An Index for the Effects of Monetary Policy in Europe: The Role of Systematic Policy

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Abstract:

This paper investigates the role of systematic monetary policy in a modified SVAR framework. Building on the identification of impulse response functions for systematic monetary policy introduced by Cochrane (1998), we construct an index of the effects of monetary policy on output, which accounts for the effects of both monetary policy shocks and rule-based policy. Using an Euroland dataset, our analysis shows that in contrast to unexpected policy shocks, systematic monetary policy has substantial effects on output. This index may also be useful for applied business cycle analysis as a tool to evaluate the real effects of monetary policy.

JEL Classification: E52, C32, C52
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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.[1] In contrast, analysis of the effects of systematic and hence anticipated monetary policy has been somewhat neglected. However, recently Cochrane (1998) has made an important contribution to this 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 European 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, which is a standard tool in applied SVAR analysis, to take anticipated monetary policy actions explicitly into account.

The motivation for this index of the output effects of monetary policy is twofold. On the one hand, we want to extend the standard SVAR analysis of the real effects of monetary policy shocks to cover also the real effects of anticipated monetary policy. If monetary policy matters for business cycle fluctuations, it is likely to be the systematic part that has substantial real effects, as 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, we believe that the SVAR approach with its identification of structural shocks hitting the economy is in principle well suited to assist practitioners in the field of applied business cycle analysis. After all, it is the essence of business cycle reports to analyse new developments in the world and domestic economy and to quantify their effects on real activity. In terms of the SVAR methodology, business cycle reports identify shocks and estimate the response of output to these shocks, which is exactly what SVAR models do too. However, there is a major difference regarding the analysis of the effects of shocks. For example, in applied business cycle analysis the effects of a foreign demand shock are usually decomposed in their direct effect on the domestic economy via their effect on the trade balance and in their indirect effect via the systematic monetary policy response to this shock. In a SVAR analysis, on the other hand, the output impulse response function to a foreign demand shock encompasses both the direct and the indirect effect and does not allow to retrieve these two effects separately. In particular, conventional SVAR analysis remains silent on the role of systematic monetary policy in propagating this shock. From the standpoint of view of a practitioner in this field this is a major shortcoming of the SVAR methodology. The output index of the effects of monetary policy is intended to enhance the usefulness of SVAR for applied work by identifying the role of systematic policy in propagating the effects of a shock. To illustrate this point, this paper presents an analysis of the role of systematic monetary policy for European business cycle fluctuations in the period from 1980 to 1999, the sample period under investigation.

Since it is the central objective of this paper to show how the analysis of anticipated monetary policy actions can in principle be incorporated into conventional SVAR analysis, we use the Euroland SVAR model proposed by Monticelli and Tristani (1999) as a starting point of our analysis, as we do not think it is necessary for our purpose to add another model to the already rich SVAR literature. It should be emphasised at this point that the empirical investigation we present in this paper is more intended to demonstrate the methodology as such than to generate new insights into the sources of European business cycle fluctuations. The underlying SVAR model employed here is probably not sophisticated enough to be suitable for such an ambitious task, but its very simplicity is useful for the purpose at hand, as it makes the following exposition easier to follow.

Before turning to the empirical analysis, the question whether anticipated monetary policy has real effects at all is from a theoretical standpoint of view of central importance for this paper. However, a comprehensive review of this issue is beyond the scope of this paper.[2] Also, the notion that anticipated monetary policy has real effects is at least implicitly widely accepted in applied business cycle analysis, hence we believe it suffices here to point to the large body of New Keynesian literature to motivate this assumption.[3] In short, in New Keynesian models the four building blocks imperfect competition, menu costs, real rigidities and price staggering

[1] See for example the survey in Christiano et al. (1999), particularly p. 70.
[2] The working paper version of this paper provides a more detailed discussion of this issue, see Gottschalk and Höppner (2001).
[3] See for example Ball et al. (1988).

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. We believe that this literature provides a comprehensive foundation for an empirical analysis of possible anticipated monetary policy effects.

The paper is organised as follows. In section 2 the SVAR model for Euroland 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 one to compute impulse response functions for anticipated monetary policy actions. In section 4 his methodology is extended to construct an index of the output effects of anticipated monetary policy. This section ends with an application of this index to the discussion of the contribution of monetary policy to European business cycle fluctuations in the period under investigation. The final section summarises the results.

2. A SVAR Model for Euroland

For our analysis of the effects of monetary policy we use the empirical model by Monticelli and Tristani (1999) as a starting point, which provides a robust and parsimonious SVAR model for the monetary transmission mechanism in the euro zone. This model appears to be well qualified for our purpose, because it employs common identifying restrictions. Also, the impulse response functions correspond well to widely held views about the monetary transmission mechanism.

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 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 zone, with data available for a time span beginning in the first quarter 1980 and ending in the fourth quarter of 1999.[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. 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.[5] We estimate the reduced form of the model by imposing a linear trend on the levels of the variables and using three lags as suggested by the Akaike and Hannan-Quinn criterion. Standard tests for the residual properties, which are given in table 2 in the appendix, suggest that this lag order is sufficient for ensuring a white noise process.[6] In addition 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 again exactly follow Monticelli and Tristiani.[7] The identifying restrictions are motivated 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 innovations are assumed to represent shocks to aggregate supply, innovations to the LM curve (money supply shocks), and innovations 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 disturbances on output. Aggregate demand disturbances 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 actions 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 until monetary shocks have real effects.

[4] Details of the aggregation procedure and the data sources are given in table 1 in the appendix. For a general discussion of aggregation issues concerning European data see Coenen and Vega (1999), p. 4 ff.

[5] 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 clear evidence for one cointegrating vector. Modeling the data in levels nevertheless involves no loss of information with respect to the long-run properties of the system. The working paper version of this paper provides an extensive discussion of this issue, see Gottschalk and Höppner (2001).

[6] The exception to this is the output equation, where there are signs for non-normality. However, increasing the lag length does not prove to be an effective remedy. The plot of the output growth series given in figure 1 in the appendix suggests that the non-normality problem is due to outliers. In principle, one could introduce dummy variables to remove them from the sample, but given that the system seems otherwise well specified, the cure is probably worse than the problem itself.

Nevertheless, monetary policy shocks are allowed to a have contemporaneous effect on prices, which accounts for possible fast effects of policy actions via the exchange rate channel on the price level.

2.2 The Response of the Economy to a Policy Shock

In this section we restrict our discussion to the dynamic response of the economy in the model to a monetary policy shock.[8] The impulse response functions are presented in figure 2 in the appendix. They are computed for a standard deviation shock to the system.

Figure 2 about here

The monetary policy shock leads to an initial increase of the nominal short rate of about 30 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 could lead to an appreciation, which lowers the costs of imports and thereby reduces the price level, which implies a one-time drop in the inflation rate. The interest rate remains around 30 basis points above its baseline level for about one year and then returns gradually to its initial value. After two and a half years the nominal short rate is back at its baseline value. 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 gone down by about 0.2 percent. The negative output gap is presumably the main factor behind the decline in inflation that sets in about one year after the policy shock. The neutrality restriction implies that output eventually returns to its baseline value. After approximately three years a gradual increase of the output gap sets in. This coincides with an 'overshooting' of the nominal short-term rate leading to an expansionary policy stance, although this effect is quantitatively small. With the closing output gap the inflation rate also returns to its baseline value. Thus, in the long-run, the monetary policy shock has no real effect on output but leads to a permanently lower price level.

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

[8] All other impulse responses are also "well behaved". For a complete description of all impulse responses the reader again is referred to the working paper version of this paper, see Gottschalk and Höppner (2001).

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

3.1 What Impulse Response Functions Do Not Tell

The limitations inherent in the interpretation of impulse response functions can be illustrated by revisiting the impulse response functions depicted in figure 2.

The key point emphasised by Cochrane (1998) is that the 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 interest rate impulse response function are ignored. Applying this narrow viewpoint to the results reported for the euro area model, the first panel in figure 2 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 0.7 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 2 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 quarter, 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. To put it another way, when European policy makers raise the short rate unexpectedly, this is 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[9] „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[10] of money?“ Contrary to widespread beliefs, conventional impulse response analysis is unsuitable for the task of simulating the effects of different policy scenarios.

3.2 The Cochrane Method

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 is then 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 2. The key idea is that if one assumes that anticipated monetary 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. 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 in this setting. 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.

Consider, for instance, the output effects of a monetary policy shock that is not followed by the customary sustained tightening of policy but 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

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

[10] To illustrate his point Cochrane uses a VAR where a monetary policy shock is identified so that it corresponds to an increase of the money supply.

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 it to compute 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 it 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 variable and a system with the Federal funds rate as proxy for the policy instrument. Since the derivation of his algorithm takes a standard New Classical model as starting point, where monetary policy is modeled with a money stock variable, monetary policy is proxied in the following also with a money variable in order to stay close to Cochrane’s notation.

To derive his algorithm more formally, we follow Cochrane and adapt his anticipated-unanticipated money model

$$y_t = a^*(L)[l m_t + (1-l)(m_t - E_{t-1} m_t)] + b^*(L) d_t \, , \qquad (1)$$

where *a*(L)* and *b*(L)* are structural lag polynomials and l is a parameter that specifies the effectiveness of anticipated monetary policy, with $0 \le l \le 1$. A value of *0* indicates that anticipated money has no effect, a value of *1* that anticipated money has the same effect as an unanticipated policy shock. Choosing a value for l is equivalent to imposing a further identifying restriction. 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: the term $(m_t - E_{t-1}m_t)$ captures the surprise effect of unanticipated money whereas the term m_t captures the direct effect of anticipated money, the relative strength of both effects depending on the parameter l . Thus, *a*(L)* gives the output response to an unexpected unit innovation to the money stock, while l *a*(L)* gives the response of output to an expected unit impulse of the money stock. In other words, once the Cochrane methodology has retrieved *a*(L)*, the response to an anticipated 'blip' can be computed in a straightforward way simply 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,

$$\begin{bmatrix} m_t \\ y_t \end{bmatrix} = \begin{bmatrix} c_{mm}(L) & c_{my}(L) \\ c_{ym}(L) & c_{yy}(L) \end{bmatrix} \begin{bmatrix} e_{m,t} \\ e_{y,t} \end{bmatrix}, \tag{2}$$

where e_{mt} and e_{yt} 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

$$a_0^* = \frac{c_{ym,0}}{c_{mm,0}} \tag{3}$$

and

$$a_j^* = \frac{c_{ym,j} - l\Sigma_{k=0}^{j-1} a_k^* c_{mm,j-k}}{c_{mm,0}}. \tag{4}$$

This recursive algorithm is easily programmable in standard software like RATS.[11] It yields the response of output to an unanticipated 'blip', *a*(L)*. Once one has calculated $a^*(L)$ from (3)

[11] 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.

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 money stock is computed. The initial money shock is going to be followed by an endogenous money response, which is given by $c_{mm}(L)$. 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 money response and thereby obtains the output reaction which is solely due to the initial monetary impulse.

3.3 The Impulse Response Functions for Anticipated Monetary Policy

Turning to the empirical results for the euro area, figure 3 plots in the upper panel the unanticipated interest rate ‘blip’ and in the lower panel the corresponding output response. Setting $l = 0$, one obtains the same impulse response function as displayed in figure 2: A monetary policy shock that raises the nominal interest rate by 100 basis points reduces output by 0.7 % 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, expected policy is only marginally effective, but the impulse response function for the unanticipated blip is considerably less hump-shaped. The peak effect of a monetary policy impulse does not materialise after two years, but is now reached after only two quarters. The effect is also smaller, reducing output at its peak by only 0.5 %. The results for $l = 0.5$ and $l = 1$ are qualitatively similar, but the output response to the unanticipated shock begins to decline more rapidly after having surpassed its peak so that the total of the real effects measured over time becomes smaller by a sizeable amount.

Figure 3 about here

The real effects of an anticipated ‘blip’ are shown in figure 4 . The shape of the impulse response functions are similar to those presented in figure 3, 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. Focusing nevertheless 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 0.5 %. Second, the ensuing real effect fades quickly, declining to 0.1 % after about three years. Third, subsequent output returns only very gradually to the baseline. This suggests that contrary to conventional wisdom the output effects of systematic policy set in soon after a change in the policy instrument, but 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.

Figure 4 about here

4. The Effects of Monetary Policy on Output

In this section, we proceed to construct an index for the effects of monetary policy in Europe. For this purpose we combine the impulse response function for unanticipated and anticipated monetary policy actions introduced in the preceding section with the historical decomposition technique often employed in the SVAR literature.

Before turning to the construction of the index, a clarification is necessary. As discussed in the previous section, the procedure to identify anticipated monetary policy effects introduced by Cochrane requires a value for the parameter lambda, which defines the effectiveness of anticipated monetary policy relative to unanticipated policy. This parameter will not be estimated here, as this task is way beyond the scope of this paper. The parameter lambda is instead a choice parameter; once one has settled on a value for lambda, our method can be used to compute the monetary policy index corresponding to this choice. To illustrate this, we present the results for different values of lambda.

4.1 The Historical Decomposition of Output

The aim of the index we propose in this paper is to show to what extent unanticipated and anticipated monetary policy actions contribute to aggregate output fluctuations over time. The technique used to construct the index is essentially a variation of the familiar historical decomposition technique, which is applied to the output series.[12]

The idea of this technique can be described as follows. Assume that

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

(5) $$X_t = C_D(L)D + C(L)e_t$$

is the moving average representation of the underlying structural model described in section 2. The vector *X* represents the three endogenous variables. The matrix D contains the deterministic part of the model, which is here the constant and the linear time trend present in all equations. The term $C_D(L)$ represents a polynomial matrix giving the effects of *D* on the variables in *X*. The vector e_t gives the three structural shocks identified in the model employed here, 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. Therefore, the deterministic part of the model, though important for other questions, can be omitted in the following analysis. Thus, for a particular period *t+j* equation (5) can be written as:

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

with *C* denoting the impulse response to a structural innovation.

It is apparent here 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, which is the so-called ‘base projection’ of X_{t+j} .[13] 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 gives 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, in a first step t is set to 1981:1 and the decomposition for $X_{1981:1+12}$ is computed on the basis of the structural innovations hitting the economy between 1981:1 and 1984:1; in the next step t is set to 1981:2 and the decomposition of $X_{1981:2+12}$ is obtained. This procedure is repeated until X_{t+12} reaches the end of the sample period. To summarize, the historical decomposition shows how at each point in time how the economy has been influenced by the three types of structural shocks considered here, as the variables in X_t are plotted as a function of each type of structural shock occurring in the time from t-12 to t.

Figure 5 displays the basic historical decomposition of the output series for the SVAR model employed here.

Figure 5 about here

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 unsystematic 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 business cycle fluctuations. Moreover, figure 5 illustrates that the historical decomposition of the output series showing the contribution of the monetary policy shocks can be interpreted as an index of the real effects of monetary policy, but it only captures the effects of monetary policy *shocks*.

The index we propose in this paper goes beyond the effects of shocks, and instead attempts to also capture the effects of systematic policy. The computation of the index of the real effects of monetary policy *shocks* requires the monetary policy shock series as a measure of the unanticipated monetary policy actions as well as the impulse response function as a measure of their effects on output. Computing an index for the real effects of anticipated monetary policy actions requires an analogous input, namely a series measuring the anticipated monetary policy

[13] The effects of the deterministic components enter the base projection.

actions plus the corresponding impulse response functions. As in section 3.2, the time series representing anticipated monetary policy is transformed into a series of anticipated ‘blips’. These ‘blips’ take the place of the structural shocks e_t in (5). The conventional impulse response functions *C(L)* in (5) are replaced accordingly by the impulse response functions for anticipated monetary policy, $l\ a^*(L)$, which were presented in section 3.3.

4.2 The Anticipated ‘Blips’

The construction of the time series for the anticipated ‘blips’ involves two steps. First, a measure of anticipated policy is needed. The SVAR model employed here provides a straightforward answer. After all, the interest rate equation of the SVAR model represents the reaction function of the European central banks and thereby models the systematic and hence anticipated monetary policy actions, while deviations of the interest rate from this rule are identified as monetary policy shocks. This implies that one needs only to subtract the series of the estimated monetary policy shocks from the interest rate series to obtain a measure of the anticipated interest rate.

For the discussion in the remainder of this paper it is useful to decompose the anticipated interest rate movements further. The anticipated policy actions are determined by the reaction function; in the model considered here monetary policy reacts to three kinds of disturbances. First, the central bank responds to aggregate supply shocks. Second, aggregate demand shocks also trigger an interest rate response. Third, monetary policy shocks lead on impact to unexpected interest rate movements, which are by definition unrelated to systematic policy, but induce an anticipated interest rate response one period after the shock has occurred. This endogenous response of the central bank to the policy shock forms part of anticipated policy.

The second step requires the transformation of the anticipated interest rate series into a series of anticipated ‘blips’. A ‘blip’ has been defined as a one period deviation of the interest rate from its baseline; the baseline represents the level of the interest rate where systematic policy has no output effect. In other words, a ‘blip’ is a deviation of the interest rate from its neutral level.

Determining the neutral interest rate is a controversial issue in the literature and we cannot hope to resolve this debate here. Regarding the historical euro area data we are employing it is even doubtful if something like the neutral rate ever existed back in the 1980s or 1990s, when the euro was not yet introduced. Nevertheless, we are going to proceed to introduce a measure for the neutral rate for the sample period under investigation. We do not do so because we believe the measure we choose is particularly accurate. Rather, this exercise serves to illustrate the principle of the construction of the monetary policy index. In this context it is also worth remembering that the analysis of the monetary policy stance in applied business cycle research practically always requires an assessment of the neutral rate, hence the fact that our method requires an estimate of the neutral rate does not distinguish our approach from common practice in this field.

The measure for the neutral rate we employ in the following analysis is derived from the SVAR model. The neutral rate corresponds to the policy stance the central bank pursues when it does not wish to influence real activity. In the SVAR model considered here the central bank is by default on a neutral course when no shocks disturb the economy. The interest path is in this case determined by the deterministic components of the model, as is apparent from equation (5). This may not appear to be a particularly sophisticated way of determining the neutral interest rate, but since most of applied business cycle research employs simple approximations like the average of the interest rate over rather arbitrary chosen sample periods, this method is not particularly primitive either.

The anticipated ‘blip,’ therefore, can be computed by simply subtracting the estimated neutral rate from the anticipated interest rate series.[14] The resulting series for the euro area is displayed in figure 6.

Figure 6 about here

The series shown in figure 6 serves as a measure of the stance of systematic monetary policy. It shows for each period the deviation of the policy instrument from its neutral baseline due to

[14] Other methods are certainly perceivable. For example, an alternative to this measure of the neutral policy stance is applying a band pass filter to the interest rate. A possible advantage is that this procedure employs additional information about the trend component of the interest rate, which is potentially useful. However, a disadvantage of this method is that it is not model consistent, as the estimated impulse response functions are based on the trend component estimated by the SVAR and not on the component identified by the filter. Nevertheless, the researcher who applies our method is certainly free to choose the measure deemed to be most appropriate for the purpose at hand. In our opinion model consistency is definitively an advantage, but we have chosen this approach mainly to present the construction of the index in a coherent framework. We do not argue that our measure of the neutral policy stance is necessarily the ‘best’ available in praxis.

structural disturbances hitting the economy, to which central banks in Europe respond. Visual inspection helps to informally assess whether this measure of the policy stance is plausible. Figure 5 indeed reveals some well-known general trends in European monetary policy. In the early eighties the economy in Europe was still substantially influenced by an inflationary environment due to the inflation inherited from the 1970s and the second oil price shock. It can be seen from figure 1 that monetary policy reacted to this situation by an overall restrictive policy stance. Following the recession in many European countries and facilitated by falling oil prices and inflation rates in Europe, policy shifted to an expansionary stance 1982. At the end of 1987, monetary policy eased further as Europe experienced a considerable stock market crash. As the European economies began to expand strongly in the late eighties, policy became restrictive again. The boom received a further impetus by German unification in 1990. In 1991, the Bundesbank began to tighten more aggressively. Moreover, the effects of the EMS crisis contributed to a very restrictive stance in 1992. With the onset of the recession in 1993 in many countries policy returned to a neutral stance, which was maintained for most of the nineties. In the wake of the Asian crisis setting in 1997 and the Russian crisis in late 1998, monetary policy became strongly expansionary in the first quarter of 1999 again, but this stance was reversed in the course of the same year. Altogether, it appears that this measure of the policy stance captures some important turning points of the European business cycle quite well.

4.3 The Index of the Output Effects of Monetary Policy

The preceding sections have introduced the building blocks necessary to construct our index of the output effects of monetary policy. As has been pointed out earlier, the index is conditional on the choice of the parameter lambda. We start by assuming that there is no distinction between the effects of shocks and systematic policy, i.e., setting $l = 1$. In figure 7, the solid line presents the overall contribution of monetary policy to the variation of output in the sample period under investigation. This is defined as the contribution of systematic monetary policy to output fluctuations plus the output effects of monetary policy shocks. To provide a reference for the assessment of monetary policy, the output gap is plotted as the dotted line. The output gap is defined by the demand conditions in the economy as identified by the VAR model, i.e., the output gap includes the effect of aggregate demand shocks as well as the demand conditions due to monetary policy.

Figure 7 about here

It is apparent from figure 7 that monetary policy has substantial effects on output, but also that these do not dominate the overall demand conditions as measured by the output gap. For example, around 1986 policy had a considerable expansionary impact, but the output gap was nevertheless close to zero. In general it appears that monetary policy demonstrates countercyclical tendencies, an issue we will return to.

Figure 8 decomposes the output effects of monetary policy into the component that is due to systematic monetary policy responses to aggregate supply and demand disturbances buffeting the economy, and into the component attributable to unanticipated monetary policy shocks, including the endogenous policy response to those shocks. This decomposition confirms an earlier finding, namely that the effect of policy shocks on real activity is of minor importance. One can identify essentially only three periods where policy shocks had a noticeable impact on output. The first period covers the years from 1986 until early 1988, when unexpectedly higher interest rates have lowered output. This tightening of policy could have had its origin in the Plaza accord of late 1985, where international central bankers came to an understanding that the US dollar was overvalued. Since the model employed here does not account for exchange rate movements, such a policy decision would be identified as a shock in the sense that it represents a deviation from the estimated reaction function. Given that it takes some time for an interest rate shock to make its effect on output fully felt, it is plausible that the output consequences of this policy action reached its maximum in early 1988. The second period with a noticeable effect of monetary policy shocks occurred from early 1988 until 1990. Here the output effect is positive. Again allowing for the transmission lags of an interest rate shock, this stimulus of activity could be attributed to a pre-emptive easing of policy in the wake of the stock market crash of 1987, which exceeded the monetary policy response warranted by the actual conditions in the economy. The third episode concerns the recession in 1993. Here it is likely that the substantial interest rate hikes occurring during the EMS crises played a major role. Apart from these three episodes, unexpected interest rate shocks have not played a noticeable role in causing output fluctuations. In contrast, the systematic response of monetary policy to non-monetary disturbances has major effects on output for most of the sample period.

4.4 Systematic Monetary Policy and its Contribution to European Business Cycle Fluctuations

Before turning to a closer examination of the role systematic monetary policy for output fluctuations, the discussion returns to the question how the conventional SVAR analysis accounts for the output effects of aggregate demand and supply shocks. As has been noticed in the introduction of this paper, the output impulse response function corresponding to an aggregate demand shock, for instance, contains both the direct and indirect effect, where the latter is attributable to the systematic response of monetary policy to this disturbance. In a conventional SVAR analysis it is not possible to identify both effects individually. The same holds for aggregate supply shocks. In the following analysis the measure of the real effects of systematic policy proposed in this paper is used to disentangle these two effects. This is done in two steps. First, the policy response to aggregate demand and supply shocks is determined. Second, the corresponding output effects are computed.

How does systematic monetary policy respond to aggregate demand and supply disturbances? The impulse response functions for the interest rate show that systematic monetary policy attempts to partly offset the effects of aggregate demand shocks, while it propagates the effects of aggregate supply shocks.[15] The response to the demand shock corresponds to the traditional notion of stabilisation policy, the response to the supply shock is related to the fact that for instance a negative supply shock raises prices.[16] To obtain a time series of the interest rate movements attributable to the policy response to these two non-monetary disturbance, a historical decomposition of the interest rate is employed.[17] Next, together with the impulse response functions measuring the output response to anticipated monetary policy actions, the respective output effects caused by the systematic policy response to the aggregate demand and supply shocks are computed. These effects correspond to the indirect effects. Since the conventional historical decomposition of the output series yields the total effects of aggregate demand and supply shocks on output, one can retrieve the direct effect by subtracting the estimated indirect effect from the total effect. The direct effect is the output effect of a non-monetary shock one would observe if the central bank would not respond to this shock. Figure 9 plots this effect for the aggregate demand shock (dotted line) together with the total effect (solid line).

[15] To preserve space, these impulse response functions are not displayed here, but they are available from the authors upon request.
[16] To ensure that the goal of price stability is not endangered, monetary policy makers respond with a tightening of policy to such a shock, which reduces output even further, but helps to contain the upward movement of prices.
[17] To preserve space this historical decomposition is not shown here, but it is also available from the authors upon request.

Figure 9 about here

The difference between these two lines in figure 9 represents the effect of the systematic policy response to this shock. In general, it is apparent that systematic monetary policy was successful in shaving off part of the peaks and filling in some of the troughs, but policy also contributed to the recession in 1993. In general, however, the effect of systematic policy on demand conditions appears to be moderate.

Figure 10 gives a more detailed picture of the response of systematic policy to aggregate demand conditions (upper panel) and aggregate supply conditions (lower panel).

Figure 10 about here

In the upper panel, the dotted line represents the direct effects of the demand shocks and the solid line shows the output effects of the systematic policy response. Four episodes regarding the demand conditions are clearly discernible. First, there was a marked shortfall in demand in the second half of the 1980s. This could be due to the strong appreciation of the euro that set in 1985, which reduced foreign demand for European products. Monetary policy responded by embarking upon an expansionary course. Second, this was followed by an upswing in the late 1980s, which subsequently received a further boost by the German unification boom in the beginning of the 1990s. Monetary policy responded by gradually turning to a restrictive course. The third episode begins in 1992 and covers the 1993 recession. During 1992, demand conditions deteriorated rapidly, but monetary policy began to reduce its restrictive effect on output only slowly. In this period the effects of tight monetary policy contributed to the recession in 1993. The fourth period covers the time from 1995 onwards when demand conditions in the euro zone were weak. An important factor for this fourth episode was probably the fiscal tightening that was undertaken in many countries to qualify for membership in the euro zone. There was a further drop in demand in the years 1998/1999, which probably was due to the effects the Asian and Russian crisis. Monetary policy had a positive effect on output from 1997 onwards, but this effect was moderate.

With regard to the systematic response of monetary policy to supply conditions, the lower panel of figure 10 shows that monetary policy responds in a roughly procyclical manner to supply conditions, but with a considerable time lag. The supply conditions are rather volatile and difficult to interpret. It is also clear that monetary policy does not attempt to respond to all fluctuations. Presumably this reflects that supply conditions are difficult for policy makers to identify, which may also account for the significant lag in the policy reaction.

The preceding discussion has shown that taking the effects of anticipated policy into account changes the overall role of monetary policy in the SVAR framework quite substantially. Nevertheless, claiming that anticipated and unanticipated policy have the same effect (i.e. $\lambda = 1$) is a strong assumption. How does the picture change if one assumes smaller values for lambda? As an example for a scenario in which anticipated monetary policy has only a relatively small effect compared to policy shocks, we consider a case where $\lambda = 0.2$.[18] Figure 11 presents the total effect of monetary policy for this scenario, again with the output gap as a reference point.

Figure 11 about here

Compared to figure 7 the overall monetary policy effect on output is noticeably weaker, especially during the eighties. This is mainly due to the fact that during this period policy shocks and systematic policy worked in opposite directions (compared to figure 8). For the period after 1991 both effects generally work in the same direction, so that for $\lambda = 0.2$ one can still observe a major restrictive effect of total monetary policy from 1990 until 1995. With regard to the decomposition of the total effect of monetary policy into the systematic and the shock component, figure 12 indicates the greater relative importance of monetary policy shocks in this scenario. Nevertheless, even in this scenario, systematic monetary policy plays a significant role in driving the variation of output over the business cycle.

Figure 12 about here

5. Summary

This paper builds on the work by Cochrane (1998), who has introduced a procedure to compute the response of output to anticipated monetary policy actions from a standard SVAR model, and presents results for the euro area. For this purpose the SVAR model proposed by Monticelli and Tristani (1999) to model the transmission mechanism in the euro area was reestimated and the Cochrane procedure was applied to this model. 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 turned out to be rather small and immediate. Next, the paper applied the results from the Cochrane procedure to construct an index for the effects of anticipated as well as unanticipated monetary policy on output. This served to investigate the contribution of monetary policy to output fluctuations. In particular, this measure allows it to go beyond shocks, which is otherwise at the centre of SVAR analysis, and to take also into account the role of systematic monetary policy in causing output fluctuations. Moreover, since both the understanding of the shocks driving the business cycle and the assessment of the effects of anticipated monetary policy on real activity is central for applied business cycle analysis, the index proposed here may turn out to be useful for practitioners in this field. The paper proceeded by demonstrating potential applications of this index to the analysis of European business cycle fluctuations over the past two decades. The results confirm earlier findings that monetary policy shocks are relatively unimportant for output variations, but the systematic response of monetary policy to aggregate demand and supply disturbances has considerable output effects. In general, monetary policy has countercyclical effects on output, even though there are often some lags. Another application of the procedure proposed here is decomposing the effects of non-monetary shocks into their direct and indirect effects, where the latter denotes the output effect of a shock attributable to the systematic response of monetary policy to this shock. It emerges that monetary policy generally attempts to offset demand disturbances but propagates supply disturbances. The results are fairly robust for different choices for the exogenous choice parameter lambda, which defines the effectiveness of anticipated relative to unanticipated monetary policy actions.

[18] We do not present the results for $l = 0.5$, as the overall picture was very similar to the one for $l = 1$. Complete results are available from the authors upon request.

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Appendix

The data are aggregates for the EU-11 countries and cover the period 1980:1 until 1999:4. From the first quarter 1991 onwards, the real activity variable (y) is based on estimates provided by Eurostat using the new accounting procedures of ESA-95. Aggregated data for the 3 month short interest rate (s) is available from Eurostat as well, beginning in the first quarter of 1998. The real GDP series and the interest rate series have been estimated backwards using historical series for the euro zone provided by Coenen and Vega (1999). The inflation series (cpi) is based upon a CPI-index provided by Datastream. All variables are seasonally adjusted. Details are given in Table 1.

Table 1: The Data

	Series	Period	Source
Y	Real gross domestic product (GDP); billions of euro. Seasonally adjusted.	Q1 1980 - Q4 1999	Eurostat, Datastream: EMESGD95D and Coenen and Vega (1999)
S	3 month interest rate series.	Q1 1980 – Q4 1999	Eurostat, Datastream: EMESIR3M and Coenen and Vega (1999).
Cpi	Consumer price index; 1996=100. Seasonally adjusted[1]	Q1 1980 - Q4 1999	Eurostat, Datastream: EMCP….F

[1] Seasonally adjusted with Census X-11 Multiplicative.

Table 2: Misspecification Tests

Test	Multivariate Statistics	Univariate Statistics		
		Δ y	s	Δ cpi
LM(1)	1.89*	1.72	3.83*	2.17
LM(4)	1.39	0.48	0.84	0.33
ARCH 4		0.57	0.84	0.70
Jarque-Bera	14.02**	11.07***	1.47	0.51
Hansen		2.46	2.30	1.71

Notes: The asterisks indicate a rejection of the null hypothesis at the 10% (***), the 5% (**) or the 1% (*) level. LM(1) is a Lagrange Multiplier test of the null hypothesis of no autocorrelation of order 1 with a F(9,146) distribution in the multivariate case and F(1,64) in the univariate case. LM(4) tests for autocorrelation of order 4; the distribution is the same as with LM(1). ARCH 4 is a LM test for autocorrelated squared residuals of order 4 with a F(4,57) distribution. Jarque-Bera is a normality test with a chi-squared (6) in the multivariate and a chi-squared (2) in the univariate case. Hansen is a stability test based on Hansen (1992); the critical values at the 10%, the 5% and the 1% level are 3.51, 2.96 and 2.69.

Figure 1: The Time Series

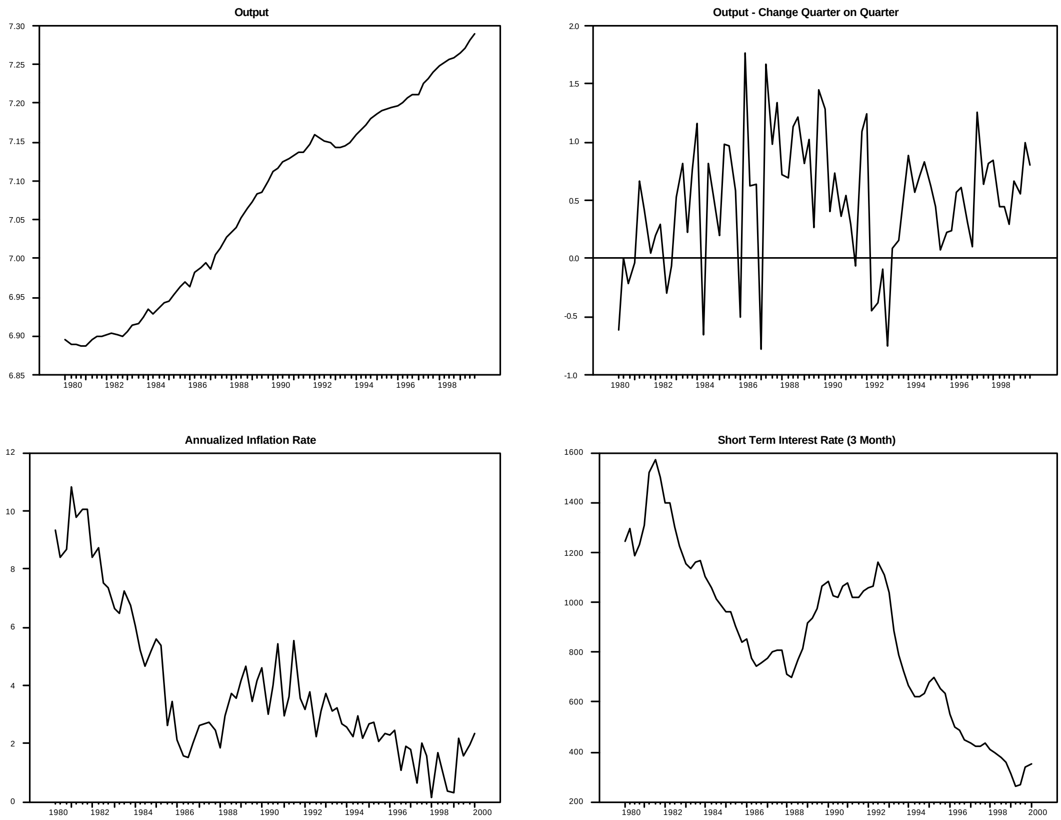

Figure 2: Impulse Responses to a Monetary Policy Shock

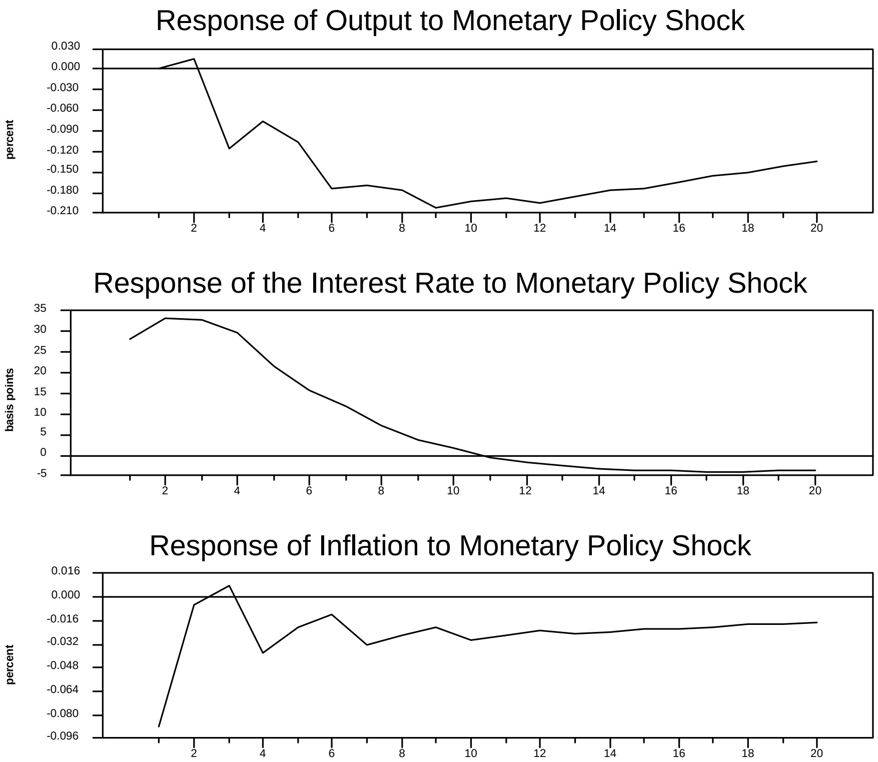

Figure 3: Response of Output to an Unanticipated Interest Rate Blip

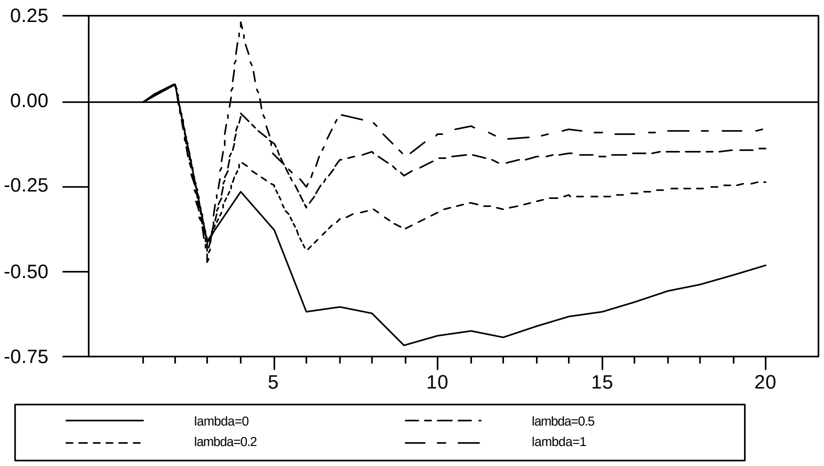

Figure 4: Response of Output to an Anticipated Interest Rate Blip

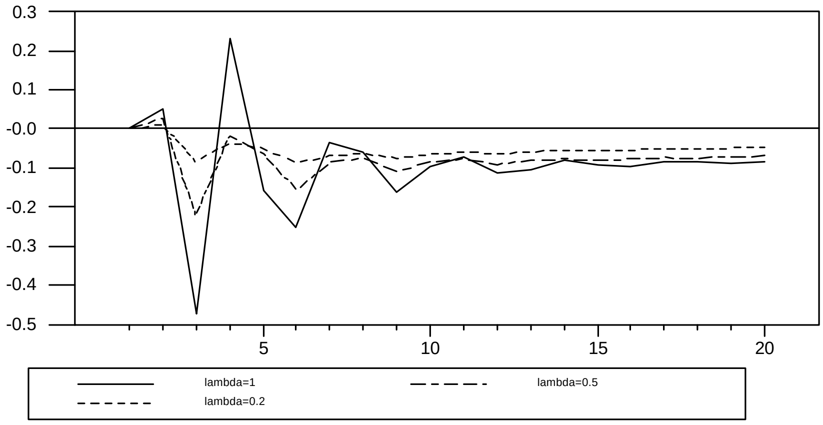

Figure 5: Historical Decomposition of Output Series

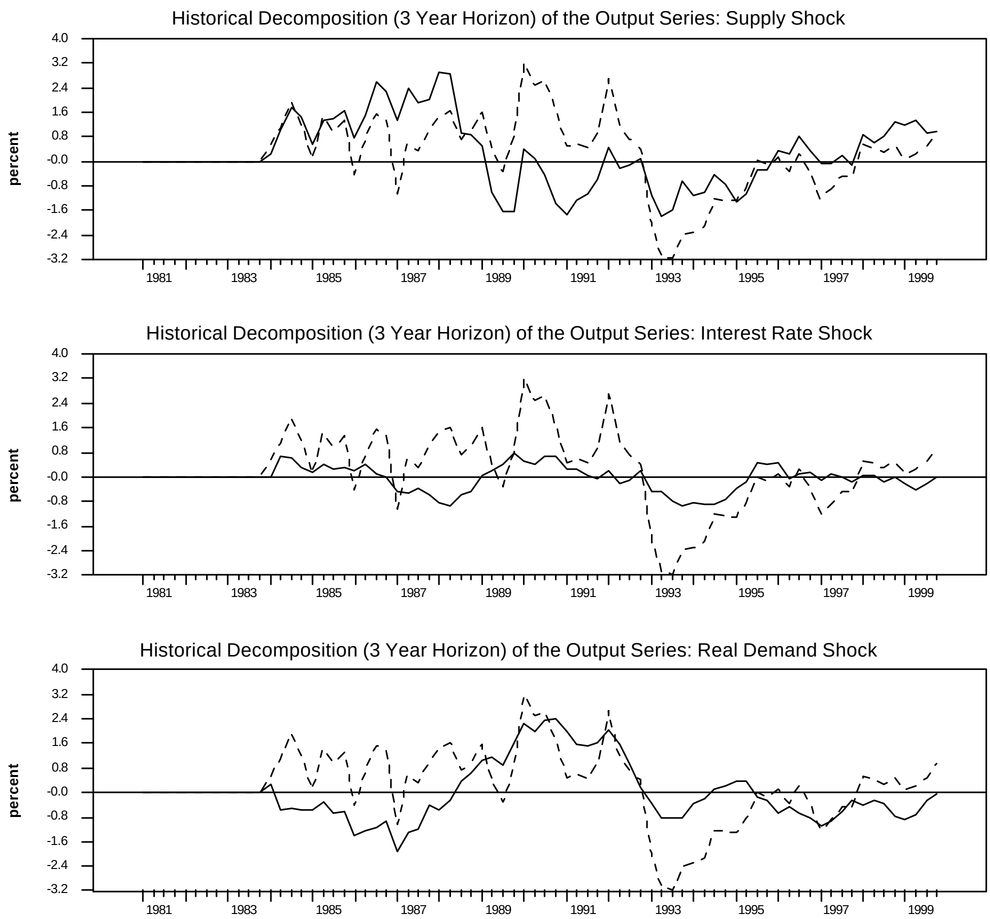

Figure 6: Anticipated Blip Series

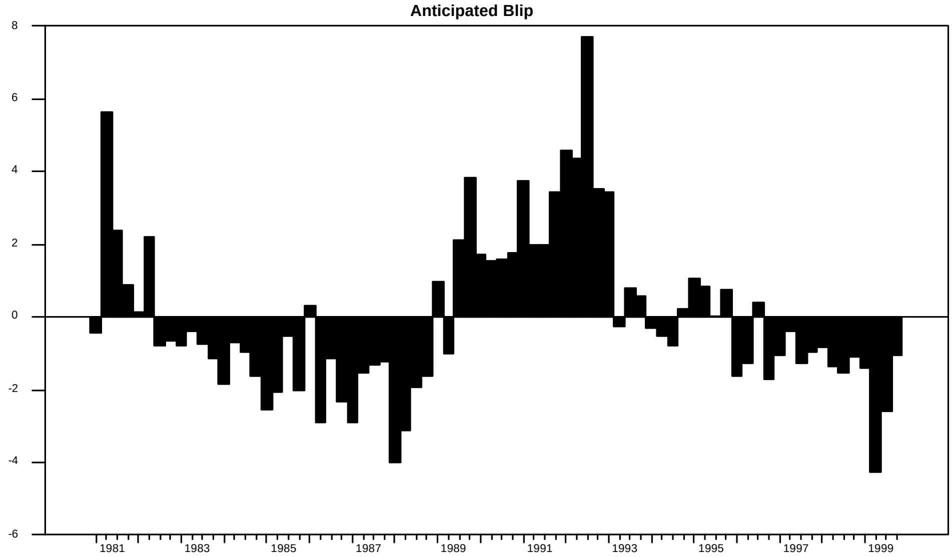

Figure 7: Effect of Overall Monetary Policy (l = 1)

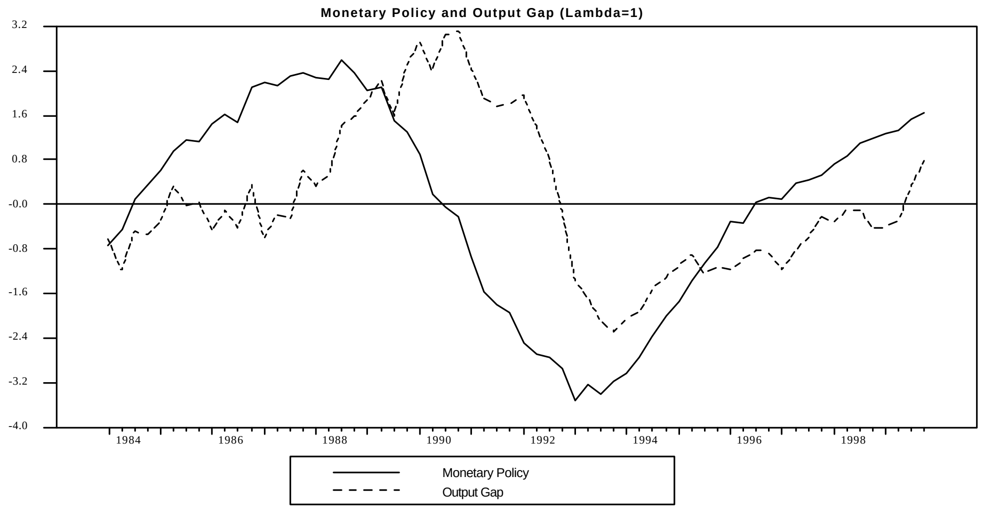

Figure 8: Decomposition of Monetary Policy (l = 1)

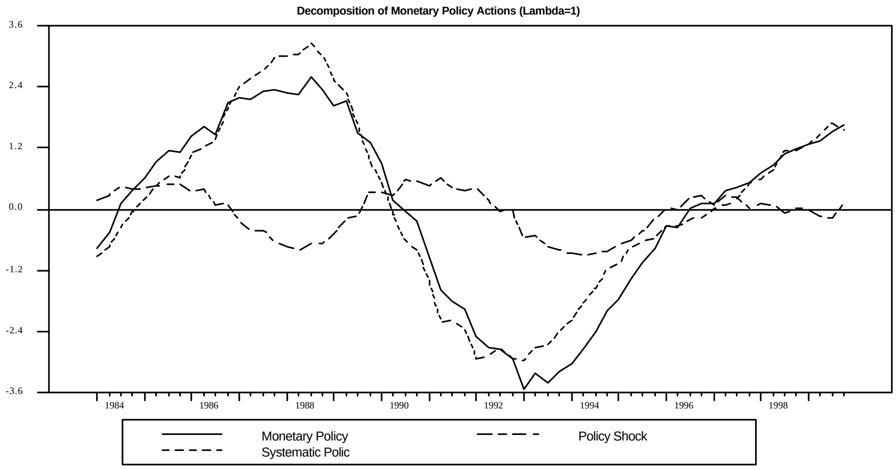

Figure 9: Decomposing the Demand Shock in its Direct and Indirect Effects

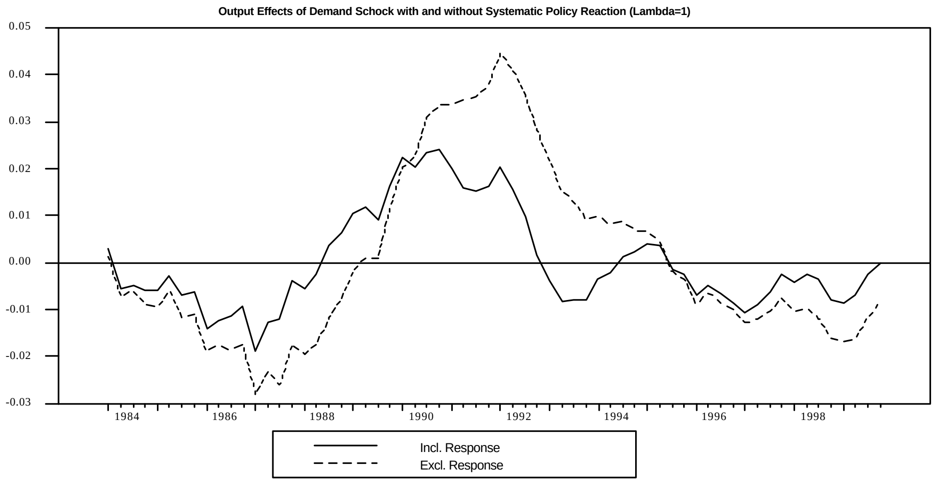

Figure 10: Response of Monetary Policy to Demand and Supply Shocks (l = 1)

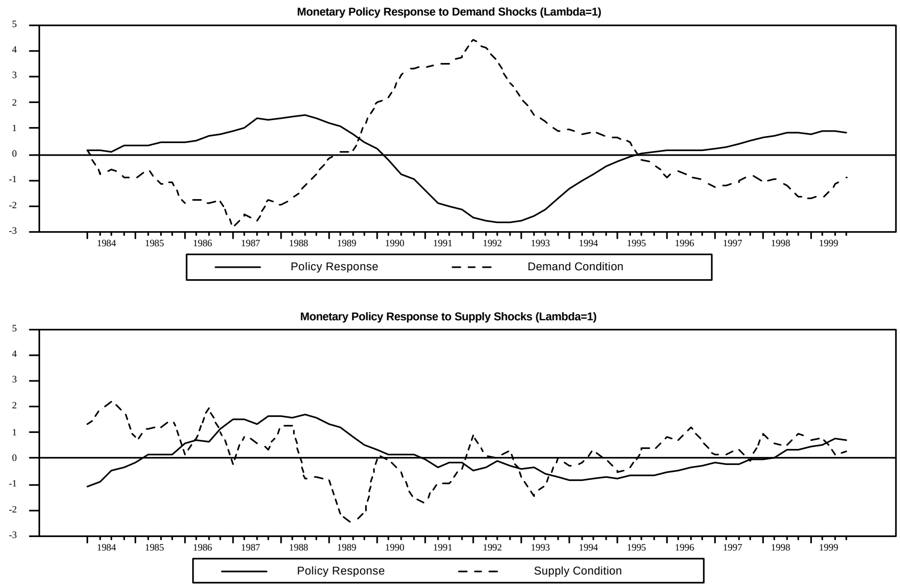

Figure 11: Effect of Overall Monetary Policy (l = 0.2)

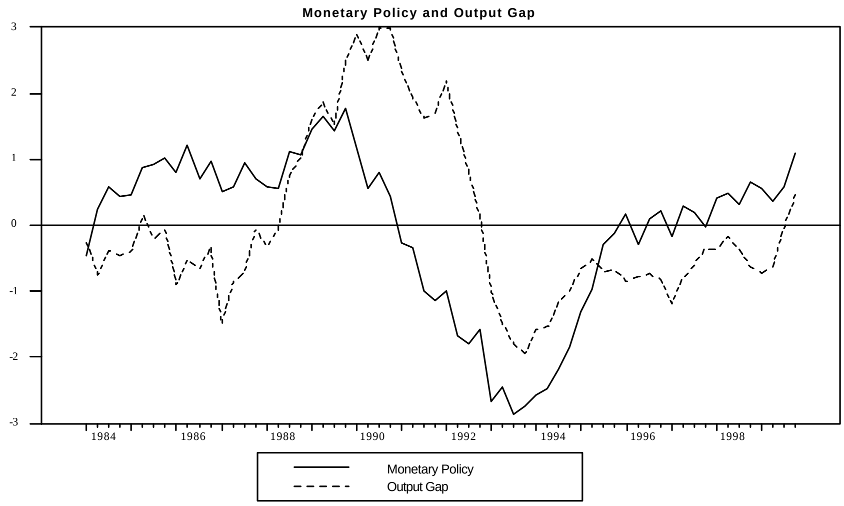

Figure 12: Decomposition of Monetary Policy (l = 0.2)