behavior of fiscal policy throughout the sample. However, by employing Markov-switching methods, we find evidence of substantial instability across fiscal regimes. Yet this precisely happens *before 1987*. We then augment the monetary VAR with a fiscal policy rule and control for the endogenous regime switches for both rules. We find that only over time windows belonging to the pre-1987 period the model based on the two rules can predict the behavior of inflation better than the one based just on the monetary policy rule. *After 1987*, when fiscal policy is estimated to switch to a regime of fiscal discipline, the monetary-fiscal mix can be appropriately described as a regime of monetary dominance. Over this period a monetary policy rule based model is always a better predictor of the inflation behavior than the one comprising both a monetary and a fiscal rule.

Keywords. Monetary and Fiscal Policy Rules, Markov Switching, Inflation.
JEL Classification Number: C32, E60, E62.

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1 Introduction

Recently we have witnessed a vivid interest in macroeconomics for the analysis of policy regimes. The state-of-the-art empirical survey by Christiano, Eichenbaum and Evans (2001) on the effects of monetary policy de-emphasizes the role of shocks and focuses the attention on the systematic component of policy in shaping the post-war U.S. business cycle. However nearly the whole literature on business cycles and monetary regimes has analyzed monetary policy in complete isolation, and in particular from fiscal policy. The main justification for this approach lies in the theoretically well-rooted paradigm according to which inflation stabilization should be a concern of the monetary authority only. The more independent such authority the more credible and therefore the more successful in achieving the primary goal of reducing and stabilizing inflation. Current analysis of U.S. monetary policy generally acknowledges that 1979 marks the beginning of a new policy regime characterized by a strong anti-inflationary stance.[1]

A different stream of the literature, usually categorized as the fiscal theory of the price level (FTPL henceforth), has challenged this "conventional view".[2] In a nutshell such a literature emphasizes that a tough independent central bank is not sufficient to ensure the goal of price stability unless fiscal policy satisfies some compatibility conditions.[3] This interpretation puts at the center stage the role of the (monetary and fiscal) *policy mix* in determining the joint dynamics of inflation and output. According to this view the strong anti-inflationary policy pursued in the U.S. with the onset of the Volcker-Greenspan regime would not have sufficed to successfully moderate inflation without the fiscal adjustment that characterized the U.S. economic policy throughout the nineties. While the argument pursued in several contributions of the FTPL is reminiscent of the unpleasant monetaristic arithmetic of Sargent and Wallace (SW) (1981), it contains a much stronger implication. SW's view of the policy mix is essentially the one of a game of chicken. In such a context, while an undisciplined fiscal policy may exert pressures on the monetary authority to sooner or later monetize the deficit, monetary growth will still determine the rate of inflation to the extent that the monetary authority hangs on. In the strongly unpleasant view of the FTPL (see e.g., Woodford (1996)) independently of the anti-inflationary stance of the monetary authority the goal of price stability cannot be

[1] Empirical investigations of the Fed's reaction function confirm this discontinuity. See the widely cited work of Clarida, Gali and Gertler (2000). Cogley and Sargent (2002) also relate the conquest of U.S. inflation to a different behaviour of the monetary policy authority under the Volcker and Greenspan tenures.

[2] See Leeper (1991), Sims (1994), Cochrane (1998), Woodford (1996, 2001).

[3] As Christiano and Fitzgerald (2000) put it the source of attrition between advocates and skeptics of the FTPL is the simple arithmetics of the present value government budget constraint (i.e., the equality between the nominal debt divided by the price level and the present discounted value of future primary surpluses). The traditional view argues that the primary surplus must necessarily adjust in order to satisfy that equation *for any level of prices.* On the other hand advocates of the FTPL view the present value government budget constraint as an *equilibrium* condition. As such, logically, nothing requires the primary surplus necessarily to adjust to satisfy that equation. In equilibrium the price level will do the job.

reached if the primary deficit fluctuates unpredictably. And even worse so, the more aggressive against inflation the monetary authority the larger is the volatility in the price level.[4]

Regardless of the stand one eventually chooses to take on the theoretical plausibility of a purely fiscalist view of inflation, one merit of the FTPL approach is to highlight that the conventional view holds under specific assumptions, usually considered innocuous, on the underlying behavior of the fiscal authorities.[5] In this spirit an appropriately defined monetary policy rule requires also an appropriately defined fiscal policy rule. However, and surprisingly enough, very little attention has been devoted so far to study *empirically* the role that the *interaction* between monetary and fiscal policy rules may have played in shaping the postwar macroeconomic outcomes.[6]

A number of authors have recently shifted the attention to the specification of fiscal policy in terms of reaction functions. Taylor (1996, 2000a, 2000b) argues that a fiscal rule can be specified for the U.S. by simply relating the measure of the fiscal stance to the deviation of output from its equilibrium level. He finds evidence of a countercyclical pattern of systematic fiscal policy. "Taylor fiscal rules" do not explicitly allow for a reaction to the evolution of the government debt. Bohn (1998) argues that a century of U.S data reveals a positive correlation between the Government surplus to GDP ratio and the government debt to GDP ratio.[7]

In this paper we have two broad goals. The first one is to transfer onto fiscal policy the same logical apparatus of the regime-based approach recently used in the empirical analysis of monetary policy. Accordingly we investigate if a rule-based systematic representation can well track the behavior of fiscal policy after 1960 in the U.S. With this respect our view contrasts the one of a recent literature that tries to quantify the effects of the *unanticipated* component of fiscal policy on a series of key macroeconomic variables.[8] Our second goal is to understand whether a *monetary-fiscal mix*, better than a monetary policy regime only, has contributed to shape the postwar inflation-output dynamics in the U.S.

We improve on the above cited contributions in two ways. First, we allow for a more general specification of the fiscal rule. In principle we maintain that fiscal policy may respond to two complementary goals. On the one hand the government may display some concern for long-run fiscal solvency and therefore for the evolution of the government debt (the "passive" component). However, fiscal policy may also be employed for business cycle stabilization purposes (the "active" component).[9] Hence

[4] See Christiano and Fitzgerald (2000) for a detailed discussion.

[5] Benhabib, Schmitt-Grohe and Uribe (2002).

[6] See Canzoneri, Cumby and Diba (2002) and Sala (2002) for an empirical analysis of some dimensions of the fiscal theory.

[7] Bohn implies from this evidence that fiscal policy in the U.S. can inherently be considered as Ricardian. See ahead for a discussion on this point.

[8] See for instance Blanchard and Perotti (2001), Perotti (2002), Burnside, Eichenbaum and Fisher (2002), Fatas and Mihov (2002).

[9] This terminology follows Leeper (1991). Woodford (1996, 2000) generalizes this characterization of the fiscal policy regimes. He defines as *Ricardian* a fiscal regime in which the present value government budget constraint holds for any path that might have been followed by prices and interest rates along the equilibrium. A passive (active) fiscal policy in the sense of Leeper is therefore

we specify a fiscal rule in which the primary deficit is allowed to respond (non-linearly) to the level of the existing debt and (linearly) to the output gap. Secondly, we allow the fiscal regime to vary over time, and employ Markov-switching regression methods to identify such regime changes endogenously.

We reach few interesting conclusions. First, we show that the fiscal policy regime in the U.S. can be adequately described in terms of a systematic rule. In such a rule both the government debt as well as the output gap enter significantly as explanatory variables.

Second, we find that the conduct of fiscal policy has displayed substantial regime instability. We believe that this poses a challenge to a recent VAR-based empirical literature trying to measure the high-frequency effects of fiscal policy shocks, for in such a literature the issue of stability of the fiscal regime is typically overlooked.

Third, we are able to empirically identify *two fiscal regimes* in the U.S. between 1960 and 2000. The first one runs from 1974:1 and breaks around 1986:2. It is characterized by a takeoff in the government debt to GDP ratio, by a destabilizing (systematic) response of the primary deficit to the debt to GDP ratio, and by a relatively small concern for output gap stabilization. With 1987 a clear break seems to take place in the fiscal policy conduct. The primary deficit starts to move in accordance with a debt stabilization motive, while a systematic response to the output gap plays a much larger role relative to the previous regime. As a result of this regime we observe a steady declining trend in the debt to GDP ratio that runs throughout the nineties. More broadly we are able to characterize 1987 as a breaking date for fiscal policy, marking the transition from a substantial regime instability to a prolonged stable phase of concern for fiscal discipline

Fourth, we explore how this break in the fiscal policy regime might have interacted with the existing monetary policy regime in shaping the U.S. output-inflation dynamics. We first show, after controlling for the history of macroeconomic (i.e., non-policy) shocks, that a regime based on a monetary policy rule only can have a low predictive power on U.S. inflation in several episodes. However this invariably happens only *before 1987.* Indeed it is only within this phase that we can identify time windows in which an empirical model based on *both* regimes (monetary and fiscal) is able to track the dynamics of inflation better than a regime based on a monetary policy rule only. After 1987 the empirical model based solely on a monetary rule is able to track the inflation dynamics remarkably well. Our results point out that a significant role of fiscal policy for inflation determination is detectable only when the monetary and fiscal regime appear in mismatch (namely with rules not jointly designed in such a way to guarantee a unique stable rational expectations equilibrium), exactly like it appears to happen frequently before 1987.

Finally we run a simple counterfactual experiment. Conditional on the "active" monetary regime commonly perceived of being in place after 1979 we ask what path inflation would have followed had fiscal policy not undergone the regime break in early 1987 as estimated in our fiscal reaction function. The experiment suggests that it would have been unfeasible to bring inflation to the actual levels only through the

Ricardian (Non-Ricardian) in the sense of Woodford.

specified monetary policy rule if fiscal policy had not switched to a regime consistent with fiscal solvency. Such results point in favor of the relevance of the monetary-fiscal mix regime (more than the monetary regime alone) in driving the stabilization of inflation during the 1990s.

The paper is structured in five sections. Section 1 takes a fresh look at the baseline monetary VAR model. Section 2 investigates to what extent a (regime-switching) fiscal rule can well track the behavior of fiscal policy after 1960 in the U.S. Section 3 discusses some stylized facts about fiscal policy in the U.S.. Section 4 evaluates the impact of the monetary-fiscal mix on macroeconomic outcomes by using factual and counter-factual simulations. Section 5 concludes.

2 Monetary Policy Regimes and Macroeconomic Outcomes: A Closer Look

The analysis of U.S. monetary policy generally acknowledges that a shift in policy emphasis occurred between 1979 and 1980. This date is generally assumed to be the beginning of a new policy regime, which later continued under the Chairmanship of Alan Greenspan.

Insert Table 1 here

Table 1 illustrates estimation results of a forward-looking reaction function for the Federal Reserve over the periods 1960:1-1979:2 and 1984:1-2000:4. The estimated forward-looking rule is in line with a wide evidence available in the literature.[10] There is strong persistence in policy rates. In the first subsample the reaction of monetary policy authorities is such that inflationary shocks are accommodated. Conversely the second subsample features a more aggressive non-accommodating policy behavior with a response of the nominal rate to expected inflation higher than unity. Such more aggressive stance towards inflation is also coupled by a more aggressive response to the output gap.

These results are obviously rather standard. Here we take a different look at the interaction between monetary policy regime and macroeconomic outcomes. We first augment the policy rule with a VAR that contains instruments employed to project future inflation. We estimate the following model over quarterly data:[11]

[10] See Taylor (1994), Clarida, Gali and Gertler (1998) and the extensive literature on estimating simple monetary policy rules that followed.

[11] All data are taken from FRED (http://research.stlouisfed.org/fred2/), with the only exception of the IMF commodity price index, which is taken from Datastream.

$$
\begin{aligned}
\begin{bmatrix} lpcm_t \\ \pi_t \\ x_t \end{bmatrix} &= A_0\left(s_t^m\right) + \sum_{i=1}^{4} A_i\left(s_t\right) \begin{bmatrix} lpcm_{t-i} \\ \pi_{t-i} \\ x_{t-i} \end{bmatrix} + \sum_{i=1}^{4} B_i\left(s_t^m\right) \begin{bmatrix} i_{t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} \\
i_t &= \beta_1\left(s_t^m\right) i_{t-1} + \left(1 - \beta_1\left(s_t^m\right)\right) i_t^* + \varepsilon_t \\
i_t^* &= \beta_0\left(s_t^m\right) + \beta_2\left(s_t\right)\left(E_t \pi_{t+4} - 2\right) + \beta_3\left(s_t^m\right) x_t \\
s_t^m &= s_1^m, s_2^m \\
s_1^m &= 1960:1\text{-}1979:2, \;\; s_2^m = 1984:1\text{-}2000:4
\end{aligned}
$$

In the specification above s_t^m denotes the (possibly time-varying) monetary policy regime, i_t and i_t^* denote the actual and the equilibrium (rule consistent) Federal Funds rate respectively, π_t is the annual CPI inflation, $lpcm_t$ is the IMF commodity price index, x_t is the percent difference between real GDP and potential GDP (as computed by the Bureau of Economic Analysis of the US Department of Commerce), ε_t denotes discretionary deviations from the policy rule (i.e., monetary policy shocks) and $u_{j,t}$ is a non-policy shock, with $j = 1, 2, 3$. We take the dating of the two regimes s_1^m and s_2^m as exogenously given.[12] Notice that we do not include data from the 1979:3-1983:4 range. In fact in that period, as showed by Bernanke-Mihov (2000), monetary policy was based on a non-borrowed reserve targeting and can be hardly described in terms of an interest rate reaction function. In Table 2 we report estimates of the coefficients for the endogenous variables in the augmented VAR model. They show that only the effect of the lagged dependent variables are precisely estimated in each equation.

Insert Table 2 here

We then conduct, over the whole sample, the following experiment. We run a dynamic simulation where we include all the macroeconomic (i.e., non-policy) estimated shocks while forcing to zero the estimated shocks to the monetary policy rule. With this strategy we can interpret the obtained simulated series as the outcome of a monetary policy maker who confronts the observed macroeconomic shocks but never deviates from the rule. In practice we stochastically simulate the following model:

$$
\begin{aligned}
\begin{bmatrix} lpcm_t \\ \pi_t \\ x_t \end{bmatrix} &= \widehat{A}_0\left(s_t^m\right) + \sum_{i=1}^{4} \widehat{A}_i\left(s_t\right) \begin{bmatrix} lpcm_{t-i} \\ \pi_{t-i} \\ x_{t-i} \end{bmatrix} + \sum_{i=1}^{4} \widehat{B}_i\left(s_t^m\right) \begin{bmatrix} i_{t-i} \end{bmatrix} + \begin{bmatrix} \widehat{u}_{1t} \\ \widehat{u}_{2t} \\ \widehat{u}_{3t} \end{bmatrix} \qquad (1) \\
i_t &= \widehat{\beta}_1\left(s_t^m\right)\; i_{t-1} + \left(1 - \widehat{\beta}_1\left(s_t^m\right)\right)\left(\widehat{\beta}_0\left(s_t\right) + \widehat{\beta}_2\left(s_t^m\right)\left(E_t \pi_{t+4} - 2\right) + \widehat{\beta}_3\left(s_t^m\right)\; x_t\right) \\
s_t^m &= s_1^m,\; s_2^m
\end{aligned}
$$

Notice that the parameters in the simulation are set to their estimated values (denoted with a circumflex) over the two different regimes s_1^m and s_2^m respectively.

[12] See Clarida et al., 2000 and our estimates as from Table 1.

We complete the model by setting in each equation the macroeconomic (non-policy) shocks to their historical values, while shutting down the shocks to the monetary policy rule. We apply this strategy under the usual block recursive identification scheme for monetary policy shocks, which assumes that, while the monetary policy authority reacts simultaneously to macroeconomic events, it takes at least one period to macroeconomic variables to react to monetary impulses.[13]

The comparison between actual and dynamically simulated variables permits an evaluation of the importance of systematic monetary policy in determining macroeconomic outcomes over the two subperiods. We report point estimates and confidence intervals of the simulated series for inflation and the output gap along with actual values in Figure 1.

Insert Figure 1 here

The simulation shows that the fit is generally quite poor before 1979. There are a few episodes in which the model-based series deviate from the historical ones in a systematic fashion. In particular there are two periods in which the series of mispredictions is remarkable: i) *1984-1987*, where the model systematically underpredicts inflation with prediction errors of the size of fifty per cent of the predicted variable; ii) *1965-1968* where conversely the model systematically overpredicts inflation, although the size of the prediction errors is smaller and the deviations of simulated inflation from actual inflation is not as significant as in the 1984-1987 episode. Significant mispredictions also occurs for the output gap especially over the period 1965-1980. Quantitatively the simulated inflation explains 68 percent of the variance of actual inflation over the sample 1984-2001. However we observe that the simulated inflation explains only 43 per cent of the variance of actual inflation in the 1984-87 sub-sample while up to 90 per cent in the 1988-2000 sub-sample. We conclude that only the latter period is one in which the dynamic of inflation is best explained by a VAR model based on a monetary policy rule only.[14]

3 Fiscal Policy: Stylized Facts and Dynamic (In)Efficiency

Figure 2 (top panel) plots the U.S *government debt* as a ratio of GDP. There is a clear downward trend that spans the period 1960-1980, with only a couple of mild episodes of debt accumulation in 70-72 and 75-77. Conversely, after 1980, the debt to GDP ratio displays a clear upward trend which starts to revert only after 1993. The bottom panel plots the ratio of the primary deficit to GDP against the difference between the rate of interest and the rate of growth of GDP.

Insert Figure 2 here

[13] See Bernanke and Mihov (2000), Christiano et al. (2001).

[14] Strictly speaking this is exactly consistent with the evidence in Taylor (1993). His evidence, though, could span only a sample up to 1992.

Notice that once again 1980 stands out as a breaking date. Before 1980 the gap between rate of return and growth rate is negative while it turns mostly positive throughout then. In other words the U.S. economy appears as *dynamically inefficient* until 1980 and *dynamically efficient* afterwards. Hence the pre-1980 period appears as one in which the government budget constraint is "less binding" relative to the post-1980 period. It is simple to see this by looking at the period-by-period government budget constraint (abstracting from seigniorage revenues for simplicity):

$$b_t = \left(\frac{1+r}{1+g}\right) b_{t-1} + d_t \tag{2}$$

Hence a non-explosive dynamic towards the steady state requires the real return-growth rate gap to be positive, i.e., $r - g > 0$.[15] What we wish to emphasize is that the 1980 break in the real return-growth rate gap is almost simultaneous to the widely recognized one in the monetary policy regime (also illustrated in the previous section). After 1980 a more active (anti-inflationary) monetary policy seems responsible for real interest rates persistently above the real growth rate of the economy and hence for rendering the government budget constraint "more binding".[16] We will elaborate on this point later.

3.1 Modelling and Identifying Fiscal Policy Regimes

Our first step towards introducing fiscal policy in the model is the specification of a fiscal policy reaction function. We assume that the fiscal authority uses the government primary deficit as the policy instrument and incorporate a distinction between a *cyclical* and a *structural*component of the deficit.[17] We then propose a specification for the fiscal regime similar in spirit to a Taylor-type rule for monetary policy and capable of accommodating both an *output gap* stabilization motive (which in principle can also capture the mechanics of automatic stabilizers) and a *public debt* stabilization motive.

[15] More generally along a steady-state path for b_t in which both r an g are allowed to vary a stable steady state dynamics requires

$$d_t = -\bar{b}\left(\frac{r_t - g_t}{1+g_t}\right)$$

which implies a negative relationship between the primary deficit and the real return-growth rate gap. The data in Figure 2 clearly show a strong negative comovement between these two variables.

[16] We are being a bit loose on the concept of "more" and "less" binding here. As it will appear more clear below (and as illustrated in Woodford (1996, 2000)) it would not be correct to conclude that in a dynamic inefficient economy (i.e, with $r_t - g_t < 0$) the government budget constraint is not binding. A transversality condition on bonds' holdings must always hold regardless of how fiscal policy is conducted (i.e., of whether or not the primary deficit is expected to explicitly adjust to meet the present value budget constraint). Advocates and skeptics of the FTPL indeed disagree on *how* this condition gets to be satisfied in equilibrium. Moreover Blanchard and Weil (2002), along with references cited therein, show that in a dynamic inefficient economy it would be feasible to roll over the debt forever only if the economy were non-stochastic and always at the steady state. More generally dynamic inefficiency is neither a necessary nor a sufficient condition for conducting a debt Ponzi game.

[17] See, e.g., Taylor (2000).

Empirically the effect of government debt on the fiscal policy stance has been studied by Bohn (1999), who specifies a simple rule relating the primary deficit to the level of the debt to GDP ratio. Our specification differs from the one in Bohn in four respects. First we employ a non-constant parameter approach. We allow for multiple regimes in the conduct of fiscal policy and estimate a Markov-switching model in which the probability of each regime can vary endogenously.[18] Within our framework a period of fiscal indiscipline might still be sustainable (i.e., compatible with a present value budget constraint of the government) if it is followed by a structural change in the parameters that describe the fiscal policy conduct, thereby generating fiscal restraints and convergent fundamentals.

Second, we allow the coefficient on government debt to depend non-linearly on the interest rate-real growth gap. Our aim is to control for variations in emphasis on the debt stabilization motive as a result of the economy being or not in a situation of dynamic efficiency (see Section 3 above).

Third, we allow for inertia in the evolution of the fiscal deficit towards the desired level by assuming that the actual fiscal instrument converges towards the equilibrium desired value only gradually.

Fourth, and in order to control for the cyclical component of fiscal policy (as opposed to the structural component captured by the debt stabilization motive), we include the output gap among the determinants of the equilibrium level of the fiscal deficit.[19]

The fiscal policy rule we estimate has the following specification:

$$\begin{aligned} d_t &= \gamma_1\left(s_t^f\right) d_{t-1} + \left(1 - \gamma_1\left(s_t^f\right)\right) d_t^* + v_t \\ d_t^* &= \gamma_0\left(s_t^f\right) + \gamma_2\left(s_t^f\right) x_t + \left[\gamma_3\left(s_t^f\right) + \gamma_4\left(s_t^f\right)(i_t - g_t)\right] b_t \\ s_t^f &= s_1^f, s_2^f \end{aligned} \tag{3}$$

where d_t is the ratio of primary deficit to GDP, d_t^* is the equilibrium or desired level of the primary deficit, g_t is the annual rate of growth of nominal potential GDP, b_t is the ratio of government debt to GDP, v_t is a term that captures discretionary deviations from the rule (interpretable as a fiscal policy shock) and s_t^f denotes possibly time-

[18] We implemented our estimation by using MSVAR for Ox (see Krolzig,1998).

[19] For a recent empirical analysis of fiscal policy rules see also Ballabriga and Martinez-Mongay (2002). Their analysis differs from ours in that they employ a constant parameter approach and do not allow the coefficient on government debt to depend non-linearly on the interest rate-real growth gap.

varying fiscal regimes.[20] The results of our estimation are reported in Table 3.[21]

Insert Table 3 here

Several aspects are worth emphasizing.

- Statistically the best characterization of fiscal policy is in terms of *two regimes* (F1 and F2). The critical factor that distinguishes the two regimes is the sign of the response of the primary deficit to the level of debt. Hence while in *regime F1* the deficit responds *negatively* (and therefore in a stabilizing fashion*)* to the stock of debt, the converse is true under *regime F2.* More precisely we have that the two regimes span the following time periods respectively:

$$\begin{gathered} \text{F1} \equiv [60:4-65:2], [68:2-74:1], [86:3\text{-}00:4] \\ \text{F2} \equiv [65:3\text{-}68:1], [74:2\text{-}86:2] \end{gathered}$$

- It seems natural to identify F1 with periods of fiscal "discipline" and F2 with periods of fiscal "indiscipline". In fact F2 covers at least two periods of fiscal (discretionary) expansions. During 1965-1967 fiscal profligacy was caused by President Johnson's spending on the Vietnam War and the War on Poverty, ended by the tax increase of 1968. The period 1974-1986 contains at least three episodes: i) The 1975 fiscal expansion caused by President Ford's tax cut following the oil price increase ("We are all Keynesians now"); ii) The military build-up started by Carter and strengthened under the Reagan's presidency; iii) The 1982 Reagan's tax cut.

- For the sake of comparison we also report in Table 3 (right-hand side column) the results of estimating our fiscal rule under the assumption of a unique fiscal regime. This would correspond to the approach followed in Bohn (1998), although with the additional inclusion of the output gap as an argument. Hence we see that both the government debt and the output gap enter significantly. However the constant-parameter estimation would be misleading in that it would predict a stabilizing fiscal regime throughout the sample (i..e, a debt feed-back coefficient always negative), concealing the significant subsample instability predicted by our Markov estimation. As it stands clear from the standard error of the residuals the rule restricted to a unique a regime would then be a worse representation of the data.

[20] Notice that our measure of the fiscal instrument is the *actual* deficit. Some authors (see e.g., Gali and Perotti (2003) for a study on European countries) use instead a *cyclically adjusted* measure of the deficit (or surplus). This distinction is particularly important when trying to disentagle the truly discretionary part of fiscal policy thereby controlling for the component whose variations are due to causes outside the direct control of the fiscal authorities. The implicit assumption in our analysis is that the output gap is the indicator that captures the cyclical component of fiscal policy and therefore may very well contain the feedback resulting from the operation of automatic stabilizers. Further controlling for this component is less important for the purpose of our analysis.

[21] We implemented our estimation by using MSVAR for Ox (see Krolzig,1998).

- Figure 3 shows the estimated probability of the fiscal regime F1 from the Markov-switching estimation of the fiscal policy rule (3), while Figure 4 shows how the long-run response of the primary deficit to the level of the debt (i.e., the total response $\gamma_3\left(s_j^f\right)+\gamma_4\left(s_j^f\right)(i_t-g_t)$ for any given state s_j^f) evolves over time. It stands clear that the non-linearity in such a coefficient is statistically significant but not decisive. In fact the sign of the deficit-to-debt response is determined by the constant and it is independent of the fluctuations in the interest rate-growth gap.

Insert Figure 3 and 4 here

- Figure 4 reports also values for $\gamma_2\left(s_t^f\right)$, the long-run response of the primary deficit to the output gap (which is forced to be constant within each regime). The sign of this coefficient is always significant and negative across fiscal regimes, indicating a relevant countercyclical role for fiscal policy. Furthermore it stands clear that the role of this component of fiscal policy has shifted over time. The switch from regime F2 to regime F1 entails a much stronger response of the deficit to fluctuations in the output gap.

We draw two broad indications from this analysis. First, the behavior of fiscal policy is characterized over time by a substantial regime instability. This result highlights a potential drawback from estimating constant-parameter reaction functions along the lines of Bohn (1998), for the sign of the estimated parameters may conceal significant breaks in the conduct of fiscal policy. This evidence seems also to pose a challenge for a recent VAR literature that tries to assess the effect at the business cycle frequency of appropriately identified fiscal shocks on a series of macroeconomic variables.[22] Typically in that stream of the literature the issue of regime instability in fiscal policy has been overlooked.

Second, 1986:3 marks a clear break in the conduct of fiscal policy. After a prolonged phase of substantial regime instability fiscal policy seems to switch to a stable regime characterized by two main features: a stronger concern for output gap stabilization and a typical "Ricardian" feature of systematic reaction to the evolution of the government debt. Once coupled with the widely accepted evidence on the shift in the monetary policy rule this result suggests that the post 86:3 period has been characterized by a policy mix in which monetary policy was active (i.e., aggressive on inflation) and fiscal policy was passive (or Ricardian). This is what sometimes is defined as a regime of *monetary dominance*. According to the analysis in Leeper (1991) and Woodford (2000) within this regime monetary and fiscal policy match in such a way to insure a unique rational expectations equilibrium.

There are caveats to the direct approach of estimating fiscal rules that we employed here. One concerns the interaction between the fiscal rule and the period by period government budget constraint as in equation (2). By simply integrating such equation forward *and* by imposing the transversality condition one can relate the

[22] See references cited in the introduction.

current real debt to the expected present discounted values of future deficits. Hence technically the current debt contains information on current and expected future fiscal deficits.[23] This is likely to generate a *negative bias* in our estimates of both γ_3 and γ_4. However it is remarkable that, this bias notwithstanding, we obtain evidence of a *change in sign* in the estimated coefficient describing the reaction of the deficit to the debt from a positive value in the F2 regime to a negative one in the F1 regime. Another concern regards an implicit assumption embedded in rule (3), namely that the unanticipated component of the fiscal deficit (captured by the shock term v_t) is uncorrelated with the output gap.[24] We checked for the correlation between the unanticipated component of fiscal policy and the residuals in our specification for the output gap. Such correlation turns out to be -0.013 over the sample 1960-1979 and 0.068 over the sample 1983-2000, showing that the potential simultaneous equation bias is not empirically relevant for our estimated fiscal rule.

Finally, it is instructive to compare the relative performance of the monetary rules traditionally estimated in the literature via GMM (yet with an exogenous switch in regime as from Table 1) with the one of our fiscal rule estimated via Markov switching. We do so by reporting in Figure 5 the historical (i_t, d_t) and equilibrium (i_t^*, d_t^*) values for both policy instruments, the Federal Funds Rate and the deficit to GDP ratio. This exercise is meant to assess the ability of our constructed measures of monetary and fiscal stances to capture the observed behavior of policy.

Insert Figure 5 here

Hence we see that deviations of the monetary policy rate from the equilibrium value (predicted by forward-looking Taylor rules) are more persistent than the same deviations of the primary deficit from the equilibrium level predicted by our fiscal rule.[25] We take this evidence as encouraging for the relative performance of the Markov-switching representation of the fiscal policy regime employed here.

4 Does Adding Fiscal Policy Matter?

In this section we turn to one of the key questions of the paper. Namely, what is the marginal contribution for predicting output gap and inflation that derives from specifying the joint monetary-fiscal regime? We proceed by augmenting the VAR model with a fiscal block and control for the changes in the fiscal regime as estimated by our previous Markov-switching regressions. Then we obtain simulated paths for

[23] See Woodford (2000) for a comment on such a point.

[24] We also experimented with versions of the rule in which the *expected* (as opposed to the actual) output gap enters the fiscal rule. Our results are barely unsensitive to this specification.

[25] The regression of the deviation of monetary policy rates from equilibrium on its own lagged values features a coefficient of *0.8*. The same regression of the deviations of the fiscal indicator from its equilibrium level features a coefficient of *0.72*. While, for the sake of brevity, we do not report the results here it stands obvious that the equilibrium value of the fiscal instrument generated via a constant parameter rule implies a much worse fit relative to the one generated via the Markov switching estimation.

inflation and output gap. In so doing, and similarly to the analysis of monetary policy of Section 1, we consider a hypothetical scenario in which the policy authorities never deviate from their rules (and hence policy shocks are zeroed out) but macroeconomic series are instead affected by the estimated historical shocks.

4.1 A Monetary-Fiscal VAR with Markov-Switching Policy Rules

The factual simulation is based on the following monetary-fiscal VAR model:[26]

$$
\begin{aligned}
\begin{bmatrix} lpcm_t \\ \pi_t \\ x_t \end{bmatrix} &= \widehat{A}_0\left(s_t^m\right) + \sum_{i=1}^{4} \widehat{A}_i\left(s_t^m\right) \begin{bmatrix} lpcm_{t-i} \\ \pi_{t-i} \\ y_{t-i} \end{bmatrix} + \sum_{i=1}^{4} \widehat{B}_i\left(s_t^m\right) \begin{bmatrix} i_{t-i} \\ d_{t-i} \end{bmatrix} + \begin{bmatrix} \widehat{u}_{1t} \\ \widehat{u}_{2t} \\ \widehat{u}_{3t} \end{bmatrix} \\
i_t &= \widehat{\beta}_1\left(s_t^m\right) i_{t-1} + \left(1 - \widehat{\beta}_1\left(s_t^m\right)\right) i_t^* \\
d_t &= \widehat{\gamma}_1\left(s_t^f\right) d_{t-1} + \left(1 - \widehat{\gamma}_1\left(s_t^f\right)\right) d_t^* \\
i_t^* &= \widehat{\beta}_0\left(s_t^m\right) + \widehat{\beta}_2\left(s_t^m\right)\left(E_t \pi_{t+4} - 2\right) + \widehat{\beta}_3\left(s_t^m\right) x_t \\
d_t^* &= \widehat{\gamma}_0\left(s_t^f\right) + \widehat{\gamma}_1\left(s_t^f\right) x_t + \left[\widehat{\gamma}_2\left(s_t^f\right) + \widehat{\gamma}_3\left(s_t^f\right)\left(i_t - g_t^p\right)\right] b_t \\
b_t &= \frac{1 + r_t}{1 + g_t} b_{t-1} + d_t
\end{aligned}
$$

where the alternative monetary and fiscal regimes are

$$
\begin{aligned}
s_1^m &= [61:3 \text{ - } 79:2] \\
s_2^m &= [84:1 \text{ - } 00:4] \\
s_1^f &= [65:3 \text{ - } 68:1],\ [74:2 \text{ - } 86:2] \\
s_2^f &= [60:4 \text{ - } 65:2],\ [68:2 \text{ - } 74:1],\ [86:3 \text{ - } 00:4]
\end{aligned}
$$

The estimated coefficients of the macro variables $(lpcm_t, \pi_t, y_t)$ are described in Table 4. Notice that the model has been estimated allowing for the same monetary regime breaks previously used in the VAR specification with no fiscal variables. Rather than commenting on coefficient estimates, which as usual are imprecisely estimated in VARs, we assess the fit of the model by dynamic simulation (as in section 1). In Figure 6 we report actual and simulated series for output gap and inflation based on two specifications: the VAR with monetary policy rule only and the VAR with both monetary and fiscal rule.

Insert Figure 6 here

We compare actual and simulated series over *three subsamples*. The first two are 1965-1968 and 1984-1987, two time periods during which we identified the performance of the monetary VAR to be particularly poor. Notice, crucially, that these

[26] The model is closed by two error-correction specifications linking respectively GDP inflation to CPI inflation, and the cost of financing the debt to monetary policy rates.

subsamples both belong to the period pre-1987, which is the date that, according to our estimates, marks the transition of fiscal policy to a stabilizing regime (and consequently of the monetary-fiscal mix to a virtuous match of monetary dominance). Hence we single out the post-1987 period as the third subsample. It is interesting to see that only in the pre-1987 period a model that includes a specification of the monetary-fiscal mix can outperform the monetary VAR model. After 1987 the baseline Taylor-rule based monetary VAR can account for the inflation dynamics remarkably well. It is worth noticing that this date marks exactly the beginning of Alan Greenspan's tenure.

What conclusions can we draw about the relative importance of the monetary-fiscal mix in driving the inflation dynamics? What the data suggest, at first glance, is that a detectable role for (the systematic component of) fiscal policy emerges only outside periods of monetary dominance (i.e., in the pre-1987 period). Does this imply that, provided that monetary policy conducts business according to a (credible) regime inspired by the polar star of the Taylor principle, fiscal policy is irrelevant for inflation determination? Our answer would be affirmative if we used the lenses of Sargent and Wallace (see our discussion in the introduction). Yet if we embraced the refinement of the FTPL view our answer would be that, after 1987, monetary policy has provided only a necessary, but not sufficient, condition for achieving its program of inflation stabilization. It is in fact precisely around 1987 that we estimate the transition in the fiscal regime (from F2 to F1) to take. This observation motivates our counterfactual analysis in the next section.

4.1.1 A Counterfactual: Fiscal Policy Sticks to F1 and Lucas Critique

In this section we exploit the Markov-switching feature of our estimated fiscal rule to perform a counterfactual exercise. We take as given that monetary policy continues to follow the Taylor-principle based regime estimated after 1982. We then generate simulated series over the same period by introducing the *counterfactual hypothesis* that in 1986:3 the fiscal authorities did *not* switch from regime F1 to regime F2, but rather kept following regime F1 (according to which the primary deficit is positively related to the level of the debt).

Before presenting our results, some discussion of the potential relevance of the Lucas critique is in order. We did not introduce such discussion in the previous sections because our simulations based on zeroing policy shocks were not altering estimated parameters and should then have been robust to the Lucas' critique. For such consideration obviously does not apply to our counterfactuals we report in Figure 8.1 the results of testing (recursively) the structural stability of the parameters linking in our model the macroeconomic variables to the policy instruments.[27] Hence we that the null of stability can never be rejected. The evidence of instability of policy rules paired with stability in a backward looking structure of the economy has been used in the past to reject empirically the relevance of the Lucas' critique (see, for a survey, Favero and Hendry,1992). Rudebusch (2002) provides a reconciliation of the evidence

[27]We use recursive Chow tests. The figures are rescaled for the appropriate ninety five per cent critical values, so that values above one imply rejection of the null at the five per cent level.

of instability in U.S. monetary policy rules with the stability of the VAR specification for the US economy. His findings point in favor of a modest empirical importance of the Lucas critique in autoregressive models used for monetary policy evaluation. Our results seem to extend this conclusion also to a broader model encompassing a role for fiscal policy.

The results of our counterfactual simulation are reported in Figure 8.2

Insert Figure 7.1-7.2 here

Actual and simulated series provide some support to the hypothesis that an active monetary policy may not have been a sufficient condition to stabilize inflation. In fact, in the absence of the change in the fiscal regime, the simulated inflation switches to a divergent path even if the monetary authorities continue to respond aggressively to any rise in inflation expectations as indicated by the adopted monetary policy rule.

5 Conclusions

Small-scale policy-rule based autoregressive models are widely used for the empirical analysis of monetary policy (see, e.g., Leeper and Zha, 2001). Typically these models comprise a (possibly forward-looking) monetary policy rule augmented with a VAR representation of the economy, and completely neglect any role for fiscal policy. However, in the light of the classic Sargent and Wallace unpleasant arithmetic analysis and, more recently, of the even more unpleasant arithmetic of the FTPL, the hypothesis that inflation is the sole outcome of the underlying monetary policy regime can be sensibly put into question. In this paper, as a first step, we take a fresh look at the standard Taylor rule-based monetary VAR and argue that such model can deliver, *before 1987*, recurrent mispredictions of inflation. We then extend this model to allow for a specification of a fiscal policy rule (in which the primary deficit is assumed to react to two arguments: the government debt and the output gap). By employing Markov-switching methods we are able to identify the end of 1986 as a breaking date for fiscal policy, marking a transition to a prolonged regime of fiscal discipline. Before that date fiscal policy seems to be subject to substantial regime instability.

It is important to notice that the Sargent and Wallace view (on the inflationary effects of the monetary-fiscal interaction) is difficult to distinguish empirically from the FTPL view. For one it holds true, from our evidence, that the model with monetary policy only seems able to account well for the behavior of inflation after 1987, a time span which corresponds to the onset of the Greenspan tenure (and hence presumably to a firm establishment of a credible anti-inflationary reputation). This element per se gives credit to a SW's interpretation that perceives the autonomy of the monetary policy authority as a sufficient condition for achieving the goal of inflation stabilization. However, on the other hand, we estimate the post-1987 period to precisely mark also the beginning of a virtuous fiscal regime which, in the light of the monetary regime in place, is exactly the type of "Ricardian" stance that assertors of the FTPL would consider adequate for achieving the goal of price stability. Hence the conclusions that the data suggest are twofold. First, that a more appropriate description of the post-87 policy regime is in terms of monetary and fiscal match (or monetary dominance) rather than simply Taylor-principle based monetary policy. Second, and more broadly, that a significant role for fiscal policy in determining inflation is detectable only when the monetary and fiscal regime appear in mismatch (namely with rules not jointly designed in such a way to guarantee a unique stable rational expectations equilibrium), exactly like it appears to happen frequently before 1987. Our evidence leaves open the issue of a strict identification of the structural channel(s) through which fiscal policy exerts an effect on inflation. We believe this is a promising avenue for future research. Yet our results already indicate that a neglect of the monetary-fiscal *mix* in assessing the policy impact on the inflationary performance can be potentially misleading.

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Table 1: **Forward-Looking Taylor Rule: Parameter Estimates**						
$i_t = \beta_1 i_{t-1} + (1-\beta_1)(\beta_0 + \beta_2 (E_t \pi_{t+4} - 2) + \beta_3 x_t) + u_t$ GMM estimation with correction for MA(4) in the residuals Instruments: constant, $i_{t-1}, i_{t-2}, i_{t-3}, i_{t-4}, \pi_{t-1}, \pi_{t-2}, \pi_{t+3}, \pi_{t-4}$ $x_{t-1}, x_{t-2}, x_{t-3}, x_{t-4}, lpcm_{t-1}, lpcm_{t-2}, lpcm_{t-3}, lpcm_{t-4}$						
	1961:3-1979:2			1984:1-2001:1		
	Coeff.	**S. E.**	**t-ratio**	**Coeff.**	**S. E.**	**t-ratio**
β_1	0.65	0.03	23.03	0.88	0.03	30.91
β_0	3.57	0.12	29.17	4.37	0.87	5.00
β_2	0.49	0.02	22.70	1.39	0.56	2.47
β_3	0.32	0.05	6.12	1.22	0.35	3.48
$\sigma(u) = 0.77$				$\sigma(u) = 0.51$		
$\mathrm{E}(i_t) = 5.7$				$\mathrm{E}(i_t) = 6.24$		

Table 2: **Parameter Estimates in the VAR with Monetary Policy Only**

$$\begin{bmatrix} lpcm_t \\ \pi_t \\ y_t \end{bmatrix} = \hat{A}_0(s_t^m) + \sum_{i=1}^{4} \hat{A}_i(s_t^m) \begin{bmatrix} lpcm_{t-i} \\ \pi_{t-i} \\ y_{t-i} \end{bmatrix} + \sum_{i=1}^{4} \hat{B}_i(s_t^m) \begin{bmatrix} i_{t-i} \end{bmatrix} + \begin{bmatrix} \hat{u}_{1t} \\ \hat{u}_{2t} \\ \hat{u}_{3t} \end{bmatrix}$$

	1961:3-1979:2				1984:1-2001:1			
	y_{t-i}	π_{t-i}•	$lpcm_{t-i}$	i_{t-i}	y_{t-i}	π_{t-i}••	$lpcm_{t-i}$	i_{t-i}
y_t	0.96 (0.00)	0.026 (0.81)	0.004 (0.004)	−0.27 (0.11)	0.88 (0.00)	−0.25 (0.01)	0.001 (0.05)	0.05 (0.26)
π_t	0.04 (0.17)	1.02 (0.00)	0.001 (0.29)	−0.07 (0.33)	0.02 (0.60)	0.80 (0.00)	0.001 (0.25)	0.06 (0.14)
$lpcm_t$	0.19 (0.26)	−0.07 (0.90)	0.99 (0.00)	0.58 (0.53)	−0.27 (0.39)	−0.23 (0.73)	1.00 (0.00)	−0.23 (0.49)

Note: π_t is annual CPI inflation, $lpcm_t$ is the IMF commodity price index, i_t is the federal fund rate,.x_t is the per cent difference between real GDP and potential GDP as computed by the Bureau of Economic Analysis of the US Department of Commerce.

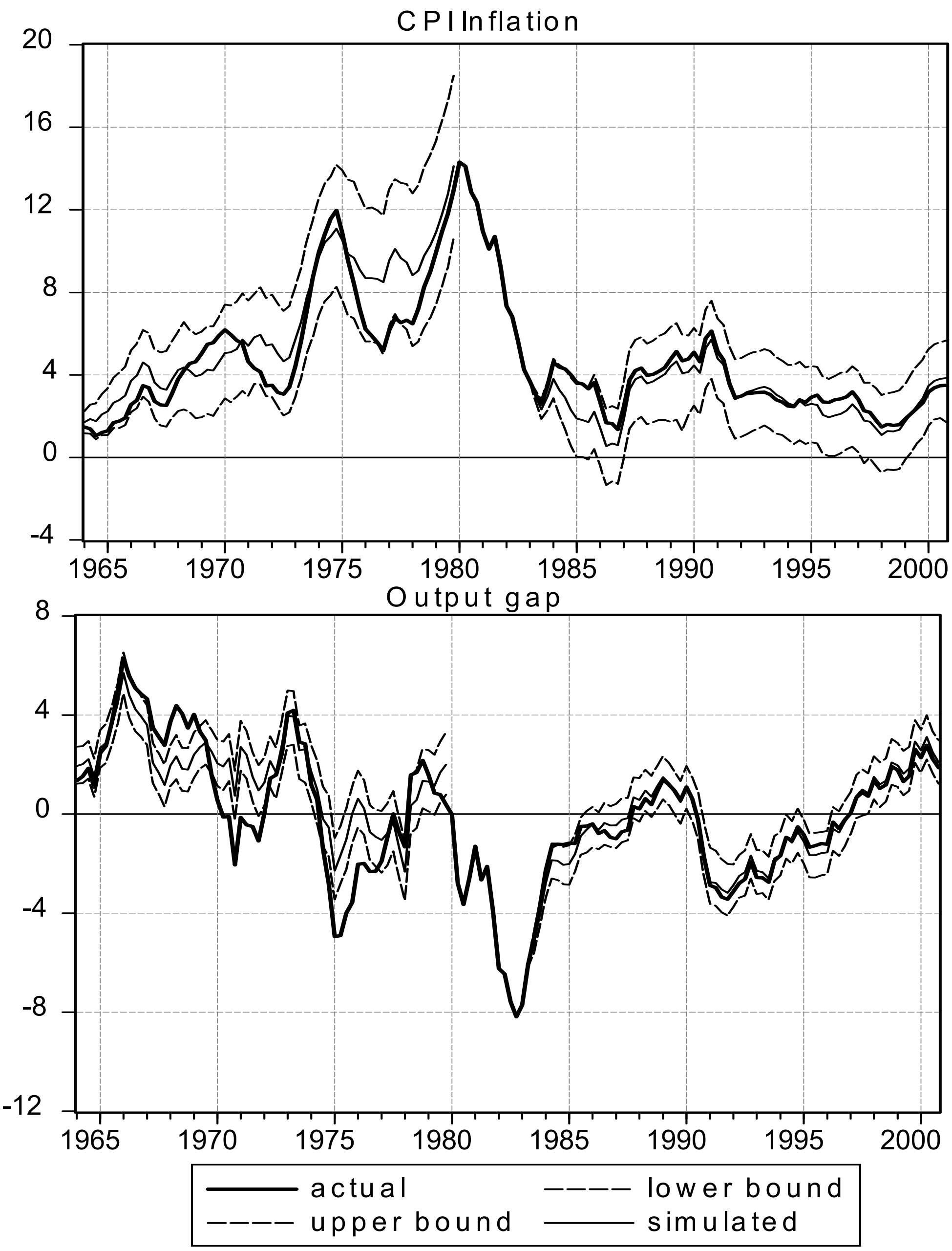
Table 3: Markov-Switching Fiscal Policy Rule									
$d_t = \hat{\gamma}_1\left(s_t^f\right) d_{t-1} + \left(1 - \hat{\gamma}_1\left(s_t^f\right)\right) d_t^* + v_{1t}$ $d_t^* = \hat{\gamma}_0\left(s_t^f\right) + \hat{\gamma}_2\left(s_t^f\right) x_t + \left[\hat{\gamma}_3\left(s_t^f\right) + \hat{\gamma}_4\left(s_t^f\right)\left(i_t - g_t^p\right)\right] b_t$									
	Regime F1			*Regime F2*			*Single Regime*		
	Coeff	**S. E.**	**t-ratio**	**Coeff**	**S. E.**	**t-ratio**	**Coeff**	**S. E.**	**t-ratio**
γ_1	**0.90**	0.03	28.73	**0.27**	0.06	4.07	**0.83**	0.03	25.9
γ_0	**1.38**	0.45	3.06	**-5.50**	0.92	-5.95	**2.78**	1.63	1.70
γ_2	**-0.16**	0.038	-4.17	**-0.35**	0.036	-9.65	**-0.68**	0.11	-6.02
γ_3	**-0.025**	0.007	-3.48	**0.10**	0.02	5.66	**-0.07**	0.02	-2.64
γ_4	**0.001**	0.0006	1.97	**-0.002**	0.0004	-5.55	**-0.002**	0.002	-1.13
$S.E.resid. = 0.41$				$S.E.resid. = 0.41$			$S.E.resid. = 0.55$		
Regime Classification (Probability)									
F1				*F2*					
1960:4-1965:2 (1.00)				1965:3-1968:1 (0.92)					
1968:2-1974:1 (0.86)				1974:2-1986:2 (0.95)					
1986:3-2000:4 (0.99)									

Note: i_t is the federal fund rate,.x_t is the per cent difference between real GDP and potential GDP as computed by the Bureau of Economic Analysis of the US Department of Commerce, d_t is the ratio of primary deficit to GDP, g_t is the annual rate of growth of nominal potential GDP, b_t is the ratio of government debt to GDP, s_t^f denotes a possibly time-varying fiscal regime.

Table 4: Parameter Estimates in the Monetary VAR augmented with Fiscal Variables										
$\begin{bmatrix} lpcm_t \\ \pi_t \\ y_t \end{bmatrix} = \hat{A}_0\left(s_t^m\right) + \sum_{i=1}^{4} \hat{A}_i\left(s_t^m\right) \begin{bmatrix} lpcm_{t-i} \\ \pi_{t-i} \\ y_{t-i} \end{bmatrix} + \sum_{i=1}^{4} \hat{B}_i\left(s_t^m\right) \begin{bmatrix} i_{t-i} \\ d_{t-i} \end{bmatrix} + \begin{bmatrix} \hat{u}_{1t} \\ \hat{u}_{2t} \\ \hat{u}_{3t} \end{bmatrix}$										
	1961:3-1979:2					1984:1-2001:1				
	y_{t-i}	π_{t-i}.	$lpcm_{t-i}$	i_{t-i}	d_{t-i}	y_{t-i}	π_{t-i}..	$lpcm_{t-i}$	i_{t-i}	d_{t-i}
y_t	0.90 (0.00)	-0.41 (0.13)	0.009 (0.24)	0.09 (0.71)	0.36 (0.07)	0.80 (0.00)	-0.18 (0.12)	-0.001 (0.94)	0.08 (0.16)	-0.11 (0.12)
π_t	0.02 (0.53)	0.72 (0.00)	0.01 (0.008)	0.18 (0.13)	0.08 (0.34)	0.04 (0.57)	0.70 (0.00)	0.005 (0.33)	0.08 (0.10)	0.04 (0.54)
$lpcm_t$	0.12 (0.76)	-0.99 (0.51)	1.00 (0.00)	1.29 (0.39)	0.81 (0.47)	0.20 (0.12)	0.06 (0.93)	0.90 (0.00)	-0.67 (0.08)	0.52 (0.29)

Each cell of the Table reports the sum of the coefficients on the lags of each variable, and, within brackets, the probability (based on a Wald test) of not rejecting the null that such sum is zero.

Figure 1: Inflation and Output Gap: Actual vs. Simulated (VAR with Monetary Policy Rule only).



Note: Simulations are based on a model comprising a forward-looking Taylor rule with a VAR for the instruments augmented to allow for an effect of lagged policy rates on macroeconomic variables.

Figure 2.1: US Government Debt to GDP Ratio

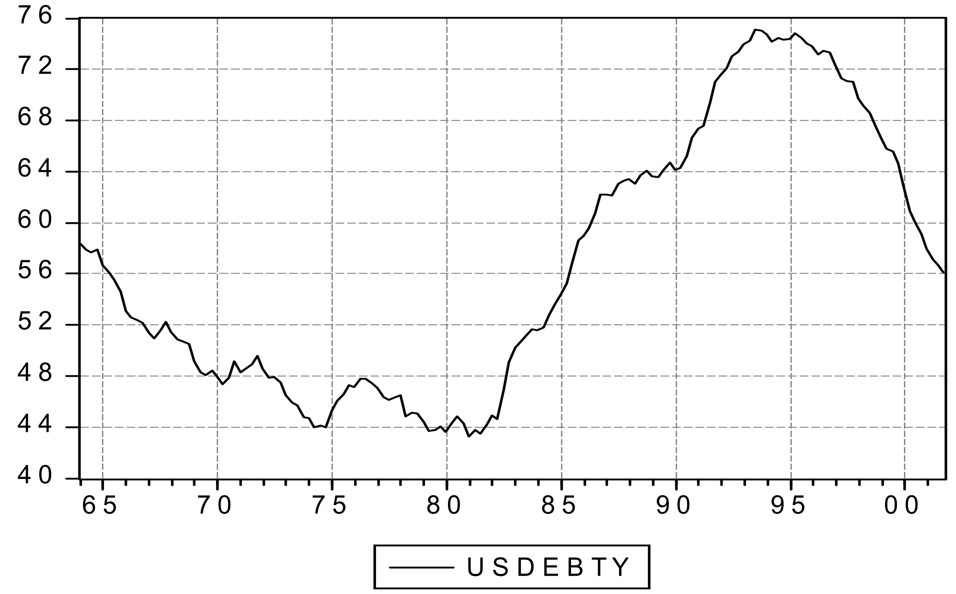


Figure 2.2: Primary Deficit to GDP Ratio (d) vs. Gap between Rate of Interest and Annual Rate of Growth of Potential Output (i-g)

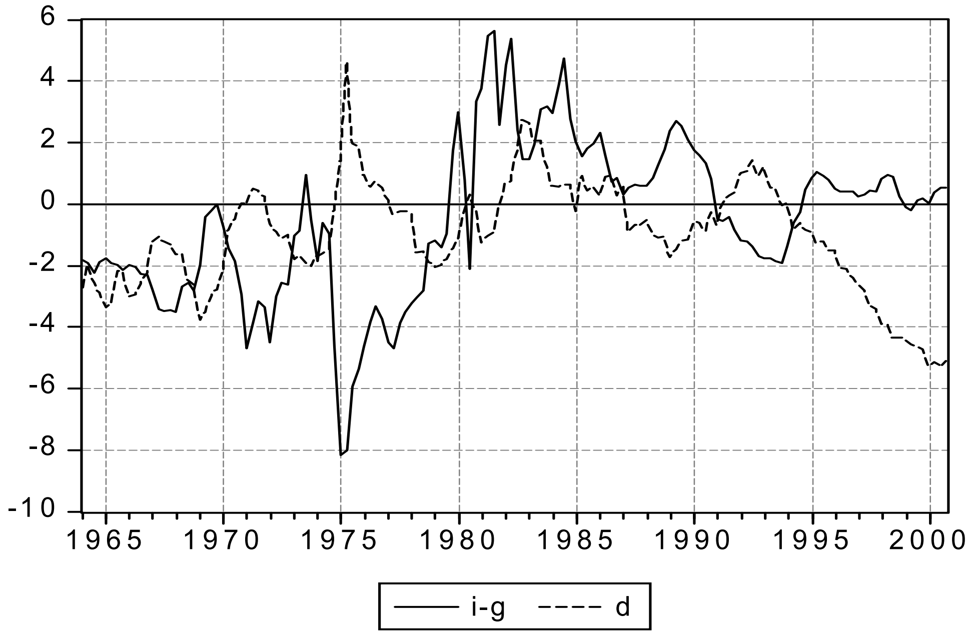


Figure 3: Probability of Regime F1 in a Two-Regime Markov-Switching Estimation of the Fiscal Policy Rule

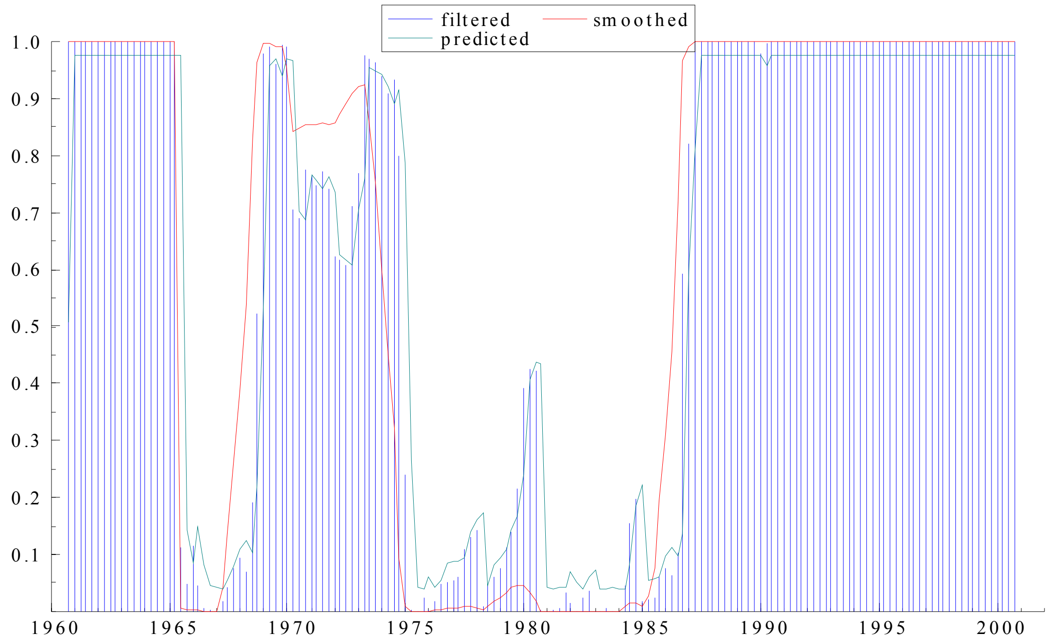


Figure 4: Estimated Fiscal Policy Rule: Regime-Dependent Response of the Primary Deficit to Government Debt and to Output Gap

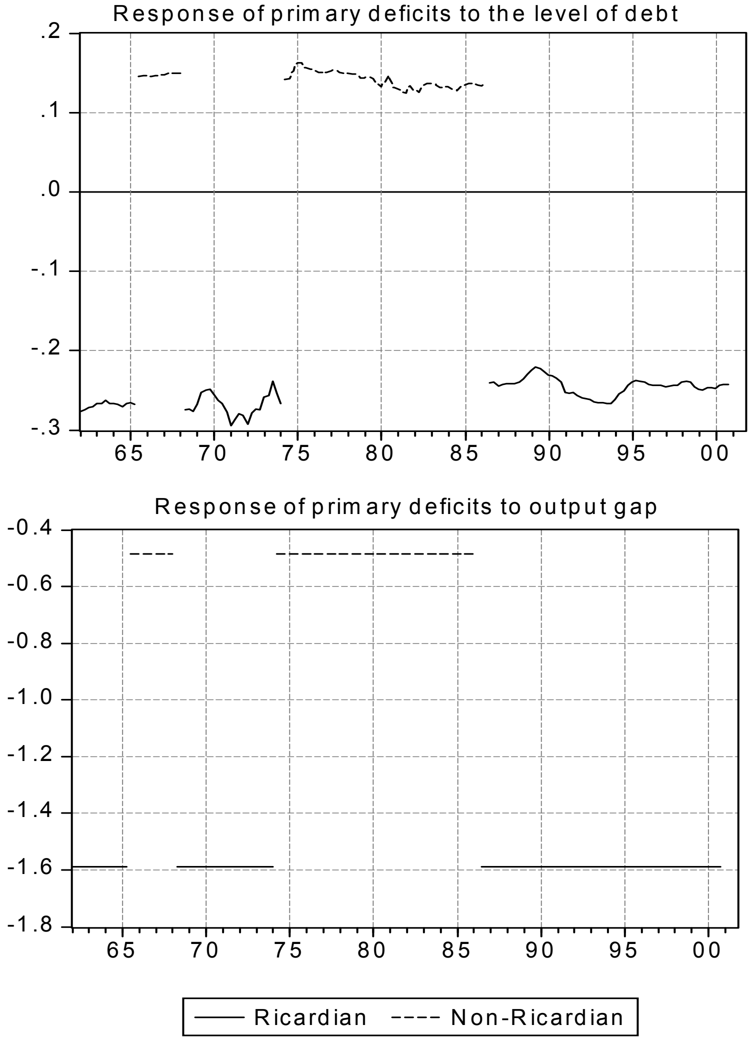
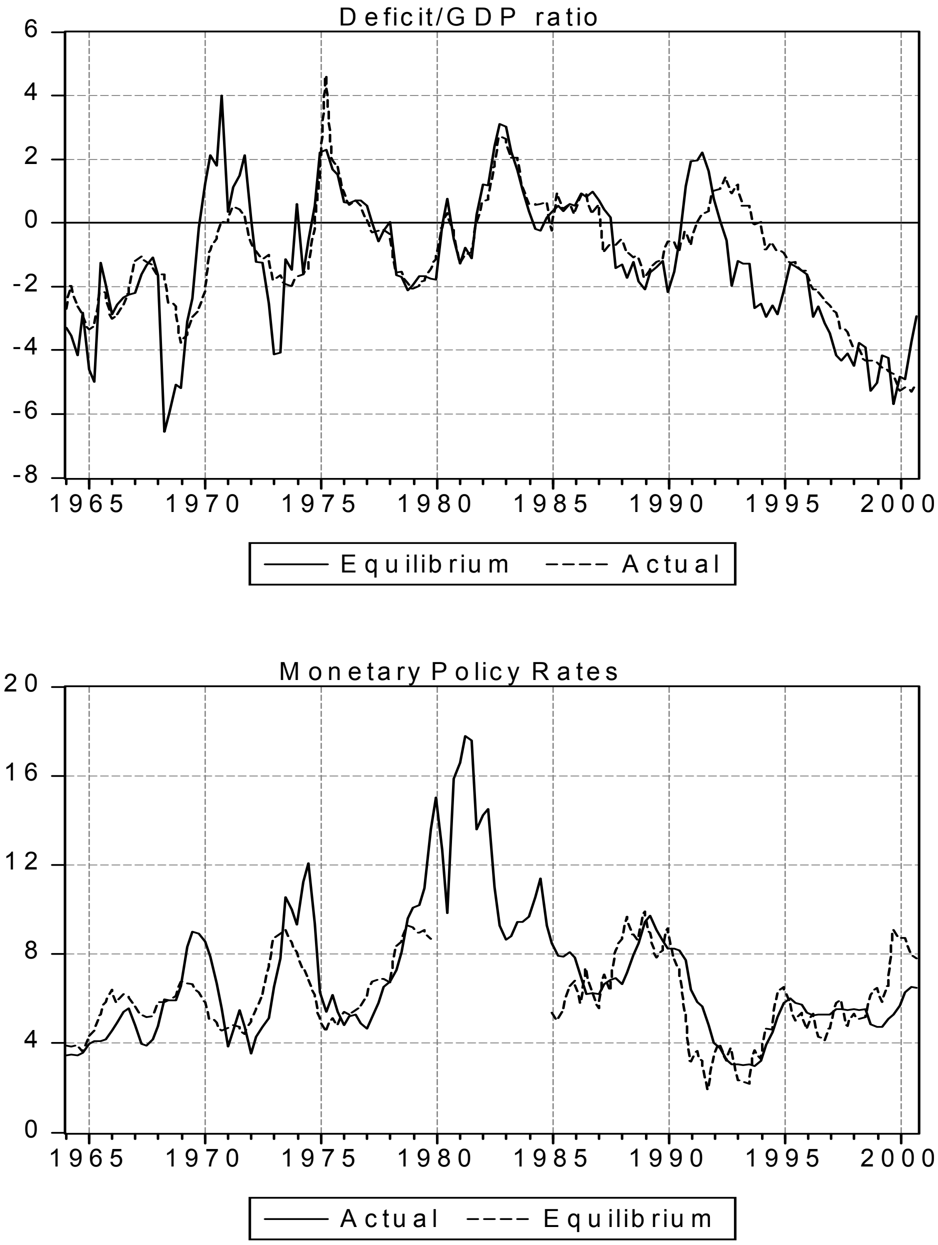
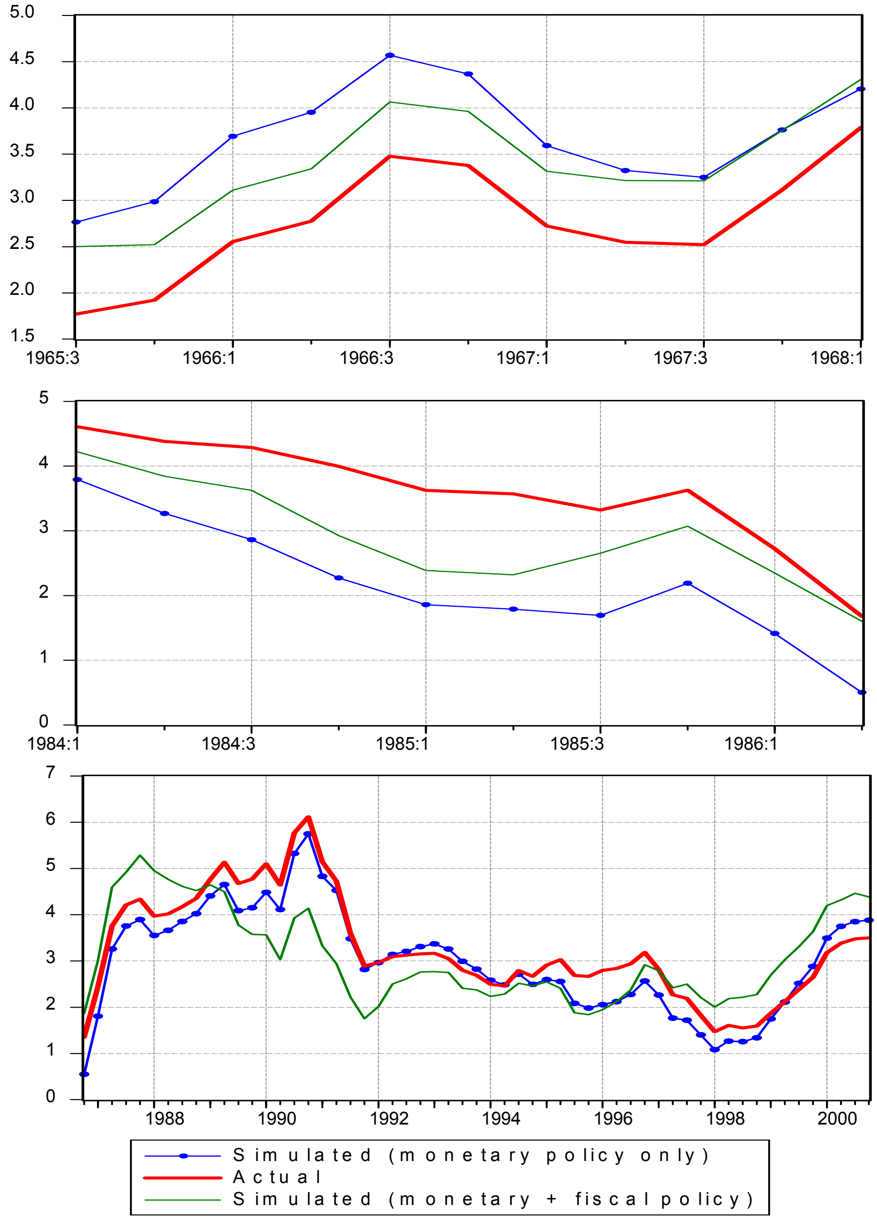


Figure 5: Actual vs Equilibrium Values of the Policy Instruments (Deficit to GDP Ratio and Interest Rate)



Note: derived respectively from the estimated fiscal and monetary policy rules

Figure 6:Actual vs Simulated Inflation: 1965:3-1968:1, 1984:1-1986:2 and 1986:4 2000:4



The simulations are based on a model comprising a forward-looking Taylor rule, a fiscal policy reaction function and a VAR model for inflation, the outptut gap and the commodity price index (augmented to allow for an effect of lagged monetary and fiscal instruments on macroeconomic variables).

Figure 7.1: Recursive Test of Structural Stability of the Dynamic Model

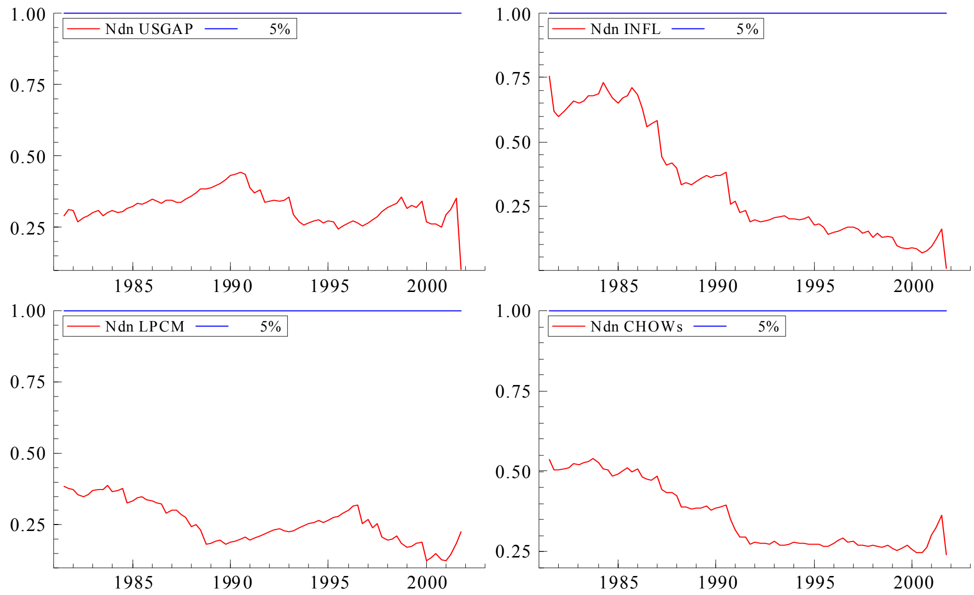
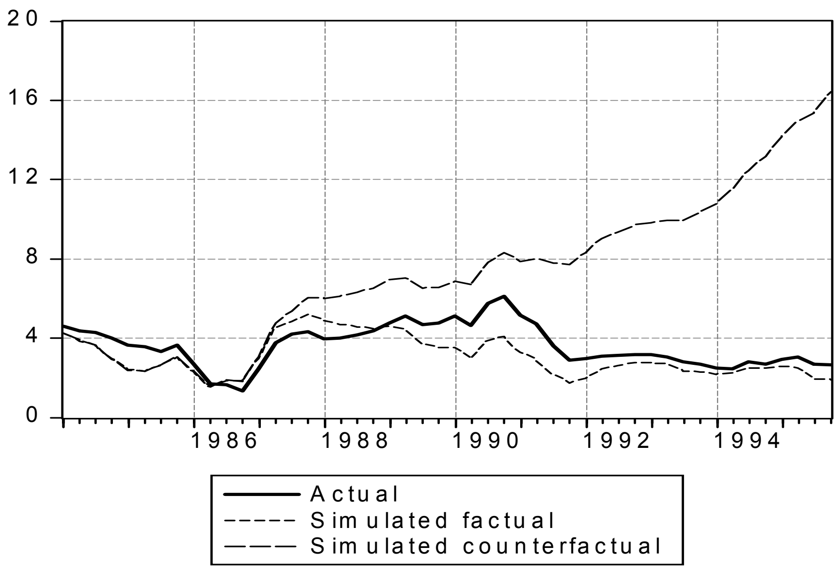


Figure 7.2: Actual vs. Simulated Inflation over the period 1984-1995



In the counterfactual scenario fiscal regime F2 is always on, while in the factual scenario the switch from regime F2 to regime F1 estimated to occur in 1986:3 is implemented.