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Abstract

This paper uses the conventional wisdom about the shift in the monetary policy stance in 1979 to compute monetary policy shocks by estimating different monetary policy reaction functions for the pre-1979 and post-1979 time periods. We use the information from the internal forecasts of the Federal Reserve to derive monetary policy shocks. The results in this paper show that a monetary policy shock in the pre-1979 period affects output and prices much more strongly and quickly than what has been reported in the literature for the full sample. Our findings suggest that the dynamic response of output and prices to a monetary policy shock declined significantly between 1980-2001. We argue that this diminished response to the monetary policy shock is the result of a successful monetary policy that has led to a less volatile economy.

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1 Introduction

Monetary policy is not exogenously given, but largely driven by policy makers' reactions to macroeconomic conditions (Bernanke, Gertler and Watson (1997)). In order to measure the impact of monetary policy, we therefore need to estimate its component that does not respond endogenously to the changes in the macroeconomic environment. To overcome the problem of endogeneity, different approaches have been proposed. One notable approach is the identification of monetary policy shocks due to Romer and Romer (2004)[1]. Romer and Romer (2004; RR hereafter) derive their measure of monetary policy shocks by regressing changes in the intended federal funds rate on information about output growth, inflation and the unemployment rate for every regular Federal Open Market Committee (FOMC) meeting in the period between 1969 and 1996.[2] The residuals from this regression show the change in the intended federal funds rate not taken in response to information about future economic developments. They therefore constitute a measure of monetary policy shocks.

The results of RR's analysis are appealing from a theoretical point of view: the "price puzzle"[3] disappears, and output also responds appropriately to monetary policy shocks. However, RR's work is based on two simplifying assumptions: first, they assume that the monetary policy makers' response to movements in inflation and output has not changed for the whole sample, and secondly, that the response of prices and output to monetary policy shocks remained the same for the whole sample. This contradicts recent literature which finds evidence of a change in the monetary policy reaction function within the examined period[4] and a change in the response of output and prices to monetary policy shocks[5].

[1] Other popular approaches include the recursive VAR approach of Christiano, Eichenbaum, and Evans (1996), the structural VAR approach of Bernanke and Mihov (1998) and Boivin and Giannoni (2006), and the Federal Funds Futures market approach of Kuttner (2001).

[2] The information about output growth, inflation and the unemployment rate is represented by the Greenbook forecasts that are prepared by the Federal Reserve staff, and presented to the policymakers before each FOMC meeting.

[3] Price puzzle refers to the positive response of prices to a monetary policy shock.

[4] Clarida, Gali and Gertler (2000), Orphanides (2001, 2002, 2004).

[5] See the NBER working paper version (no. 5145, June 1995) of Bernanke and Mihov (1998), Barth and Ramey (2000), Boivin and Giannoni (2002, 2006), Gertler and Lown (2000), Kishor and Kochin (2006), and Kuttner and Mosser (2002). Boivin and Giannoni (2002, 2006) arrive at the same conclusions as our paper

Our approach in this paper is based on the compelling evidence that the monetary policy response to changes in macroeconomic conditions has changed since Paul Volcker took over the chairmanship of the Federal Reserve in 1979 and that the Federal Reserve has played a significant role in the stabilization of the macroeconomy between 1980-2001. We also recognize that the macroeconomic stability experienced in the U.S. between 1980-2001 might have changed the response of output and prices to monetary policy shocks. Our approach of sub-sample analysis allows us to examine the dynamic response of macroeconomic variables to monetary policy shocks across the two sub-samples.

Using RR's approach, we derive monetary policy shocks by estimating different monetary policy reaction functions for the pre-1979 and post-1979 periods. Our findings suggest that ignoring the instability in the monetary policy reaction function can provide a misleading effect of the monetary policy shock on output and prices for the whole sample. We find that the estimate of monetary policy shocks for the whole sample is disproportionately affected by the pre-1979 period shocks, and hence the response of output and prices to a monetary policy shock for the whole sample in RR's analysis mainly reflects the impact of the shocks estimated from the first sub-sample. If monetary policy shocks are estimated using different sub-samples, we find that the response of prices to a monetary policy shock is significant and in the right direction in both sub-samples. However, the effect on prices is much weaker in the second sub-sample. The response of output to monetary policy shocks is stronger and quicker in the first sub-sample than what has been reported by RR for the whole sample period. In the second sub-sample, however, the effect of a monetary shock on output disappears completely.

Consequently, our results indicate that the dynamic response of output and prices to monetary policy shocks computed from the internal forecasts of the Federal Reserve has declined substantially since 1980. This result is consistent with what other researchers including Bernanke and Mihov (1998), and Boivin and Giannoni (2002, 2006) have found using different methodologies for the estimation of monetary policy shocks.

using a different approach.

We argue that the smaller impact of monetary policy shocks on output and prices do not in any way reflect the reduction in the potency of monetary policy. In fact, the decline in the responsiveness may itself be the result of a very successful monetary policy. If the systematic component of monetary policy is perfectly successful, then the goal variables including output and prices would become a constant. In that case we would therefore observe a zero correlation between monetary policy shocks and output and prices. To illustrate this point, we present a very simple New Keynesian model where we show that the reduction in the response of output and prices to monetary policy shocks may arise from stabilizing monetary policy[6].

The rest of this paper is organized as follows: section 2 gives an overview of the approach by Romer and Romer (2004) to estimate monetary policy shocks; section 3 presents the estimation and analysis of monetary policy shocks for different sub-periods; section 4 presents a simple model to motivate the main results of the paper, and section 5 concludes.

2 Estimation of Monetary Policy Shocks

We follow RR's approach for the estimation of monetary policy shocks. RR derived the change in the intended federal funds rate for every regular FOMC meeting by using narrative evidence from the FOMC meetings, the FOMC transcripts and the Greenbook. The changes in the intended federal funds rate from meeting to meeting are regressed on the Greenbook forecasts of inflation, output growth and the unemployment rate:

$$\begin{aligned} \triangle ff_m &= \alpha + \beta ffb_m + \sum_{i=-1}^{2} \gamma_i \triangle \widetilde{y}_{mi} + \sum_{i=-1}^{2} \lambda_i (\triangle \widetilde{y}_{mi} - \triangle \widetilde{y}_{m-1,i}) \\ &\quad + \sum_{i=-1}^{2} \varphi_i \widetilde{\pi}_{mi} + \sum_{i=-1}^{2} \theta_i (\widetilde{\pi}_{mi} - \widetilde{\pi}_{m-1,i}) + \rho \widetilde{u}_{m0} + \varepsilon_m. \end{aligned} \tag{1}$$

[6] Using a structural VAR model, Bovin and Giannoni (2006) show that the diminished response of output and prices to monetary policy shocks can be explained by an increase of the Fed responsiveness to inflation expectations. Senda (2005) has also shown that the reduction in the volatility of output and inflation has been caused by a more aggressive response of the Federal Reserve to macroeconomic fluctuations.

In (1) $\triangle ff_m$ represents the change in the intended federal funds rate, ffb_m is the level of the intended federal funds rate before the meeting, $\triangle \widetilde{y}_{mi}$ and $\widetilde{\pi}_{mi}$ are the forecasts of output growth and inflation, which are included for the previous and current quarter as well as for two quarters ahead. $\triangle \widetilde{y}_{mi} - \triangle \widetilde{y}_{m-1,i}$ and $\widetilde{\pi}_{mi} - \widetilde{\pi}_{m-1,i}$ are the revisions in the forecasts for a certain quarter from the last to the current meeting, and u_{m0} is the current quarter estimate of the unemployment rate. The residuals ε_m represent the monetary policy shocks arising from every meeting.

The effect of a monetary policy shock on prices and output is analyzed by estimating a VAR that has three variables; the log of industrial production, the log of the PPI for finished goods and the measure of the monetary policy shock derived from the above method[7]. Since the federal funds rate enters the VAR in levels the shocks are converted into monthly shocks and cumulated. In what follows, we use the above approach by RR to analyze the results with an extended data set (1969-2001).

As a first step, we make sure that the extension of the data set does not alter the main results obtained by RR. When we compare the shocks computed with our sample to the ones by RR for 1969-1996, we find a correlation of 0.990 for the cumulated shocks. They are plotted in figure 1. The monthly shock series can be found in table 1. Figure 3 presents the impulse-response functions for the estimated VAR system. They show the impact of the cumulated shock on output and the price level for the period between 1969 and 2001. Not surprisingly, the results for the larger data set are qualitatively similar to what RR report in their paper. After a slight increase during the first seven months, output shows a negative response with a t-statistic of over 2 after the first year. The peak response of output is 2.1 percent in month 23. It returns to its initial level after about three years. Prices respond only slightly, irregularly, and mostly insignificantly in the first seven months. Afterwards, we observe a negative response throughout which becomes significant after month 27 and find an effect of -4.4 percent after 48 months. Thus, considering the sample period 1969-2001 as a whole, the responses of output and prices to monetary shocks are compatible with what

[7] The description of the data used in this paper is given in the Data Appendix.

monetary theory would predict.

But what drives this almost text-book like result for the whole period? The cumulated monetary policy shocks plotted in figure 1 give an answer to this question. They reveal the problem associated with RR's estimation of monetary policy shocks by using a single monetary policy reaction function spanning the whole time period. Shocks are either persistently negative or positive with an obvious turning point around 1979, which is consistent with the compelling anecdotal evidence on the changes in the monetary policy around that time. Keeping in mind that the monetary policy shocks are the residuals from a monetary policy reaction function, the interpretation of this graph is straight forward. Since monetary policy shock is the difference between the intended federal funds rate and the fitted value of the intended federal funds rate, we get consistently negative values of the residuals for the pre-1979 period. By construction, the use of whole sample leads to a lower value of the fitted federal funds rate in the second sub-sample, and hence the residuals are consistently positive. The use of the full sample to estimate the monetary policy shocks would give the impression of a more aggressive response to inflation and real activity movements than it originally was during the first sample.

Thus the results of the VAR using the original approach by Romer and Romer (2004) have one main drawback: They do not take into account the change in the macroeconomic environment that took place around 1979. The next two sections consider this problem.

3 Changes in the Conduct and Impact of Monetary Policy

Recent literature supports the view that there has been a structural shift in the way monetary policy has responded to the movements in inflation and output since Paul Volcker took over the chairmanship of the Federal Reserve. Clarida, Gali and Gertler (2000) estimate a forward-looking policy rule for the periods before and during the Volcker-Greenspan era in order to evaluate monetary policy's effectiveness. Their results suggest that in the period before 1979 monetary policy was too accommodative, whereas after 1979, beginning with Paul Volcker's regime, monetary policy played a stabilizing role in containing inflation. Orphanides (2000, 2001 and 2004) criticizes Clarida, Gali, and Gertler's results on the ground that monetary policy makers are constrained by the availability of the real-time data. He argues that the use of revised data in their paper provides misleading estimates of the monetary policy reaction function's coefficients. Orphanides' results indicate that it was the aggressive response to movements in the output gap that might have created the inflationary environment in the pre-1979 era, as the response to inflation was not statistically different across different sub-periods. Though the conclusions of the papers are certainly different, both approaches reveal that the policy-makers' response to changes in macroeconomic variables has changed over time.

The evidence presented in the previous section supports the conventional wisdom that there was a fundamental shift in the way the Fed responded to inflation and the output gap since Paul Volcker became the chairman of the Federal Reserve. In addition, we perform a Chow test for a structural break in coefficients of equation (1) in the third quarter of 1979. The test rejects the null hypothesis of no structural break in the third quarter of 1979 with a p-value of 0.000. Therefore we estimate separate reaction functions for the pre-Volcker and the Volcker-Greenspan periods for the derivation of the monetary policy shocks. Apart from breaking the sample into two sub-periods and using a larger data set, we use the same methodology as Romer and Romer (equation 1). Since performing the estimation for two time periods (1969-1979 and 1979-2001) makes the sub-samples substantially shorter, we use 24 lags instead of 36 lags in the VAR system. We therein adopt a middle ground in the lag length selection: Christiano, Eichenbaum and Evans (1996) choose 12 lags in their study of monetary policy shocks, whereas RR choose 36 lags in their estimation.

Following the methodology described in section 2, we initially estimate monetary policy shocks for both sub-periods. The monthly shock series thus obtained is given in table 2. We plot the cumulated monthly shock series in figure 3 and do not find an obvious period of persistently positive or negative shocks. Supported by the graphical evidence we find that there is a low correlation between the cumulated shocks for RR's and our approach for the whole sample (0.130). The correlation differs remarkably for the pre-1979 (correlation of 0.514) and the post-1979 (correlation of only 0.042) periods.

To analyze the impact of a monetary policy shock on output and prices, a VAR system is estimated that includes the log of industrial production, the log of the PPI for finished goods and the new cumulated monetary shocks derived from two different monetary policy reaction functions for pre-1979 and post-1979 sub-periods.

The results suggest that the effect of a monetary policy shock is significantly different across the two time periods: For the pre-1979 sub-sample, we find an immediate and negative response of output to a one unit monetary policy shock which becomes significant beginning in month 6 (figure 4). The peak effect of a 5.2 percent decline in month 14 is much stronger and quicker than the response for the whole sample period and for one policy reaction function. Interestingly, the effect on output dies out at the beginning of the second year and becomes positive and insignificant in month 28. The response of prices is negative beginning with the second month and becomes significant within a year. The price effect peaks in month 32 with a response of -6.5 percent and begins to die out afterwards.

The results for the second sub-period are entirely different. If we look at the second sub-sample beginning in July 1979 (figure 5), we find that the response of output to the monetary contraction is throughout tiny, irregular, and insignificant. For inflation the negative effect is small, but becomes significant in month 7 and stays significant until month 14. There is also a slightly significant effect at the end of the fourth year. Note that the peak effect of less than -1.5 % in month 12 is much smaller as compared to the pre-1979 sub-sample.[8][9]

It has been argued that the period of non-borrowed reserves targeting (1979-1982), also known as the "Volcker Experiment" was a period of excessive volatility, and it might have played a big role in the estimation of monetary policy shocks. This problem has been

[8] The first part of the effect on prices is consistent with current literature on price changing behavior such as by Taylor (1999), Nakamura and Steinsson (2006) and Bils and Klenow (2004).

[9] We also performed a similar analysis by estimating monetary shocks with a single reaction function but dividing the sample into pre-1979 and the post-1979 periods. We find qualitatively similar results for the first sub-sample. However, we do not find any significant response of output and prices to monetary policy shock in the second sub-period. In fact, for some time periods output and prices move in the opposite direction to what the theory would predict. The results are available upon request.

emphasized by Bernanke and Mihov (1998), who state that the federal funds rate should not be used as a monetary policy indicator for the time period between 1979 and 1982. Although the Chow test of a structural break in coefficients of equation (1) at the end of 1982 clearly fails in rejecting the null hypothesis of no structural break (p-value of 0.38), we want to make sure that the dynamic responses reported above are not driven by the huge variation in the monetary shocks from this short sample. We therefore perform the above analysis for the post-1982 sub-period. We find that the effect of a monetary policy shock on prices to be tiny and insignificant throughout. The response of output is significantly positive for the first eight months and insignificant afterwards.[10] Thus eliminating the three years of non-borrowed reserves targeting makes the change in the response of output and prices to the unsystematic part of monetary policy even more obvious: Not only does the effect on prices decrease – it vanishes completely. Not only does the effect on output disappear – the response partially even reverses its sign.

Consequently, our results indicate that if the monetary policy shocks are estimated using different reaction functions for the pre-1979 and the post-1979 time periods, then the response of output and prices changes significantly across these two sub-periods. Monetary policy shocks influenced prices almost "textbook-like" throughout the whole period from 1969 to 2001, though the response of the prices was smaller in the second period than in the first. In contrast, monetary policy shocks had a significant effect on output only in the first sub-sample. Overall our results show that the dynamic response of output and prices to monetary policy shocks has declined significantly in the second sub-period.

4 Has Monetary Policy Lost its Effectiveness?

The empirical evidence presented in the previous sections suggests that the response of output and prices to monetary policy shocks has decreased considerably since 1980. Does this imply that the Federal Reserve has partly lost its effectiveness in controlling the economy?

[10] We also estimate the dynamic response of output and prices to monetary policy shocks estimated from a single monetary policy reaction function for pre-1982 and post-1982 time periods. The results are qualitiitatively similar, they are available upon request.

Our results certainly do not imply that. In fact, the reduction in the response to monetary policy shocks may result from the success of *systematic* monetary policy in dampening economic fluctuations. To illustrate this point, consider an extreme example. If monetary policy is perfectly successful, then it would make the goal variable (output or price) a constant[11]. By construction, a constant is uncorrelated with any variable, and thus it will be uncorrelated with monetary policy shocks. Therefore if systematic monetary policy was perfectly successful in stabilizing the economy, we would not find any correlation between monetary policy shocks and inflation and output.

To stress this point, we consider a simple New Keynesian model with a dynamic IS-curve (2) and the New Keynesian Phillips curve (3)[12]:

$$y_t = E_t y_{t+1} - \sigma r_t + g_t, \quad \sigma > 0 \tag{2}$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + u_t, \tag{3}$$

where y_t is output, π_t is the rate of inflation, and r_t is the real interest rate. All variables are in terms of percent deviations from their long-run values. Output is negatively correlated with the real interest rate and also depends on expected future output, as consumers want to smooth their consumption over time. The parameter σ is associated with the elasticity of intertemporal substitution in consumption. Inflation depends positively on future expectations about inflation (discounted with the time preference factor β) and is positively linked to the IS-curve through the output gap. The positive parameter κ summarizes a plethora of parameters from the New Keynesian model.[13] The zero-mean disturbance terms g_t and u_t can be interpreted as demand and cost-push shocks, respectively. Iterating equation (1) forward, we obtain

$$y_t = -\sigma r_t^L + g_t \tag{4}$$

where

$$r_t^L = E_t \left[\sum_{j=0}^{\infty} r_{t+j} \right]$$

[11] Kishor and Kochin (2007).
[12] Clarida, Gali, Gertler (1999).
[13] For details and the derivation of the two equations see Gali (2008).

represents the long-run real interest rate which is determined by the expected path of the short-term interest rates. Equation (4) implies that output is determined by the long-run interest rate. Similarly, we can iterate (2) forward and find that inflation is determined by a weighted sum of expected deviations of output from its natural level:

$$\pi_t = E_t \left[\sum_{k=0}^{\infty} \beta^k \kappa y_{t+s} \right] + u_t. \tag{5}$$

In our example, the central bank conducts monetary policy by setting short-term interest rates. Monetary policy actions can alter the path of expected short-term interest rates, and hence influence the long-term interest rate. It has been suggested by Taylor (1993) that monetary policy follows an interest rate rule of the following type:

$$r_t = \phi_y y_t + \phi_\pi \pi_t + \varepsilon_t. \tag{6}$$

ϕ_y and ϕ_π represent the magnitudes of the response of the central bank to deviations of output from its natural level and to inflation. ε_t is the monetary policy shock which is assumed to be uncorrelated with the demand shock g_t and the cost-push shock u_t. Combining equations (4), (5) and (6), we obtain

$$y_t = \frac{g_t - \sigma\phi_\pi u_t - \sigma\varepsilon_t}{1 + \sigma\phi_y + \sigma\kappa\phi_\pi} \tag{7}$$

$$\pi_t = \frac{\kappa g_t + (1 + \sigma\phi_y) u_t - \sigma\kappa\varepsilon_t}{1 + \sigma\phi_y + \sigma\kappa\phi_\pi}. \tag{8}$$

The above expressions imply that equilibrium output and inflation depend on demand, cost-push and monetary policy shocks, as well as on the parameters σ, κ, ϕ_y and ϕ_π. An unexpected unit increase in the short-term interest rate ($\varepsilon_t = 1$) reduces equilibrium output by $\sigma/(1 + \sigma\phi_y + \sigma\kappa\phi_\pi)$, and decreases inflation by $\sigma\kappa/(1 + \sigma\phi_y + \sigma\kappa\phi_\pi)$. A reduction in the impact of monetary policy shocks can arise through different channels: a reduction in σ or κ or a higher value of ϕ_y or ϕ_π. If monetary policy has become less potent, then, the lower output response is due to a smaller elasticity of intertemporal substitution in consumption or due to an increase in the slope of the Phillips curve. If the lower output response is due to higher values of ϕ_y or ϕ_π, then it is not related to the degree of potency of monetary policy. In this case, the lower response of output to monetary policy shocks simply reflects the greater willingness on the part of the monetary policymakers to neutralize fluctuations in output and inflation. In the extreme case, the central bank could, for instance, perfectly stabilize output and inflation by letting ϕ_π become very large.

There is a compelling evidence in support of the stabilizing role of monetary policy in the U.S. since 1980. The monetary policy literature suggests that the Federal Reserve has responded aggressively to expected movements in output and inflation to stabilize the economy since 1980[14]. Therefore the evidence of a decrease in the response of output and prices to monetary policy shocks is likely not due to less potency of monetary policy, but a result of successful monetary policy and its effectiveness in stabilizing inflation and output. This explanation of lower responses of output and inflation to monetary policy shocks is consistent with the results obtained by other researchers in the monetary policy literature[15].

5 Conclusions

In this paper, we revisit the estimation of monetary policy shocks using the methodology of Romer and Romer (2004) for the sample that runs from 1969 through 2001. We utilize the conventional wisdom about a fundamental shift in the monetary policy formulation in the U.S. after the appointment of Paul Volcker as the chairman of the Federal Reserve in 1979 to divide the sample into pre-Volcker and Volcker-Greenspan sub-periods. Romer and Romer (2004) assumed similar responses of the Federal Reserve to movements in inflation and the output gap for the whole sample period, 1969-1996, for the estimation of their monetary policy shocks.

Our results indicate that the monetary policy shocks from the pre-Volcker sub-sample disproportionately affect the result for the whole sample when a single monetary policy re-

[14] Clarida, Gali, and Gertler (2000), Boivin and Giannoni (2002, 2006), Favero and Rovelli (2003), Senda (2005).

[15] For example, Barth and Ramey (2000), Boivin and Giannoni (2002, 2006), Gertler and Lown (2000), Kishor and Kochin (2006), and Kuttner and Mosser (2002).

action function is used to estimate them. If monetary policy shocks are estimated using different reaction functions for the two different sub-samples, the results are strikingly different. We find that prices and output respond almost in a textbook fashion for the pre-Volcker period. The response of output to a monetary policy shock is faster in the first sub-sample than what has been reported by Romer and Romer for the whole sample period. In contrast to Romer's and Romer's findings, our results show that output's response to a monetary policy shock in the second period is very small and insignificant, whereas the response of prices is significant and in the right direction. However, the magnitude of the price response is much smaller as compared to the first sub-sample and vanishes completely when the three years of non-borrowed reserves targeting are excluded from the sample. The decline in the magnitude of the response of prices and output to monetary policy shocks is consistent with the results of Boivin and Giannoni (2005), and Bernanke and Mihov (1998).

We stress that the decline in the response of output and inflation does not mean that monetary policy has become less effective after 1979. On the contrary, it can be shown that the lack of response to the *unsystematic* part of monetary policy might be due to the success of the *systematic* part of monetary policy in stabilizing output and inflation.

Thus the results in this paper present an interesting conundrum about the impact of monetary policy shocks. The exogenous shocks to monetary policy are estimated to separate it from the endogenous response of monetary policy to changes in the macroeconomic environment. The role of the systematic monetary policy or the endogenous movements in the federal funds rate is to stabilize the economy. If the monetary policy is perfectly successful in its objective, then the important question of what happens after an exogenous shock to monetary policy becomes hard to answer, as the correlation between a perfectly stable variable and the monetary policy shock would be zero. On the other hand, if the monetary policy is not successful, then there remains enough variation on the goal variable to capture the dynamic effect of an exogenous shock to monetary policy.

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Data Appendix

In order to make the results of the papers comparable we use the same data series as Romer and Romer (2004).

Derivation of the monetary policy shocks

For 1969 to 1996, we use the data set by Romer and Romer (2004), which is available at the http://elsa.berkeley.edu/~dromer/. For the time after 1996 we use the so called "Greensheets" (available at the Federal Reserve of Philadelphia's website) containing the Federal Reserve staff's internal forecasts of inflation (the implicit GDP deflator/GDP chain waited price index at an annual rate), output growth (percentage change in real GDP at an annual rate) and the unemployment rate. As the FOMC began stating its federal funds rate target explicitly in 1994, we use the announced federal funds rate target from the Federal Reserve Banks website as the measure of the intended federal funds rate.

The monetary policy shocks are derived for every regular FOMC meeting with available Greenbook forecasts (8 to 14 per year).

Measuring the impact of monetary policy shocks on output and inflation

As in Romer and Romer (2004), the measure of output growth in the VARs is the log of the non-seasonally-adjusted index of industrial production (series B50001, available on the website of the Board of Governors). The measure of inflation is the log of the non-seasonally-adjusted producer price index (series WPUSO3000, available at the website of the Bureau of Labor Statistics). The series contain monthly data.

The monetary policy shocks derived from (equation 1) are converted into monthly shocks by setting shocks equal to zero for months without regular FOMC meeting, and by summing shocks for months with more than one FOMC meeting. The shocks are cumulated for the VAR estimation.

Figure 1: Cumulated Monetary Policy Shocks Estimated Using a Single Reaction Function

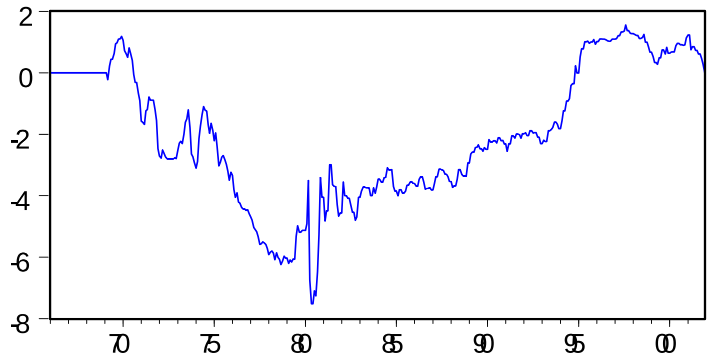


Figure 2: Cumulated Monetary Policy Shocks Estimated Using Different Reaction Functions

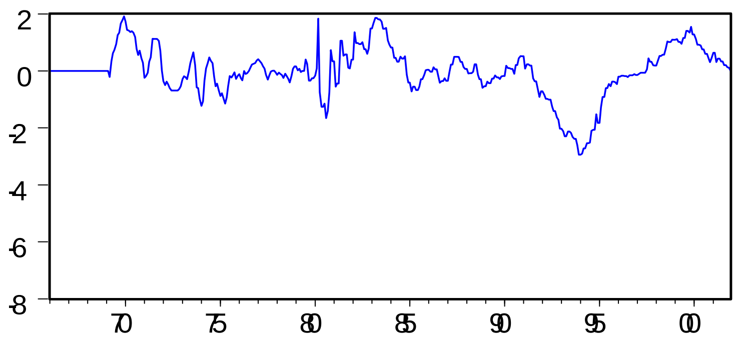


Figure 3: Impulse Responses Based on Single Monetary Policy Reaction Function (1969-2001)

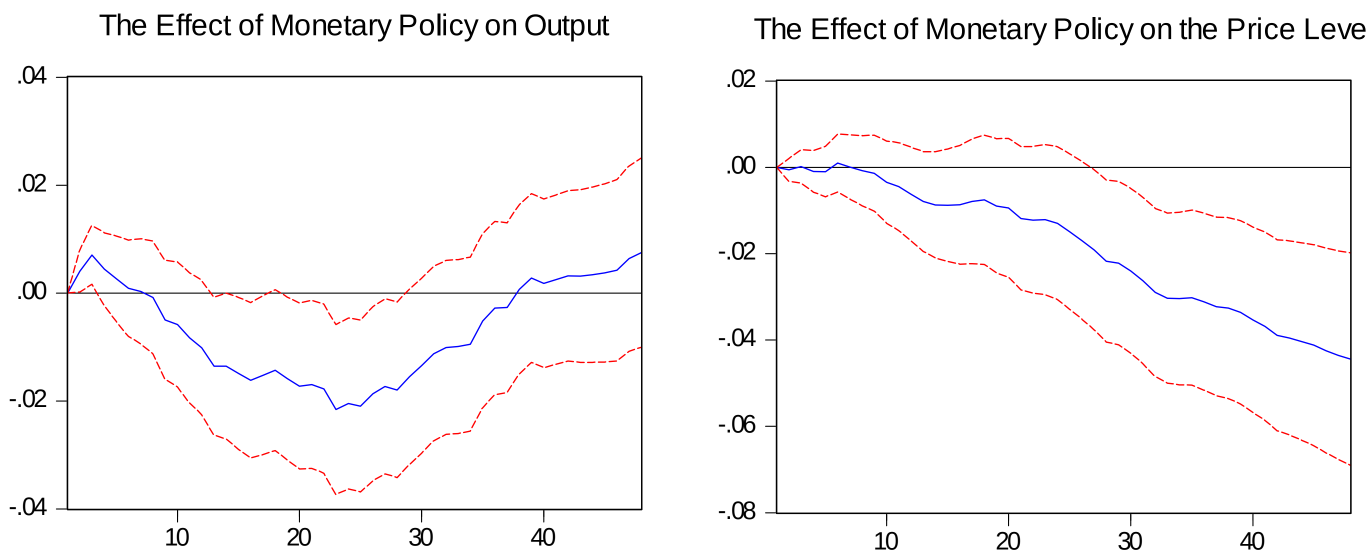


Figure 4: Impulse Responses Based on Separate Monetary Policy Reaction Functions (1969-1979:Q2)

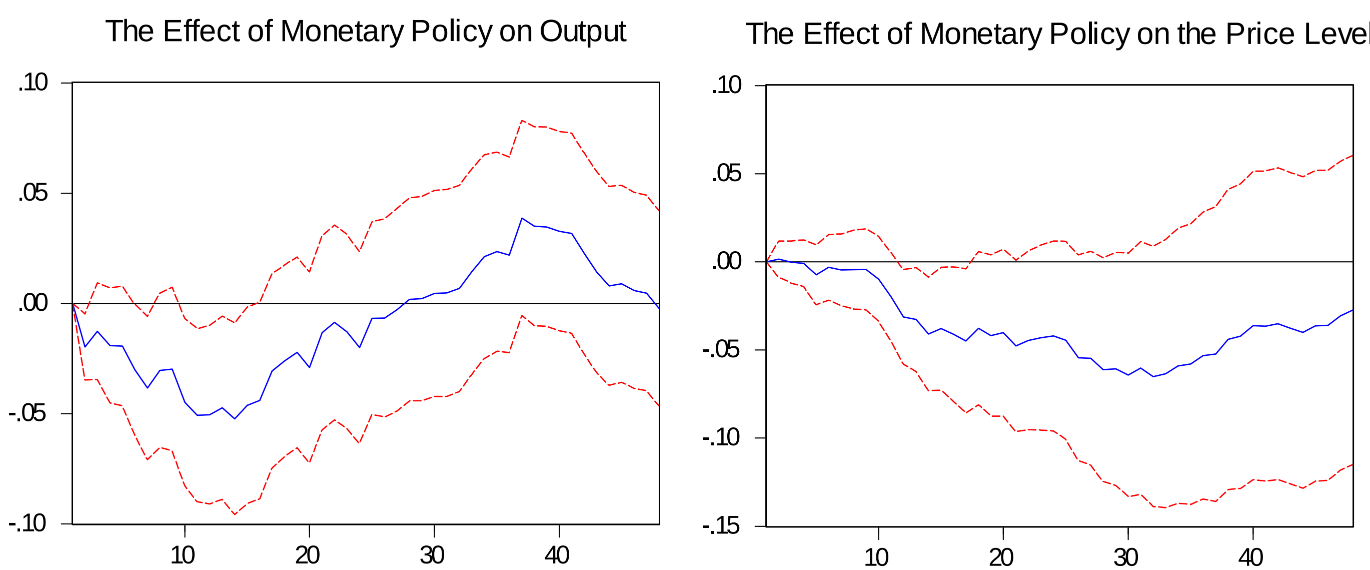
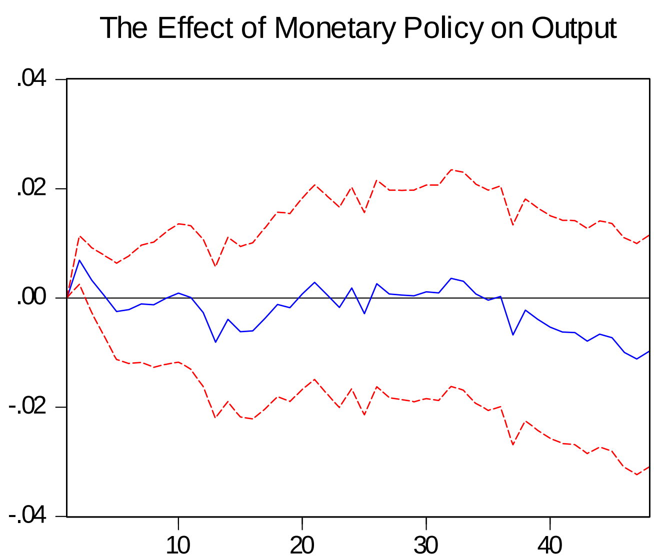


Figure 5: Impulse Responses Based on Separate Monetary Policy Reaction Functions (1979:Q3-2001)



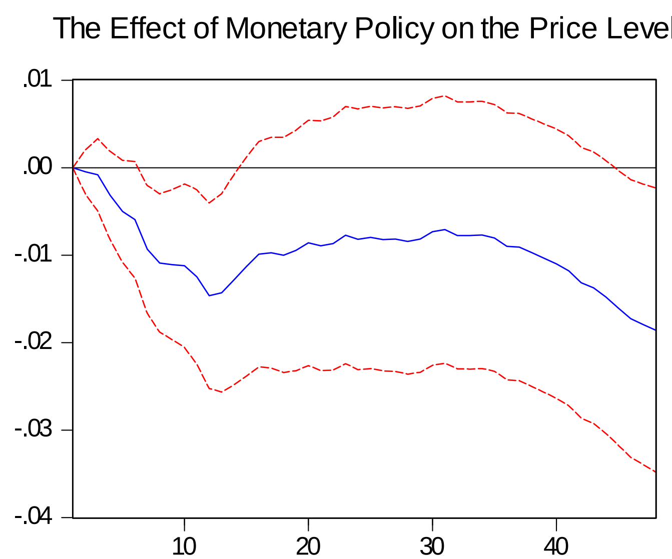


Table 1: Monetary Policy Shocks Using One Policy Reaction Function for1969-2001 (in percentage points)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sep	Oct.	Nov.	Dec.
1969	0.000	0.000	-0.224	0.448	0.217	-0.003	0.190	0.316	0.035	0.117	0.012	0.080
1970	-0.130	-0.338	-0.102	-0.113	0.306	-0.172	-0.232	-0.459	-0.257	-0.001	-0.352	-0.242
1971	-0.670	-0.032	-0.077	0.447	0.043	0.407	-0.106	0.000	0.000	-0.311	-0.352	-0.914
1972	-0.235	-0.070	0.262	-0.107	-0.117	-0.062	0.000	0.000	0.000	0.000	0.028	-0.025
1973	0.278	0.224	0.065	-0.075	0.304	0.393	0.107	0.292	-0.585	-0.847	-0.096	-0.183
1974	-0.185	0.214	0.754	0.397	0.379	0.261	-0.113	-0.038	-0.437	-0.283	0.328	-0.234
1975	-0.334	0.251	-0.449	-0.621	0.114	0.171	0.053	-0.144	-0.148	-0.218	-0.289	0.257
1976	-0.104	-0.463	-0.251	0.144	-0.295	-0.042	-0.138	-0.046	0.005	-0.052	0.016	-0.123
1977	-0.099	-0.110	-0.243	-0.069	-0.069	-0.158	-0.253	0.019	0.060	-0.028	-0.056	-0.126
1978	-0.207	0.091	0.028	-0.066	-0.213	0.219	-0.144	-0.068	-0.168	0.121	0.151	-0.056
1979	0.000	-0.174	0.111	-0.068	0.093	0.000	0.747	0.338	-0.208	0.000	0.059	0.000
1980	-0.003	0.223	1.407	-3.243	-0.769	0.000	0.420	-0.166	0.781	1.209	1.865	-0.642
1981	0.000	-0.772	0.328	0.000	1.498	0.000	-0.643	-0.063	0.000	-0.585	-0.380	0.105
1982	0.000	1.005	-0.439	0.000	-0.093	0.000	-0.215	-0.239	0.000	-0.254	0.101	0.646
1983	0.000	0.197	0.135	0.000	-0.020	0.000	-0.001	-0.249	0.000	0.250	-0.172	0.202
1984	0.254	0.000	-0.095	0.000	0.148	0.000	0.319	-0.070	0.000	0.015	-0.553	-0.152
1985	0.000	-0.153	0.202	0.000	-0.110	0.000	0.064	0.189	0.000	0.103	0.019	-0.065
1986	0.000	-0.092	0.000	0.225	0.084	0.000	-0.173	-0.226	0.018	0.000	0.030	-0.073
1987	0.000	0.203	0.220	0.000	0.250	0.000	-0.029	-0.012	-0.131	0.000	-0.078	-0.154
1988	0.000	-0.198	0.055	0.000	0.212	0.321	0.000	-0.163	-0.049	0.000	-0.015	0.443
1989	0.000	0.289	0.059	0.000	0.154	0.000	0.084	-0.127	0.000	-0.080	0.120	-0.062
1990	0.000	0.322	-0.081	0.000	0.045	0.000	-0.069	0.163	0.000	-0.096	0.013	-0.117
1991	0.000	-0.241	0.249	0.000	0.254	0.000	-0.070	0.133	0.000	-0.023	-0.113	0.143
1992	0.000	0.028	-0.089	0.000	0.158	0.000	-0.071	0.014	0.000	-0.152	-0.001	-0.210
1993	0.000	0.113	-0.044	0.000	0.353	0.000	0.036	0.068	0.178	0.000	-0.071	-0.141
1994	0.000	0.241	0.329	0.000	0.316	0.000	0.078	0.431	0.058	0.000	0.581	-0.232
1995	0.000	0.523	0.262	0.000	0.229	0.000	0.021	-0.072	0.044	0.000	0.077	-0.149
1996	0.085	0.000	0.085	0.000	-0.007	0.000	-0.016	-0.034	-0.016	0.000	0.069	0.001
1997	0.000	0.013	0.102	0.000	0.117	0.000	0.029	0.198	-0.183	0.000	-0.088	-0.011
1998	0.000	-0.025	-0.033	0.000	-0.103	0.000	0.034	0.101	-0.251	0.000	-0.154	-0.172
1999	0.000	-0.146	-0.192	0.000	-0.058	0.213	0.000	0.258	0.000	-0.136	0.220	-0.195
2000	0.000	0.0412	0.006	0.000	0.200	0.076	0.000	-0.043	0.000	-0.023	0.016	0.228
2001	0.095	0.000	-0.482	0.098	0.000	-0.117	0.000	-0.119	0.000	-0.154	-0.188	-0.272

Table 2: Monetary Policy Shocks Using Two Separate Policy Reaction Functions for 1969-1979:2 and 1979:3-2001 (in percentage points)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sep	Oct.	Nov.	Dec.
1969	0.000	0.000	-0.212	0.551	0.282	0.118	0.202	0.319	0.080	0.320	0.126	0.125
1970	-0.175	-0.300	-0.020	-0.054	0.034	-0.051	-0.152	-0.422	-0.215	0.156	-0.272	-0.155
1971	-0.528	0.054	0.121	0.386	0.158	0.648	-0.001	0.000	0.000	-0.073	-0.338	-0.702
1972	-0.369	-0.143	0.125	-0.100	-0.121	-0.092	0.000	0.000	0.000	0.000	0.054	0.010
1973	0.249	0.100	-0.036	-0.068	0.276	0.287	0.197	0.184	-0.453	-0.779	-0.027	-0.371
1974	-0.251	0.157	0.728	0.426	0.194	0.196	-0.111	-0.090	-0.466	-0.344	0.090	-0.246
1975	-0.185	0.096	-0.173	-0.193	0.214	0.406	0.351	-0.055	0.081	0.010	-0.233	0.115
1976	0.054	-0.135	-0.081	0.328	-0.107	0.032	0.073	0.119	0.107	0.029	0.027	0.090
1977	0.044	-0.065	-0.072	-0.110	-0.086	-0.218	-0.167	0.148	0.134	0.032	0.006	-0.062
1978	-0.091	0.083	-0.049	-0.044	-0.099	0.149	-0.083	-0.093	-0.131	0.234	0.246	0.085
1979	0.000	-0.141	0.056	-0.115	0.042	0.000	0.399	-0.152	-0.587	0.000	0.081	0.000
1980	0.098	0.249	1.749	-2.582	-0.513	0.000	0.111	-0.510	0.255	0.652	1.484	-0.396
1981	0.000	-0.888	0.110	0.000	1.502	0.000	-0.525	0.043	0.000	-0.462	-0.029	0.310
1982	0.000	0.965	-0.382	0.000	-0.041	0.000	0.071	-0.251	0.000	-0.161	0.183	0.706
1983	0.000	0.190	0.180	0.000	-0.049	0.000	-0.074	-0.256	0.000	0.029	-0.438	-0.142
1984	-0.104	0.000	-0.361	0.000	-0.140	0.000	0.176	-0.070	0.000	0.085	-0.645	-0.279
1985	0.000	-0.309	0.164	0.000	-0.119	0.000	0.123	0.257	0.000	0.149	0.171	0.014
1986	0.000	-0.070	0.000	0.161	-0.078	0.000	-0.246	-0.221	0.058	0.000	0.099	-0.089
1987	0.000	0.309	0.262	0.000	0.267	0.000	0.005	-0.007	-0.173	0.000	-0.179	-0.066
1988	0.000	-0.161	0.013	0.000	0.047	0.262	0.000	-0.371	-0.152	0.000	-0.303	0.055
1989	0.000	0.162	-0.050	0.000	0.156	0.000	0.115	-0.070	0.000	-0.061	0.097	0.014
1990	0.000	0.361	-0.084	0.000	-0.032	0.000	-0.169	0.309	0.000	0.239	0.071	-0.004
1991	0.000	-0.435	0.155	0.000	-0.046	0.000	-0.448	-0.105	0.000	-0.301	-0.245	0.195
1992	0.000	-0.118	-0.142	0.000	-0.029	0.000	-0.241	-0.161	0.000	-0.221	-0.084	-0.312
1993	0.000	-0.089	-0.179	0.000	0.167	0.000	-0.048	-0.138	-0.069	0.000	-0.221	-0.336
1994	0.000	0.040	0.181	0.000	0.183	0.000	0.020	0.412	0.037	0.000	0.545	-0.302
1995	0.000	0.554	0.355	0.000	0.309	0.000	0.145	-0.078	0.161	0.000	-0.019	-0.069
1996	0.260	0.000	0.038	0.000	-0.017	0.000	-0.034	0.067	-0.001	0.000	0.036	-0.027
1997	0.000	0.035	0.046	0.000	-0.003	0.000	0.120	0.383	-0.118	0.000	-0.125	-0.010
1998	0.000	0.165	0.176	0.000	0.043	0.000	0.217	0.248	-0.020	0.000	0.085	-0.006
1999	0.000	0.023	-0.096	0.000	-0.073	0.211	0.000	0.247	0.000	-0.058	0.199	-0.266
2000	0.000	-0.162	-0.199	0.000	-0.025	-0.138	0.000	-0.158	0.000	-0.149	-0.143	0.141
2001	0.193	0.000	-0.327	0.120	0.000	-0.101	0.000	-0.126	0.000	-0.078	-0.014	-0.113