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Self-Fulfilling Expectations and the Inflation of the 1970s: Evidence from the Livingston Survey[1]

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Abstract

Using survey data on expectations, we examine whether the post-war data are consistent with theories of a self-fulfilling inflation episode during the 1970s. Among commonly cited factors, oil and fiscal shocks do not appear to have triggered an increase in expected inflation that was subsequently validated by monetary policy. However, the evidence suggests that, prior to 1979, the Fed accommodated temporary shocks to expected inflation, which then led to permanent increases in actual inflation. We do not find this behavior in the post-1979 data.

1. Introduction

The post-war inflation experience of the U.S. economy is dominated by the dramatic acceleration of inflation during the decades of the 1960s and 1970s and the sharp disinflation of the 1980s. The sustained peacetime inflation of the 1970s had no parallel in the previous 100 years of U.S. history.[1] Why was inflation so high in the 1970s and low in the 1980s and 1990s? An understanding of high and low inflation episodes would help in the design of monetary policy institutions that will reduce the likelihood of revisiting the poor outcomes of the 1970s.

Recent, and perhaps controversial, theories of high and low inflation center on the idea that high inflations can come about because increases in inflation expectations become self-fulfilling as a consequence of the nature of monetary policymaking and monetary institutions. One avenue by which self-fulfilling inflations can come about is that the monetary authority may find itself in a bind when confronted with an upward revision to inflation expectations: It can either choose to accommodate the higher expectations, resulting in higher actual inflation, or it can choose not to accommodate and suffer the consequence of a drop in output and employment. In this light, the experience of the 1970s is interpreted as demonstrating that monetary policymakers were unwilling to pay the costs of disinflation in a self-fulfilling inflation environment. On the other hand, during the 1980s, monetary policymakers were willing to pay the costs of disinflation, and inflation came down rapidly, though at the cost of a severe recession.

We examine whether the post-war data are consistent with theories of a self-fulfilling inflation episode during the 1970s that was reined in by more aggressive monetary policy in the 1980s and 1990s. The unique aspect of our empirical methodology is the use of a long time series on inflation expectations from the Philadelphia Fed's Livingston Survey. Since 1946, this survey has been recording forecasters' expectations of CPI inflation and many other macroeconomic variables. The benefit of using the survey data is that we have independent information on inflation expectations and so do not have to impose modeling assumptions to generate those expectations.[2]

The Livingston Survey data are used in several small VAR models to study whether monetary policy in the 1970s accommodated sudden move-

[1] See DeLong (1997)

[2] Although the Michigan Survey of Households and the Survey of Professional Forecasters also maintain a database on expected inflation, their series start in the 1960s.

ments in expected inflation resulting in highly persistent actual inflation. Our evidence suggests that it did. During the 1970s, temporary shocks that increased expected inflation led to permanent increases in actual inflation. However, during the 1980s and 1990s, we do not find this permanent inflation response to temporary shocks in the data. Consistent with theories that associate sunspots and self-fulfilling inflations with activist monetary policy, we find that the 1970s represent an episode in which rising inflation was accompanied by a falling real interest rate.

The theories that underlie self-fulfilling inflations suggest there may be a permanent rise in inflation in response to temporary shocks to fundamentals or to exogenous movements in expectations via sunspot equilibria. What triggered the rise in expected inflation in the 1970s? We investigate the response of inflation expectations to oil price shocks, monetary policy shocks, and fiscal shocks. For the most part, we find that oil and fiscal shocks are not associated with long-lasting, statistically significant increases in expected or actual inflation. On the other hand, our results indicate that temporary monetary policy shocks, which raise expected inflation, lead to a persistent effect on the inflation rate. We also find a strong and significant inflation response to exogenous shocks to expected inflation: A one-time exogenous increase in expected inflation leads to significantly higher inflation 10 years after impact. However, we show that expectations shocks are much more important for the variability of inflation and the unemployment rate than monetary policy shocks. Expectations shocks account for approximately 50 percent of the variability of inflation and 20 percent of the variability of unemployment in the pre-1979 data. In comparison, the contribution of monetary policy shocks is 10 and 5 percent, respectively.

The rest of the paper is organized as follows. The next section briefly describes the theoretical findings of models of self-fulfilling inflation and the channels through which they operate. We then describe the behavior of actual and expected inflation since the mid-1950s and discuss our identification procedures for the different shocks we wish to analyze. Section 5 introduces the benchmark model and describes our main findings, and Section 6 conducts some sensitivity analysis. The last section concludes.

2. Theories of Self-Fulfilling Inflation

The expectations trap hypothesis, as developed in Chari, Christiano and Eichenbaum (1998), and Albanesi, Chari, and Christiano (2001,2002), pro-

vides a mechanism by which expected inflation can become self-fulfilling in a dynamic, general equilibrium environment with rational agents. These models build on the time-inconsistency literature of Kydland and Prescott (1977) and Barro and Gordon (1983) in modeling policymakers at the level of objectives and constraints, but extend those models by explicitly modeling the actions of a rational private sector.

An expectations trap is a situation in which a benevolent monetary authority may be pushed into accommodating the inflation expectations of the private sector because the cost of not doing so is an undesirable loss of output and employment. Dynamic inconsistency and lack of a commitment technology make possible self-fulfilling inflation equilibria. Without commitment, two types of expectations traps can arise. In the first, agents expect monetary policymakers will react to shocks that don't affect preferences or technology. Thus, nonfundamental shocks may become a source of volatility for the economy. In the second type of expectations trap, the monetary authority may overreact to fundamental shocks, amplifying volatility. In this situation, temporary shocks to fundamentals may lead to long-lasting effects on variables like inflation. In the expectations trap models, the principal driving force for multiplicity of equilibria is that defensive actions taken by households and firms to protect themselves from high inflation reduce the costs of inflation for policymakers.[3]

A second, closely related line of research that investigates self-fulfilling inflation outcomes is the work of Clarida, Gali, and Gertler (2000) and Christiano and Gust (1999, 2000). These models differ from Chari et al. and Albanesi et al. in that policymakers are modeled at the level of decision rules rather than at the level of objectives and constraints. Clarida et al. estimate a forward-looking Taylor rule for the 1970s and use it in a small sticky-price, dynamic ISLM model to show that the Fed's 1970s policy gave rise to indeterminacy. The key mechanism by which these models can deliver self-fulfilling inflation outcomes is that the coefficient on expected inflation in the Taylor rule is less than one. Thus, a rise in expected inflation leads to a fall in the real interest rate. In Clarida et al., this

[3]In Chari et al. and Albanesi et al. unexpected inflation raises output because some prices are sticky. Monopoly power causes output to be inefficiently low. When firms expect high inflation, they set high prices. If the monetary authority does not accommodate, output will be low. When households expect high inflation, they will shift consumption away from goods that require cash for their purchase. Hence, the cost of unanticipated inflation will be low, and the monetary authority has an incentive to inflate.

stimulates spending by standard sticky-price mechanisms, leading to a rise in output that eventually gives way to a rise in inflation.

Christiano and Gust use the Taylor rule estimated by Clarida et al. for the 1970s in a limited participation model to examine whether that model better explains the 1970s data. In particular, their model accounts for the simultaneous rise in inflation and drop in output during the 1970s.[4] In Christiano and Gust's limited participation framework, the fall in the real interest rate leads households to reduce deposits with financial intermediaries, which puts upward pressure on nominal interest rates (firms borrow to finance their wage bill). The monetary authority pursues a policy of not letting the nominal interest rate rise too much, so it injects liquidity that eventually leads to higher inflation. Since the monetary authority does permit some rise in the nominal interest rate, output and employment fall.[5] Thus, the limited participation model gives a stagflation outcome. Note that the Clarida et al. model does not give an expectations trap outcome, and so differs from the analysis of the other papers cited. In Clarida et al., an exogenous rise in expected inflation does not put the central bank in the dilemma of choosing between higher inflation or lower growth. If the monetary authority chooses not to accommodate higher inflation expectations, it simply prevents output and inflation from simultaneously going above trend.

3. Actual and Expected Inflation in the 1970s

The dynamics of inflation, expected inflation, and the real interest rate are plotted in Figure 1. Actual inflation begins a marked acceleration beginning in the mid to late 1960s and peaked in 1979. Expected inflation rose through the late 1960s and 1970s as well, but largely underpredicted actual inflation during the period when actual inflation was accelerating and overpredicted inflation during the disinflation of the early 1980s. The

[4]The Clarida et al. model may be able to deliver a drop in output in response to revised expectations in a self-fulfilling inflation environment if the revision to expectations is due to a bad supply shock.

[5]The mechanism in Chari et al. and Albanesi et al. is slightly different. In those models, higher expected inflation leads people to demand and receive higher wage settlements. Firms pay higher wages because they expect the general price level to be higher, so higher labor costs can be passed on to the public. If the Fed does not accommodate the higher expected inflation, real labor costs rise, leading to lower output and employment.

expected inflation series shows much less volatility than the actual inflation series.

Figure 1 shows that monetary policy was very accommodative in the 1970s, with the real interest rate turning negative between 1974 and 1977. The stance of monetary policy became much more restrictive by the end of the decade. Indeed, at the end of 1979, the real interest rate was approximately 3.5 percent, more than 150 basis points above its historical average. But for a temporary drop in the early 1980, the real interest rate continued to rise, reaching close to 7 percent in 1981. With tight monetary policy in place, inflation and expected inflation fell rapidly and stabilized around 2 to 2.5 percent in the mid-1990s.

Is the fact that expected inflation tended to lag actual inflation evidence against the view that the inflation of the 1970s was the result of self-fulfilling expectations or an expectations trap?[6] It is true that expected inflation lagged actual inflation, but expected inflation rose strongly during the 1970s. Statements by Federal Reserve officials suggest that the Fed was surprised at how strong and resilient inflation expectations seemed to be, even during recessions. In addition, the record suggests the Fed believed that bringing down expectations would require a recession whose economic and political consequences were deemed to be unacceptably high.[7] The record suggests that the Fed saw itself on the horns of a dilemma: recession or inflation. We think that a more thorough attempt at identifying what could be a sudden, unanticipated rise in expected inflation, or the response of expected inflation to different shocks hitting the economy, is required before the self-fulfilling inflation hypothesis can be rejected.[8]

4. Fundamentals or Sunspots?

Several factors have been cited as contributing to the inflation acceleration of the 1970s. Supply shocks, such as the OPEC production cutbacks and oil embargoes were contributing factors to upward pressure on the level of the CPI. Government spending accelerated sharply from 1964 to 1967 with the Great Society programs and Vietnam war buildup. Under

[6]See Delong (1997) and Andolfatto (1999) for an exposition of this view.

[7]See Christiano and Gust (2000) and Chari, Christiano, and Eichenbaum (1998) for some of the relevant excerpts from Federal Reserve officials' statements to the public and Congress.

[8]The fact that expected inflation consistently lagged actual inflation throughout the 1970s and early 1980s seems to be problematic for any theory based on rational expectations.

the self-fulfilling inflations hypothesis, any increase in expected inflation, exogenous or endogenous, could lead to permanently higher inflation under an accommodative monetary policy.[9]

4.1. Oil and Government Spending Shocks

The self-fulfilling inflation hypothesis requires that an increase in expected inflation, by whatever means, leads to an increase in actual inflation. Here, we discuss two fundamental shocks that may have led to increases in expected inflation.

The sudden and unprecedented rise in oil prices in 1973-74 and again in 1979 is a widely cited factor in explanations of the 1970s inflation (see Blinder [1979,1982]). Prices for crude oil rose from about $3 per barrel in mid-1973 to more than $10 per barrel in 1974. At the end of 1978, oil prices averaged about $14 per barrel, and then rose to more than $30 per barrel in 1979. Hamilton (1983) convincingly demonstrates that exogenous oil price increases triggered most economic downturns in the post-World War II period.[10] However, evidence on the inflation effects of the oil shocks is less clear (see Barsky and Killian [2001]). Blinder (1982) argues that special factors, such as oil price increases, contributed to a large extent to the rise in *overall* inflation. However, if oil price shocks are a key element of the inflation story, one needs to explain how one-time increases in oil prices led to permanent, or at least very long-lasting, increases in overall inflation. If oil price shocks led to an increase in expected inflation that was accommodated by monetary policy, a long-lasting effect on inflation could result.

Although the two OPEC oil embargoes contributed to the rise in inflation in the 1970s, Figure 1 suggests that the beginning of the acceleration of inflation dates to the mid-late 1960s, well before the oil price shocks hit the economy. DeLong (1997) and others have argued that a more likely inflationary trigger was the increase in government spending associated with the Great Society programs and the Vietnam war. Again, though, the fiscal shocks appear to be temporary in nature and so would be unlikely to drive

[9] In models of self-fulfilling inflations, permanently higher money growth is typically not the *trigger* for the acceleration of inflation. Therefore, we do not think of this possibility when we refer to fundamentals.

[10] The extent to which oil price increases *per se* cause recession has also been subject to debate (see Bernanke, Gertler, and Watson [1997], Hamilton and Herrara [2000], and Leduc and Sill [2001]).

a lasting inflation, absent an accommodative monetary policy. Inflation continued to accelerate well after these fiscal shocks hit the economy.

Our empirical exercises examine whether exogenous, one-time increases in oil prices and government spending led to increases in expected inflation and permanent increases in inflation during the 1970s. To identify exogenous, unanticipated increases in oil prices, we use the quantitative dummy variable developed by Hamilton (1999). This variable captures the disruptions in the oil market due to political events in the Middle East that are arguably exogenous to developments in the U.S. economy.[11] The dummy variable takes a value equal to the drop in oil production for these historical episodes and is otherwise set to zero. To identify fiscal shocks, we use the narrative account of Ramey and Shapiro (1998). Their reading of the post-war U.S. data leads them to identify three exogenous and unanticipated fiscal shocks: 1950:3, which is associated with the Korean War; 1965:1, capturing the Vietnam War effort; and 1980:1, the Carter-Reagan military buildup.[12]

4.2. Expectations Shocks

In the Chari et al. and Albanesi et al. models that deliver self-fulfilling inflation equilibria, expectations can react to fundamental shocks or to pure sunspots. Even more so than in the case of oil and fiscal shocks, identifying an exogenous movement in expected inflation is difficult. However, we exploit the design of the Livingston Survey to aid in identifying expected inflation shocks. An understanding of our identification scheme requires some detail on how the Livingston Survey is conducted.

The survey, which was initiated in 1946, reports eight-month-ahead forecasts by a pool of professional forecasters, on several economic variables.[13] The forecasters are from nonfinancial businesses, investment banking firms, commercial banks, academic institutions, and from labor, government, and insurance companies.[14] The survey is conducted twice a year. Survey

[11] Hamilton identifies the following dates as being associated with exogenous declines (in parathenses) in world petroleum supply: November 1956 (10.1%), November 1973 (7.8%), December 1978 (8.9%), October 1980 (7.2%), and August 1990 (8.8%).

[12] See Eichenbaum (1998) and Edelberg, Eichenbaum, and Fisher (1999) for an appliciation of this identification strategy in a VAR.

[13] Note that the survey also reports 14-month-ahead forecasts.

[14] The average number of responses for the survey is about 50. Moreover, the survey does not give complete information on who provided each forecast.

questionnaires go out in May and November, after the release of the CPI data for April and October, and are returned before the release of the CPI data for May and November (see Croushore [1997]).[15] A timeline of the survey is shown in Figure 2. A forecaster receiving the survey in May 2002 (when the CPI for April is known) is asked to predict the level of the CPI in December 2002, which requires an eight-month forecast. The forecaster will then receive another survey questionnaire in November 2002 and be asked to predict the level of the CPI in June 2003. The timing of the survey is critical for our identification of expected inflation shocks. The survey's timing suggests putting expected inflation first in a recursive identification scheme, since when making time t forecasts, agents do not know the time t realization of inflation (and the other variables in our VAR), by construction.

Of course, any expectations shocks that we claim are exogenous could only be so to the extent that our statistical model includes all the fundamentals that drive movements in expected inflation. Since it is unlikely that any model could take into account all the variables agents use in making inflation forecasts, we think of our identified expectations shocks as being due to sunspots and/or to omitted fundamentals. To the extent that our model includes the fundamentals that drive expected inflation, the probability that our identified expectations shock is exogenous is higher. Note, though, that for the self-fulfilling inflations hypothesis this distinction is not so important. Both transitory fundamental and sunspot shocks can have long-lasting effects on inflation through the interaction of expectations and monetary policy.[16]

Another potential problem with our identification scheme is that forecasters, when forming expectations for the survey, may have access to data unobserved by the econometrician that give information about actual inflation. In effect, this means that expected inflation would be responding to contemporaneous data. It takes time to mail out and receive the survey, and agents are continuously updating their forecasts over this time. Since we cannot fully include agents' conditioning sets in our VAR, it is sensible to think of allowing expected inflation shocks to be contemporaneously conditioned on other variables in the model. We follow this strategy in the empirical section and assess the importance of alternative Cholesky orderings for the results.

[15] Note that the CPI data are released with a one-month delay.

[16] Note, however, that similar criticisms about omitted variables can be leveled at any VAR.

5. Empirical Model

We set up a benchmark VAR with four variables: expected CPI inflation (EPDOT), CPI inflation (PDOT), the unemployment rate (U), and the three-month T-bill rate (R), plus a dummy variable capturing either oil shocks (O) or shocks to government spending (G).[17] Because of the timing of the Livingston Survey, our data are at a six-month frequency: from April to October, and October to April. Actual inflation for the period between April and October is constructed as the log of the ratio of the October CPI level to the April CPI level (similarly for the period between October and April). The unemployment and T-bill rates are six-month averages of the monthly data. Because the inflation forecasts are really eight-month-ahead forecasts, the constructed measure of expected inflation is slightly different from the constructed measure of actual inflation. In particular, suppose we are in May 2002 (see Figure 2) right after the April CPI data have been released. Expected inflation is measured as the expected CPI in December 2002 divided by the observed CPI in April 2002 (an eight-month period).

Though we describe the data as bi-annual, the observations in EPDOT in the Livingston survey overlap: expected inflation has a horizon of eight months, while the other variables in our system are measured at a six-month frequency.[18] This data construction is used so that forecasters are not given more information in the VAR at time t than they really have. To see this, imagine we are in May 2002 (see Figure 2) and working on the June survey. Forecasters' information set for the June survey includes the April 2002 CPI data, but not the May CPI (which is released in June). An eight-month measure of actual inflation would include June data (i.e., the data would cover the period October 2001 to June 2002).[19]

Finally, note that since the frequency of our data differs from that of Hamilton's (1999) quarterly analysis, the timing of our dummy variable is slightly different from his. We constructed our dummy variable by setting

[17] We use the unemployment rate to avoid real-time data issues associated with revisions in real GDP. Since they are generally limited to changes in seasonal factors, revisions in the unemployment rate are historically less important than those for real GDP.

[18] Our measures of the T-bill, inflation, and expected inflation rates are annualized. All variables are expressed in percentage points.

[19] The potential problem with aligning the data as we do is that serial correlation may be introduced because of the overlapping data intervals. However, this does not appear to be a severe problem, since the unit of time in our VAR (six months) is longer than the period over which the data overlap (two months).

the drop in production equal to that in Hamilton (1999), whenever one of the historical episodes he described falls within one of our six-month periods. The same is true of our dating of the Ramey-Shapiro (1998) fiscal shocks.

Our benchmark model is a VAR on expected inflation, inflation, the unemployment rate, and the federal funds rate:

$$Y_t = A(L)Y_{t-1} + B(L)D_t + u_t, \tag{5.1}$$

where Y_t is a 4x1 vector of data and D_t represents a dummy variable for either oil (O) or government spending shocks (G).[20] $A(L)$ and $B(L)$ are finite-ordered matrix-polynomials in nonnegative power of L, the lag operator. SIC tests indicate that two lags are sufficient to capture the system dynamics.

The benchmark specification uses a recursive identification scheme for generating impulse response functions with the ordering [EPDOT, PDOT, U, R]. Expected inflation is ordered first since, by construction, it is predetermined for our data. Because the frequency of our dataset is bi-annual, we assume that the Fed can freely adjust the interest rate in response to contemporaneous movements in all the other variables in the system. Hence, we order the federal funds rate last. The sensitivity of the system to alternative orderings of the variables is examined below.

We investigate impulse responses to see if the predictions of theories of self-fulfilling expectations are confirmed in the 1970s data. As in Clarida et al., we estimate our VARs over two sample periods: 1952:1 to 1979:1 and 1979:2 to 2001:1.[21] For the pre-1979 era, we look to see if temporary shocks to expectations and fundamentals lead to permanent effects on inflation via an accommodative monetary policy. We examine whether the response to shocks then changed in post-1979 era.

Temporary shocks to fundamentals can have permanent effects on the inflation rate only if the latter is a unit root process. The augmented Dickey-Fuller (ADF) test is used to test the data for unit roots. Table 1 reports the results for both the pre- and the post-Volcker periods. The tests indicate that the unit root null hypothesis cannot be rejected for inflation, expected inflation, nominal interest rate, and unemployment rate

[20] Because there are relatively few data points per estimated VAR coefficient, the effects of oil and government spending shocks are analyzed separately.

[21] Note that because we have two lags, our effective sample is 1953:1 to 1979:1 for the pre-Volcker period and 1980:2 to 2000:1 for the post-Volcker era.

in the pre-1979 era. On the other hand, we can reject the hypothesis that actual and expected inflation follow unit processes in the post-Volcker period, though we cannot reject the null for the nominal interest rate and the unemployment rate. These results suggest that temporary shocks to either fundamentals or to expectations could, *a priori,* lead to permanent effects on inflation in the 1970s, but that this will not occur in the post-Volcker era. To verify this conjecture, we now look at the response of the economy to oil, fiscal, expectations, and monetary policy shocks.

5.1. Oil Shock

Figure 3 presents system impulse responses to a one-time unit change in Hamilton's quantitative oil variable ($[I - A(L)]^{-1} B(L)$). The first column of the figure presents the responses for the pre-1979 estimated model and the second column the responses for the post-1979 estimated model. In each plot, the solid line represents the point estimate, while dashed lines denote a 90 percent confidence interval.[22] The figure shows that, pre-1979, a temporary oil shock initially leads to a significant rise in both expected and actual inflation, but the response of these variables is not significantly different from zero one year after the shock. Positive oil shocks lead to a rise in the unemployment rate (of about 21 basis points), one year following the shock, with this increase persisting for about one year.

In the pre-1979 estimates, the real interest rate falls in response to a positive oil shock, reaching its maximum drop about 18 months after the shock.[23] Thus, monetary policy appears to be passive. However, since the temporary oil shock does not lead to a long-lasting effect on actual inflation, we conclude that it is unlikely that this shock is the trigger that set up the inflation take-off in the 1970s. Note also that the impact of oil shocks on the economy is much less substantial post-1979, with only the initial rise in actual inflation being significant.

5.2. Fiscal Policy

We use Ramey and Shapiro's (1998) fiscal dummy variable to investigate whether a positive, transitory fiscal shock in the mid-1960s led to long-lasting inflation. This may have occurred if it led the public to revise their

[22] We use the bootstrap Monte Carlo method described in Eichenbaum (1998).

[23] The real interest rate response is constructed as the difference between the nominal interest rate response and the expected inflation response.

inflation expectations upward, and the Fed then validated these expectations. Figure 4 shows the impact of a transitory fiscal shock in our model. The figure presents impulse response functions only for the pre-1979 period, since we do not have a shock to government spending that falls in the post-1979 era.[24]

The impulse response point estimates are consistent with the findings of Ramey and Shapiro (1998) and Edelberg, Eichenbaum, and Fisher (1999) on the effects of government spending shocks. However, in contrast to these models, our specification includes an equation that captures the interest rate response of the Fed to an unanticipated change in fiscal policy. An increase in government spending leads to a delayed increase in economic activity, represented by the drop in the unemployment rate one year following the shock. Inflation rises, peaking at the same time as the unemployment rate. The Fed responds to this change in fiscal policy by raising the nominal interest rates enough, initially, to raise the real interest rate. However, the increase in the nominal interest rate is not strong enough to keep the real interest rate from falling two years after the shocks. This relatively passive policy then brings about a permanent rise in actual and expected inflation. Note, though, that none of our point estimates are significantly different from zero at the 90 percent confidence level. In this respect, we differ from the results in Ramey et al. and Edelberg et al. As in the case of an oil shock, an unanticipated increase in government spending does not bring about a statistically significant, long-lasting increase in the inflation rate.

5.3. Expectations Shocks

Consider now the effect of an unanticipated, one-time shock to expected inflation. Figure 5 presents the impulse responses, with the first and second columns describing, respectively, the response of the economy before and after 1979.[25] Looking at the pre-1979 results, a positive, one-time

[24] It is true that Ramey and Shapiro isolated 1980:1 as an exogenous event that led to a large military buildup and that this date falls in the post-Volcker period. However, because of our lag structure (two lags), our effective sample starts in 1980:2. Similarly, our pre-1979 sample, which effectively covers the period from 1953:1 to 1979:1, includes only the military buildup of 1965:1.

[25] Our impulse responses to expectations and monetary policy shocks are normalized such that the contemporanous own responses are unity.

shock to expected inflation leads to a large and permanent increase in both actual and expected inflation. Moreover, these responses are significantly different from zero for more than 10 years after the shock, in sharp contrast to the effects of oil and fiscal shocks. Actual inflation rises about 1.5 percent one year after the exogenous increase in expected inflation, and then stabilizes around one percent higher than it was prior to the shock. The Fed responds to the jump in expected inflation by raising the nominal interest rate, but the rise is not enough to increase the real interest rate, which initially falls 50 basis points. Note that the drop in the real interest rate is statistically significant both initially and in the longer run. The monetary policy response is strong enough to stimulate the economy in the first year, with the unemployment rate falling 0.5 percent. But in the long run, both unemployment and inflation are higher.The impulse responses for the post-1979 period are in striking contrast to those of the pre-1979 period. An unanticipated increase in expected inflation brings about an initial rise in actual inflation, but this increase is quickly reversed and is not significantly different from zero one year after the shock. Just as in the pre-1979 era, the nominal interest rate increases following the shock, but by less than the rise in expected inflation, so the real interest rate also rises.[26] Monetary policy appears to be much more active: The real interest rate rises sharply in response to higher expected inflation. As a consequence, the rise in expected inflation is rapidly reversed so that expected inflation returns to zero about two years after the shock. The activist policy leads to an economic slowdown: The unemployment rate rises 50 basis points three years after the shock.[27]

On balance, our impulse response functions seem to provide evidence for a self-fulfilling inflation/expectations trap story for the 1970s inflation. Note, though, our evidence is not quite in agreement with the predictions of sticky-price models of self-fulfilling inflations as explanations of the 1970s inflation. Recall that in the model of Clarida et al. output is demand determined. When the monetary authority is passive, a rise in expected inflation leads to a fall in real interest rates that stimulates demand and

[26]The fact that the real interest rate rises in response to an expectations shock suggests there would no indeterminacy in a standard equilibrium monetary model. In this case, expectations are a deterministic function of the economy's state variables. An expectations shock, in our framework, could then be interpreted as a mismeasurement error to which the Fed may then respond.

[27]Note that the unemployment rate initially falls, probably because the real interest rate is unchanged initially (in a statistical sense) and only starts rising half a year after the shock.

increases output and employment. Eventually, the rise in output fully gives way to higher inflation. Our impulse responses suggest that indeed real interest rates fell in response to a rise in expected inflation, but the unemployment rate rises as well, resulting in a stagflation. Our evidence is more in line with the predictions of a model like that in Christiano and Gust (2000) where higher expected inflation and passive monetary policy can lead to lower real interest rates, higher nominal interest rates, and lower employment.

5.4. Monetary Policy

Can monetary policy shocks account for the high inflation of the 1970s? Figure 6 presents the response functions of the variables to a one-percentage-point increase in the nominal interest rate. In the pre-Volcker era, the increase in the nominal interest rate initially raises the real rate because expected inflation is predetermined in our benchmark specification. Actual and expected inflation rise, suggesting a strong Fisher effect, which is not surprising given the highly accommodative nature of policy in that period. Actual and expected inflation stay high even in the long run (although the confidence interval is only marginally above zero). On the other hand, as shown in the second column of Figure 6, the economy, post-1979, behaves much more in accord with typical findings from VAR analysis. The positive monetary shock leads to a rise in the unemployment rate and to a fall in actual and expected inflation. Moreover, temporary changes in monetary policy, in this period, do not bring about persistent changes in inflation.

How is it that a temporary change in monetary policy leads to such long-lasting effects on inflation in the pre-1979 era? Using a structural VAR to study U.S. economic fluctuations, Gali (1992) estimates permanent responses of nominal variables to money supply and *IS* shocks. He argued that the presence of this unit root possibly resulted from the desire of the Fed to stabilize output and avoid the costs of a recession by simply accommodating the positive effects of the shocks on the inflation rate. Clarida et al.'s estimated Taylor rule (as discussed in Section 2) suggests that Fed policy in the 1970s could introduce nominal and real indeterminacies in a simple framework with nominal rigidities. A standard monetary policy shock, in a model with a passive monetary authority and multiple equilibria, could have a permanent effect on the inflation rate, through its effects on expected inflation.

Our results do suggest that monetary policy has been more active in the

post-1979 era, since temporary shocks to expectations and fundamentals do not lead to permanent responses in inflation. Orphanides (2001) suggests that the reason for the 1970s high inflation was that the Fed placed a lot of weight on stabilizing output and mismeasured the expected output gap because it was slow to recognize the productivity slowdown that began in the early 1970s. As a consequence, it ran an easy monetary policy that resulted in higher inflation. Orphanides' estimates suggest that the Fed was about equally aggressive in responding to expected inflation in the pre- and post-1979 eras. Our evidence, on the other hand, suggests that the Fed did not respond as strongly to expected inflation shocks in the 1970s as it did in the post-1979 era.

5.5. A Historical Reading of U.S. Inflation

How important are the various shocks in our statistical model in accounting for the variability of inflation and unemployment? We saw that temporary expectations shocks led to persistent inflation responses in the pre-1979 era, but are expectations shocks an important component of the overall variation in inflation? Table 2 shows the variance decompositions of inflation and unemployment for our benchmark specification in the pre- and post-1979 episodes. We computed the variance of the six- and twelve-step-ahead forecast error (which corresponds to three and six years) that is attributable to each variable: inflation, expected inflation, unemployment, and nominal interest rate shocks. In the pre-1979 period, we find that a little less than 50 percent of the variance of inflation can be attributed to expectations shocks, a number about five times as large as the contribution of interest rate shocks. The importance of expectations shocks for the variability of inflation post-1979 is also very large: 30 percent, which is again about five times as much as the contribution of monetary policy shocks.

Expectations shocks also account for a substantial fraction of the unemployment rate forecast variance in both the pre- and post-1979 periods. In fact, about 30 percent of that variability is due to expectations shocks, and monetary policy shocks contribute only about 5 percent. Note that, in the post-1979 era, a larger share of the unemployment variability is accounted for by expectations shocks. This is consistent with the view that, post-1979, the Fed accepted more volatile unemployment to achieve lower inflation. In this view, the Fed reacts quickly and strongly to a rise in

expected inflation.[28]

The historical decomposition of the U.S. inflation rate offers another perspective in understanding the contribution of expectations shocks to the time path of inflation. We again split the data set into two periods: pre- and post-1979. The historical decomposition of inflation is based on the moving average representation of the VAR in the structural errors (5.1):

$$Y_{T+j} = \sum_{s=0}^{j-1} \Psi_s u_{T+j-s} + E_T Y_{T+j},$$

The summation term captures the movement in inflation that is due to the realized structural errors between periods $T+1$ and $T+j$. The term $E_T Y_{T+j}$ is the forecast of Y_{T+j} based on information available at time T. The decompositions begin with the first period of each era, so the forecast of Y_{T+j} at the start date reflects initial conditions, the (estimated) constant term, and the deterministic dummy variable capturing oil shocks. The historical decompositions are shown in Figure 7. The first row of the figure shows the actual and forecast values of inflation for the pre- and post-1979 periods. The plots in the second through fifth rows show the cumulative contribution of structural shocks to inflation, expected inflation, unemployment, and monetary policy. We also plot the difference between actual inflation and its forecast (i.e., $Y_{T+j} - E_T Y_{T+j}$) in each of the graphs. For both the pre-1979 and post-1979 eras, the broad contour of the deviations of inflation from trend is driven primarily by shocks to expected and actual inflation. Observe that as inflation reached new peaks between 1965 and 1979, the cumulative contribution of expected inflation shocks was generally rising, which means that shocks to expected inflation contributed positively to inflation. Moreover, the cumulative effect of expectations shocks on inflation appears nonstationary in the pre-Volcker era and stationary post-1979. This agrees with our earlier conclusion that expectations shocks have very long-lasting effects on the inflation rate pre-1979, but not thereafter. Finally, the figure shows that the contribution of monetary policy and unemployment shocks to actual inflation are much smaller than the contribution of shocks to expected inflation during both eras.

[28] Our results are different than those of Lubik and Schorfheide (2002), who, based on a maximum likelihood estimation of a monetary model with sunspot equilibria, found that the contribution of sunspot shocks to aggregate fluctuations was small.

6. Sensitivity Analysis

To gauge the sensitivity of our results, we modify the benchmark specification to take into account two possibilities: (*i*) agents' inflation forecasts are conditioned on contemporaneous data, unobserved by the econometrician, so that expected inflation is not predetermined;(*ii*) the behavior of the economy after 1979 is contaminated by the inclusion in the post-1979 sample of the monetarist experiment between 1979 and 1982, which represents a structural change in monetary policy.

6.0.1. Re-Ordering Expected Inflation

To analyze whether predetermined expected inflation is important for our results, we re-order the vector Y_t in equation (5.1) as: PDOT, U, EPDOT, R. Hence, expected inflation can react to contemporanous information on inflation and the unemployment rate in our recursive identification scheme. We order expected inflation before the nominal interest rate, since we are interested in understanding how the Fed responds to changes in expected inflation.[29]

Figure 8 shows the impulse response functions for an expectations shock under our alternative ordering. Overall, the response of the economy is very similar to that under the benchmark specification shown in Figure 5. The general message from the alternative ordering is that a shock to expected inflation leads to a long-lasting increase in actual inflation, consistent with the view that the Fed validates the rise in expected inflation by letting the real interest rate fall. In this sense, our model is robust to the alternative ordering.

6.0.2. The Monetarist Experiment

Is monetary policy responsible for the better inflation performance of the U.S. economy since 1979, or was it luck? Ireland (1999) argues that a sequence of bad supply shocks pushed the natural rate of unemployment up in the 1970s. This then brought about a rise in the inflation rate because of the time-inconsistency problem faced by the central bank. The Fed was able to bring the inflation rate down in the post-1979 era only because it did not face a similar series of bad shocks. In a related paper, Sims and Zha (2002) argue that the only period since 1950 with a noticeably different

[29]The impulse responses are very similar to the baseline model when we order EPDOT last.

monetary policy is the monetarist experiment between 1979 and 1982, in which the Fed targeted monetary aggregates. Otherwise, monetary policy in the 1970s and the post-1982 period appears to be very similar. Sims and Zha do find that the period since 1982 is characterized by a decrease in the volatility of shocks hitting the economy.

To investigate this possibility, we removed the 1979-1982 period from the post-1979 era. We then assessed whether there is a change in the economy's response to expectations shocks. Figure 9 describes the results. This set of impulse response functions clearly shows that expectations shocks did not lead to a long-lasting increase in the inflation rate during the post-1982 era. However, the data do not allow us to attribute this change in the response of the economy to a more active monetary policy: For instance, the real interest rate does not rise substantially in the post-1982 period. As a result, we cannot rule out the possibility that the structure of the economy (other than monetary policy) changed between the pre-1979 and post-1982 periods.

7. Conclusion

We examined whether the post-war data are consistent with theories of a self-fulfilling inflation episode in the 1970s. Our evidence suggests that it is. During the pre-1979 era, temporary shocks to expected inflation led to a permanent increase in actual inflation, which did not occur post-1979. The mechanism by which this occurred was a passive monetary policy: The real interest rate fell in response to the expectations shock. Our results for the 1979-2001 sample suggest that monetary policy became more active, with the Fed responding aggressively to an increase in expected inflation. However, once we remove the "monetarist" episode of 1979-82, it is difficult to distinguish Fed behavior post-1982 from that of the pre-1979 era. Nonetheless, we do find, for the post-1982 era, that temporary shocks to expectations do not lead to long-lasting effects on actual inflation.

Self-fulfilling inflations can arise because of shocks to expectations and shocks to fundamentals. We found that exogenous oil and fiscal shocks did not contribute significantly to the 1970s inflation. However, monetary policy shocks did have long-lasting consequences for inflation. This can happen when monetary policy accommodates higher expectations. Nonetheless, the contribution of monetary policy shocks for the variability of inflation is dwarfed by that of expectations, which accounted for about 50

percent of that variance.

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Table 1. Augmented Dickey-Fuller Test for Unit Roots

	Pre-1979		Post-1979	
	ρ	*ADF*	ρ	*ADF*
EPDOT	1.06	---	0.87	-2.96**
PDOT	0.95	-0.57	0.54	-5.07**
U	0.82	-2.53	0.91	-2.25
R	0.97	-0.41	0.85	-2.14

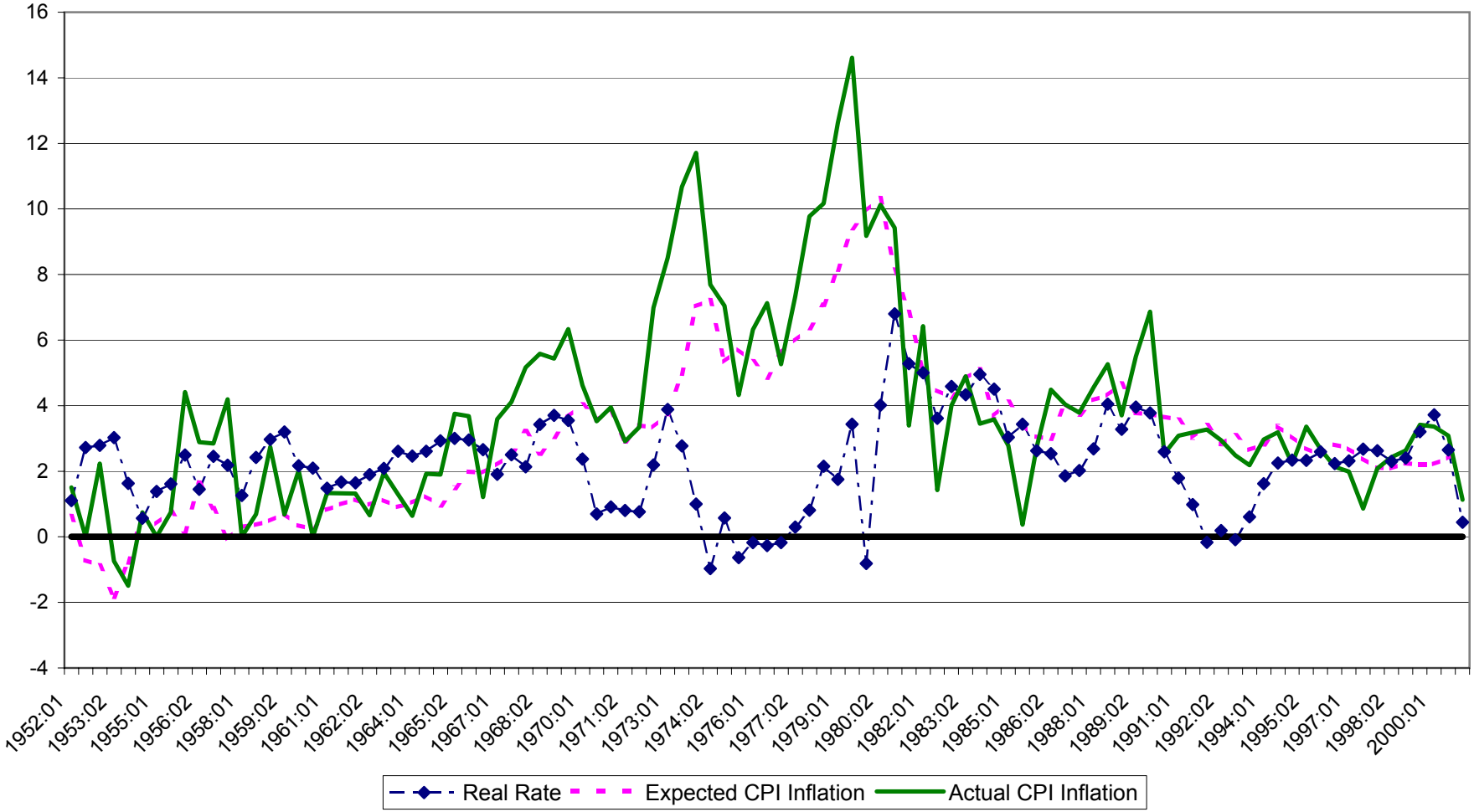
ρ is the coefficient estimate on the lagged variable. The variables are as described in the text. ** denotes significance at the 5-percent level, using MacKinnon's (1991) critical values. *EPDOT* = expected inflation, *PDOT* = inflation, *U* = unemployment rate, and *R* = nominal interest rate.

Table 2. Variance Decomposition of Inflation and Unemployment (Benchmark Specification)

	PDOT	*EPDOT*	*U*	*R*
Inflation				
Pre-1979				
3 years	39.86	47.36	3.56	9.23
6 years	37.01	49.37	2.48	11.15
Post-1979				
3 years	62.56	30.27	1.12	6.04
6 years	61.96	30.40	1.62	6.02
Unemployment				
Pre-1979				
3 years	10.26	21.54	65.32	2.88
6 years	13.22	28.02	53.80	4.97
Post-1979				
3 years	3.860	41.285	44.900	9.955
6 years	7.988	47.330	35.532	9.150

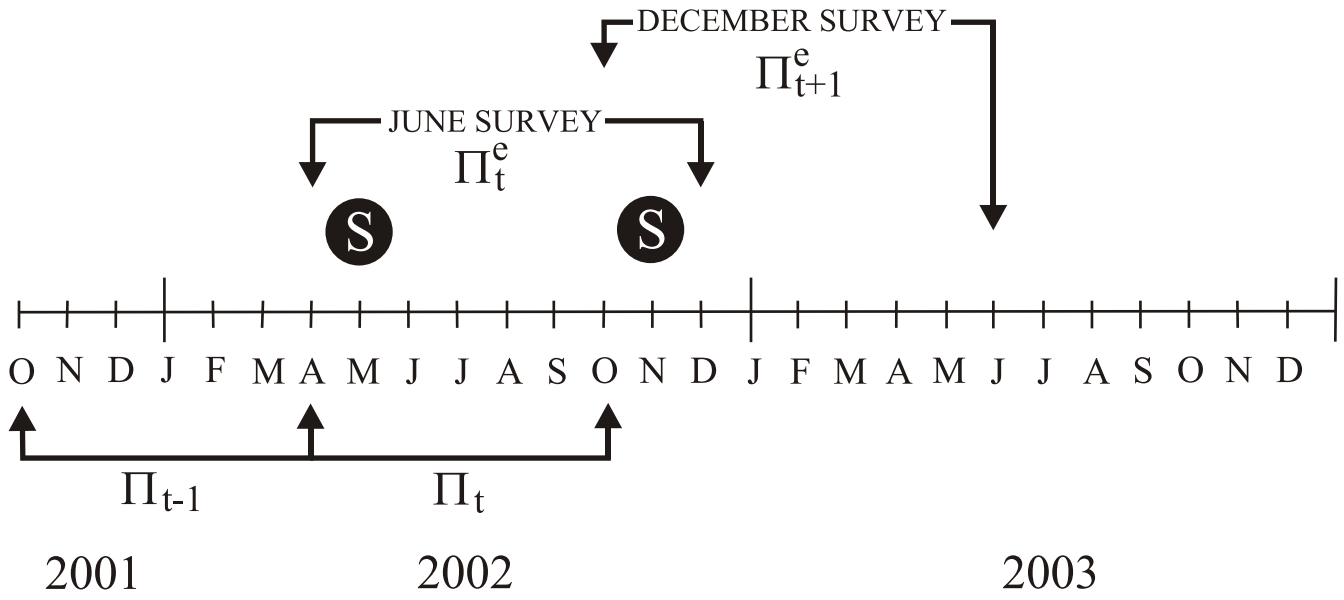
All entries are in percentage term. The variables are as described in the text. 3 and 6 years refer to the step ahead forecast for which the variance decomposition is done.

Figure 1. Real Interest Rates and Inflation (annualized percentage points)



Actual inflation is measured by the actual change in the CPI over six months. The 8-month forecast of the CPI level from the Livingston survey is used to construct the series for expected inflation. The real interest rate is measured as the 3-month TBill less expected CPI inflation.

Figure 2
Dating of the Livingston Survey

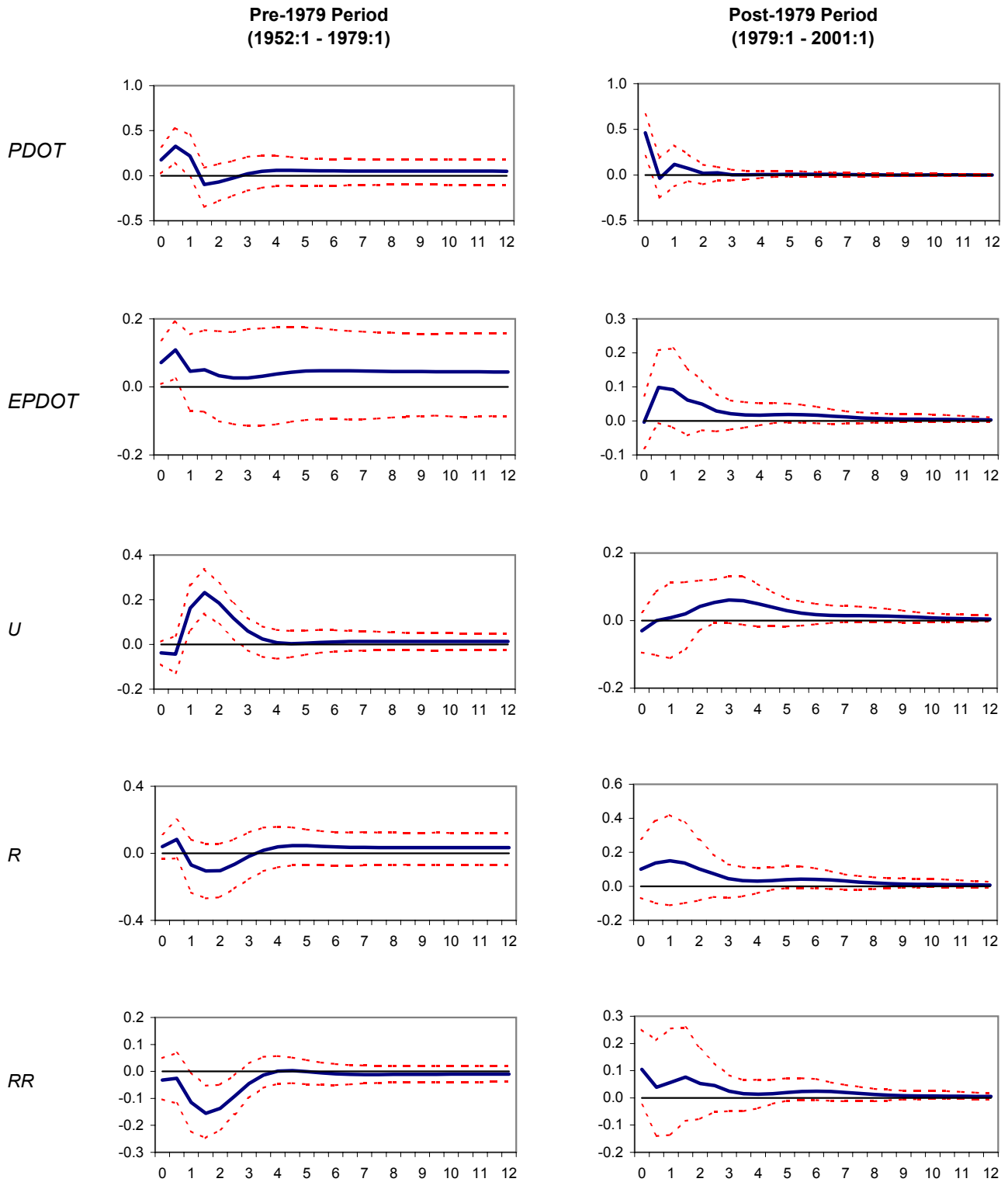


S = dates of the survey, mailed in May and November

Π_t = actual CPI inflation in period t $\left(\text{eg. } \log \frac{\text{CPI (October)}}{\text{CPI (April)}}\right)$

Π^e_t = expected CPI inflation in period t $\left(\text{eg. } \log \frac{\text{CPI}^e\text{ (December)}}{\text{CPI (April)}}\right)$

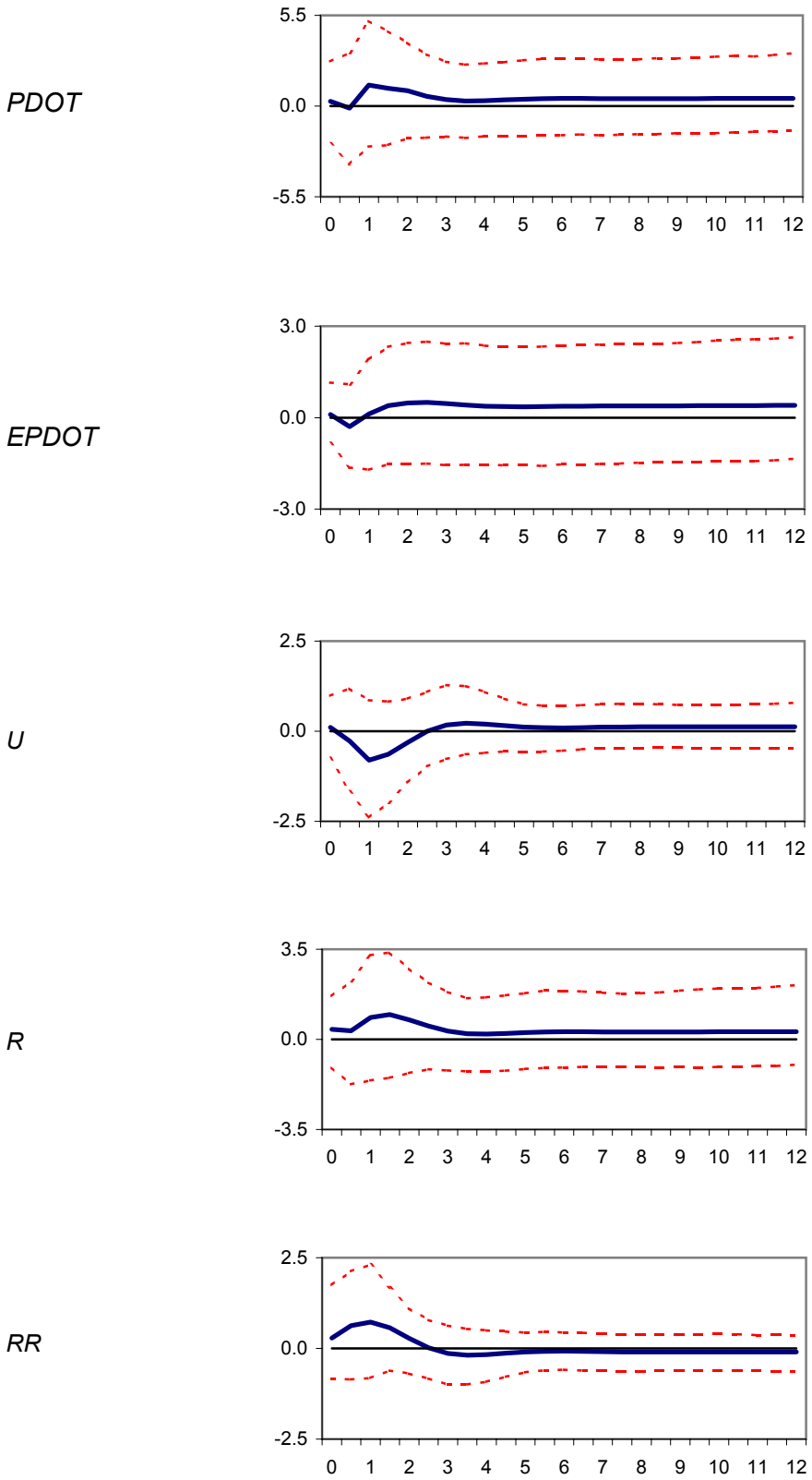
Figure 3. Responses to an Oil Shock



PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.

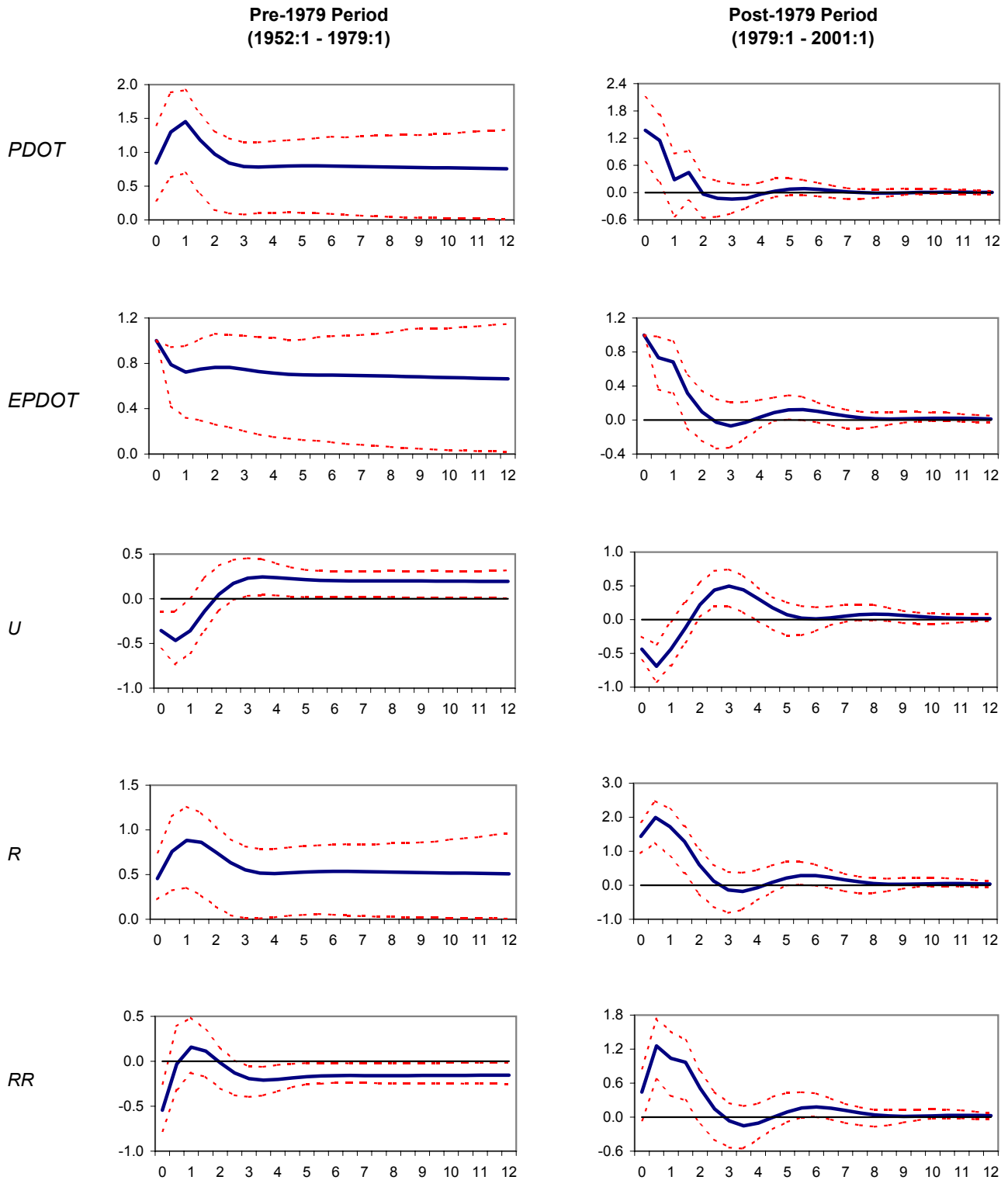
Figure 4. Responses to a Fiscal Shock

Pre-1979 Period
(1952:1 - 1979:1)



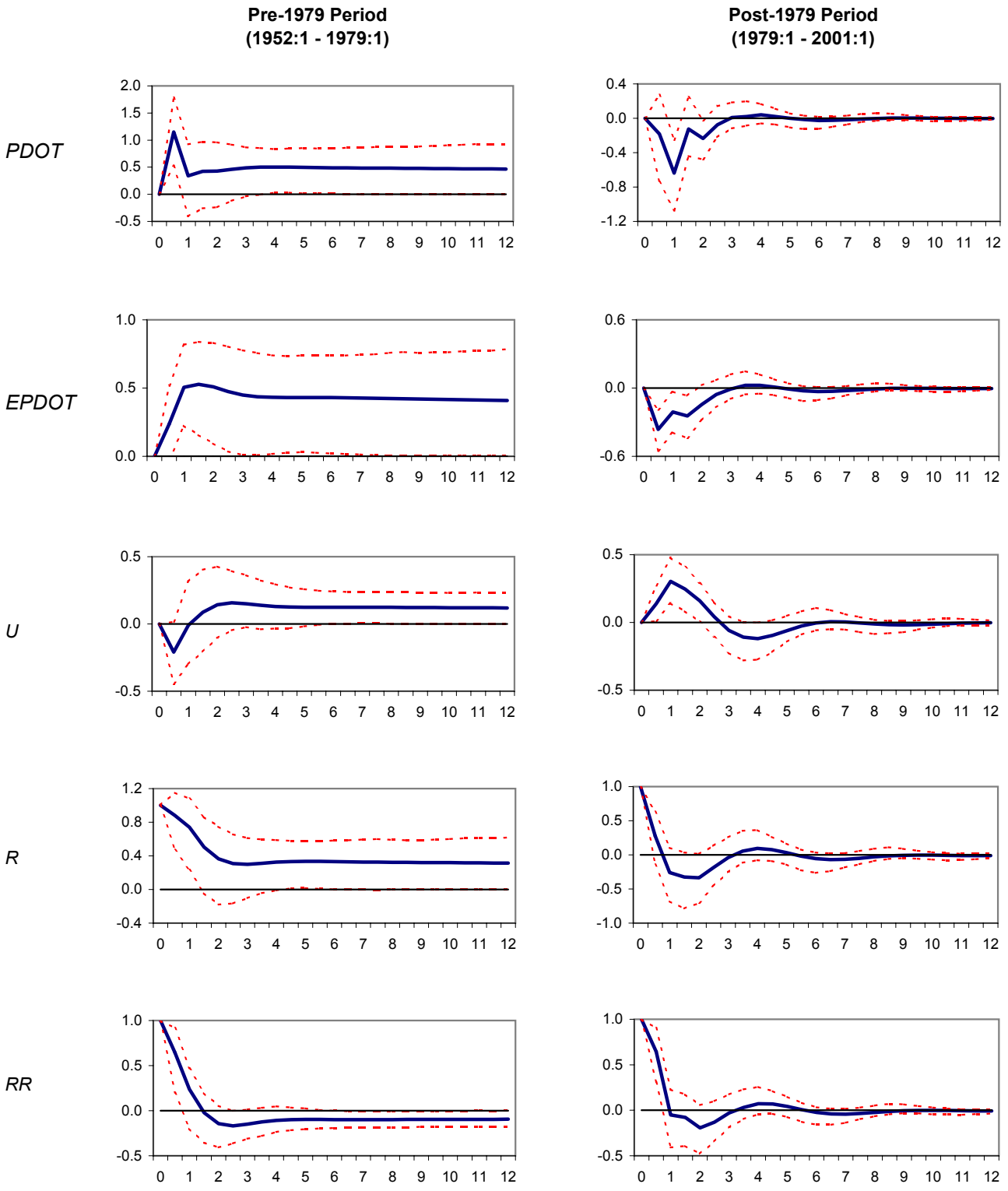
PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.

Figure 5. Responses to a Shock to Expected Inflation



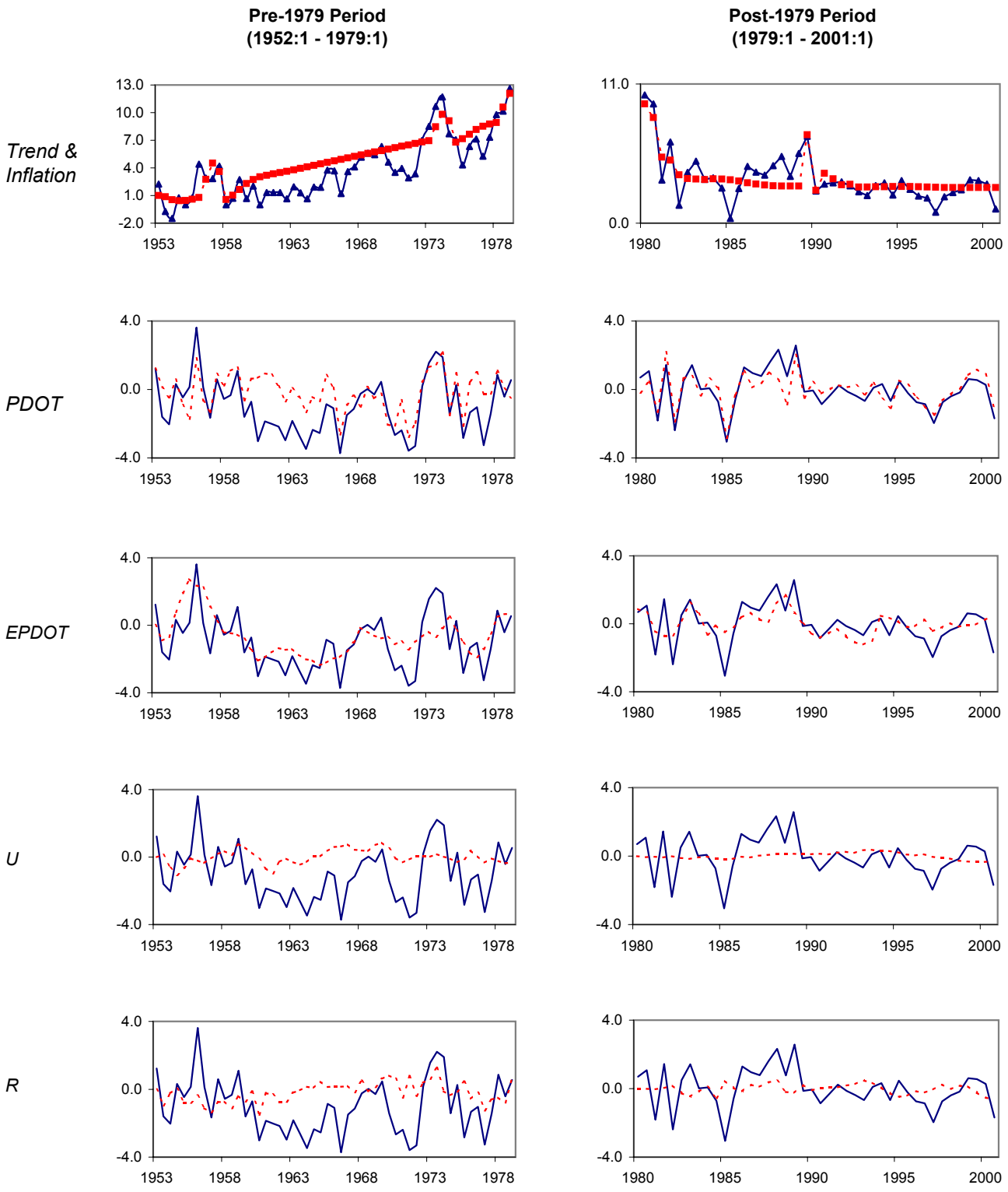
PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.

Figure 6. Responses to a Monetary Policy Shock



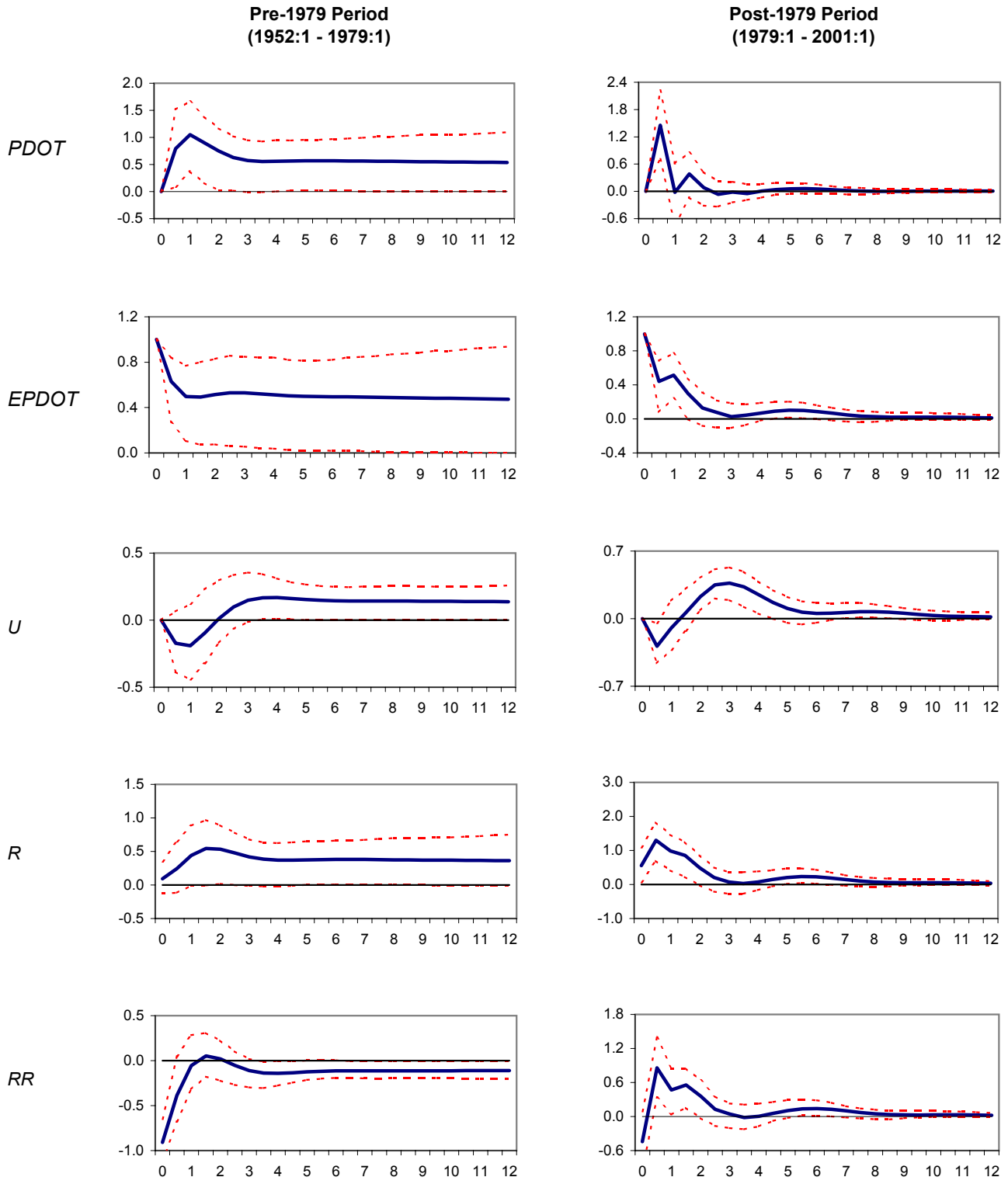
PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.

Figure 7. Historical Decomposition of Inflation



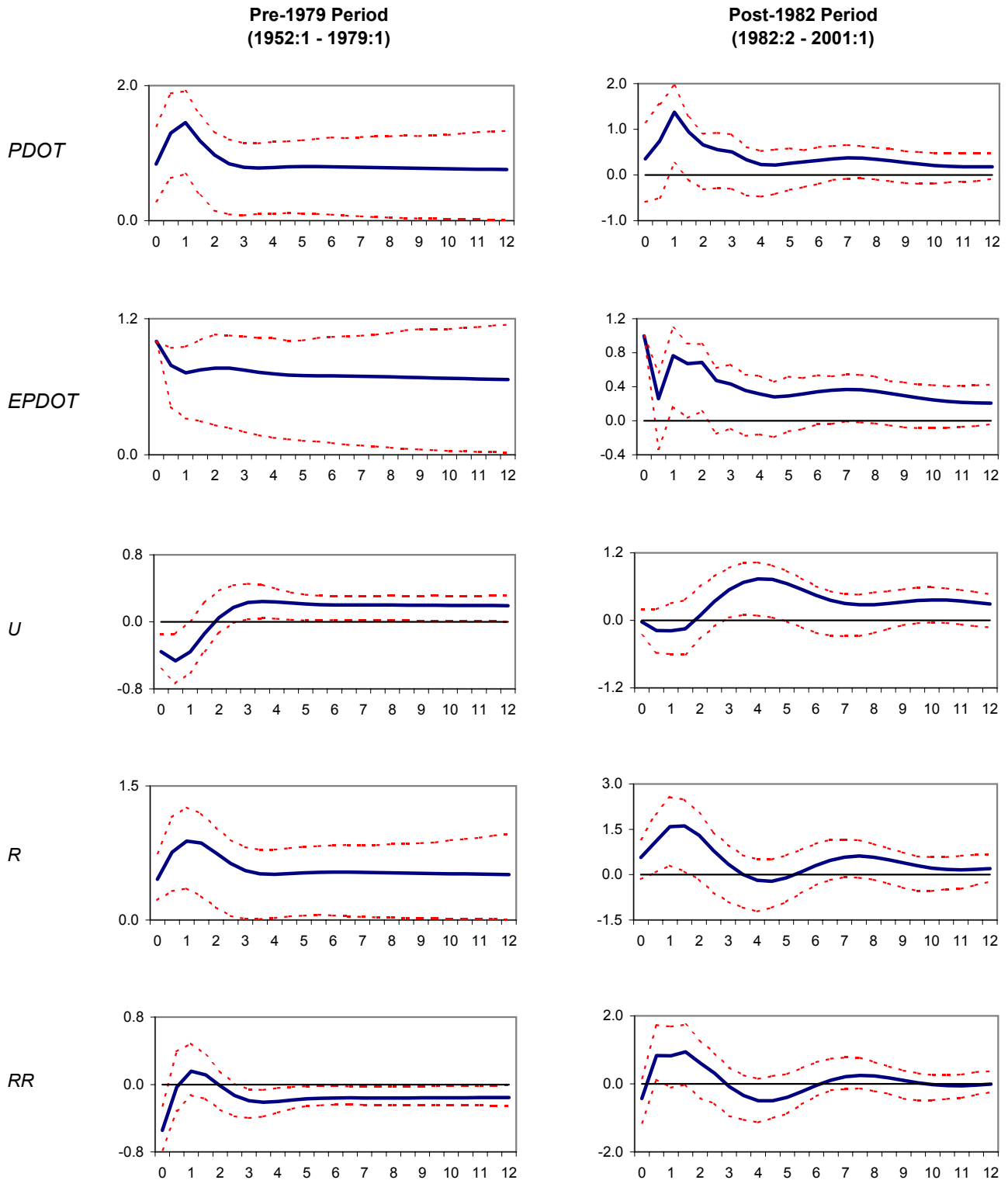
In the first row of the figure, the squares denote the foreast of inflation and the trangles represent actual inflation.
In rows 2-5, the solid line represents the difference between actual inflation and the forecast, while the dotted line represents the cumulative contribution of the structural shocks to either PDOT, EPDOT, U, and R.
PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate.
The units on the y-axis are in percent.

Figure 8. Responses to a Shock to Expected Inflation (Alternative Ordering)



PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.

Figure 9. Responses to a Shock to Expected Inflation



PDOT = inflation, EPDOT = expected inflation, U = unemployment rate, R = nominal interest rate, RR = nominal interest rate - expected inflation. The units on the y-axis are in percent, while those on the x-axis are in years.