Economic Quarterly—Volume 94, Number 2—Spring 2008—Pages 121–146

On the Sources of Movements in Inflation Expectations: A Few Insights from a VAR Model

Yash P. Mehra and Christopher Herrington

The public's expectations of inflation play an important role in influencing actual inflation and the Federal Reserve's ability to achieve price stability. Hence, there is considerable interest in identifying the economic factors that determine the public's expectations of inflation.[1] In this article, we consider some important macroeconomic determinants of inflation, including commodity and oil prices, and investigate empirically their influences on a survey measure of the public's expectations of inflation from 1953 to 2007, using a structural VAR.[2] We also investigate how the influences of these macroeconomic variables on inflation expectations may have changed during the sample period.

In a recent paper, Leduc, Sill, and Stark (2007) use a structural VAR to investigate the sources of the persistent high inflation of the 1970s. This structural VAR contains a direct survey measure of the public's expectations

The authors would like to thank Kevin Bryan, Robert Hetzel, Pierre Sarte, and John Weinberg for their helpful comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] See Ang, Bekaert, and Wei (2006), Bernanke (2007), and Mishkin (2007) for a good introduction to issues related to inflation expectations, actual inflation, and monetary policy. Ang, Bekaert, and Wei provide evidence indicating that survey measures of inflation expectations contain useful information for forecasting inflation. The studies by Bernanke and Mishkin highlight the need for research that promotes a better understanding of the factors that determine inflation expectations and how those expectations affect actual inflation.

[2] Mankiw, Reis, and Wolfers (2003) run single equation regressions relating inflation expectations to several macroeconomic variables. The VAR model, however, allows richer dynamic interactions and, hence, may provide better estimates of the influences of macroeconomic variables on inflation expectations.

of inflation, represented by the median Livingston survey forecast of the eight-month-ahead CPI inflation rate.[3] The other variables in this VAR are actual CPI inflation, a commodity price index, the unemployment rate, a short-term nominal interest rate, and an oil shock variable. The timing of the survey and the way other VAR variables are defined and measured mean the survey participants do not observe contemporary values of VAR variables when making forecasts, thereby helping to identify exogenous movements (shocks) in this survey measure of expected inflation. Leduc, Sill, and Stark (2007) show that the monetary policy response to exogenous movements in expected inflation could explain the persistent high inflation of the 1970s. In particular, prior to 1979 the Federal Reserve accommodated exogenous movements in expected inflation, seen in the result that nominal and real interest rates do not increase in response to such movements, which then led to persistent increases in actual inflation. Such behavior, however, is absent post-1979: The Federal Reserve did not accommodate and aggressively raised nominal and real interest rates, thereby preventing temporary movements in expected inflation from generating persistent increases in actual inflation.[4]

This article uses the structural VAR given in Leduc, Sill, and Stark (2007), denoted hereafter as LSS (2007). While the LSS paper focuses on explaining the sources of the persistently high inflation of the 1970s, this article focuses on explaining the sources of movement in the public's expectations of inflation represented here by the Livingston survey measure of expected inflation. As indicated above, the use of the survey helps identify the exogenous component of expected inflation. We are interested in identifying the role of other macrovariables that may cause movements in expected inflation. Using impulse response functions, we first investigate the responses of expected inflation to temporary surprise movements in macroeconomic variables including expected inflation itself, and using the forecast error variance decomposition of expected inflation, we investigate changes in the relative importance of different macrovariables in explaining the variability of expected inflation.

To investigate how the influences of other macrovariables on expected inflation may have changed over time, we break the whole sample period into one pre-1979 sub-sample, 1953:1–1979:1, and two post-1979 sub-samples,

[3] The participants in this survey are professional forecasters, not the general public. The forecasters are from nonfinancial businesses, investment banking firms, commercial banks, academic institutions, local government, and insurance companies. The survey recently conducted by the Federal Reserve Bank of Philadelphia is biannual. We use this survey primarily because it is the only survey available for the longer sample period covered here. Ang, Bekaert, and Wei (2006) present evidence that indicates the survey contains useful information for predicting future inflation.

[4] The structural VAR contains a short-term nominal interest rate. The behavior of the real interest rate is inferred from the behavior of the nominal interest rate and expected inflation, as the real interest rate is defined as the nominal interest rate minus expected inflation.

1979:2–2001:1 and 1985:1–2007:1.[5] The break in 1979 is suggested by the key result in LSS (2007) that the monetary policy response to exogenous movements in expected inflation changed actual inflation dynamics. It is plausible that monetary policy also changed expected inflation dynamics. The post-1979 sub-sample 1979:1–2001:1 is covered in LSS (2007). We consider another post-1979 sub-sample, 1985:1–2007:1, that we get by modifying the sub-sample 1979:1–2001:1, trimming observations from the initial Volcker disinflation era but including more recent observations from the low inflation period of the 2000s. This sub-sample spans a period of relatively low and stable inflation as its start date corresponds roughly to the beginning of the Great Moderation. The pre-1979 sub-sample includes the period of the Great Inflation of the 1970s.[6] We particularly examine how the influences of different variables on expected inflation may have changed across high and low inflation periods. The use of two post-1979 sub-samples helps us discern the influence of initial Volcker disinflation on post-1979 expected inflation dynamics.

The empirical work presented here suggests several conclusions. First, the survey measure of expected inflation moves intuitively in response to several macroeconomic shocks. Generally speaking, expected inflation increases if there is a temporary unanticipated increase in actual inflation, commodity prices, oil prices, or expected inflation itself, whereas it declines if there is a temporary increase in unemployment. However, the strength and durability of those responses, as well as their relative importance in explaining the variability of expected inflation, have changed considerably over time, especially across pre- and post-1979 sample periods.

Shocks to actual inflation, commodity prices, and expected inflation itself have been three major sources of movement in expected inflation. These three shocks together account for about 95 percent of the variability of expected inflation at a four-year horizon in the pre-1979 sample period, whereas they account for a little over 80 percent of the variability in post-1979 sample periods. The modest decline in the relative importance of these three shocks in explaining the variability of expected inflation is in part due to the decline in the relative contribution of commodity price shocks: They account for about 11 to 22 percent of the variability of expected inflation in post-1979 samples, compared to 40 to 50 percent in the pre-1979 sample period.

[5] Other recent research indicating that the responses of inflation to some macroeconomic variables have indeed changed is summarized in Blanchard and Gali (2007) and Mishkin (2007).

[6] Strictly speaking, the first sub-sample period includes the subperiod 1953:1–1965:2 when inflation was also low and stable. Hence, the correct subperiods corresponding to high and low inflation should be 1966:1–1984:1 and 1985:1–2007:1. We, however, follow LSS in breaking up the sample from 1979 for two main reasons. First, the break in 1979 corresponds to the well-known break in the conduct of monetary policy. Second, the use of a somewhat longer sample period (1953:1–1979:1) is necessary for more reliable estimates of VAR parameters, because we have two observations per year due to the use of the Livingston survey data.

Positive shocks to actual inflation, commodity prices, and expected inflation itself lead to increases in expected inflation that are large and long-lasting in the pre-1979 sample period, but muted and short-lived in post-1979 sample periods. The positive response of the real interest rate to several of these shocks, including shocks to expected inflation itself found in the 1979:2–2001:1 sample period but absent in the pre-1979 sample period, is consistent with the view that the above-noted changes in expected inflation dynamics may in part be due to monetary policy, namely, that the Federal Reserve accommodated surprise increases in expected inflation prior to 1979 but not after 1979.

Oil price shocks have only transitory effects on expected and actual inflation in all three sub-sample periods. However, the transitory positive impact of a surprise increase in oil prices on expected inflation has progressively become muted over time, disappearing altogether in the most recent 1985:1–2007:1 sample period. The results also indicate that in response to an unexpected increase in oil prices the real interest rate declines in the pre-1979 sample period, but it increases in post-1979 sample periods. The interest rate responses suggest that the aggressive response of policy to oil shocks since 1979 may in part be responsible for the declining influence of oil prices on expected inflation. The weakened response of inflation expectations to oil price shocks may also explain, in part, the more muted response of actual inflation to oil prices, documented recently in Blanchard and Gali (2007).[7] The result—that there is no longer a significant effect of oil price shocks on inflation expectations—suggests that the Federal Reserve may have earned credibility.

Second, exogenous shocks to expected inflation itself remain a significant source of movement in expected inflation. At a four-year horizon, expectations shocks still account for 35 to 58 percent of the variability of expected inflation in post-1979 sample periods, compared to 36 to 42 percent in the pre-1979 sample period. This result suggests that the Federal Reserve must continue to monitor short-term inflation expectations to ensure that surprise increases in expected inflation do not end up generating persistent increases in actual inflation.

Finally, in the most recent sample period, 1985:1–2007:1, surprise increases in expected inflation die out quickly and expected inflation returns to pre-shock levels within roughly two years after the shock. This response pattern is in the data because the Federal Reserve has not accommodated sudden increases in short-term expected inflation. In such a regime, a positive

[7] Using a VAR, Blanchard and Gali (2007) compare the macroeconomic effects of oil price shocks over two different sample periods, 1970:1–1983:4 and 1984:1–2006:4. Their results also indicate that the response of actual inflation to oil price shocks has become more muted in the more recent sample period. Their VAR, however, does not include inflation expectations and the short-term nominal interest rate and, hence, does not capture the additional channels of expected inflation and policy through which oil prices may affect actual inflation.

shock to short-term expected inflation may lead the public to revise upward their medium- but not necessarily long-horizon expected inflation. Hence, one may find that shocks to short-term expected inflation are no longer correlated with long-term measures of inflation expectations, generating the so-called anchoring of long-term inflation expectations. The fact that one survey measure of long-term inflation expectations—such as the Survey of Professional Forecasters' measure of long-term (10-year) CPI inflation expectations—has held steady since the late 1990s, in contrast to the considerable variation seen before that time, suggests that the public may have come to believe that the Fed would continue not to accommodate temporary shocks to short-term expected inflation.

The rest of the article is organized as follows. Section 1 describes the empirical model. Section 2 presents the empirical results. Section 3 provides further discussion of the results pertaining to expected inflation. Finally, we analyze robustness in Section 4, and provide concluding observations in Section 5.

1. EMPIRICAL METHODOLOGY

Structural Identification

The main advantage of using a structural VAR that contains the Livingston survey measure of expected inflation is that the timing and design of the survey and the way other variables in the VAR are defined and measured help identify exogenous movements in expected inflation. In order to illustrate this identification, consider a VAR that allows for the potential presence of contemporaneous feedbacks among all the five variables contained in the VAR: expected CPI inflation (π_t^e), actual CPI inflation (π_t), the log of a commodity price index (cp_t), the unemployment rate (ur_t), and the three-month Treasury bill rate (sr_t). Shocks to oil prices, captured by disruptions to world oil production due to political events in the Middle East, are assumed exogenous with respect to other variables and therefore are included as a dummy variable (oil_t) in the VAR. We focus on a simple version that allows for only one-period lagged values of endogenous variables as in equation (1):

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \varepsilon_t, \tag{1}$$

where X is a 5 x 1 vector of variables $\left[\pi_t^e, \pi_t, cp_t, ur_t, sr_t\right]$; B , Γ_0 , and Γ_1 are matrices of structural coefficients; and ε_t is a vector of structural shocks $[\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, \varepsilon_{5t}]$. We assume that structural shocks have zero means and are uncorrelated with each other. B is a 5 x 5 matrix, which contains ones along the main diagonal, and its off-diagonal elements are the structural coefficients that allow for the presence of contemporaneous feedbacks among the variables. We can see this clearly if we explicitly write the equations in the structural VAR, as shown in equations (1.1) through (1.5):

$$\pi_t^e + b_{12}\pi_t + b_{13}cp_t + b_{14}ur_t + b_{15}sr_t = \tag{1.1}$$

$$\tau_{10} + \tau_{11}\pi_{t-1}^e + \tau_{12}\pi_{t-1} + \tau_{13}cp_{t-1} + \tau_{14}ur_{t-1} + \tau_{15}sr_{t-1} + \varepsilon_{1t},$$

$$b_{21}\pi_t^e + \pi_t + b_{23}cp_t + b_{24}ur_t + b_{25}sr_t = \tag{1.2}$$

$$\tau_{20} + \tau_{21}\pi_{t-1}^e + \tau_{22}\pi_{t-1} + \tau_{23}cp_{t-1} + \tau_{24}ur_{t-1} + \tau_{25}sr_{t-1} + \varepsilon_{2t},$$

$$b_{31}\pi_t^e + b_{32}\pi_t + cp_t + b_{34}ur_t + b_{35}sr_t = \tag{1.3}$$

$$\tau_{30} + \tau_{31}\pi_{t-1}^e + \tau_{32}\pi_{t-1} + \tau_{33}cp_{t-1} + \tau_{34}ur_{t-1} + \tau_{35}sr_{t-1} + \varepsilon_{3t},$$

$$b_{41}\pi_t^e + b_{42}\pi_t + b_{43}cp_t + ur_t + b_{45}sr_t = \tag{1.4}$$

$$\tau_{40} + \tau_{41}\pi_{t-1}^e + \tau_{42}\pi_{t-1} + \tau_{43}cp_{t-1} + \tau_{44}ur_{t-1} + \tau_{45}sr_{t-1} + \varepsilon_{4t}, \text{ and}$$

$$b_{51}\pi_t^e + b_{52}\pi_t + b_{53}cp_t + b_{54}ur_t + sr_t = \tag{1.5}$$

$$\tau_{50} + \tau_{51}\pi_{t-1}^e + \tau_{52}\pi_{t-1} + \tau_{53}cp_{t-1} + \tau_{54}ur_{t-1} + \tau_{55}sr_{t-1} + \varepsilon_{5t}.$$

Equation (1.1) relates expected inflation to its own lagged value, current and one-period lagged values of actual inflation, commodity prices, the unemployment rate, and the short-term interest rate, suggesting that expected inflation at time t is likely to be influenced by period t values of other variables in the VAR and, hence, is endogenous. If one is interested in recovering the component of expected inflation that is uncorrelated with contemporaneous (and lagged) values of other VAR variables (namely, the shock ε_{1t}), one needs to impose restrictions on the structural coefficients that allow contemporaneous feedback among variables.

One simple identification strategy used in LSS (2007) assumes expected inflation does not respond to contemporaneous information on actual inflation and the other variables of the VAR. In particular, in this recursive identification scheme we impose the following restrictions on the structural coefficients given in B matrix:

$$\left.\begin{array}{r} b_{12} = b_{13} = b_{14} = b_{15} = 0.0 \\ b_{23} = b_{24} = b_{25} = 0.0 \\ b_{34} = b_{35} = 0.0 \\ b_{45} = 0.0 \end{array}\right\}. \tag{2}$$

The restrictions given in equation (2) amount to having a B matrix that contains ones along the main diagonal and zeros above, denoting the identification scheme as $\{\pi_t^e, \pi_t, cp_t, ur_t, sr_t\}$. This identification scheme is recursive, meaning a given variable is correlated only with variables that precede it in the ordering. Thus, the first variable (expected inflation) is not correlated with any other variable of the VAR, the second variable (actual inflation) is contemporaneously correlated only with the preceding expected inflation variable, and so on, and the last variable (short-term nominal interest rate) is correlated with all the preceding variables. This recursive identification scheme is hereafter referred to as benchmark ordering. If we were to focus just on the structural equation for expected inflation, under these restrictions, the expected inflation equation is

$$\pi^e_t = \tau_{10} + \tau_{11}\pi^e_{t-1} + \tau_{12}\pi_{t-1} + \tau_{13}cp_{t-1} + \tau_{14}ur_{t-1} + \tau_{15}sr_{t-1} + \varepsilon_{1t}. \quad (3)$$

Equation (3) is the familiar VAR equation, suggesting that the VAR residuals are estimates of structural shocks to expected inflation under this recursive identification scheme. In general, if we pre-multiply (1) by B^{-1}, we obtain the standard VAR (4):

$$\begin{aligned} X_t &= A_0 + A_1 X_{t-1} + e_t, \quad (4) \\ \text{where } A_0 &= B^{-1}\Gamma_0,\ A_1 = B^{-1}\Gamma_1,\ e_t = B^{-1}\varepsilon_t, \end{aligned}$$

where e_t is a 5 x 1 vector of reduced-form errors, and A_0 and A_1 are matrices of reduced-form coefficients. The identification issue is that of obtaining estimates of structural parameters (B, Γ_0, Γ_1) and structural shocks (ε_t) given estimates of the reduced-form parameters (A_0, A_1) and residuals (e_t). As is well known, we must impose enough identifying restrictions in order to recover structural parameters and shocks. The recursive identification scheme given in (2) imposes 10 restrictions and structural shocks can be recovered using the relationship $\varepsilon_t = Be_t$.[8]

Rationale for Benchmark Ordering

As indicated earlier, the main rationale for the benchmark identification scheme is that the timing and design of the Livingston survey and the way other variables in this structural VAR are defined and measured enable one to assume that the survey participants who forecast CPI inflation at time t do not know the time t realization of inflation and the other variables. Under those assumptions, the restrictions $b_{12} = b_{13} = b_{14} = b_{15} = 0.0$ hold and an expectations shock (ε_{1t}) could be treated as predetermined within the contemporaneous period. As noted previously, the reduced-form error (shock) in the

[8] Quite simply, the identification issue arises because the number of structural parameters we are interested in recovering are usually more than the number of reduced-form parameters that we observe using a reduced-form VAR. Hence, we must impose enough restrictions, thereby reducing the number of structural parameters that need to be recovered. In general, given an $n \times 1$ dimensional VAR and that structural shocks have zero means and are uncorrelated, one needs $\left(n^2 - n\right)/2$ restrictions to identify the structural parameters and shocks. The VAR used here has five variables, so we need 10 restrictions to identify structural parameters and shocks.

expected inflation equation is then an estimate of the structural shock to expected inflation $e_{1t} = \varepsilon_{1t}$.

To analyze robustness we consider an alternative identification ordering. In benchmark ordering, the public's expectations of inflation are not allowed to respond to contemporaneous information on other variables of the VAR, because the public does not observe contemporaneous values of those variables. However, it is plausible that the public has access to other variables that convey information about current values of those variables. Since it is difficult to know what other variables the public may have access to, we examine the sensitivity of our conclusions to an alternative ordering in which expected inflation is ordered last $\{\pi_t, cp_t, ur_t, sr_t, \pi_t^e\}$, thereby allowing expected inflation to respond to contemporaneous information on other variables of the VAR. As indicated later, this alternative ordering yields results that are qualitatively similar to those derived using benchmark ordering.

Measurement of Variables

The structural VAR contains a direct survey measure of the public's expectations of inflation, represented by the median Livingston survey forecast of the eight-month-ahead CPI inflation rate. The participants in this survey are professional forecasters, rather than the general public. Since the Livingston survey is conducted twice a year, the data represent a six-month frequency: May to October and November to April. The timing of the survey and the way the data are measured makes expected inflation a predetermined variable within the contemporaneous period, as explained below.

First, note that survey questionnaires go out to participants 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. The participants receiving the survey, say, in May (when the CPI for April is known) are asked to predict the level of CPI in December, which is an eight-month forecast. Hence, a forecast of CPI inflation made in period t is measured as the log of the ratio of the expected December CPI level to the actual April CPI level.[9] Other variables of the VAR in period t are then measured as follows: Actual inflation in period t is the log of the ratio of the October CPI level to the April CPI level; the commodity price index, the unemployment rate, and the three-month Treasury bill rate in period t are six-month averages of the monthly data (May to October). Together these observations imply that

[9] The participants receive another questionnaire in November and are asked to predict the level of the CPI in June of the next year, generating a forecast of CPI inflation made in period $t + 1$. Actual inflation is for the period between October and April and is constructed as the log of the ratio of the next year's April CPI level to the October CPI level. The CPI, unemployment rate, and the three-month Treasury bill rate in period $t + 1$ are six-month averages of the monthly data (November to April).

the survey participants, when making inflation forecasts at time t (namely, in May), do not know the time t realization of actual inflation and other variables in the VAR.

As indicated above, oil price shocks are included as a dummy variable, thereby implicitly assuming they are predetermined. Oil price shocks are measured in two alternative ways. The first method focuses on oil price increases that might be attributed to drops in world oil production due to political events in the Middle East, as in Hamilton (2003). Hamilton identifies the following episodes associated with exogenous declines (in parentheses) in world petroleum supply: November 1956–Suez Crisis (10.1 percent); November 1973–Arab-Israel War (7.8 percent); December 1978–Iranian Revolution (8.9 percent); October 1980–Iran-Iraq War (7.2 percent); and August 1990–Persian Gulf War (8.8 percent). The oil price shock variable is then the oil supply shock variable, included as a quantitative dummy variable that takes a value equal to the drop in world production for these historical episodes, and is otherwise zero.

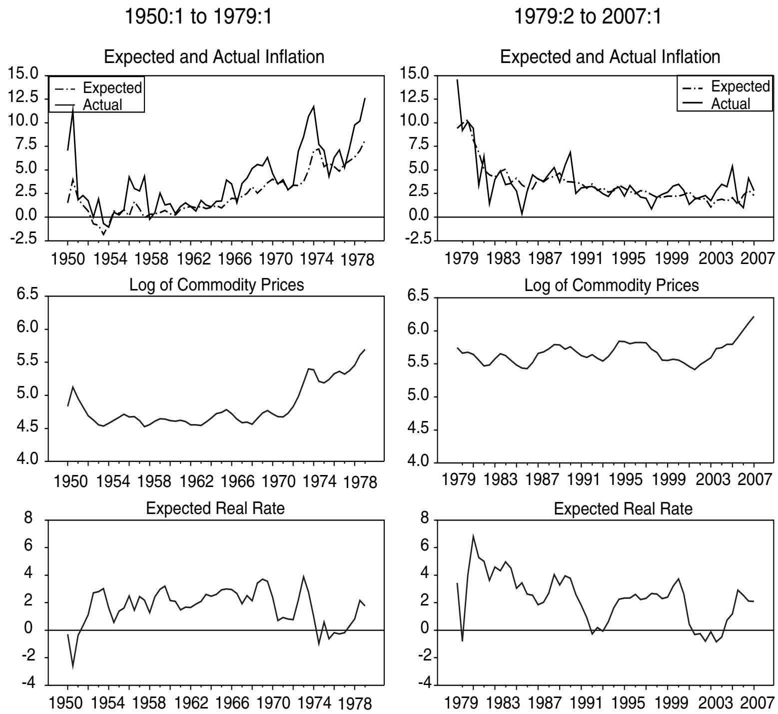
During the most recent period, 1985:1–2007:1, there is only one episode of a drop in world oil production. However, there are several episodes of large increases in oil prices that are due not to drops in world oil production but instead to increases in world demand for oil generated by the growing economies of India, China, and other Asian developing economies. In order to consider such episodes, we consider Hamilton's other measure, net oil price increases, which is a measure of net oil price increases relative to past two-year peaks. We include this measure of net oil price increases as a dummy variable in the VAR, treating it as predetermined with respect to domestic variables included in the VAR. This specification assumes that oil price increases caused by drops in world oil supplies and those caused by increases in world oil demand are alike, having similar consequences for the behavior of macroeconomic variables.[10]

A Visual Look at Data

Figure 1 charts four variables: expected inflation, actual inflation, the log of the commodity price index, and the expected real rate (the three-month Treasury bill rate minus expected inflation). The left panel in Figure 1 charts the data from 1950:1 to 1979:1 and the right panel charts the data from 1979:2 to 2007:1. Several observations stand out. First, even though the actual and expected inflation series move together over time, the Livingston survey participants underpredicted actual inflation when inflation was accelerating and overpredicted inflation during the disinflation of the early 1980s.

[10] Kilian (2007), however, argues otherwise, suggesting it might be important to disentangle the influences of demand- and supply-induced oil price shocks on the economy.

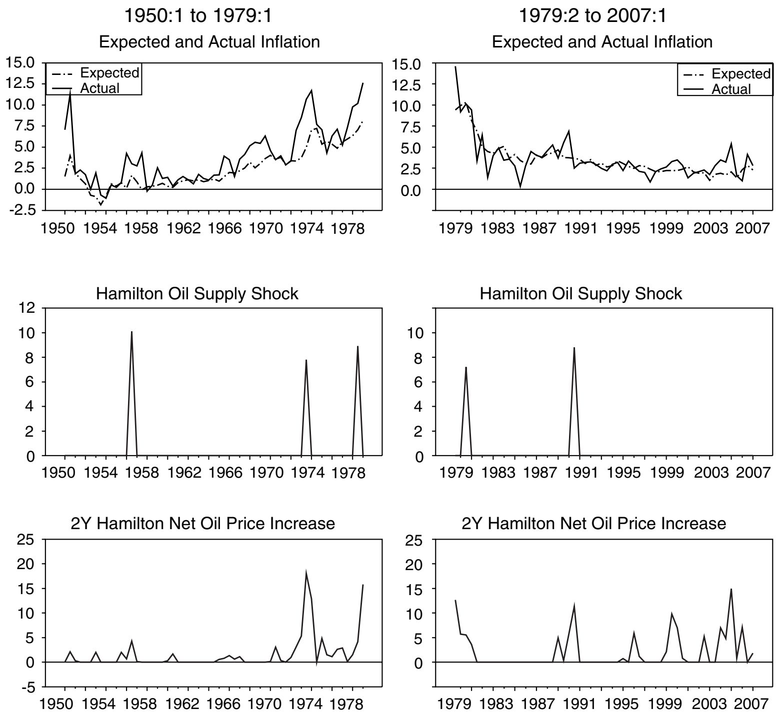
Figure 1 VAR Data



Survey participants could have improved their forecasts by paying attention to actual inflation, suggesting expectations did not respond aggressively to actual inflation. This suggests that the co-movement of the actual and expected inflation series was due more to inflation responding to expectations than expectations responding to inflation. Second, the acceleration in actual inflation does appear to coincide with the pickup in commodity prices. However, the acceleration in inflation appears muted in the post-1985 sample period. Third, Figure 1 also suggests that monetary policy was accommodative in the 1970s. The real interest rate turned negative between 1974 and 1977. By contrast, monetary policy turned very restrictive during the early 1980s, but it again appears accommodative between 2001 and 2004, when the real interest rate turned negative.

Figure 2 charts two measures of oil shocks: one measures drops in world oil production and the other, net oil price increases. Actual and expected inflation are also charted. Two observations stand out. First, oil supply shocks do appear to be associated with spikes in actual inflation in the pre-1979 sample period, but such association appears muted in post-1979 sample periods.

Figure 2 Oil Data



Furthermore, the acceleration in inflation that started during the late 1960s occurred well before the oil shocks of the early 1970s, suggesting that higher oil prices are not a likely explanation of the Great Inflation of the 1970s. Second, in the sample period 1979:2–2007:1, only one episode of a war-related drop in world oil output occurs in 1990, resulting in higher oil prices as measured by net oil price increases. However, the most recent increases in oil prices, as measured by the net oil price increases series, have occurred without a drop in world oil production, suggesting that recent oil price increases could well be due to an increase in global aggregate demand for oil. When comparing the responses of expected inflation to oil shocks across sample periods, the VAR specification employs the second measure of oil shocks, namely, net oil price increases measured relative to past two-year peaks.

Unit Root Properties

As shown in the next section, temporary shocks to some fundamentals (for example, actual inflation, commodity prices) have permanent effects on expected inflation in the pre-1979 sample period, but not in post-1979 sample periods. But temporary shocks can have a permanent effect on expected inflation only if the latter is a unit root process, suggesting the time series properties of expected inflation must have changed prior to and after 1979. In particular, the expected inflation series must have a unit root in the pre-1979 sample period. This observation is confirmed by the augmented Dickey-Fuller test for unit roots; namely, the test results indicate that both expected and actual inflation series have unit roots in the pre-1979 sample period but are stationary in post-1979 sample periods.[11] In order to identify the fundamentals that may be at the source of generating the permanent changes in expected inflation dynamics, we use a VAR that includes those potential fundamentals other than expected inflation.

2. EMPIRICAL RESULTS

In this section, we examine the responses of expected inflation to different shocks. We focus on shocks to actual inflation, commodity prices, and expected inflation itself, because these three shocks together, as discussed below, account for most of the variability in expected inflation. We also discuss the effects of oil shocks on expected inflation.

Responses of Expected Inflation to Different Shocks

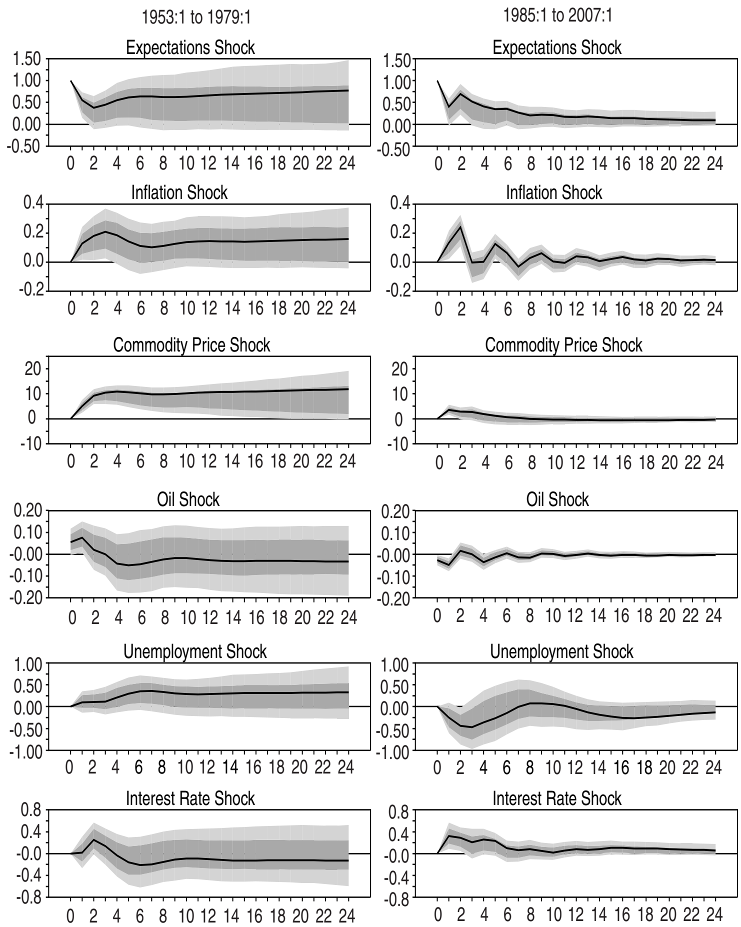
Figures 3 and 4 show the effects of individual, one-time surprise increases in actual inflation, expected inflation, commodity prices, the unemployment rate, interest rate, and oil prices on expected inflation.[12,13] The left panel in Figure 3 shows responses in the Great Inflation (GI) period 1953:1–1979:1, and the right panel shows responses in the Great Moderation (GM) period 1985:1–2007:1; Figure 4 shows responses in the period 1979:2–2001:1 covered in

[11] The test results in LSS (2007) also indicate that expected and actual inflation series have a unit root in the pre-1979 sample period, but are stationary in the post-1979 sample period 1979:1–2001:1 covered there.

[12] Figure 3: The expected inflation responses were generated from a VAR with expected inflation, actual inflation, a CPI, the unemployment rate, the three-month Treasury bill rate, and the Hamilton oil shock variables. For the 1953:1–1979:1 period, oil shock is the shock to the Hamilton oil supply dummy, and for the 1985:1–2007:1 period, oil shock is the shock to the Hamilton net oil price increases. All responses are in percentage terms. The commodity price shock is 100 percent, whereas all other shocks represent 1 percent increases. In each chart, the darker area represents the 68 percent confidence interval and the lighter area represents the 90 percent confidence interval. The x-axis denotes six-month periods.

[13] Figure 4: The expected inflation responses were generated from a VAR with expected inflation, actual inflation, a CPI, the unemployment rate, the three-month Treasury bill rate, and the Hamilton oil supply shock variable. All responses are in percentage terms. The commodity price shock is 100 percent, whereas all other shocks represent 1 percent increases. In each chart, the darker area represents the 68 percent confidence interval and the lighter area represents the 90 percent confidence interval. The x-axis denotes six-month periods.

Figure 3 Expected Inflation Response to. . .



LSS (2007). In these figures, and those that follow, the solid line indicates the point estimate, while the shaded areas represent 68 percent (darker) and 90 percent (lighter) confidence bands.[14]

Focusing first on the responses of expected inflation to expectations, actual inflation, and commodity price shocks, and comparing them across GI and GM periods as seen in Figure 3, expected inflation increases in response to surprise

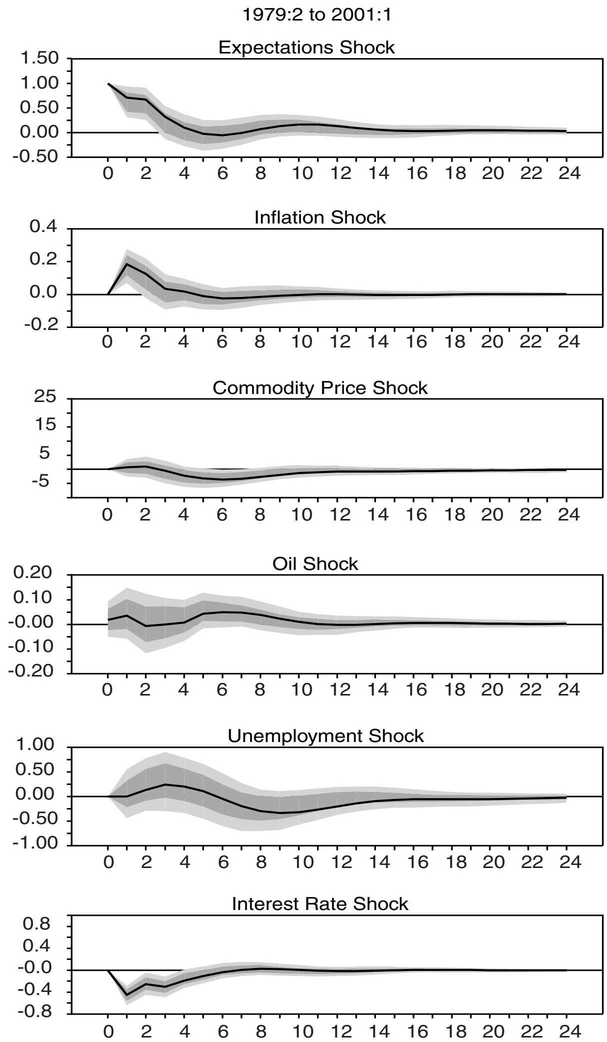
[14] Following LSS (2007), we focus on 68 percent and 90 percent confidence bands. The confidence bands use the bootstrap Monte Carlo method described in Eichenbaum (1998). We would like to thank Keith Sill for providing the programming code used to estimate the confidence bands for the impulse response functions.

increases in each of these three variables. However, both the duration and strength of expectations responses to these three shocks differ substantially across GI and GM sample periods. In the GI period, surprise increases in actual inflation, commodity prices, and expected inflation itself lead to long-lasting increases in expected inflation; in the GM period, those surprise increases have a short-lived effect on expected inflation. To highlight a few features: (a) In response to an expectations shock, expected inflation does not return to its pre-shock level even 12 years after the shock in the GI period, whereas it does so within two years after the shock in the GM period; (b) a similar result holds with respect to the effect of a surprise increase in commodity prices on expected inflation; namely, expected inflation does not return to its pre-shock level in the GI period, whereas it does so within one year in the GM period; (c) in both GI and GM periods, expectations shocks have a much larger effect on the public's expectations inflation than do actual inflation shocks. For example, in the GI period, expected inflation remains at about a .8 percent higher level in response to a one-time 1 percent surprise increase in expected inflation, whereas it remains at about a .2 percent higher level in response to a 1 percent surprise increase in actual inflation. In the GM period, about two years after the shock, expected inflation is still about .4 percent above its pre-shock level in response to a 1 percent surprise increase in expected inflation, whereas it is back to its pre-shock level in response to a 1 percent surprise increase in actual inflation. The previous result also suggests that expected inflation returns more slowly to its pre-shock level after an exogenous shock to expectations than it does in response to an actual inflation shock (see relevant panels in Figure 3).

In traditional Phillips curve inflation models, rising unemployment indicates rising slack in the economy and, hence, should lead the public to expect lower inflation. Similarly, a positive monetary policy shock implies lower inflation and, hence, should lower expected inflation. If we examine the responses of expected inflation to unemployment and monetary policy shocks, the results are mixed (see Figure 3). In response to a surprise increase in the unemployment rate, expected inflation declines only in the GM sample period. The response of expected inflation to a surprise increase in the short nominal interest rate is positive, but these responses are generally not statistically significant. In contrast, the effect of an exogenous oil supply shock on expected inflation is positive and statistically significant in the GI period. However, in the GM sample period, higher oil prices do not have a positive effect on expected inflation. We discuss more about oil price shocks later.

Figure 4 shows the responses of expected inflation to different shocks in the 1979:2–2001:1 sample period. These responses are qualitatively similar to those found in the GM period 1985:1–2007:1 in the sense that shocks lead to changes in expected inflation that are muted and short-lived. Expected inflation still increases in response to a temporary increase in actual inflation or

Figure 4 Expected Inflation Response to…



expected inflation itself. However, a temporary increase in commodity prices, oil prices, or unemployment has no effect on expected inflation. In contrast, expected inflation declines in response to a surprise increase in the short nominal interest rate, and this drop in expected inflation is statistically significant, suggesting monetary policy actions can directly influence the public's expectations of inflation.

Table 1 Variance Decomposition of Expected Inflation

Steps	Ordering: π^e, π, cp, ur, sr					Ordering: π, cp, ur, sr, π^e				
	Sample Period 1953:1 to 1979:1									
n	π^e	π	cp	ur	sr	π^e	π	cp	ur	sr
1	100.00	0.00	0.00	0.00	0.00	74.06	1.53	2.74	19.32	2.35
2	83.72	4.55	11.39	0.33	0.01	66.04	8.08	8.72	14.86	2.30
3	58.17	8.55	30.82	0.44	2.01	47.53	12.16	25.30	10.03	4.97
4	45.14	11.04	41.55	0.50	1.78	38.75	14.81	34.29	7.56	4.59
8	35.86	8.48	51.34	2.64	1.69	41.62	12.16	40.41	3.77	2.03
16	34.05	7.21	54.26	3.29	1.20	43.88	11.00	41.64	2.50	0.99
	Sample Period 1979:2 to 2001:1									
Steps	Ordering: π^e, π, cp, ur, sr					Ordering: π, cp, ur, sr, π^e				
n	π^e	π	cp	ur	sr	π^e	π	cp	ur	sr
1	100.00	0.00	0.00	0.00	0.00	58.52	11.16	17.21	10.02	3.09
2	71.42	15.79	0.23	0.00	12.56	38.49	34.19	11.69	5.81	9.82
3	69.51	17.31	0.50	0.25	12.44	36.51	38.15	12.10	4.56	8.68
4	66.96	16.23	0.55	0.97	15.30	37.85	36.35	11.23	4.23	10.34
8	58.07	14.37	10.77	1.82	14.97	35.59	31.91	17.87	4.69	9.94
16	54.47	12.89	13.35	5.89	13.40	33.25	28.72	17.41	11.63	9.00
	Sample Period 1985:1 to 2007:1									
Steps	Ordering: π^e, π, cp, ur, sr					Ordering: π, cp, ur, sr, π^e				
n	π^e	π	cp	ur	sr	π^e	π	cp	ur	sr
1	100.00	0.00	0.00	0.00	0.00	89.10	7.78	2.83	0.29	0.00
2	74.89	2.69	18.39	3.12	0.91	61.13	10.92	23.41	3.63	0.91
3	58.22	14.05	18.36	3.61	5.76	41.48	25.21	23.37	4.18	5.76
4	52.44	14.34	19.54	5.13	8.56	35.30	25.58	24.77	5.80	8.55
8	54.25	12.93	16.24	6.69	9.89	35.45	25.30	21.58	7.79	9.88
16	50.48	11.08	19.88	9.43	9.13	35.22	22.77	21.99	10.89	9.12

Notes: Entries are in percentage terms with the exception of those under the column labeled "steps." Those entries refer to n-step-ahead forecasts for which decomposition is done.

How important are different shocks in accounting for the variability of expected inflation? Table 1 presents the variance decompositions of expected inflation in three sample periods, with the left panel containing results for benchmark ordering and the right panel for the ordering in which expected inflation is placed last. We focus on the variance of the eight-step-ahead forecast error (which corresponds to four years) that is attributable to each variable of the VAR. As one can see, shocks to actual inflation, commodity prices, and expected inflation itself together account for approximately 95 percent of the variability of expected inflation in the pre-1979 sample period, but account for a little over 80 percent in post-1979 sample periods. The decline in the relative importance of these three shocks that explain variability of expected inflation in post-1979 sample periods is in part due to a decline in the relative contribution of commodity prices: commodity price shocks account for 11 to 22 percent of the variance of expected inflation compared with 40 to 50 percent in the pre-1979 sample period.

3. MONETARY POLICY EXPLANATION OF THE CHANGE IN THE DYNAMIC RESPONSES OF INFLATION TO SHOCKS

As noted before, Leduc, Sill, and Stark (2007) argue that weakness in the monetary policy response to surprise movements in expected inflation can explain the persistent high inflation of the 1970s. In particular, they find that both nominal and real interest rates rose significantly in response to surprise increases in expected inflation in the post-1979 sample period, but not in the pre-1979 sample period. They interpret this evidence as indicating that the Federal Reserve accommodated increases in the public's expectations of inflation pre-1979, but not post-1979.

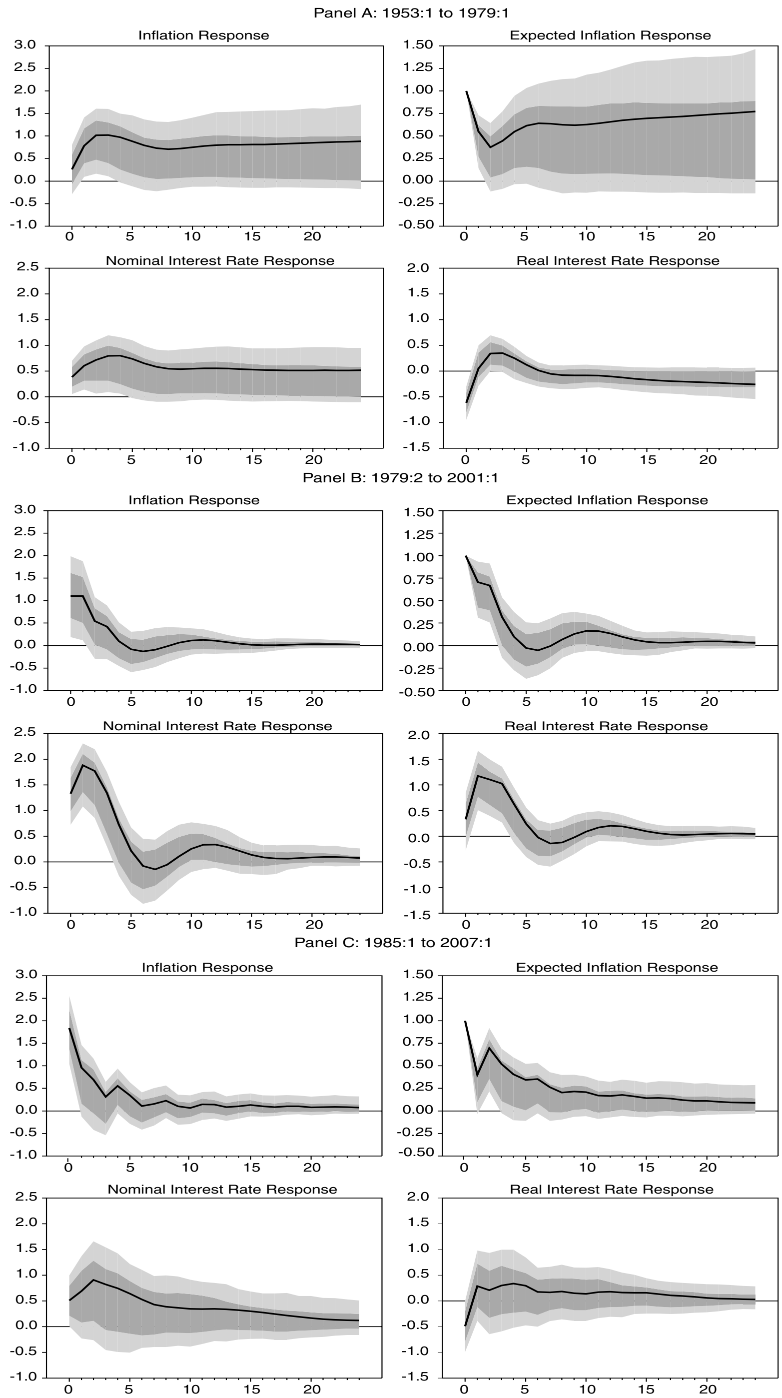
Figure 5 reproduces the above-noted result: It charts the dynamic responses of actual inflation, expected inflation, and nominal and real interest rates to an expectations shock, with the graphs in panels A and C covering sample periods 1953:1–1979:1 and 1985:1–2007:1 and the graphs in panel B spanning the sample period 1979:2–2001:1.[15] Note that the real rate increases significantly in response to an expectation shock in the sample period 1979:2–2001:1, whereas such a response is absent in the pre-1979 sample period.[16] In the most recent sample period (1985:1–2007:1) that includes the 2000s, the response of the nominal interest rate to an expectations shock is somewhat muted relative to the 1979:2–2001:1 sample period, so much so that the real rate initially declines and returns to its pre-shock level just one period after the shock (see graphs in panel C).[17] Since this is the sample period during which inflation has been low and stable and inflation expectations stabilized, the interest rate response to a shock to expected inflation is not as aggressive as it was when the Federal Reserve was trying to disinflate during the early 1980s. However, one must be aware of the fact that a shock to expected inflation gets reversed and no longer leads to a persistent increase in actual inflation,

[15] Figure 5: Responses to a 1 percent shock to expected inflation. The responses are generated from a VAR with expected inflation, actual inflation, CPI, the unemployment rate, the three-month Treasury bill rate, and a Hamilton oil dummy. For the 1953:1–1979:1 and 1979:2–2001:1 samples, the dummy is the Hamilton oil supply shock. For the 1985:1–2007:1 sample, the dummy is the Hamilton net oil price increase. To conserve space, we report the responses of expected inflation, actual inflation, and nominal and real interest rates. All responses are in percentage terms. In each chart, the darker area represents the 68 percent confidence interval and the lighter area represents the 90 percent confidence interval. The x-axis denotes six-month periods.

[16] As shown in LSS (2007), the strong response of the nominal interest rate to a shock to expected inflation over 1979:2–2001:1 is not driven by the initial Volcker disinflation period. The LSS paper finds such a strong interest rate response over 1982:1–2001:1.

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

Figure 5 Shock to Inflation Expectations



precisely because the public believes the Federal Reserve will continue not to accommodate and, hence, keep inflation low and stable.

Expected Inflation Response to Commodity Prices

As noted above, commodity prices have had significantly less influence on expected inflation over time. The dynamic response of expected inflation to a commodity price shock exhibited in Figures 3 and 4 clearly indicates that the effect of a surprise increase in commodity prices on expected inflation is long lasting in the pre-1979 sample period but short-lived in post-1979 sample periods. Figure 6 shows the responses of nominal and real interest rates to a commodity price shock for three sample periods, in addition to showing the responses of actual and expected inflation.[18] If we focus on the graph for the sample period 1953:1–1979:1, we see that nominal and real interest rates initially increase in response to a surprise increase in commodity prices, but the nominal interest rate does not rise enough to offset the commodity-induced increase in expected inflation, leading to a decline in the real rate. This drop in the real rate persists and is statistically significant, with the expected real rate remaining negative even 12 years after the shock. In contrast, the response of the real interest rate to a commodity shock is quite different in post-1979 sample periods. In particular, in the 1985:1–2007:1 sample period the real interest rate increases and remains positive for about six months after the shock (compare graphs across Panels A and C, Figure 6). These results are consistent with the view that the Federal Reserve's aggressive response to commodity prices is responsible for generating the short-lived response of expected inflation to a commodity shock. The public believes the Fed will continue to restrain inflation, thereby limiting the pass-through of higher commodity prices into expected and actual inflation.

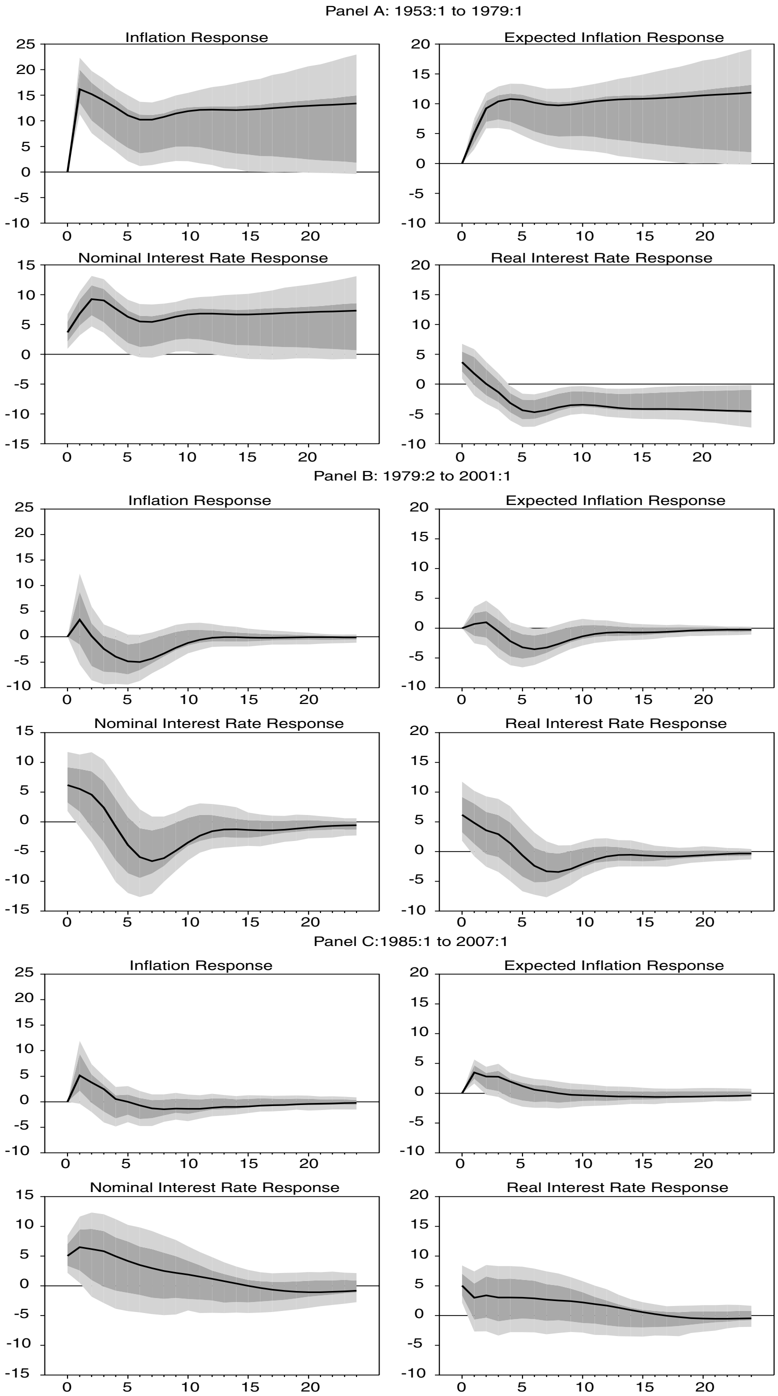
Expected Inflation Response to Oil Price Shocks

Figure 7 shows the responses of actual inflation, expected inflation, nominal interest, and the real interest to oil price shocks.[19] As indicated above,

[18] Figure 6: Responses to a 100 percent shock to the CPI. The responses are generated from a VAR with expected inflation, actual inflation, a CPI, the unemployment rate, the three-month Treasury bill rate, and a Hamilton oil dummy. For the 1953:1–1979:1 and 1979:2–2001:1 samples, the dummy is the Hamilton oil supply shock. For the 1985:1–2007:1 sample, the dummy is the Hamilton net oil price increase. To conserve space, we report the responses of expected inflation, actual inflation, and nominal and real interest rates. All responses are in percentage terms. In each chart, the darker area represents the 68 percent confidence interval and the lighter area represents the 90 percent confidence interval. The x-axis denotes six-month periods.

[19] Figure 7: Responses to a 10 percent shock to the Hamilton net oil price increases. The responses are generated from a VAR with expected inflation, actual inflation, a CPI, the unemployment rate, the three-month Treasury bill rate, and the Hamilton net oil price dummy

Figure 6 Commodity Price Shock



oil price increases that have occurred during the past few years are likely due to increased global demand for oil rather than to disruptions in Middle East oil production. In order to compare the effects of an oil price increase on macroeconomic variables across sample periods, we employ Hamilton's (2003) net oil price increases as the oil shock measure.

The responses to oil price shocks shown in Figure 7 suggest several conclusions. First, oil price shocks have only transitory effects on actual and expected inflation in all three sample periods considered here. Since oil shocks have a transitory effect on actual inflation, it is unlikely that oil shocks can account for the persistently high inflation of the 1970s, as noted in LSS (2007).

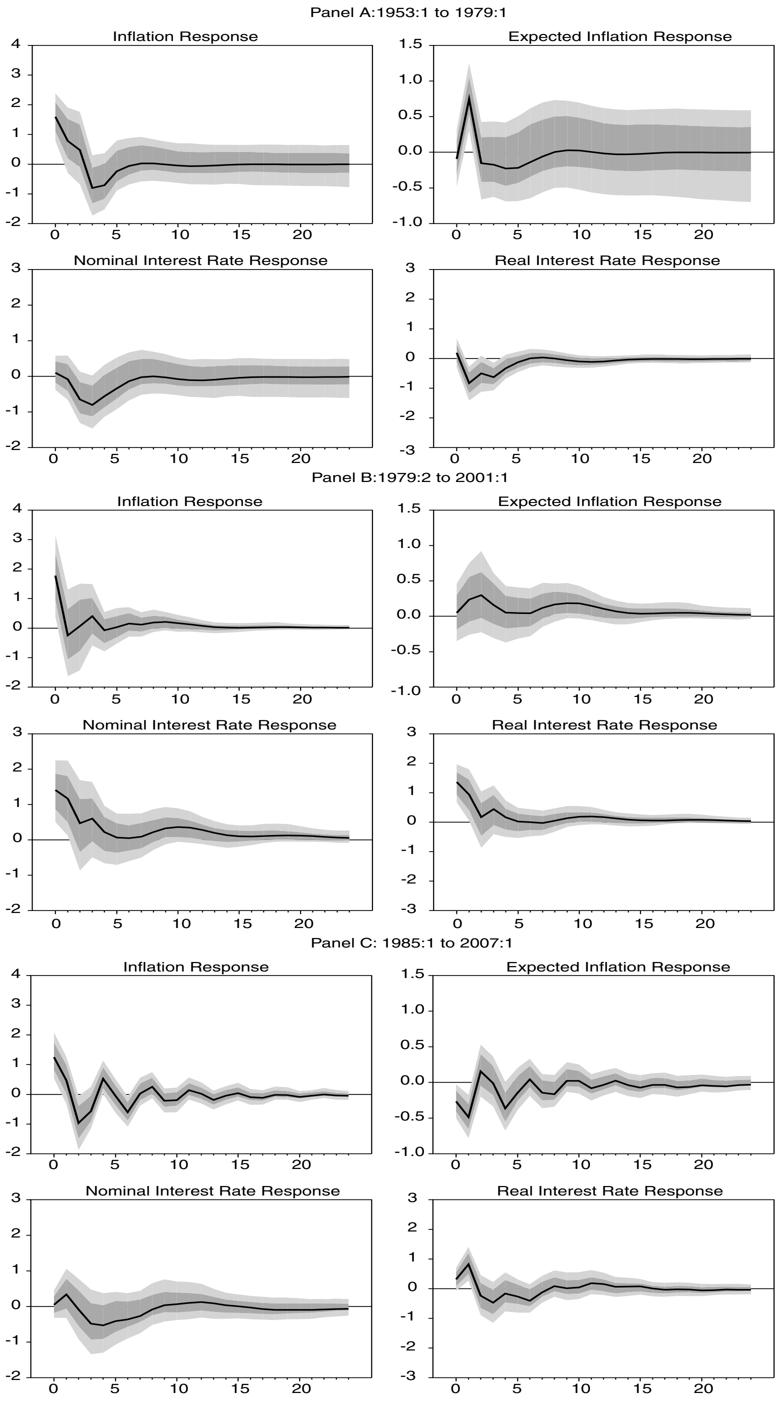
Second, the transitory positive effects of oil price shocks on actual and expected inflation are muted and reversed somewhat sooner in post-1979 sample periods. In the pre-1979 sample period, a positive oil price shock leads a transitory increase in both actual and expected inflation, and those increases are statistically significant (see Figure 7, Panel A). In post-1979 sample periods, however, while a positive oil price shock does lead to an increase in actual inflation, its effect on expected inflation is absent. In fact, in the most recent sample period, 1985:1–2007:1, the initial response of expected inflation to a positive oil price shock is negative and statistically significant. These results appear to be consistent with a view that the public believes the oil-induced increase in actual inflation is likely to be reversed soon and, hence, does not revise its forecast of inflation.

Third, the interest rate responses to oil shocks shown in Figure 7 indicate that monetary policy may in part be responsible for the muted responses of actual inflation to oil shocks found in the most recent sample period, 1985:1–2007:1. In the pre-1979 sample period, the real interest rate declines in response to a positive oil shock, the drop remaining significant up to two years after the shock. In the 1979:2–2001:1 sample period, however, the real interest rate rises significantly following the oil price shock. In the most recent sample period, 1985:1–2007:1, the real interest rate still rises due to a decline in expected inflation. Together these estimates suggest that the aggressive response of policy to oil shocks beginning in 1979 may have been responsible for the muted responses of actual inflation to oil shocks observed in the most recent sample period. The weakened response of expected inflation to oil price shocks may have also contributed to a much more muted response of actual inflation to oil shocks. The negative response of expected inflation to oil shocks also suggests that the public believes the Federal Reserve will continue to restrain inflation and, hence, will not nudge up its forecasts of

---

variables. To conserve space, we report the responses of expected inflation, actual inflation, and nominal and real interest rates. All responses are in percentage terms. In each chart, the darker area represents the 68 percent confidence interval and the lighter area represents the 90 percent confidence interval. The x-axis denotes six-month periods.

Figure 7 Oil Shocks



inflation, despite oil-induced increase in actual inflation. The result—positive oil price shocks do not lead the public to raise its inflation forecast—suggests the Federal Reserve may have earned credibility.

4. EXPECTATIONS SHOCKS: OMITTED FUNDAMENTALS OR SUNSPOTS?

The results pertaining to the variance decomposition of expected inflation presented here indicate that exogenous shocks to expected inflation remain a significant source of movement in expected inflation, even after controlling for its other determinants, such as commodity prices, actual inflation, the unemployment rate, and monetary policy. It is plausible that this VAR does not include some relevant determinants of expected inflation, so that the identified expectations shocks represent the omitted fundamentals. The evidence favoring this view appears in Ang, Bekaert, and Wei (2006), who show that surveys outperform several alternative methods of forecasting inflation and may be capturing information from many different sources not captured by a single model. Moreover, the VAR includes lagged values of fundamentals and, hence, the information captured is backward-looking, whereas survey participants may be responding to information about fundamentals that is forward-looking, namely, the likely expected future values of fundamentals. Finally, the VAR model captures linear relationships among the variables, ignoring any nonlinearity that may be present in the structural equations.

It is equally plausible that exogenous shocks reflect sunspots (nonfundamentals) like random movements in moods of survey participants. In fact, Goodfriend (1993), using a narrative approach, has argued that financial market participants have experienced inflation scares and that, by reacting to inflation scares with a delay, the Federal Reserve generated an upward trend in actual inflation in the 1970s. Such behavior, however, is absent post-1979, when the Federal Reserve, by reacting strongly to inflation scares, prevented such inflation scares from generating persistent increases in actual inflation.

Although it is difficult to identify and test for all potential omitted fundamentals that may be driving movements in expected inflation, the LSS paper does consider some possible candidates. In particular, the paper backs out the structural shocks to expected inflation implied by the VAR model (using the relationship $\varepsilon_t = Be_t$) and then tests whether shocks to expected inflation are related to other macrovariables such as the Producer Price Index, the S&P 500 stock index, the monetary base, and the exchange rates. The results there indicate that none of the variables predict expectations shocks at the 5 percent significance level. But as indicated above, all these variables capture information that is backward-looking. Hence, the issue of whether exogenous movements in expected inflation represent omitted fundamentals or nonfundamentals, akin to inflation scares in Goodfriend (1993), is unsettled.

5. ANALYZING ROBUSTNESS

The major conclusions of this article appear robust to changes in some specifications of the VAR. In particular, in an alternative identification scheme in which we allow expected inflation to respond to all other variables of the VAR within the contemporaneous period, the responses of expected inflation to various shocks do not differ substantially from those found in the benchmark identification, with the exception of the unemployment rate. In particular, expected inflation declines in response to surprise increases in the unemployment rate in both sample periods.

6. CONCLUDING OBSERVATIONS

Using a VAR that includes a survey measure of the public's expectations of inflation represented by the Livingston survey of expected inflation, this article investigates the responses of expected inflation to temporary shocks to several macroeconomic variables over three sample periods, 1953:1–1979:1, 1979:2–2001:1, and 1985:1–2007:1. The empirical work presented suggests that expected inflation moves in an intuitive manner in response to several of these macroeconomic shocks. Generally speaking, expected inflation increases if there is a temporary surprise increase in actual inflation, commodity prices, oil prices, or expected inflation itself, whereas it declines if there is a temporary increase in unemployment. However, the strength and durability of these responses, as well as their relative importance in explaining the variability of expected inflation, have changed considerably across pre- and post-1979 sample periods.

Shocks to actual inflation, commodity prices, and expected inflation itself have been three major sources of movement in expected inflation. These three shocks together account for about 95 percent of the variability of expected inflation at a four-year horizon in the pre-1979 sample period, whereas they account for a little over 80 percent of the variability in post-1979 sample periods. The modest decline in the relative importance of these three shocks in explaining the variability of expected inflation is in part due to the decline in the relative contribution of commodity price shocks: they account for only 11 to 22 percent of the variability of expected inflation in post-1979 sample periods, compared to 40 to 50 percent in the pre-1979 sample period.

The results indicate that temporary positive shocks to actual inflation, commodity prices, and expected inflation itself lead to increases in expected inflation that are long-lasting in the pre-1979 sample period but are muted and short-lived in post-1979 sample periods. This change in the dynamic responses of expected inflation to these shocks across sample periods can be attributed to monetary policy, as the real interest rate rises significantly in response to several of these shocks in post-1985 sample periods, thereby preventing temporary shocks from generating persistent increases in expected and actual inflation.

The empirical work indicates oil price shocks have only transitory effects on expected and actual inflation in all three sub-sample periods. However, the transitory positive impact of a surprise increase in oil prices on expected inflation has progressively become muted over time, disappearing altogether in the most recent period 1985:1–2007:1. The results also indicate that in response to a surprise increase in oil prices, the real interest rate declines in the pre-1979 sample period, but it increases in post-1979 sample periods. The interest rate responses suggest that the aggressive response of policy to oil shocks since 1979 may in part be responsible for the declining influence of oil prices on expected inflation. The result that there is no longer a significant effect of oil price shocks on inflation expectations suggests the Federal Reserve may have earned credibility.

Exogenous shocks to expected inflation itself remain a significant source of movement in expected inflation. At a four-year horizon, expectations shocks still account for 35 to 58 percent of the variability of inflation expectations in post-1979 sample periods, compared with 36 to 42 percent in the pre-1979 sample. This result suggests that the Federal Reserve must continue to monitor the public's short-term inflation expectations to ensure that surprise increases in expected inflation do not end up generating persistent increases in actual inflation.

Finally, in the recent sample period, 1985:1–2007:1, surprise increases in expected inflation (the measure of short-term inflation expectations) die out quickly, with expected and actual inflation returning to pre-shock levels within about two years after the shock. This response pattern is in the data because the Federal Reserve has not accommodated the increase in actual inflation. In such a regime, a positive shock to short-term expectations may lead the public to revise upward their medium- but not necessarily long-horizon expectations of inflation. Hence, one may find that shocks to short-term inflation expectations are no longer correlated with long-term measures of inflation expectations, generating the so-called anchoring of long-term inflation expectations. The fact that one survey measure of long-term inflation expectations—such as the Survey of Professional Forecasters' measure of long-term (10-year) CPI inflation expectations—has held steady since the late 1990s, in contrast to the considerable variation seen before that time, suggests that the public may have come to believe that the Fed will continue not to accommodate temporary shocks to short-term expectations.

REFERENCES

Ang, Andrew, Geert Bekaert, and Min Wei. 2006. “Do Macro Variables, Asset Markets, or Surveys Forecast Inflation Better?” Finance and Economics Discussion Series 2006-15, Board of Governors of the Federal Reserve System.

Bernanke, Ben S. 2007. “Inflation Expectations and Inflation Forecasting.” Remarks at the Monetary Economics Workshop of the NBER Summer Institute, Cambridge, Mass., 10 July.

Blanchard, Olivier J., and Jordi Gali. 2007. “The Macroeconomic Effects of Oil Price Shocks: Why Are the 2000s So Different from the 1970s?” Working Paper 13368. Cambridge, Mass.: National Bureau of Economic Research. (September).

Eichenbaum, M. 1998. “Costly Capital Reallocation and the Effects of Government Spending: A Comment.” Carnegie Rochester Conference on Public Policy, 48: 195–209.

Goodfriend, M. 1993. “Interest Rate Policy and the Inflation Scare Problem: 1979–1992.” Federal Reserve Bank of Richmond *Economic Quarterly* 79 (Winter): 1–24.

Hamilton, J.D. 2003. “What is an Oil Shock?” *Journal of Econometrics* 113: 363–98.

Kilian, Lutz. 2007. “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market.” University of Michigan and CEPR.

Leduc, Sylvain, Keith Sill, and Tom Stark. 2007. “Self-Fulfilling Expectations and the Inflation of the 1970s: Evidence from the Livingston Survey.” *Journal of Monetary Economics* 54: 433–59.

Mankiw, N. Gregory, Ricardo Reis, and Justin Wolfers. 2003. “Disagreement about Inflation Expectations.” Working Paper 9796. Cambridge, Mass.: National Bureau of Economic Research. (June).

Mishkin, Frederick S. 2007. “Inflation Dynamics.” Working Paper 13147. Cambridge, Mass.: National Bureau of Economic Research. (June).