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Measuring the Effects of Monetary Policy in the Euro Area: The Role of Anticipated Policy[1]

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Abstract:

This paper investigates within a SVAR framework the effects of anticipated monetary policy in the euro area. Building on a procedure recently proposed by Cochrane yielding the response of output to an anticipated monetary policy impulse, we show that in the past twenty years anticipated monetary policy had a considerable influence on output. Moreover, we compute the output effects of the systematic monetary policy response to aggregate demand and supply shocks. We find that monetary policy pursues a counter-cyclical policy in response to demand shocks and is pro-cyclical with regard to supply shocks, even though there are considerable lags. (100 words)

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1. Introduction

There exists a considerable amount of literature that analyses the effects of monetary policy on the business cycle using the method of structural vector autoregression (SVAR). A standard finding of these studies is that the effects of monetary policy shocks on aggregate output and the price level are rather small and therefore do not play a considerable role in business cycle generation or stabilisation.[2] Whereas this analysis focuses on the role unanticipated policy shock, the analysis of the effects of systematic and hence anticipated monetary policy, in contrast, has been somewhat neglected. To fill this gap, Cochrane (1998) recently made an important contribution to this latter field by developing an algorithm that allows one to identify impulse response functions for unanticipated and anticipated policy actions, depending on an exogenous choice parameter that indicates the relative effectiveness of anticipated monetary policy.

In this paper, we apply the methodology proposed by Cochrane to an aggregate euro area dataset. Moreover, based on these results we construct a historical time series of output fluctuations attributable to anticipated and unanticipated monetary policy actions. In doing so, we modify the historical decomposition technique, a standard tool in applied SVAR analysis, to take anticipated monetary policy actions explicitly into account. The objective of this modification is twofold:

First, the approach proposed in this paper allows to extend the SVAR analysis of the real effects of monetary policy to go beyond shocks and to also investigate the real effects of anticipated monetary policy. If monetary policy matters for business cycle fluctuations, it is likely to be the anticipated part that has substantial real effects, since unexpected monetary policy shocks are usually not found to contribute much to output fluctuations. To shed light on this question, we compute the output effects of anticipated monetary policy for different assumptions about the effectiveness of anticipated relative to unanticipated policy.

Second, having a measure of the effects of the anticipated part of monetary policy makes it possible to gain a better understanding of the effects of non-monetary policy shocks. The SVAR model employed in this paper identifies two such non-monetary policy shocks, a real demand shock and an aggregate supply shock. The overall effects of an aggregate supply shock, for

[2] Sims (1998), p. 933, summarizes the literature as follows: "... (2) Responses of real variables to monetary policy shifts are estimated as modest or nil, depending on the specification. ...". See also the survey in Christiano et al. (1999), particularly p. 70.

example, can be decomposed into the direct effect of the shock and the indirect effect attributable to the systematic monetary policy response to this shock. In a standard SVAR analysis the output impulse response function to such a shock encompasses both the direct and the indirect effects and does not allow to estimate these two effects separately. In particular, conventional SVAR analysis remains silent on the role of systematic monetary policy in propagating this shock. If one observes, for example, that an adverse supply shock like a strong increase in oil prices is followed by a recession, it remains unclear whether the recession is due to the direct effects of higher oil prices on the economy or to the effects of a tighter monetary policy stance in response to the inflationary pressures arising from this shock. This paper investigates this issue by identifying the role of systematic policy in propagating the output effects of non-monetary policy shocks.[3] To illustrate this point, this paper presents an analysis of the role of systematic monetary policy for euro area business cycle fluctuations in the period from 1980 to 2000.

For our analysis of the effects of monetary policy we use the SVAR model proposed by Monticelli and Tristani (1999) as a starting point. This model appears to be well qualified for our purposes because it employs common identifying restrictions, and the impulse response functions correspond well to widely held views about the monetary transmission mechanism. Given that we aim to show how the analysis of anticipated monetary policy actions can in principle be accomplished with any SVAR model, it is not necessary for our purposes to add another model to the already rich SVAR literature. Using a standard model ensures that the discussion of the underlying model can be kept brief in the following.

The paper is organised as follows. In section 2 the SVAR model for the euro area proposed by Monticelli and Tristani is introduced. The following section discusses the limitations of the interpretation of conventional impulse response functions and presents the Cochrane method, which allows it to compute impulse response functions for anticipated monetary policy actions. In section 4 this methodology is extended to construct an index of the output effects of anticipated monetary policy. Section 5 investigates the contribution of systematic monetary policy to euro area business cycle fluctuations. The final section summarises the results.

[3] For a discussion of this issue see also Bernanke et al. (1997), who investigate the real effects of systematic monetary policy with the help of stochastic simulations.

2. A SVAR Model for the Euro Area

2.1 Specification and Identification of the SVAR Model

The SVAR model proposed by Monticelli and Tristani is a trivariate model containing the growth rate of real output as the real activity variable, the rate of change over the previous quarter of the consumer price index as the inflation series, and the 3-month interbank interest rate as a measure for the nominal short term interest rate. The latter variable is the monetary policy instrument in this setup. An important assumption for the following analysis is that the central bank can sufficiently control the short term interest rate. We estimate the model using a data set comprised of quarterly aggregated data for the euro area, with data available for a time span beginning in 1980:1 and ending in 2000:4.[4]

Monticelli and Tristani find that the evidence from unit root tests for their data set is not clear-cut and proceed by assuming that the growth rate of output, the inflation rate and the short rate are stationary and thus estimate their model in levels.[5] As we do not want to depart from the specification of the benchmark model, we model the data in the same way the authors do.[6] We estimate the reduced form of the model using three lags as suggested by the Akaike information criterion and a Likelihood Ratio test. Regarding the deterministic component of the empirical model, we include a constant, a segmented trend variable and a step-dummy. The latter two variables represent a departure from Monticelli and Tristani model. For our purposes it has proven important to model the deterministic component of the nominal short-term interest rate carefully since it approximates in the analysis of the monetary policy stance the neutral interest rate. Usually, the neutral rate is assumed to be constant in time. In the euro area, however, the short-term interest rate is characterized by a downward trend over most of the sample period. If this trend reflected a change in the policy stance, monetary policy would have been on a course of ever easier monetary policy, which is unlikely. Thus, the trending behavior is likely to reflect a changing neutral rate, which is modeled here with the help of a segmented time trend and a

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[4] The data has been taken from the euro area Area-Wide Model (AWM) data set, published by Fagan et al. (2001). From 1996 onwards, the time series have been updated using data from the ECB Monthly Bulletins. These time series have been obtained from DATASTREAM. A plot of the time series is included in the appendix.

[5] That is, we do not difference the interest rate and the inflation series.

[6] Note, however, that for our dataset, the augmented Dickey Fuller (ADF) test statistics suggest that the level of output, the inflation rate and the short rate are I(1) variables which is also in line with results found by other authors, for example Coenen and Vega (1999) or, more recently, Brand and Cassola (2000). Moreover, we find evidence for a cointegration relationship between these two variables. The cointegration restriction is not imposed on the model; instead, the unrestricted level specification used by Monticelli and Tristani is adopted, which involves no loss of information with respect to the long-run properties of the system. The Kiel Working Paper version of this paper provides an extensive discussion of this issue, see Gottschalk and Höppner (2001).

step-dummy. The time trend, which is intended to model the reduction in trend inflation in the euro area, ends in 1997:2 and subsequently remains constant, yielding the segmented trend variable. The secular decline in inflation modeled by this variable is likely to have induced a similar reduction in the neutral interest rate. The step-dummy variable, which takes the value one from 1997:3 onwards and is zero otherwise, is intended to model a downward shift in the equilibrium real short-term interest rate due to the risk premium becoming smaller during the transition to European Monetary Union (EMU). A more detailed explanation of the role of these two variables in our model is given in section 4. Also, an impulse dummy taking the value one in 1987:1 and zero otherwise is included to capture a large outlier in the output growth series, which has led to substantial problems with the normality assumption for the residuals of the system. Standard tests for the residual properties, which are given in Table 1 in the appendix, show that the specification with three lags and the three intervention variables yields well-behaved residuals. The stability of the reduced form system has been tested using the Hansen (1992) test, which indicates no sign of instability.

To identify the structural form of the VAR, we follow Monticelli and Tristani.[7] The identifying restrictions are derived from the conventional aggregate supply – aggregate demand model. Similar to authors such as Galí (1992), Monticelli and Tristani impose short run as well as long run restrictions on the model. The three identified structural shocks are assumed to represent shocks to aggregate supply, shocks to the LM curve (money supply shocks), and shocks to the IS curve (real aggregate demand shocks). The aggregate supply curve is assumed to be vertical in the long-run, so that there are no long-run effects of demand shocks on output. Money supply and real aggregate demand shocks can have output effects, but only in the short-run. Hence, only supply shocks (technological innovations etc.) are allowed to have a lasting effect on economic activity. In addition, monetary policy shocks are assumed to have no contemporaneous effects on real activity. For the quarterly model considered here, this assumption implies that it takes as least three months before a monetary policy shock has real effects. Nevertheless, monetary policy shocks are allowed to a have a contemporaneous effect on prices, which accounts for possible fast effects of policy actions via the exchange rate channel on the price level.

[7] We are very grateful to the authors for providing us with their RATS code. See their paper for a detailed description of the identification procedure.

2.2 The Response of the Economy to a Policy Shock

In this section we restrict our discussion to the dynamic response of the model to a monetary policy shock.[8] The impulse response functions are presented in Figure 1. They are computed for a one standard deviation shock to the system.

The monetary policy shock leads to an initial increase in the nominal short rate of about 35 basis points. While the contemporaneous output response has been restricted to zero, there is initially a noticeable drop in the inflation rate which could be due to the exchange rate channel. More precisely, a tightening of the monetary policy stance is likely to lead to an appreciation, which lowers the costs of imports and thus reduces the price level, leading to a one-time drop in the inflation rate. The interest rate remains around 35 basis points above its base line level for about one year and then begins to fall. It returns to the base line after approximately two and a half years. The higher interest rate leads to a gradual decrease in output. Given that a monetary policy shock in the AS/AD framework has no effect on potential output, this decrease in output corresponds to a negative output gap. The maximum effect of the policy shock on output is reached after two years, when output has declined by about 0.2 percent. The negative output gap is presumably the main factor behind the renewed decline in inflation that sets in about one year after the policy shock.[9] Eventually the output gap closes again, due to the neutrality restriction. The closing of the output gap coincides with an 'overshooting' of the nominal short-term rate leading to an expansionary policy stance, but this effect is quantitatively small. With output returning to potential, the inflation rate also returns to its base line. Thus, in the long-run, the monetary policy shock has no real effect on output but leads to a permanently lower price level.

3. Identifying the Real Effects of Anticipated Monetary Policy in SVAR Models

3.1 What Standard Impulse Response Functions Do Not Tell

The limitations inherent in the interpretation of impulse response functions can be illustrated by revisiting the impulse responses depicted in Figure 1. The key point emphasised by Cochrane (1998) is that interpretation of the output effect caused by a monetary policy shock often focuses on the output impulse response function alone, while the further policy actions depicted in the

[8] All other impulse responses are also “well behaved”.

[9] Inflation is computed as the rate of change over the previous quarter and not as an annualized rate.

interest rate impulse response function are ignored. Applying this narrow viewpoint to the results reported here, the first panel in Figure 1 in isolation conveys the impression that the output effects of a monetary policy impulse are hump-shaped, peaking after two years, but then taking a considerable time to die out. They are also quite large, since a policy shock that raises the interest rate on impact by 100 basis points reduces output by approximately 0.6 percent. It is now tempting to conclude that these are exactly the output effects to be expected when the ECB raises the interest rate by one percentage point. Indeed, conventional wisdom states that the full output effects of such a policy action materialises only after about two or three years, corresponding exactly to the output impulse response function depicted here. But such a conclusion would be premature, since the output response depicted in the second panel of Figure 1 is conditional on the interest rate path given in first panel. Taking this information into account as well, it is apparent that a monetary policy shock does not lead to an interest rate hike lasting for one quarter; instead, this tight policy stance lasts for four quarters, according to the interest rate impulse response function. Cochrane stresses that this information should not be neglected in the interpretation of the output impulse response function. His point is that impulse response functions capture *history*, in the sense that these functions give the average path of output and the interest rate following a monetary policy shock. In other words, when European policy makers raise the short rate unexpectedly, this has been on average followed by another three quarters of tight policy before the central bank begins to return policy to a neutral stance. On average, this particular policy course has the output effects given in the second panel. Unfortunately, the average path of the interest rate and output following a monetary policy impulse provides at best an incomplete answer regarding the output effects of monetary policy actions. Cochrane summarizes this by asking „What does this *history* tell us about the *effects* of monetary policy? What does it tell us, for example, about the course of events we should expect if there is a monetary shock *not* followed by the customary further expansion of money [To illustrate his point Cochrane uses a VAR model where a monetary policy shock corresponds to an increase in the money supply.] ?“[10] Contrary to widespread beliefs, conventional impulse response analysis is, hence, unsuitable for the task of simulating the effects of different policy scenarios.

[10] Cochrane (1998), p. 278.

3.2 The Cochrane Methodology

To obtain a more complete answer regarding the effects of a given monetary policy action, Cochrane argues that a further theoretical identification is necessary. More specifically, his approach requires an identifying assumption which specifies the output effects of an anticipated policy impulse relative to those of an unanticipated policy shock of similar size. With this identifying assumption it becomes possible to calculate from the estimated impulse response functions the output effects of a given anticipated policy move.

The intuition behind the algorithm Cochrane proposes for this purpose can be illustrated with the help of Figure 1. The key idea is that if one assumes that anticipated monetary policy has no effect on the economy at all, as is done for instance in New Classical models, the output response depicted in the second panel is entirely due to the monetary policy shock. In this case, the output response depicted in the second panel is entirely due to the monetary policy shock, whereas the further tightening of policy following in the wake of the initial interest rate hike corresponds to the systematic part of monetary policy and therefore is irrelevant for the path of real activity, since it is anticipated by the economic agents. In this special case conventional impulse response analysis is sufficient to answer the question regarding the effects of monetary policy. However, if instead one believes that anticipated systematic monetary policy has real effects, one part of the output response is again due to the initial shock, but another still to be quantified part is due to the endogenous systematic reaction of the central bank following the policy shock.

To illustrate the implications of the assumption that anticipated policy has real effects, it is useful to consider the output effects of a monetary policy shock that is not followed by the customary sustained tightening of policy but instead by an immediate return to a neutral policy stance. In this case, the output effect could be small and immediate instead of large and hump shaped, because the sustained tightening of policy visible in the interest rate impulse response function is bound to have left its mark on the output path following the monetary policy shock. More specifically, it is likely that the fact that policy remains tight for one year and then becomes only gradually less restrictive is an important reason why the maximum effect of a policy shock on real activity is reached only after two years. In other words, the fact that the output response to a policy shock unfolds only gradually is less an indication of considerable lags in the transmission mechanism, but rather reflects the sustained tightening of policy following this shock. The Cochrane methodology quantifies the real effects of this endogenous tightening of policy. Having determined the share of the output effects attributable to the endogenous interest rate response, this in turn allows for the computation of the output response to a monetary policy impulse which triggers no further interest rate response. Cochrane denotes such an interest rate hike lasting only for one period a ‘blip’.

It has become clear by now that it is the objective of the Cochrane procedure to derive impulse response functions which show the response of output to an anticipated and an unanticipated ‘blip’ in the policy instrument. Regarding the policy instrument itself, it is important to note that his algorithm is applied to impulse response functions after they have been estimated and in general the algorithm works independently of the choice of the policy instrument, which could be either an interest rate or a money stock variable. Cochrane uses his methodology for instance for both types of policy variables, as he considers a VAR with M2 as the policy instrument and a system with the Federal funds rate as proxy for the policy instrument. In the following, we denote the policy instrument as i^p, which represents in the context of our empirical model the nominal short-term interest rate, but could represent also, depending on the respective model chosen, a monetary aggregate or the real short-term interest rate.[11]

To derive his algorithm more formally, we follow Cochrane and adopt his anticipated-unanticipated monetary policy model

$$y_t = a^*(L)\left[l\, i_t^p + (1-l)\left(i_t^p - E_{t-1} i_t^p\right)\right] + b^*(L) d_t\,, \tag{1}$$

where $a^*(L)$ and $b^*(L)$ are structural lag polynomials and l is a parameter that specifies the effectiveness of anticipated monetary policy relative to unanticipated policy, with $0 \leq l \leq 1$. A value of 0 indicates that anticipated monetary policy has no real effects, whereas a value of 1 implies that anticipated monetary policy is as effective as its unanticipated counterpart. Choosing a value for l is equivalent to imposing a further identifying restriction. It needs to be stressed here this parameter is a choice parameter which cannot be estimated from our data set, because systems with different l are observationally equivalent.The term d_t consists of other possible output disturbances that are orthogonal to the monetary shock.

The function given by equation (1) is a standard description of the effects of monetary policy in the economy, where the term $\left[i_t^p - E_{t-1} i_t^p\right]$ captures the unanticipated component of a monetary policy impulse. In a New Classical model, only this component has real effects. In contrast, when the change in the policy instrument is fully anticipated, this term becomes zero and the

[11] More precisely, i^p measures the monetary policy stance, which in our model corresponds to the deviation of the nominal interest rate from the neutral interest rate. This is discussed in more detail in section 4.

monetary policy stance is represented by i_t^p. Consequently, the lag polynomial $a^*(L)$ gives the output response to an unanticipated unit impulse to the policy instrument, while $l\ a^*(L)$ gives the corresponding output response to an anticipated unit impulse.[12] In the terminology of Cochrane, these unit impulses to the policy variable lasting one period are called 'blips'. In other words, once the Cochrane methodology has retrieved $a^*(L)$, the response to an anticipated 'blip' can be computed in a straightforward way by multiplying the response to an unanticipated 'blip' with l.

The starting point of the procedure to identify $a^*(L)$ for different values of l is the estimated structural VAR model. Consider the moving average representation of output and the policy instrument,

$$\begin{bmatrix} i_t^p \\ y_t \end{bmatrix} = \begin{bmatrix} c_{i^p i^p}(L) & c_{i^p y}(L) \\ c_{y i^p}(L) & c_{yy}(L) \end{bmatrix} \begin{bmatrix} e_{i^p,t} \\ e_{y,t} \end{bmatrix} \tag{2}$$

where e_{i^p} and e_y are the structural residuals from the VAR that are uncorrelated and have unitary variance. The $C(L)$ are the structural polynomials of the moving average representation of the VAR. In order to identify $a^*(L)$, the moving average representations of equation (2) are substituted into (1).

With some algebra, one can show that the elements of $a^*(L)$ are given by

$$a_0^* = \frac{c_{y i^p,0}}{c_{i^p i^p,0}} \tag{3}$$

and

$$a_j^* = \frac{c_{y i^p,j} - l \sum_{k=0}^{j-1} a_k^* c_{i^p i^p,j-k}}{c_{i^p i^p,0}}, \tag{4}$$

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[12] Rearrange equation (1) to obtain $y_t = a^*(L)\left[l E_{t-1} i_t^p + \left(i_t^p - E_{t-1} i_t^p\right)\right] + b^*(L) d_t$. Here, the term $E_{t-1} i_t^p$ corresponds to the anticipated component of monetary policy and $\left[i_t^p - E_{t-1} i_t^p\right]$ is the unanticipated component.

with $j \succ 0$. This recursive algorithm is easily programmable in standard software like RATS.[13] It yields the response of output to an unanticipated 'blip', $a^*(L)$. Once one has calculated $a^*(L)$ from (3) and (4), it is straightforward to obtain the output response to an anticipated 'blip', since this is simply $l a^*(L)$. Intuitively, this algorithm works as follows: First, the initial response of output to a unit innovation in the policy instrument is computed, a_0^*. The initial impulse to the policy instrument is followed by an endogenous policy response, which is given by $c_{i_{p} i_{p}}(L)$. If $l \succ 0$, this will have an effect on output. The second part of the algorithm removes the output effects attributable to this endogenous policy response and thereby obtains the output reaction which is solely due to the initial monetary policy impulse.[14]

3.3 The Impulse Response Functions for Anticipated Monetary Policy

Regarding the empirical results for the euro area, Figure 2 plots the response output to an unanticipated 'blip' in the interest rate for different values of l.[15] Setting $l = 0$, one obtains the same impulse response function as displayed in Figure 1: a monetary policy shock that raises the nominal interest rate by 100 basis points reduces output by 0.6 % after two years, when the output effect is at its peak. Afterwards, the output effect gradually dies out. Allowing for some real effects of anticipated policy changes this picture markedly. With $l = 0.2$, for example, anticipated policy is assumed to be only marginally effective, but this is sufficient to make the impulse response function for the unanticipated blip considerably less hump-shaped: The peak effect of a monetary policy impulse does not materialise after two years, but is now reached after about one year. The effect is also smaller, reducing output at its peak by 0.35 %. For $l = 0.5$ and $l = 1$ the peak effect materializes even faster (2 quarters) and then declines

[13] We are grateful to John H. Cochrane for making available to us his GAUSS code. The RATS version is available from the present authors upon request.

[14] The question whether anticipated monetary policy has real effects at all is from a theoretical standpoint of view of central importance for this paper. The notion that anticipated monetary policy has real effects (at least implicitly) is widely accepted in applied business cycle analysis; moreover, there is a large body of New Keynesian literature showing that real effects of anticipated policy is consistent with rational expectations, contrary to the predictions of New Classical models. In New Keynesian models the four building blocks imperfect competition, menu costs, real rigidities and price staggering provide a framework where optimising agents may choose to create substantial nominal rigidities due to small private costs, even though this may lead to substantial unwanted economic fluctuations with considerable social costs in the presence of nominal demand shocks. For a survey on this literature see, for example, Ball et al. (1988). We believe that this literature provides a comprehensive foundation for an empirical analysis of possible anticipated monetary policy effects.

[15] In our model, the 'blip' corresponds to a one-time increase of the nominal short-term interest rate by 100 basis points. In the following period the interest rate returns immediately to its base line.

more rapidly so that the total of the real effects measured over time becomes smaller by a sizeable amount.

The real effects of an anticipated ‘blip’ are shown in Figure 3 . The shape of the impulse response functions are similar to those presented in Figure 2 since the only difference between the effects of an anticipated and unanticipated ‘blip’ is the scale factor l . Accordingly, for $l = 1$ the output impulse response functions for anticipated and unanticipated ‘blips’ are identical. This response is of particular interest since much of applied business cycle analysis work does not make a distinction between expected and unexpected policy actions and thus implicitly assumes that $l = 1$ holds. Unfortunately, the estimated output response is quite jagged, which suggests that it is estimated relatively imprecisely. Nevertheless, focusing on the underlying shape of the impulse response function, three noteworthy features of the output response can be observed. First, an anticipated ‘blip’ reduces output after two quarters by about 0.35 %. Second, the output effect fades quickly, declining to 0.1 % after about three years. Third, subsequent output returns only very slowly to the base line. This suggests that, contrary to conventional wisdom, the output effects of systematic policy set in soon after the monetary policy stance has changed, but these effects dissipate quickly if the new policy stance is not sustained even though it takes quite some time before the real effect has died out completely.

4. The Effects of Anticipated Monetary Policy on Output

In this section, we proceed to construct an index for the output effects of anticipated monetary policy in the euro area. The objective is to analyse to what extent unanticipated and anticipated monetary policy actions have contributed to aggregate output fluctuations over time. To this end, we use the impulse response functions for unanticipated and anticipated monetary policy actions estimated in the preceding section in conjunction with the historical decomposition technique often employed in the SVAR literature. This enables us to compute a time series reflecting the output effects of anticipated monetary policy. In the following section, we will use this technique to investigate the output effects of the systematic response of monetary policy to demand and supply shocks. We begin this section by discussing first the conventional historical decomposition technique and then introduce our modification to this technique.

4.1 The Historical Decomposition of Output

The idea of the historical decomposition technique, which is applied here to the output series, is based on the moving average representation of the structural model.[16] In particular,

$$X_t = C_D(L)D_t + C(L)e_t \tag{5}$$

is assumed to represent the moving average representation of the underlying structural model described in section 2. The vector X represents the three endogenous variables. The vector D contains the deterministic part of the model, which here consists of the constant and the three intervention variables. The term $C_D(L)$ represents a polynomial matrix giving the effects of D on the variables in X. The vector e contains the three structural shocks, namely the aggregate supply shock, the aggregate demand shock and the monetary policy shock. Finally, the matrix *C(L)* contains the estimated impulse response functions, showing how the endogenous variables respond to the structural shocks. Equation (5) states that the dynamics of output, prices and the interest rate can be expressed as the sum of the deterministic and the stochastic component of the model. The latter is attributed to the three structural shocks driving the model. The historical decomposition focuses on the effects of these shocks. To simplify the exposition, the deterministic part of the model is omitted in the following presentation of the historical decomposition technique. For a particular period $t+j$, equation (5) can be written as

$$X_{t+j} = \sum_{s=0}^{j-1} C_s e_{t+j-s} + \sum_{s=j}^{\infty} C_s e_{t+j-s}\ , \tag{6}$$

with C denoting the impulse response to a structural innovation. It is apparent from (6) that the variable X_{t+j} is composed of two types of terms. The term on the far right contains the information that is available at time t. Based on this information the expected X_{t+j} can be computed. This is the so-called 'base projection' of X_{t+j}, which contains also the effects of the deterministic part of the model. However, the base projection is unlikely to coincide with X_{t+j}, because in the time period from $t+1$ to $t+j$ 'new' structural innovations hit the system. By their very nature these shocks are unexpected; hence, the first term on the right-hand side can be interpreted as the forecast error of X_{t+j}. The historical decomposition is based on this part of the system, thereby allowing one to attribute the unexpected variation of X_{t+j} to individual structural innovations buffeting the economy, which is useful for exploring the sources of fluctuations.

The historical decomposition presented below is computed by keeping the forecast horizon given by j fixed while the time index t moves from the beginning of the sample period to the end. A forecast horizon of three years (12 quarters) is chosen since this horizon corresponds to a typical business cycle frequency. The effective sample period begins in 1981:1. To illustrate the procedure, t is first set to 1981:1 and the decomposition for $X_{1981:1+12} = X_{1984:1}$ is computed on the basis of the structural innovations hitting the economy in the time period from 1981:2 until 1984:1. Next, t is set to 1981:2 and the decomposition of $X_{1981:2+12} = X_{1984:2}$ is obtained on the basis of the structural innovations occurring in the time from 1981:3 until 1984:2. This procedure is repeated until X_{t+12} reaches the end of the sample period. To summarize, the historical decomposition plots the variables in X_t as a function of the structural shocks occurring in the time period t to $t-11$, thereby showing how at each point in time the economy has been influenced at the business cycle frequency by the three types of structural shocks in our model.

Figure 4 displays the historical decomposition of the output series implied by our SVAR model. The solid line shows the contributions of the three individual shocks to the output variation, while the dashed line represents the combined effect of all three shocks. It is apparent that the aggregate supply and the real demand shocks account for most of the output movements at the business cycle frequency, whereas monetary policy shocks account for only a small part of overall output variation. This confirms a widespread finding in the SVAR literature. In this respect it is important to recall that monetary policy shocks only represent the unanticipated part of monetary policy. Hence, this finding does not imply that monetary policy is unimportant, but only that discretionary monetary policy did not contribute much to the output fluctuations. Put another way, the output fluctuations due to the monetary policy shock reported in Figure 9 can be interpreted as an index of the output effects of monetary policy, but this index only captures the effects of monetary policy *shocks*.

[16] See e.g. Fackler and McMillin (1998) for a detailed description of the historical decomposition technique.

4.2 Measuring the Output Effects of Anticipated Monetary Policy

The index we propose in the remainder of this paper goes beyond the effects of shocks, and instead aims to measure the effects of anticipated policy. The starting point for the construction of this index is not, as in the historical decomposition, the moving average presentation of the system, which expresses output as a function of the structural shocks, but a reformulation of equation (1) expressing output as a function of anticipated and unanticipated monetary policy:

$$y_t = l a^*(L) E_{t-1} i_t^p + a^*(L)\left(i_t^p - E_{t-1} i_t^p\right) + b^*(L) d_t \tag{7}$$

The term $b^*(L)d_t$ is omitted in the following, because it is not related to monetary policy actions. The first term on the right hand side represents the part of output fluctuations attributable to anticipated monetary policy and the second term represents the output effects of unanticipated monetary policy. Focusing on the effects of anticipated policy, output in a particular period $t+j$ is given by

$$y_{t+j} = \sum_{s=0}^{j-1} l a_s^* E_{t+j-s-1} i_{t+j-s}^p + \sum_{s=j}^{\infty} l a_s^* E_{t+j-s-1} i_{t+j-s}^p + \ldots \quad . \tag{8}$$

Compared to the moving average representation of output given by (6), in equation (8) the matrix C for the impulse responses to structural innovations is replaced by the vector $l a^*$, which gives the output response to an expected unit impulse to the monetary policy instrument, and the vector e for the structural innovations is replaced through the time series for anticipated monetary policy, $E_{t-1} i_t^p$. Below, in accordance with the historical decomposition technique we will plot the time series given by the first term on the right hand side of equation (8), which shows for each point in time t the effects on output of anticipated monetary policy actions occurring in the time period from t to $t+1-j$. When we compute this index of the output effects, we choose again a forecast horizon of 12 quarters to investigate the role of anticipated monetary policy in output fluctuations at the business cycle frequency.

The empirical analysis in the preceding section has yielded most of the input required for the computation of this output index. Most important, in section 3 we estimated the output response to an anticipated ‘blip’ in the policy instrument, $l a^*(L)$. But for the computation of our output index we still need to construct the series for the anticipated monetary policy stance, $E_{t-1} i_t^p$.

The monetary policy stance has two components. On the one hand, we require a measure of the anticipated path of the nominal short-term interest rate, the policy instrument in our model. Below, we approximate the anticipated interest rate path with the variation of the interest rate explained by the interest rate equation of our VAR model. On the other hand, a measure of the neutral interest is needed, which defines the level of the policy instrument where monetary policy has no output effects. The anticipated monetary policy stance is given by the difference between the anticipated interest rate path and the neutral interest rate.

4.2.1 Measuring the Anticipated Monetary Policy Stance

The challenge in constructing a series of the anticipated monetary policy stance is finding an appropriate measure of the neutral interest rate. In the case of the euro area this is complicated by the fact that the neutral interest has not been constant in the time period under investigation, as has been discussed earlier. For our purpose, it will prove useful to think of the neutral interest rate as the policy stance that is obtained when the central bank does not wish to influence the economy. In our SVAR model, the central bank sets the nominal short-term interest rate in response to aggregate supply and demand shocks. Moreover, the interest rate is determined by monetary policy shocks, representing the discretionary component of monetary policy. In the absence of those three type of shocks, the central bank has no reason to act and one may call the resulting policy stance 'neutral'. It is apparent from equation (5) that in this case the path of the nominal short-term interest rate is determined entirely by the deterministic component of this time series, so modeling this component is equivalent to modeling the neutral interest rate in the euro area.

According to the Fisher relation, the nominal interest rate corresponds to the sum of the ex-ante real interest rate and expected inflation.[17] The central bank pursues a neutral course only when it is satisfied with the state of the economy. That is, output is at its natural level, and the expected inflation rate is equal to the central bank's inflation objective. This suggests a definition of the nominal neutral interest rate as the sum of the equilibrium real interest rate and the inflation objective.[18] This definition ensures that the ex-ante real interest rate is equal to its equilibrium value when monetary policy is on a neutral course.

[17] For the euro area Coenen and Vega (1999) and, more recently, Gottschalk and Schumacher (2001) show that the nominal short-term interest rate and the inflation rate cointegrate (1,-1), which is consistent with the Fisher relation in the long-run.

[18] The equilibrium real interest rate is equal to the value the real interest rate has when the economy is in equilibrium. King (2000) calls this variable the natural rate of interest. Regarding the nominal neutral interest

Accordingly, our task is twofold: On the one hand we have to model the changing inflation objective in the time period under investigation, on the other hand we have to model the path of the equilibrium real interest rate. Since inflation is deemed to be ultimately a monetary phenomena, it is fair to suggest that the reduction in trend inflation occurring over most of the sample period reflects a commitment of monetary policy to a gradually downward shifting inflation objective. In 1997, with an average rate of 1.5%, inflation finally reached a level low enough to conform to the goal of price stability, so further reductions in the inflation objective are not required. To model this disinflation process, our segmented trend variable is comprised of a time trend for the time period from 1980:1 until 1997: 2 and a constant component for the remaining sample period.[19] With respect to the equilibrium real interest rate, this variable is usually assumed to be constant in time.[20] However, there is a widespread perception that with the advent of EMU the equilibrium real interest rate in the euro area has shifted downwards.[21] It is argued that with the ECB poised to take responsibility for monetary policy, a number of countries in the euro area have experienced a transition from a high- to a low-inflation environment, which has been accompanied by a reduction in the risk premium, leading to a lower equilibrium real interest rate.[22] To account for this reduction in the equilibrium real interest rate due to EMU, we include a step-dummy in our model, which takes the value one from 1997:3 onwards and is zero otherwise.[23]

To show the implications of these two intervention variables for the deterministic component of the nominal short-term interest rate, the resulting deterministic trend is plotted together with the interest rate in the upper panel of Figure 5. The lower panel shows the deviation of the anticipated interest rate from our estimate of the neutral interest rate. This measure is used in the remainder of this paper as an approximation of the anticipated monetary policy stance.

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rate, he argues on the basis of the New IS-LM model that "a neutral interest rate policy must make the nominal interest rate vary with the natural rate of interest and the inflation target." See King (2000), p. 57.

[19] Our results are, in general, not particular sensitive to the exact specification of this segmented trend variable.

[20] Empirical evidence supporting this assumption includes the finding of a stationary real interest rate in the euro area in the time period from 1980 until 1997 in Coenen and Vega (1999). This finding implies that the real interest rate tends to return to a constant mean. Gottschalk and Schumacher (2001) show that the real interest rate in the euro area remains stationary after the beginning of the third stage of EMU, provided a one-time downward shift in the equilibrium real interest rate is accounted for.

[21] For this reason, most researchers in applied business cycle research employ data from Germany, a low-inflation country, to compute the equilibrium real interest rate, which is usually approximated with the average value of the real interest rate over long sample periods.

[22] For empirical evidence on the reduction in the risk premium see Gerlach and Schnabel (1999).

[23] The decision for the third stage of EMU to go ahead was made in the second quarter of 1998, but the transition to a low-inflation environment was completed in many countries already in 1997, so we choose an earlier date for our EMU-dummy variable to take effect. The results of our analysis are not sensitive with respect to the exact specification of the EMU-dummy variable.

The deterministic component of the nominal short-term interest rate exhibits a smooth decline over most of the sample period.[24] From 1997 onwards, it converges to a new long-run value of around 4.5%. It is interesting to notice in this context that in applied business cycle research the equilibrium real interest rate in the euro area is often put at a value close to 2.5%, while the inflation objective of the ECB is thought to be approximately 1.5%.[25] Taken together, this yields an estimate of the nominal neutral interest rate the in euro area of approximately 4.0%, which is close to the 4.5% predicted by our model. This suggests that the deterministic component of the nominal short-term interest rate represents a somewhat crude, but nevertheless plausible estimate of the neutral rate in the euro area. The lower panel shows the resulting measure of the anticipated monetary policy stance. Regarding the most recent past, this measure of the monetary policy stance shows that the short-term interest rate is approximately 25 basis points higher than the neutral interest rate, which suggests that monetary policy in the euro area is broadly neutral. The six leading German economic research institutes come to the same conclusion, which gives additional support to our approach.[26]

4.2.2 The Output Effects of Anticipated Monetary Policy

Having obtained a measure of the stance of anticipated monetary policy, we now proceed to compute the output effects of these monetary policy actions. Figure 6 shows the results of our output index for different values of the parameter lambda and using a forecast horizon of 12 quarters. In the first panel, we start by assuming that there is no difference between the output effects of anticipated and unanticipated monetary policy actions, i.e., we are setting $l = 1$. The solid line presents for each point in time t the output effects of anticipated monetary policy actions occurring in the time from t to $t-11$. Since conventional SVAR analysis focuses on the role of unanticipated monetary policy actions on output, to compare the relative importance of anticipated and unanticipated monetary policy we also plot the output effects of the monetary policy shocks identified in section 3. The latter are computed in an analogous way to the output

[24] An exception is the ‘bump’ in 1987, which is attributable to the effects of the impulse dummy taking the value one in 1987:1 and zero otherwise, which has been included to capture an outlier in the output growth series.

[25] Alesina et al. (2001), for example, choose a value of 2.5% for the equilibrium real interest rate in their benchmark interest rate rule for the ECB. See Alesina et al. (2001), pp. 27. For a discussion of the inflation objective of the ECB, see Svensson (1999), p. 95.

[26] See Arbeitsgemeinschaft (2001), p. 18.

effects of anticipated monetary policy actions, and are given by the dotted line in Figure 6.[27] It is apparent from Figure 6 that anticipated monetary policy accounts for a considerable part of output fluctuations. For example, the expansionary monetary policy stance in the second half of the eighties increased output in the late eighties by about 2 percent above its base line[28], whereas the restrictive policy stance in the early nineties reduced output in 1993 by 3 percent below its base line. In the year 2000, output is approximately 1 percent above its base line due to an expansionary stance of anticipated monetary policy during the previous three years. The output effects of unanticipated monetary policy actions are negligible in comparison. If one assumes that anticipated monetary policy is less effective than unanticipated monetary policy and accordingly chooses a value for the parameter l smaller than one, for example $l = 0.5$ or $l = 0.2$, the role of anticipated monetary policy for output fluctuations becomes smaller but remains considerable larger than the role of unanticipated monetary policy, even for $l = 0.2$. For $l = 0$, anticipated monetary policy actions have no output effects. The output effects of unanticipated monetary policy plotted in the last panel of Figure 6 correspond exactly to the output effects of monetary policy shocks plotted in Figure 3, which proved to be quite small in comparison to the effects of non-monetary policy shocks.

5 The Output Effects of the Systematic Monetary Policy Response to Non-Monetary Shocks

The finding in the previous section raises the question, what is behind anticipated monetary policy? Since most monetary policy actions presumably represent a systematic reaction to the state of the economy, the latter is likely to be an important determinant of the anticipated monetary policy stance. Within our model, the state of the economy is largely determined by

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[27] In particular, according to equation (7) the output effects of unanticipated policy, y_{t+j}^{up}, are given by $y_{t+j}^{up} = \sum_{s=0}^{j-1} a_s^* \left(i_{t+j-s}^p - E_{t+j-s-1} i_{t+j-s}^p\right) + \sum_{s=j}^{\infty} a_s^* \left(i_{t+j-s}^p - E_{t+j-s-1} i_{t+j-s}^p\right)$. Here, we approximate unanticipated monetary policy, $\left(i_t^p - E_{t-1} i_t^p\right)$, with the time series of monetary policy shocks estimated in section 3. The dotted line in Figure 6 corresponds to the first term on the right hand side of the expression for y^{up} for a forecast horizon of 12 quarters.

[28] The base line corresponds to the base projection of output, which gives the path of output that would have been obtained in the absence of anticipated monetary policy actions occurring in the time from *t* to *t-11*.

demand and supply shocks.[29] The finding that anticipated monetary policy has considerable output effects raises the prospect that it may play an important role in the propagation of these two non-monetary shocks, since the systematic response of monetary policy to these shocks is likely to account for a large part of anticipated monetary policy actions.

In this section, we employ the technique developed in the preceding section to investigate the contribution of systematic monetary policy to the real effects of aggregate demand and supply shocks. To accomplish this, first we determine the part of the monetary policy stance attributable to the systematic response of monetary policy to non-monetary shocks, which we denote as the systematic component of monetary policy. In a second step, we compute the output effects of this component of monetary policy.

5.1 The Systematic Monetary Policy Response to Demand and Supply Shocks

We begin by decomposing the monetary policy stance into three components. This decomposition uses the fact that in our model monetary policy responds to three kinds of disturbances:

First, the central bank responds in a systematic fashion to aggregate demand shocks. The systematic nature of this response implies that economic agents anticipate this policy response once they realize that a demand shock has occurred. Besides this anticipated component, the systematic policy response is also comprised of the contemporaneous response of monetary policy to the aggregate demand shock, which cannot be anticipated because the demand shock itself is unanticipated. However, empirically we find that the systematic policy response is dominated by its anticipated component. Regarding the nature of the systematic policy response to this shock, an aggregate demand shock which raises output is accompanied in our model by higher inflation.[30] The impulse response function for the interest rate shows that monetary policy reacts by tightening the policy stance, thereby limiting the inflationary pressures arising from this shock. This is consistent with a counter-cyclical policy.

Second, the central bank responds in our model in a systematic fashion to aggregate supply shocks. The systematic response again consists of a large anticipated and a small unanticipated component. A positive aggregate supply shock which raises output tends to lower inflation. This allows the central bank to ease policy, thereby further stimulating output and bringing

[29] The historical decomposition of output depicted in Figure 9 shows that these two type of shocks account for most of the output fluctuations at the business cycle frequency.

[30] To preserve space the impulse response functions for the aggregate demand and supply shocks are not shown here, but they are included in the Kiel Working Paper version of this paper, Gottschalk and Höppner (2001).

inflation back to target. This implies that monetary policy pursues a pro-cyclical policy in response to a supply shock. Taken together, monetary policy actions triggered by aggregate demand and supply shocks represent the systematic component of monetary policy.

Third, discretionary policy, which in our model is represented by the monetary policy shocks, also plays a role in the behaviour of the central bank. In this section, we define the monetary policy shock together with the endogenous interest rate response triggered by this shock as the monetary policy shock component of monetary policy.

Using the historical decomposition technique for the interest rate, Figure 7 shows the contribution of these three components to the movements of the interest rate.[31] As in Figure 5, the deviations of the interest rate from the neutral interest rate are depicted. The difference to Figure 5 is that Figure 7 consists of not only the anticipated part of monetary policy but also its unanticipated part. However, the latter part is quantitatively very small, so the first panel of Figure 7 showing the 'total' monetary policy stance is almost identical to the anticipated monetary policy stance shown in Figure 5. The second and the third panel show the part of monetary policy accounted for by the systematic monetary policy response to aggregate demand and supply shocks. This part is considerable larger than the monetary policy shock component shown in the last panel. This suggests that the output effects of anticipated monetary policy shown in Figure 6 reflect to a large extent the systematic response of monetary policy to aggregate demand and supply conditions.

5.2 The Output Effects of the Systematic Component of Monetary Policy

Before investigating the output effects of systematic monetary policy, it is useful to recall how the conventional SVAR analysis accounts for the output effects of aggregate demand and supply shocks. As has been noted in the introduction of this paper, the output impulse response function to an aggregate supply shock, for example, contains both the direct and indirect effect of this

[31] In contrast to the historical decomposition for the output series, here we do not employ a forecast horizon of three years for the historical decomposition, but plot the interest rate in time t as a function of *all* realizations of a given structural shock that have occurred since the beginning of the sample period. That is, we do not set the parameter *j* to 12 and then compute X_{t+12} by letting the time index *t* move from the beginning of the sample period to the end, so that the historical decomposition shows X_t as a function of the structural shocks which have occurred in the time period from t until $t-11$. Instead, in equation (6) we set *t* to the beginning of the sample period and then increase *j* until X_{t+j} reaches the end of the sample period. For a given point in time *t*, the resulting historical decomposition plotted in Figure 7 shows the nominal interest rate as a function of all structural shocks which have occurred in the time period from the beginning of the sample period until time *t*. The reason for this departure from the earlier procedure is that, here, we are interested in the total effects of non-monetary shocks on the interest rate and not only on their effects at a business cycle frequency.

shock. The indirect effect is attributable to the systematic response of monetary policy to this disturbance. The direct effect, on the other hand, denotes the output effects of the aggregate supply shock that would have been obtained if monetary policy had not reacted to this shock. In a conventional SVAR analysis, however, it is not possible to identify both effects individually. In the following analysis we use our measure of the output effects of anticipated and unanticipated policy actions to disentangle these two effects. In particular, we estimate the output effects of the systematic policy response to demand and supply shocks. These correspond to their indirect effects on the economy. Next, we compute the direct output effects. Having estimated both the direct and indirect effects, it is possible to evaluate the contribution of systematic monetary policy to the real effects of demand and supply shocks in our model.

Based on our index of the output effects of anticipated and unanticipated monetary policy actions, we can compute the output effects of systematic monetary policy in a straightforward way. Denoting the output effects of the systematic monetary policy response to a demand shock as $y_t^{sys,d}$, and writing the anticipated (unanticipated) component of the systematic monetary policy response to this shock as $E_{t-1}i_t^{sys,d}$ ($e_t^{sys,d}$), we modify equation (8) to obtain $y_t^{sys,d}$:

$$y_{t+j}^{sys,d} = \sum_{s=0}^{j-1} l a_s^* E_{t+j-s-1} i_{t+j-s}^{sys,d} + \sum_{s=0}^{j-1} a_s^* e_{t+j-s}^{sys,d} + \sum_{s=j}^{\infty} l a_s^* E_{t+j-s-1} i_{t+j-s}^{sys,d} + \sum_{s=j}^{\infty} a_s^* e_{t+j-s}^{sys,d} \qquad (9)$$

Below, we will plot for a forecast horizon of 12 quarters the time series corresponding to the first and second term on the right hand side of equation (9), which show for each point in time t the effects on output of the anticipated and unanticipated systematic monetary policy actions taking place in the time from t to $t-11$ in response to aggregate demand shocks. The output effects of the systematic policy response to aggregate supply shocks are computed in an analogous way. As noted above, these effects correspond to the indirect effects of the two non-monetary shocks. Since the conventional historical decomposition of the output series yields the total effects of aggregate demand and supply shocks on output, we retrieve the direct effect of a given shock by subtracting the estimated indirect effect from the total effect. The results for the direct and indirect effects of the aggregate demand and supply shocks are plotted in Figure 8.

In the upper panel, the solid line represents the direct effect of the aggregate demand shocks and the dotted line shows the output effects of the systematic policy response to these shocks. The lower panel shows the results for the aggregate supply shock. To preserve space, only the results for $l = 1$ are reported.[32] Regarding the aggregate demand shock, it is apparent that monetary policy operates in a counter-cyclical fashion, thereby helping to stabilize the economy. The systematic monetary policy response to aggregate demand shocks is generally successful in filling in the troughs and shaving off the peaks of aggregate demand fluctuations, particularly so in the slump in the late eighties and during the boom in the early nineties. Nevertheless, compared to the direct effects of the aggregate demand shocks the output effects of the systematic policy response are moderate. Moreover, the effectiveness of the policy response is apparently reduced by lags in the decision making process and in the transmission mechanism. It seems systematic monetary policy contributed in particular to the recession in 1993, because the tight monetary policy stance maintained in the preceding boom was not reversed quickly enough when demand conditions faltered in the beginning of 1993. Since the middle of the nineties, the contribution of the systematic monetary policy response to aggregate demand shocks to output fluctuations is negligible. With regard to the systematic response of monetary policy to supply conditions, the lower panel of Figure 8 shows that monetary policy responds in a roughly pro-cyclical manner to supply conditions, but with a considerable time lag. The supply conditions are rather volatile and it is clear that monetary policy does not attempt to respond to all fluctuations. This reflects presumably the fact that supply conditions are difficult to identify and to interpret, which is likely to account also for the significant lag in the policy reaction.

Having estimated the output effects of systematic monetary policy, we end this section by comparing its role for output fluctuations to that of the monetary policy shock component. The output effects of the latter are computed in an analogous fashion to those of systematic monetary policy. The results are reported in Figure 9. Again, to preserve space, only the results for $l = 1$ are shown. The solid line shows the total effects of monetary policy on output. The dotted line shows the effects of systematic monetary policy, comprising of the monetary policy response to both aggregate demand and supply shocks. The dashed line gives the output effects of the monetary policy shock component. In contrast to Figure 6, this includes in addition to the unanticipated monetary policy shocks the effects of the anticipated endogenous policy response to these shocks. Even though the output effects of monetary policy shocks become larger when this component is accounted for, they remain relatively small compared to the systematic component of monetary policy.

[32] Full results are available from the authors upon request.

6. Conclusion

This paper builds on the work by Cochrane (1998), who introduced a procedure to compute the response of output to anticipated monetary policy actions from a standard SVAR model, by presenting the results of this procedure for the euro area. We re-estimate the SVAR model of the euro area transmission mechanism proposed by Monticelli and Tristani (1999) and apply the Cochrane procedure to the estimated impulse response functions. Compared to the conventional impulse response function showing the output response to a monetary policy shock, the output response to an anticipated interest rate impulse turns out to be rather small and immediate.

Furthermore, we construct an index of the output effects of anticipated monetary policy using the conventional historical decomposition technique in conjunction with the results from the Cochrane procedure. With this measure we can go beyond shocks, which is otherwise at the centre of SVAR analysis, and extend the analysis to the role of anticipated monetary policy for output fluctuations. The results confirm earlier findings that unanticipated monetary policy shocks are relatively unimportant for output variations, but we find that in contrast to monetary policy shocks the anticipated part of monetary policy has considerable output effects. To investigate this issue further, we compute the systematic response of monetary policy to aggregate demand and supply disturbances and estimate the corresponding output effects of those monetary policy actions.

Overall, this paper seeks to demonstrate that with the techniques proposed in this paper the scope of conventional SVAR analysis can be extended considerably. In principle, these can be applied to any SVAR model, since the only inputs required are the conventional impulse response functions and the estimated time series of the structural shocks. The usefulness of the extended SVAR analysis for applied business cycle research should have become evident from our analysis of the sources of output fluctuations in the euro area. Another potential application includes an evaluation of the effectiveness of different monetary policy rules regarding the stabilization of output. Generally, the techniques proposed here allow to use SVAR models for tasks which have been previously the domain of traditional structural macroeconomic models.

References

Alesina, Alberto, Olivier Blanchard, Jordi Galí, Francesco Giavazzi and Harald Uhlig (2001): Defining a Macroeconomic Framework for the Euro Area. Monitoring the European Central Bank 3, Centre for Economic Policy Research, London.

Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute (2001): Die Lage der Weltwirtschaft und der deutschen Wirtschaft im Frühjahr 2001.

Ball, Lawrence, N. Gregory Mankiw and David Romer (1988): The New Keynesian Economics and the Output-Inflation Trade-off, *Brookings Papers on Economic Activity*, 1988(1): 1 – 82.

Bernanke, Ben S., Mark Gertler and Mark Watson (1997): Systematic Monetary Policy and the Effects of Oil Price Shocks, *Brookings Papers on Economic Activity*, 1997 (1): 91 – 157.

Brand, Claus and Nuno Cassola (2000): A Money Demand System for Euro Area M3, ECB Working Paper No. 39.

Christiano, Lawrence J., Martin Eichenbaum and Charles L. Evans (1999): Monetary Policy Shocks: What Have we Learned and to What End?, In: Taylor, John B. and Michael Woodford (eds.): Handbook of Macroeconomics.

Coenen, Günter and Juan-Luis Vega (1999): The Demand for M3 in the Euro Area, ECB Working Paper No. 6.

Cochrane, John H. (1998): What do the VARs Mean? Measuring the Output Effects of Monetary Policy, *Journal of Monetary Economics*, 41(2): 277 – 300.

Fackler, James S. and W. Douglas MacMillin (1997): Historical Decomposition of Aggregate Demand and Supply Shocks in a Small Macro Model, *Southern Economic Journal*, 64 (3): 648 – 664.

Fagan, Gabriel, Jerome Henry and Ricardo Mestre (2001): An Area-Wide Model (AWM) for the Euro Area, ECB Working Paper No. 42.

Galí, Jordi (1992): How Well does the IS-LM Model fit Postwar U.S. Data?, *Quarterly Journal of Economics* 107: 709 – 738.

Gerlach, Stefan and Gert Schnabel (1999): The Taylor Rule and Interest Rates in the EMU Area, CEPR Discussion Paper No. 2271.

Gottschalk, Jan and Florian Höppner (2001): Measuring the Effects of Monetary Policy in Europe: The Role of Systematic Policy, Kiel Working Paper, forthcoming.

Gottschalk, Jan and Christian Schumacher (2001): Measuring the Monetary Policy Stance in the Euro Area – An Application of the Multivariate Beveridge-Nelson Decomposition, mimeo.

Hansen, Bruce E. (1992): Testing for Parameter Instability in Linear Models, *Journal of Policy Modeling*, 14 (4): 517-533.

King, Robert G. (2000): The New IS-LM Model: Language, Logic and Limits, Federal Reserve Bank of Richmond *Economic Quarterly*, 86 (3): 45 – 103.

Monticelli, Carlo and Oreste Tristani (1999): What does the Single Monetary Policy Do? A SVAR Benchmark for the European Central Bank, ECB Working Paper No. 2.

Sims, Christopher A. (1998): Comment on Glenn Rudebusch' s "Do Measures of Monetary Policy in a VAR Make Sense?", *International Economic Review*, 39 (4): 933 – 941.

Svensson, Lars E.O. (1999): Monetary Policy Issues for the Eurosystem, *Carnegie-Rochester Conference Series on Public Policy*, 51: 79 – 136.

Appendix

Figure 1A: The Time Series

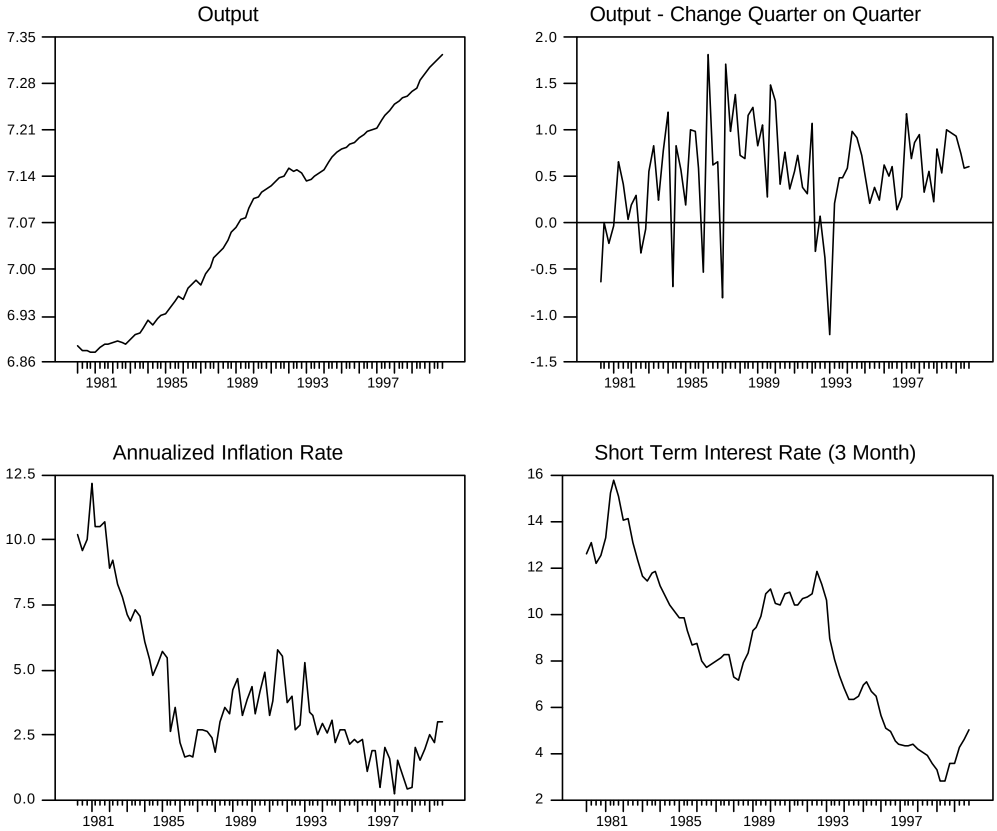


Table 1: Misspecification Tests

Test	Multivariate Statistics	Univariate Statistics		
		Δ y	**s**	**Δ cpi**
AR (1-5)	1.29	1.17	2.06	0.26
Jarque-Bera	3.33	1.65	1.21	0.53
ARCH (4)		0.84	1.01	1.05
White	0.82	0.70	1.92*	0.40
Hansen		2.56	2.24	1.54

Notes: The asterisks indicate a rejection of the null hypothesis at the 5% (*) or the 1% (**) level.
The AR (1-5) statistic gives the result of a LM-test for autocorrelated residuals up to order 5. For single equations this test statistic has a F(5,62) distribution, in the multivariate case it is F(45,149). Jarque-Bera is a normality test with a chi-square (6) distribution in the multivariate and a chi-square (2) in the univariate case. ARCH 4 is a LM test for autocorrelated squared residuals of order 4 with a F(4,59) distribution. The White statistic is the test statistic of a test for heteroscedasticity. The respective distributions are F(21,45) and F(126,239).Hansen is a stability test based on Hansen (1992); the critical values at the 5% and the 1% level are 3.15 and 3.69.

Figures:

Figure 1: Impulse Responses to a Monetary Policy Shock

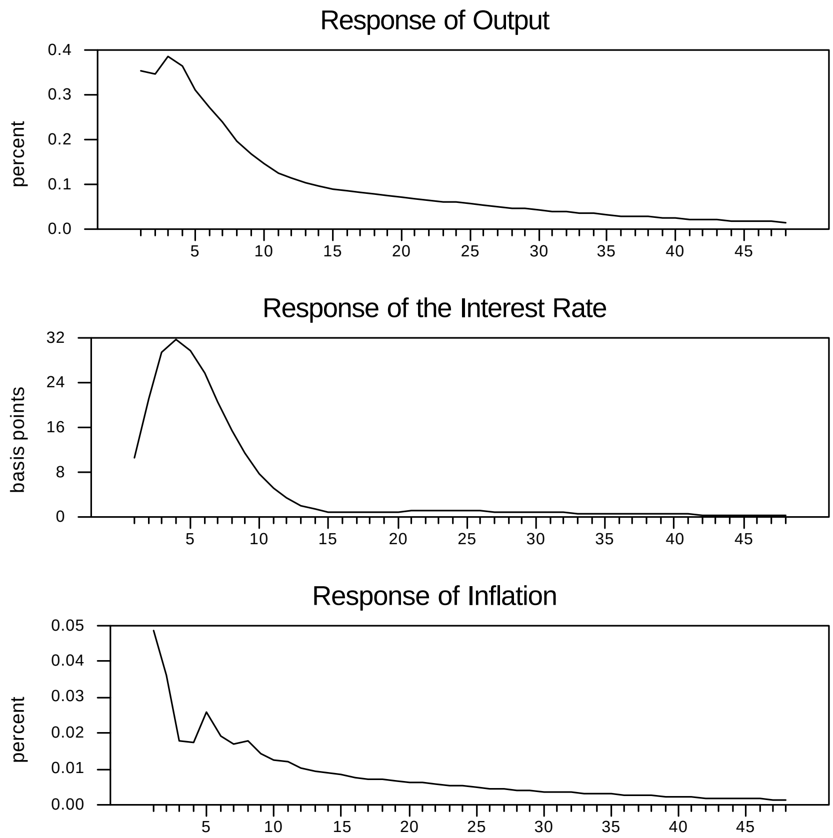


Figure 2: Response of Output to an Unanticipated Interest Rate Blip

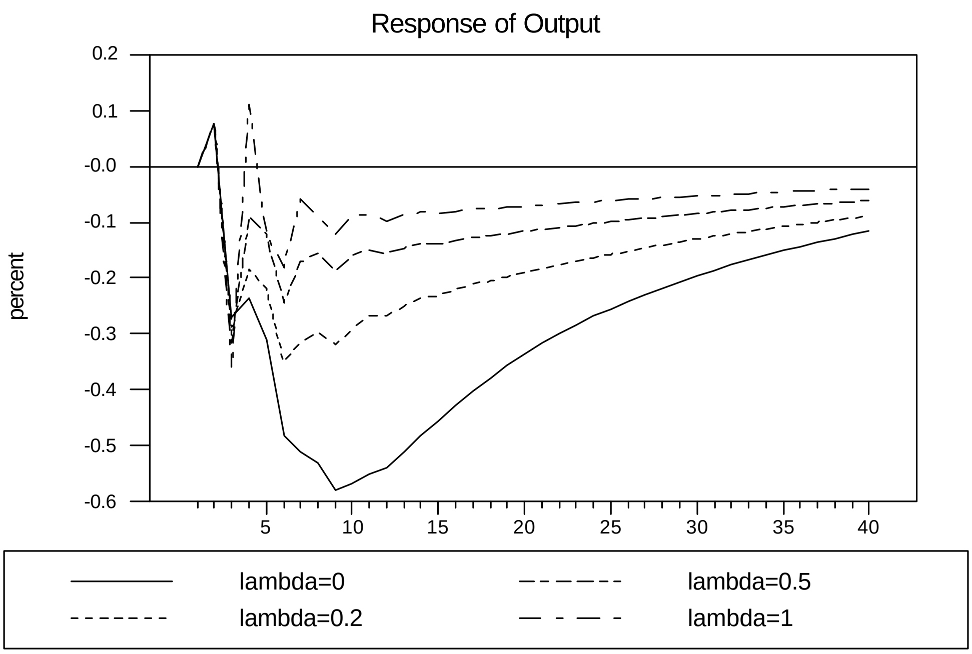


Figure 3: Response of Output to an Anticipated Interest Rate Blip

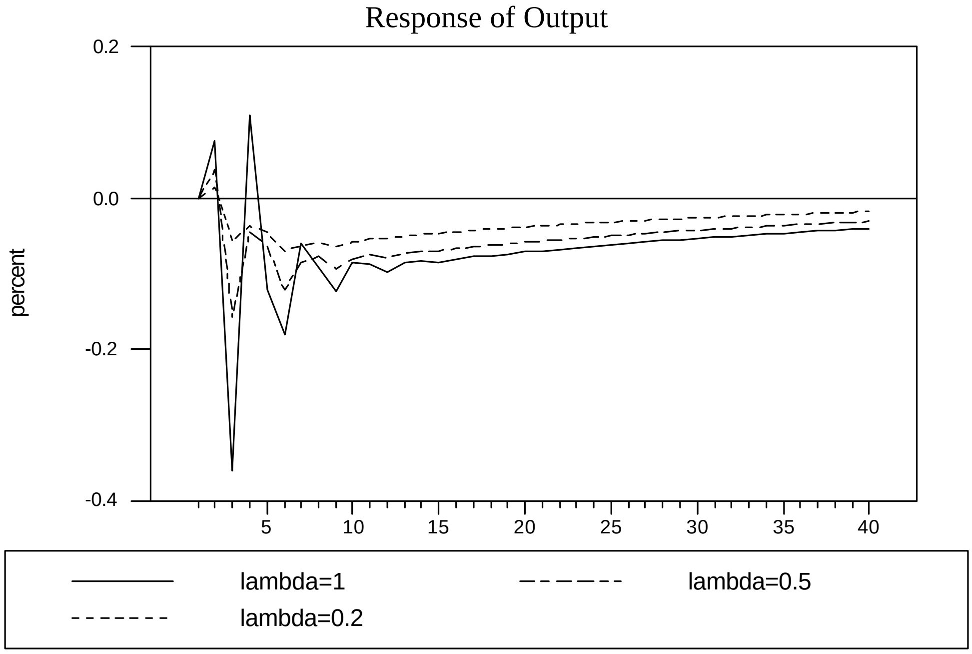


Figure 4: Historical Decomposition of the Output Series

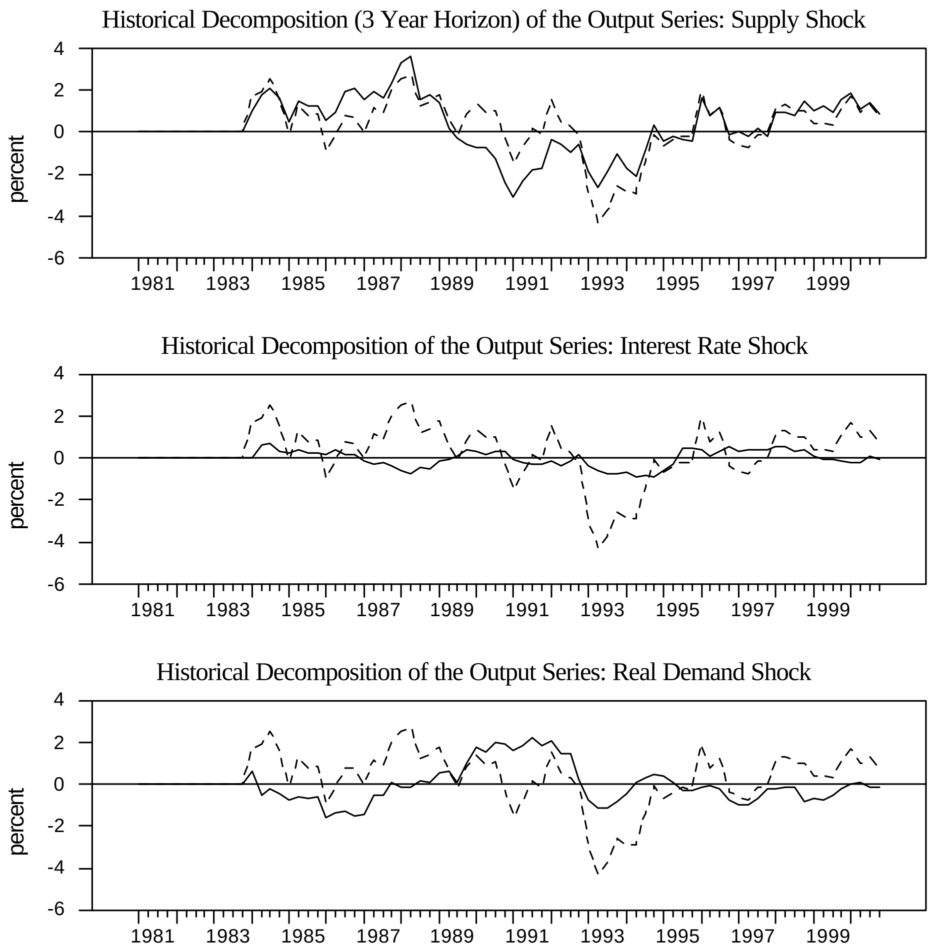


Figure 5: Anticipated Monetary Policy and the Monetary Policy Stance

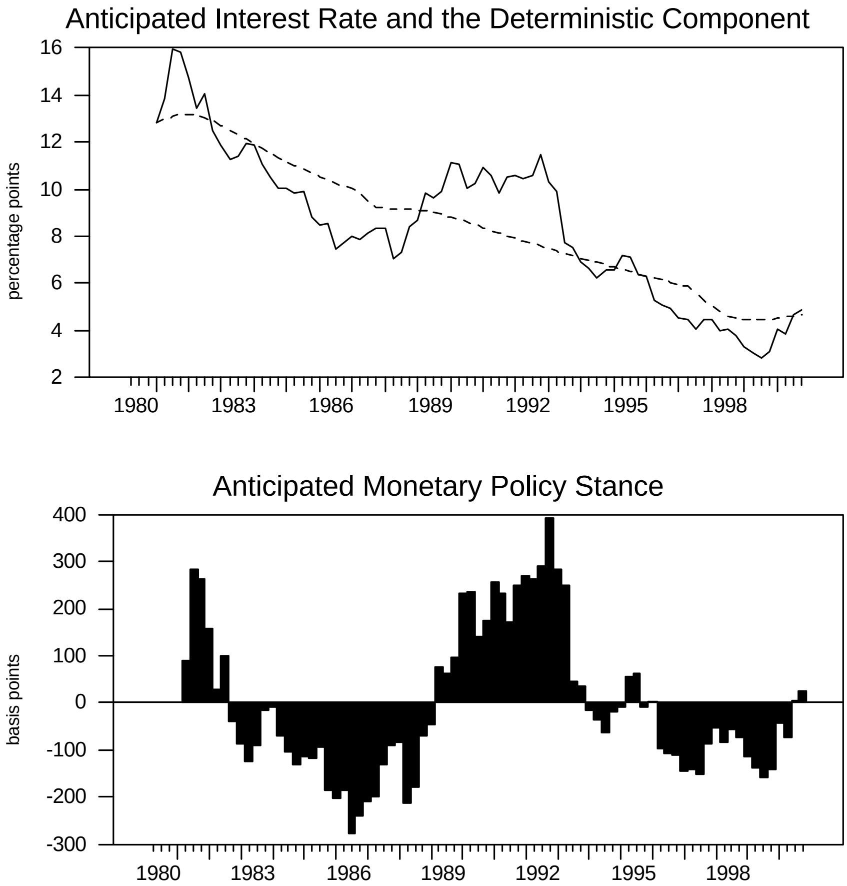


Figure 6: The Output Effects of Anticipated and Unanticipated Monetary Policy

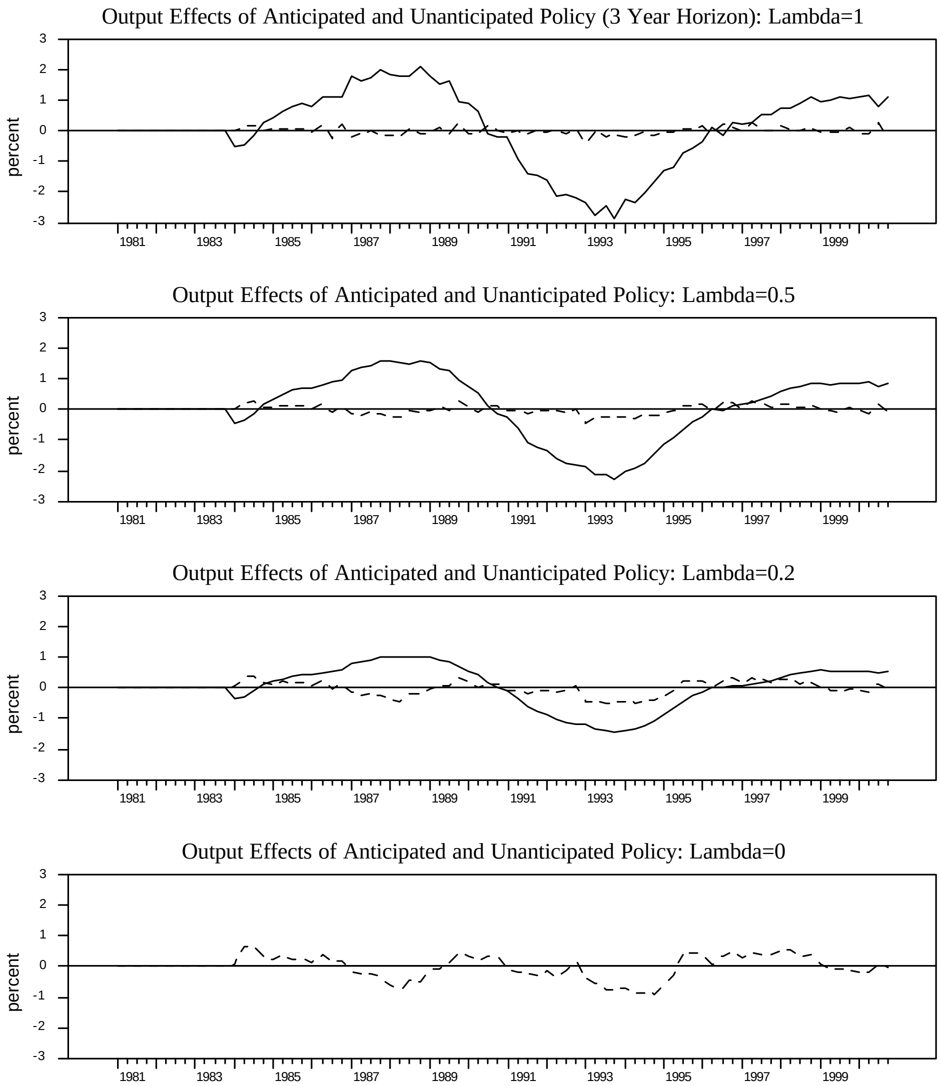


Figure 7: Decomposition of the Nominal Interest Rate

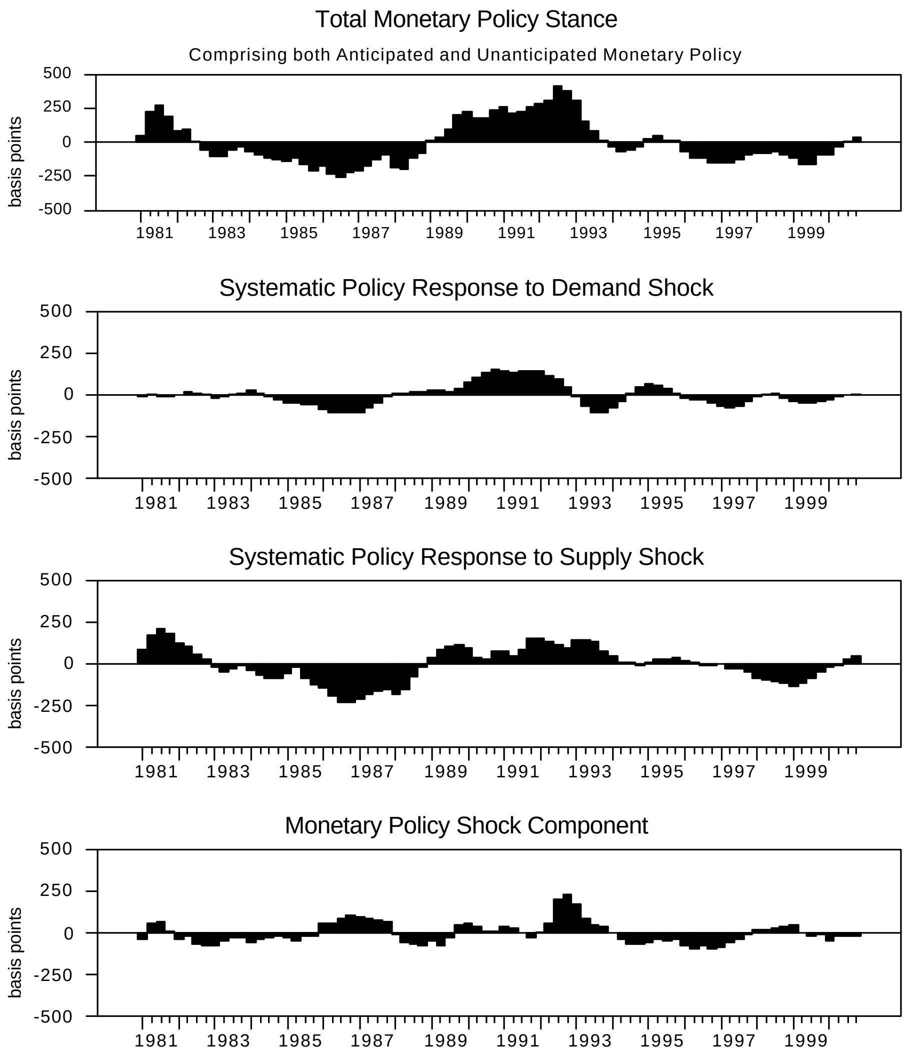
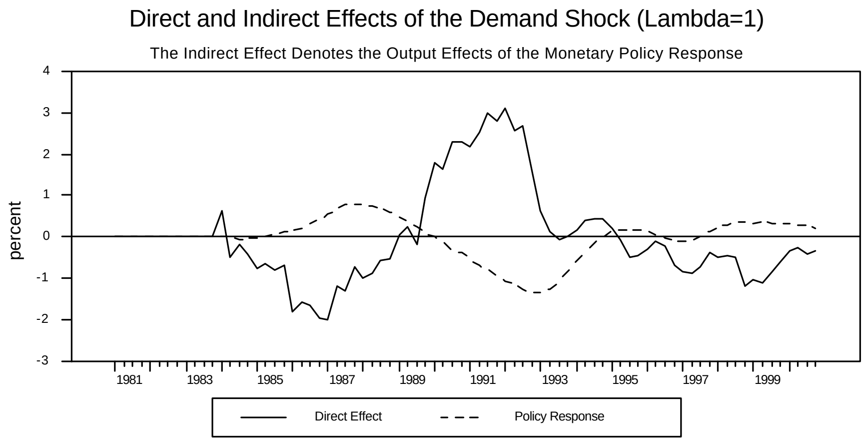


Figure 8: Output Effects of the Systematic Policy Response to Non-Monetary Shocks



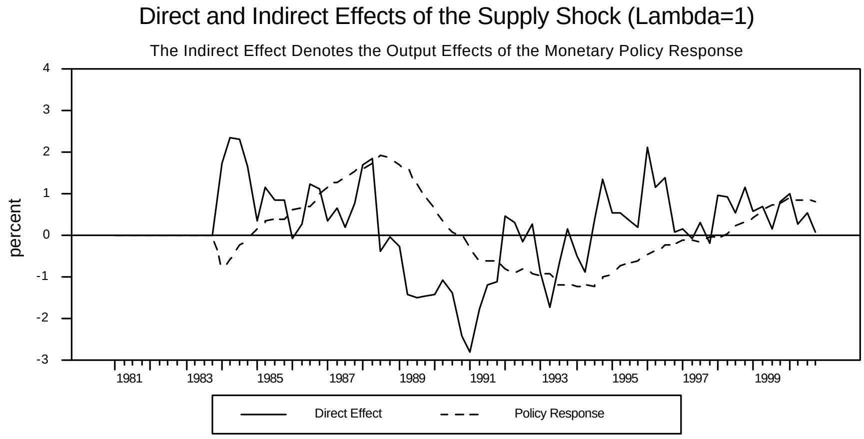


Figure 9: Decomposition of the Output Effects of Monetary Policy