Oil Price Shocks, Monetary Policy and Stagflation

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Abstract: One of the central questions in recent macroeconomic history is to what extent monetary policy as opposed to oil price shocks contributed to the stagflation of the 1970s. Understanding what went wrong in the 1970s is the key to learning from the past. One explanation explored in Barsky and Kilian (2002) is that worldwide shifts in monetary policy regimes not related to the oil market played a major role in causing both the major oil price increases of the 1970s and stagflation in many economies. A competing view exemplified by Bernanke, Gertler and Watson (1997) is that the oil price shocks of the 1970s and 1980s arose exogenously with respect to global macroeconomic conditions, but were propagated by the reaction of monetary policy makers, causing stagflation in the process. This paper reviews the evidence for these two main explanations, interprets recent events in light of this evidence, and outlines implications for monetary policy.

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1. Introduction

One of the central questions in recent macroeconomic history is to what extent monetary policy as opposed to oil price shocks contributed to the stagflation of the 1970s. Understanding what went wrong in the 1970s is the key to learning from the past. One explanation explored in Barsky and Kilian (2002) is that worldwide shifts in monetary policy regimes not related to the oil market played a major role in causing both the subsequent oil price increases and stagflation in many economies. A competing view exemplified by Bernanke, Gertler and Watson (1997) is that the oil price shocks of the 1970s arose exogenously with respect to global macroeconomic conditions, but were propagated by the reaction of monetary policy makers, causing stagflation in the process. The argument is that policy makers responded to the inflationary pressures caused by oil price shocks by raising interest rates, thereby causing a deep recession that would not have occurred without the central bank's intervention. If policy makers are only partially successful in controlling inflation, stagflation will ensue.

A challenge for macroeconomists is to explain why stagflation never occurred again after the 1970s and more generally why the economy has remained remarkably resilient to the sustained real oil price increases of 2003-mid 2008. Although Hamilton (2009) documented that these oil price increases ultimately have contributed to the economic decline that followed the financial crisis of 2007/08, without doubt this response has been far more muted, smaller in magnitude, and more delayed than most economists would have imagined based on the historical precedent of the 1970s and early 1980s. Moreover, even granting that oil price increases contributed to the current recession, inflation has remained stable and there is no evidence of stagflation. The question is what makes recent events so different from the earlier episodes of oil price shocks in the 1970s.

The analysis of Barsky and Kilian (2002) implies that given the absence of major shifts in monetary policy regimes since the 1980s there is no reason to expect stagflation to occur. In other words, monetary policy makers appear to have internalized the lessons of the past. Unlike in the 1970s, price stability has become universally accepted as the key objective of monetary policy. To the extent that the public views the central bank's commitment to price stability as credible, the pass-through from oil price shocks to the domestic price level is not associated with sustained inflation. This view fully explains the absence of stagflation in recent years, but necessitates an alternative explanation of the recent surge in the real price of oil. Kilian (2009a)

and Kilian and Hicks (2009) have made the case that indeed this latest oil price shock was driven not by monetary policy shifts in OECD economies as in the 1970s, but by structural economic changes in emerging Asia.

If we believe that stagflation is caused by the endogenous monetary policy response to oil price shocks, in contrast, we may try to explain the absence of stagflation as the result of improved monetary policy responses to oil price shocks. In that view, the central bank – by quenching completely the inflationary pressures associated with unexpectedly high oil prices – prevents stagflation from arising, but at the cost of a recession. The problem is that the data do not show a significant recession between 2003 and mid-2008, so this explanation seems implausible. An alternative explanation is that oil price shocks are no longer as inflationary as they used to be, allowing the central bank to respond less aggressively to a given oil price shock. For example, Blanchard and Galí (2008) recently made the case that the U.S. economy has become much more flexible since the 1980s and that the real wage rigidities that are thought to have characterized the U.S. economy in the 1970s have been greatly reduced. Such a structural change could help explain the remarkable resilience of the U.S. economy to the sustained oil price increases of 2003-07.

In sections 2 and 3 of the paper, I explore the evidence for these two main explanations and outline implications for monetary policy. In section 4, I consider explanations for the diminished importance of oil price shocks, including the hypothesis that U.S. real-wage rigidities have diminished. Section 5 investigates to what extent oil demand and oil supply shocks are inherently stagflationary. In section 6, I highlight differences between the 2003-08 oil price shock and earlier oil price shock episodes. Section 7 discusses how the central bank should respond to oil price shocks in the context of the 2003-08 oil price shock. Further policy implications are discussed in section 8.

2. Shifts in Monetary Policy Regimes

There has been much interest in the Great Moderation in recent years, but a longer historical perspective reveals that U.S. macroeconomic performance in the 1990s was not so different from the early 1960s. The aberration appears to be the period of the 1970s and early 1980s. Barsky and Kilian (2002) suggest that the 1970s were different from the preceding and following decade because of the absence of effective constraints on monetary policy. They document that the

beginning and end of the 1970s coincided with major shifts in monetary policy regimes. The initial shift toward a less restrictive monetary policy regime became apparent with the breakdown of Bretton Woods, which loosened the remaining constraints on national monetary policy. As a result monetary policy lost its anchor. An anchor was reestablished only under Paul Volcker after 1979. Similar shifts in monetary policy took place in many OECD countries at the same time.

As the world economy entered uncharted territory in the early 1970s with the emergence of flexible exchange rates and as the long post-war expansion appeared to come to an end, there was much uncertainty among policy makers and the public about the rules of the game. Policy making entered a stage of experimentation and learning. There was increased concern about the level of employment and central bankers felt the responsibility to stimulate employment by loosening monetary constraints, even if that perhaps meant some moderate inflation. There was a collective sense in industrialized countries that some action was required.[1]

Barsky and Kilian (2002) document a dramatic increase in worldwide liquidity in the early 1970s, representing a departure from historical precedent. If inflation is sluggish, as would be the case if the public is slow to catch on to the shift in monetary policy regime, it can be shown that an unexpected monetary expansion will create a temporary output boom. Inflation will rise only slowly initially, but will continue to rise even after output has peaked, resulting in stagflation. As inflation peaks, the economy goes into recession. In practice, this recession was deepened by the decision of the central bank to raise interest rates to combat the inflationary pressures it had itself unwittingly created, as discussed in section 3.

If we grant this explanation, why were policy makers so slow to catch up to their mistake? One reason is that the acceleration of inflation coincided with the oil price shock of late 1973 and early 1974 which seemed to provide a natural explanation of the inflationary pressures at the time. After all, monetary policy seemed to have worked just fine prior to the oil price shock. Indeed, central bankers following the recession of 1974/75 reverted to the same go-and-stop monetary policies they had adopted in the early 1970s, causing another real output boom in the late 1970s. As the public increasingly caught up to the change in monetary policy regime, however, stimulative policies became less effective and inflation a growing concern.

[1] With the benefit of hindsight we know that central bankers had misperceptions about the level of potential output and about the extent to which inflationary pressures would materialize. Nor did they fully appreciate the risk of undermining the central bank's credibility in the eyes of the public.

Only when Paul Volcker stepped in in 1979 and insisted on the primacy of the inflation objective to the detriment of the employment objective, this cycle was broken. The monetary tightening under Volcker represented a regime shift back toward a more stable regime. As in the case of the initial shift, the public was slow to accept the permanency of the shift and inflation was slow to come down, even as the economy went into a sharp recession in the early 1980s. In essence, the same model that explains the early 1970s also applies to the early 1980s, except in reverse.

Given that central bankers worldwide have accepted the primacy of the inflation objective, it is not surprising that there have been no more outbreaks of stagflation ever since the 1970s. There have been several more oil price shocks, however, which were not followed by stagflation, suggesting that such shocks are not inherently stagflationary. The fact that both inflation surges in the early and late 1970s coincided with major increases in the real price of oil is no coincidence, however. Economic theory predicts that the real price of oil as well as other industrial commodities responds endogenously to fluctuations in global real activity, as the demand for industrial commodities is tied to the state of the global business cycle. To the extent that the increases in global liquidity in the early and mid-1970s fostered a global output boom, they also drove up the prices of oil and other industrial commodities. Much has been made of the quadrupling of nominal oil prices in the early 1970s, for example, but it is easy to forget that similar increases were common in other industrial commodity prices.[2] Recognizing the endogeneity of the price of oil is important, because it means that a substantial part of the oil price increases of the 1970s was not a causal factor, but rather a symptom of deeper causes, namely the preceding monetary expansions. It also means that we cannot think of these oil price shocks as occurring in isolation, while holding everything else constant. Rather they are part of a broader pattern of price and quantity responses triggered by the earlier monetary policy regime shift.

The fact that the oil price increases of the 1970s were driven in substantial part by a shift in the monetary policy regime does not mean that *all* oil price shocks are due to monetary policy shifts. In fact, these were the only episodes in history in which monetary policy regime shifts

[2] A comparison of the evolution of these prices is complicated by the fact that oil prices were kept artificially low by contractual agreements in the early 1970s, whereas industrial commodities were freely traded. For a detailed analysis of this and competing explanations of these historical episodes based on oil supply shocks see Barsky and Kilian (2002, 2004) and Kilian (2008a, 2009b).

caused major oil price increases. Not only are shifts in monetary policy regimes rare, but it takes concerted regime shifts by many countries to exert enough demand pressure to drive global commodity prices. This was the case both in the early 1970s and in the early 1980s, when most industrialized countries followed the U.S. lead.

The key economic mechanism at play here is that unexpected fluctuations in the global business cycle will drive oil and other industrial commodity prices. The cause of these global business cycle fluctuations is secondary. For example, unexpected productivity gains in industrialized countries or the emergence of newly industrializing economies in emerging Asia, all else equal, will have very similar effects on the demand for commodities and their price as global shifts in monetary policy regimes. Kilian (2009a) and Kilian and Hicks (2009), using alternative methodologies, demonstrate, for example, that the surge in the real price of oil between 2003 and mid-2008 can be explained almost exclusively on the basis of unexpected growth in emerging Asia.

In addition, there are other potentially important determinants of the price of oil such as oil supply shocks or oil-market specific demand shocks. Kilian (2008b, 2009a) demonstrates that oil supply disruptions have had very limited effects historically on the real price of oil, not only since the mid-1980s, but even in the 1970s and early 1980s. There also is growing interest in the role of uncertainty and of expectations shifts on the demand for crude oil, notably during 1979, 1990/91 and possibly after 2003 (see, e.g., Alquist and Kilian 2009; Dvir and Rogoff 2009; Kilian 2008b, 2009a). While there is no compelling evidence of such effects in recent data, there is considerable evidence that expectations-driven demand shifts mattered in 1979 and 1990/91. While some of these shocks may be viewed as exogenous with respect to macroeconomic conditions, a key insight is that in general oil price shocks cannot be treated as exogenous.

3. Monetary Policy Reactions

Now consider the alternative view that stagflation is inexorably tied to the endogenous response of the central bank to exogenous oil price shocks. How should a monetary policy maker respond to an oil price shock? For simplicity suppose that a one-time oil price shock occurs, while everything else is held constant. There are two main channels of transmission. One is the increased cost of producing domestic output (which is akin to an adverse aggregate supply shock); the other is the reduced purchasing power of domestic households (which is akin to an

adverse aggregate demand shock). The latter channel of transmission may be amplified by increased precautionary savings and by the increased operating cost of energy-using durables (see Edelstein and Kilian 2007a; Kilian 2008a).

Empirical evidence suggests that the supply channel of transmission is weak and that the demand channel of transmission dominates in practice. On that basis, one would expect an oil price shock, if it occurs in isolation, to be recessionary and deflationary, suggesting that there is no reason for monetary policy makers to raise interest rates. In fact, one could make the case that policy makers should lower interest rates to cushion the recessionary impact. Moreover, if both the aggregate demand and the aggregate supply curves shift to the left, as seems plausible, the net effect on the domestic price level is likely to be small, so there is little need for central bankers to intervene.

This is, of course, not the interpretation favored by economists ascribing stagflation to the monetary policy reaction to oil price shocks. Bernanke, Gertler and Watson (1997), for example, implicitly take the stand that exogenous oil price shocks are inherently adverse aggregate supply shocks that are both recessionary and inflationary. Their argument is that the recessionary impact in the absence of a monetary policy reaction is weak, but that the potential inflationary impact can be substantial, perhaps owing to wage-price setting dynamics. If it is correct that oil price shocks empirically are associated with significant recessions, then a natural conjecture is that the central bank in combating the inflationary pressures emanating from oil price shocks causes that recession. The reason that Bernanke et al. were drawn to this interpretation was simply that conventional explanations of the link between oil price shocks and recessions based on the direct effects of oil price shocks had failed at explaining the recessions of 1974/75 and 1982, yet the conventional wisdom at the time was that there must be a causal link.

With the benefit of hindsight, the rationale for the type of monetary policy reaction described by Bernanke et al. is weak. Unless a good case for the existence of a wage-price spiral can be made, oil price shocks would not be expected to cause sustained inflation. More importantly, the recent literature has established that oil price shocks do not take place in isolation, violating the premise of the analysis in Bernanke, Gertler and Watson (1997). This point matters. For example, Nakov and Pescatori (2007) demonstrate that a welfare-maximizing central banker should not respond to innovations in the price of oil. More generally, Kilian (2008a) observes that policy makers should respond not to the price of oil (which is merely a

symptom rather than a cause), but directly to the underlying demand and supply shocks that drive the real price of oil along with other macroeconomic variables.

This does not mean that we should not take Bernanke et al.'s explanation seriously. Even if there is no good justification for such a policy response in light of recent research, it may have seemed perfectly reasonable to policy makers at the time. What then is the evidence that monetary policy reactions caused the recessions that followed earlier oil price shocks? Bernanke, Gertler and Watson (1997) – and subsequent papers building on their analysis – utilized semi-structural vector autoregressions to support their interpretation. Their model included censored changes in nominal oil prices. Kilian and Vigfusson (2009) show that the impulse response estimates constructed from such censored VAR models are inconsistent because the underlying structural model cannot be represented as a vector autoregression and because the impulse response functions were computed ignoring the nonlinearity of the model. Moreover, Kilian and Vigfusson formally show that there is no statistical evidence against the hypothesis of symmetric responses in positive and negative oil price shocks.

Following Kilian and Lewis (2009), we address this problem by fitting a recursively identified monthly linear VAR model for the percent change in real commodity prices, the percent change in the real price of oil, U.S. real output expressed in deviations from trend, U.S. CPI inflation, and the Federal Funds rate. Our measure of real output is the monthly CFNAI principal components index constructed by the Federal Reserve Bank of Chicago. The sample period is 1967.5-2008.6. How well does this model fit the data? Figure 1 shows selected impulse response estimates for the 1967.5-1987.7 and 1987.8-2008.6 subsamples.[3] The start of the second subsample coincides with the beginning of Greenspan's tenure as Fed chairman. All responses have been normalized to represent the effects of an unanticipated 10% real oil price shock. The response estimates for the first subsample are similar to those in Bernanke, Gertler and Watson (1997). An oil price shock causes a persistent increase in the real price of oil, a temporary increase in inflation, followed by a temporary increase in the Federal Funds rate, and ultimately a reduction in inflation and a temporary decline in real output about one year later, exactly as hypothesized in the literature. Interestingly, there is no evidence that these responses are stagflationary.

[3] The full sample estimates are qualitatively similar to the first subsample, while somewhat smaller in magnitude, indicating that the experience of the 1970s and early 1980s dominates the empirical results for the full sample.

In sharp contrast, the same model applied to post-1987 data shows no evidence at all of an interest rate response or a substantial decline in real output. There is no indication that monetary policy reactions to oil price shocks played any role after the mid-1980s. This means that the evidence in favor of the policy reaction hypothesis is driven by the 1973/74 and 1979/80 oil price shocks. It is instructive to focus on the ability of this VAR model to explain the evolution of the U.S. data during these two episodes. Figure 2 shows the cumulative contribution of oil price shocks through time on U.S. real output and inflation. It is evident that oil price shocks had little impact on observed real activity and inflation in the United States. Based on this model, we conclude that there is no evidence that central bankers caused the recessions of the 1970s and early 1980s in an effort to stabilize inflation. The only plausible alternative explanation of these recessions is that proposed by Barsky and Kilian (2002) based on shifts in monetary policy regimes.

It is noteworthy that even Bernanke et al.'s original analysis, which we have to be skeptical of for the reasons discussed above, concluded that the 1974/75 recession was not caused by the Federal Reserve's reaction to the oil price shock.[4] This result is consistent with evidence from Federal Reserve policy statements (see Barsky and Kilian 2002). The Fed by its own account was responding to rising industrial commodity prices when it continuously raised interest rates long before the oil price shock of late 1973. The observed rapid increases in global industrial commodity prices in 1972/73 were an indication of an overheating global economy, consistent with the analysis in Barsky and Kilian (2002). In fact, the Fed's initial reaction to the doubling of nominal oil prices in October of 1973 was to lower the interest rate, as would be consistent with the interpretation of oil price shocks as adverse aggregate demand shocks (see Figure 3). Only after the second doubling in 1974.1, interest rates were increased in early 1974, reaching a peak in 1974.7.

Even regarding the 1979/80 oil price shock, Bernanke et al. found that at best part of the subsequent recession was attributable to the Fed's reaction to this oil price shock.[5] Given the erratic evolution of the Federal Funds rate between April of 1979, when oil prices started their

[4] Specifically, Bernanke, Gertler and Watson (1997) concluded: "The 1974-75 decline in real output is generally not well explained by the oil price shock. The … major culprit was (non-oil) commodity prices. Commodity prices … rose very sharply before this recession and stimulated a sharp monetary policy response of their own." (p. 121).
[5] "The decline in output through 1981 is well explained by the 1979 oil price shock and the subsequent response of monetary policy. After the beginning of 1982, the main source of output declines … was the lagged effect of the autonomous tightening of monetary policy in late 1980 and 1981." (Bernanke, Gertler and Watson 1997, p. 121)

ascent and the oil price peak of February 1981, documented in Figure 3, it is not surprising that simple policy rules about how the Federal Reserve responds to oil price shocks do not fit the data well.

The fact that Bernanke, Gertler, and Watson's only evidence for monetary policy responses to oil price shocks comes from the 1979/80 episode is troublesome because there is reason to suspect the existence of an identification problem for this episode. When Paul Volcker raised interest rates, did he do so in response to the oil price shock of 1979 or in response to rising inflation driven by domestic policies? Since both interest rates and oil prices moved at about the same time, it is difficult to separate correlation from causation. Given the additional evidence in Figure 2 that the empirical evidence for 1979/80 is much weaker than suggested by Bernanke et al.'s original results, even that concern seems moot. The linear symmetric model suggests that there is no evidence that the monetary policy reaction to the 1973/74 and 1979/80 oil price shocks was the primary cause of the subsequent recessions, nor does this policy reaction model appear to be a good representation of policy actions in the post-1987 period.

The lack of temporal stability in these VAR model results could have a number of reasons. Perhaps the most obvious reason, in light of the earlier discussion about the endogeneity of oil price innovations, is that one would expect the Federal Reserve to respond differently to oil price shocks associated with, say, unexpected booms in global demand, than oil supply disruptions. For example, an unexpected demand boom driven by the global business cycle will stimulate the U.S. economy in the short run, whereas an oil supply disruption will not, calling for potentially different policy responses, depending on the underlying composition of oil price shocks. Figure 4 investigates this point by adding the Federal Funds rate as the fourth variable to the recursively identified VAR model utilized in Kilian (2009a).[6] We trace out the effects on the Federal Funds rate of unanticipated oil supply disruptions ("oil supply shocks"), unexpected positive innovations to the global business cycle ("aggregate demand shocks") and demand shocks that are specific to the oil market ("oil-market specific demand shocks"). Figure 4 shows that the Federal Reserve tends to respond to positive oil demand shocks by raising the interest rate, whereas it tends to lower the interest rate in response to oil supply disruptions. The former responses are statistically significant at the 5% level, whereas the latter are not. The positive

[6] This exercise is based on Kilian and Park (2009). The assumption that oil demand and supply shocks are predetermined with respect to the interest rate is consistent with evidence in Kilian and Vega (2009).

response to aggregate demand shocks in particular is consistent with the Fed's decision to raise interest rates long before the oil price shock of late 1973. The negative response to unanticipated oil supply disruptions is consistent with the view that the Federal Reserve views the resulting oil price increases as adverse aggregate demand shocks. Interpreting the positive response to demand shocks in this context is more difficult, as higher oil prices are but one of many consequences of such demand shocks.

4. The Role of Real-Wage Rigidities

To the extent that an unexpected one-time increase in the price of crude oil, all else equal, will be passed on to retail consumer prices, the question arises of how the central bank should respond to the resulting inflationary pressures. In the absence of real-wage rigidities, there is no reason for the central bank to be concerned with such a one-time event. As long as the monetary policy regime is credible, an inflation targeter may allow for drift in the price level without jeopardizing the objective of stable medium-term inflation.[7] Only if the economy is subject to recurring oil price shocks for extended periods, as during 2003-2008, is there a risk that the public may begin to doubt the central bank's determination to contain inflation. This situation may change, if the oil price shock occurs in an environment of monetary instability. If inflation expectations have become unhinged, there will be a tendency to respond to (or even anticipate) upward revisions in the price level. As consumption real wages drop in response to an oil price shock, workers will aim to offset these losses by insisting on higher nominal wages. This may give rise to a wage-price spiral. If workers are successful at preserving the real wage, unemployment will ensue. This observation explains why a central bank has to be especially vigilant of inflation risks and move more aggressively to combat inflationary pressures, when inflation expectations are no longer anchored.

It is useful in its own right to investigate the hypothesis that reduced real-wage rigidities help explain the diminished importance of oil price shocks for U.S. real output and inflation documented in Figure 1. The notion of real wage rigidities was originally designed to explain high European unemployment (see Bruno and Sachs 1982). The idea was that strong unions tend to resist cuts in real wages associated with increases in the price level. To the extent that higher oil prices are passed on to consumers, unions insist on raising the nominal wage to preserve the

[7] In contrast, a price-level targeter would have to tighten monetary policy to restore the initial price level.

real wage level. Excessively high real wages in turn cause unemployment. While this explanation may sound vaguely plausible for European economies, it seems less appealing for the United States. Clearly, U.S. real wages fell in response to oil price shocks even in the 1970s and 1980s (see Rotemberg and Woodford 1996). Moreover, while the real wage response shows some variability over time, it does not show a tendency towards a larger response since the mid-1980s. Recently, Blanchard and Galí (2008) have refined that argument. Since the response of unemployment to the same shock has declined dramatically over time, they suggest that the decrease in real wages, which required a large increase in unemployment in the 1970s, today is achieved with barely any increase in unemployment, consistent with a reduction in real wage rigidities.

It is not clear that this argument is valid, however, since the composition of oil demand and supply shocks underlying the innovations to the price of oil has changed over time. The structural VAR estimates in Kilian (2009a) suggest that different oil demand and oil supply shocks involve different responses of U.S. real output and unemployment (see Figure 5). As a consequence, the estimated responses of these aggregates to oil price innovations will evolve with changes in the composition of oil demand and oil supply shocks. To the extent that global aggregate demand shocks have increased in importance in recent years, one naturally would expect precisely the diminished unemployment response documented by Blanchard and Galí (2008), even in the absence of structural changes in labor markets. In fact, this is one of the central implications of Kilian (2009a). Figure 6 shows that a structural model can fully account for the diminished importance of oil price shocks in 2002-2007 compared with 1979-1982, for example, even in the absence of structural change. This does not preclude that real wages may have become more flexible, as conjectured by Blanchard and Galí (2008), but it says that no direct evidence has been presented that supports that hypothesis.

We can, however, use cross-country evidence to assess the plausibility of the real-wage rigidity argument. For example, it is uncontroversial that real-wage rigidities in continental Europe (and in the U.K. prior to Margaret Thatcher) must have been higher than in the U.S. If real wage rigidities were the primary explanation of the severity of real output response to oil price shocks, we would expect these countries to have performed worse than the U.S. during major oil price surges. Table 1 shows the economic performance of the G7 countries during selected oil price shock episodes. The data show that no G7 country experienced as steep a

decline in real GDP growth (relative to average growth) following the 1973/74 and 1979/80 oil price shocks as the United States, contradicting the real wage rigidity hypothesis.

Likewise, it seems reasonable to presume that the degree of real wage rigidity was approximately constant between 1973 and 1980. Germany, Italy, and Japan all experienced below average real GDP growth following the first oil crisis, yet these same countries experienced above average growth following the second oil crisis. That pattern is again inconsistent with real wage rigidities being the primary explanation, but it is consistent with shifts in monetary policy regimes (see Bohi 1989).

Not only are reduced real-wage rigidities not a plausible explanation of the diminished importance of oil price shocks since the mid-1980s, but neither are fluctuations in the energy share. Arguments that the declining U.S. energy share in expenditures helps explain the reduced importance of oil price shocks have been shown to be misleading (see Edelstein and Kilian 2007a,b). One observation that is sometimes overlooked is that the U.S. energy share is primarily driven by the price of oil and has rebounded sharply in recent years. Moreover, while it is true that fluctuations in the energy share have affected the transmission of energy price shocks, even controlling for the evolution of energy expenditures there is strong evidence for the reduced importance of oil price shocks. The latter phenomenon, as discussed above, is an artifact of changes in the composition of oil price shocks. It illustrates the dangers of thinking of oil price shocks as occurring in isolation from the state of the global economy.

5. Are Oil Price Shocks Inherently Stagflationary?

The discussion in section 2 stressed that stagflation may arise naturally following a shift toward a less restrictive monetary policy regime. We also observed that oil price shocks are not necessarily stagflationary, given that none of the oil price shocks since the 1980s was associated with stagflation. Of course, that analysis is subject to the same caveat that oil price shocks in general do not represent causal determinants, but merely symptoms of demand and supply shocks in oil markets that in turn may reflect broader global macroeconomic developments. We now take the analysis a step further and ask whether there is evidence that specific oil demand or oil supply shocks are associated with stagflationary responses. Figure 7 formally addresses this question based on a statistical measure of conditional co-movement developed by Den Haan (2000). This measure is applied to the responses of U.S. CPI inflation and U.S. real GDP growth

to each of the oil demand and oil supply shocks in the Kilian (2009a) model, allowing us to assess which – if any – of these shocks have stagflationary effects. Following Den Haan and Summer (2004, p. 1340), the plot shows conditional covariances rather than conditional correlations. This normalization facilitates a comparison of the statistic across horizons. The conditional covariance at horizon *h* is constructed as

$$C(h) = \Delta y_h^{imp} \; \pi_h^{imp}$$

where z_h^{imp} denotes the response of variable z_t at horizon *h* to a given structural innovation (see Den Haan 2000, p. 8). Stagflation in the form of rising prices and falling output means that this measure will be negative. It is natural to conduct a one-sided test of the null of zero conditional covariance against the stagflationary alternative. Figure 7 plots 90 percent bootstrap confidence intervals along with the point estimates. The coverage rates are chosen such that the rejection probability in the lower tail corresponds to 5 percent. While it appears that oil demand shocks are more stagflationary than oil supply shocks, Figure 7 suggests that none of these covariances are significantly negative at conventional significance levels. Thus, stagflation is likely to have other causes, consistent with the analysis of section 2.

6. Did the Federal Reserve Contribute to the 2003-08 Oil Price Shock?

Along many dimensions the surge in the price of oil since 2003 is reminiscent of the 1970s. Given the sustained increase in both industrial commodity prices and oil prices between 2003 and mid-2008, it is natural to suspect another monetary policy regime shift in recent years. Indeed, Greenspan has been blamed with the benefit of hindsight for being too lenient in dealing with asset market bubbles, and both Greenspan and Bernanke occasionally have been criticized for being overly concerned with the employment objective. Nevertheless, as observed in section 2, this explanation does not seem plausible. U.S. monetary policy has been openly stimulative only very recently in response to the mortgage and financial crisis. Given this timing, U.S. monetary policy regime shifts are an unlikely candidate for explaining the oil price increases of 2003-2007.

Moreover, the effect of this recent monetary expansion was tempered by the credit crunch. How expansionary U.S. monetary policy since 2001 has been, may be gauged with the help of the following data. Figure 8 plots three indicators of the stance of monetary policy, allowing us to contrast the experience of the 1970s and 2000s. The first key difference is that the

two monetary expansions of the early and mid-1970s coincided with real output in excess of potential output for extended periods, resulting in inflationary pressures. In contrast, the monetary expansions that took place since 2001 never were associated with an overheating domestic economy. One indication of the excessively easy stance of monetary policy in the early and mid-1970s was that ex ante real interest rates temporarily turned negative. The experience since 2001 at first sight may seem similar in that the expected real interest rate was negative between 2002 and 2006 and again in 2008. This superficial similarity is deceiving. Whereas the negative ex ante real interest rates of the 1970s were driven by rising inflation expectations, those since 2001 were driven by low nominal interest rates. Figure 8 shows that U.S. inflation expectations remained remarkably stable as late as 2008.I.[8] Just when it appeared that inflation expectations might become unhinged after all in mid-2008, the oil and commodity price boom collapsed, along with the global economy, rendering concerns over inflation expectations moot.

Even if we grant that after 2000 the United States may have been somewhat more expansionary than called for, the degree of expansion prior to 2008 was not comparable to the 1970s. Moreover, unlike in the 1970s, there was no similar monetary expansion elsewhere in the OECD. Without such reinforcement it is hard to see how a shift in U.S. policy could have caused a global oil and commodity price boom. Even more to the point, Kilian (2009a) and Kilian and Hicks (2009) showed that this latest oil price boom was driven by unexpected growth in emerging Asia rather than in the OECD, as illustrated by the data on professional real GDP forecast errors shown in Table 2. What happened was not that OECD demand for oil and other industrial commodities increased substantially, as had happened in the 1970s, but that additional unexpected demand arose from emerging Asia, given continued high demand from OECD economies. This evidence on the geographic origins of demand leaves room for more subtle interpretations. One hypothesis is that the weak dollar helped stimulate global demand for crude oil. Implicit in this argument is the assertion that the weakening dollar was caused by U.S. monetary policy actions. The extent to which this was the case, however, is unclear. Moreover, it has yet to be established that exchange rate fluctuations have predictive power for the real price of oil, casting doubt on the empirical content of this hypothesis.

[8] While the survey data used here only relates to one-year horizons, alternative measures of inflation expectations paint a very similar picture. For example, the 2-year and 5-10-year inflation expectations reported by Consensus Economics are flat in early 2008, notwithstanding an increase in the 1-year expectation. Likewise, the TIPS breakeven inflation rate (BEIR) for 5-10 years ahead shows only a slight upward drift in early 2008.

This does not mean that there is no link between strong demand for oil from emerging Asia and the state of the U.S. economy. As observed in Kilian (2009b), a key question is how much of that unexpected growth reflected an exogenous economic transformation in emerging Asia. The alternative explanation is that the Federal Reserve sustained growth in the U.S. longer than appropriate by easing monetary policy too early and too much, enabling the export-based Chinese economy and more generally the world economy to thrive and fueling the commodity and oil price boom that contributed to the current collapse of the real economy. This possibility deserves careful study. A third explanation is that the sustained prosperity in the United States between 2002 and mid-2008 was not directly linked to monetary policy, but to the failure of the Federal Reserve and other regulators to reign in financial and housing markets. A fourth possibility is that expansionary monetary policy in emerging Asia fueled and sustained the Asian growth miracle and contributed to the oil and commodity price boom. To unravel the relative contribution of each of these complementary explanations would require the help of a fully specified multi-country open economy model. While it is conceivable that allowing the U.S. economy to slow down earlier would have somewhat alleviated the commodity price boom of 2003-2008, it seems unlikely, however, that a slower easing of monetary policy would have made much of a difference.

7. How Should the Central Bank Respond to Oil Price Shocks?

The oil price shock of 2003-08 raises the broader question of how the central bank of an oil importing economy should respond to such events. This question remains topical, as there is every reason to believe that oil prices will rise again, as soon as the world economy recovers from the financial crisis. As the analysis in Kilian (2009a) makes clear, it would be a mistake for policy makers to respond to oil price shocks as such because relative price shocks are often merely symptoms of broader global macroeconomic developments. Rather central banks must identify the deeper causes of oil price shocks and respond to the underlying fundamental shocks.

This requires a different class of structural models than are customarily used by policy makers. Recent advances in the DSGE modeling of oil price shocks are a step in the right direction. For example, Bodenstein, Erceg and Guerrieri (2007) model oil-market specific demand shocks, and Balke, Brown, and Yücel (2009) model the dependence of oil demand on global macroeconomic conditions. In related work, Nakov and Pescatori (2007) explicitly model

the endogeneity of oil production decisions. While none of these papers provides a comprehensive analysis of all relevant aspects of the relationship between oil prices and the macro economy, a new class of models is beginning to emerge. In addition, future work will have to incorporate in more detail the external transmission of oil demand and oil supply shocks (see Kilian, Rebucci and Spatafora 2009) as well as the nexus between crude oil prices and retail energy prices (see Edelstein and Kilian 2007a). DSGE models also may allow us to distinguish between alternative causes of fluctuations in the global demand for industrial commodities, and to simulate the impact of alternative policy choices of the type discussed in section 6.

In contrast, the traditional monetary policy reaction framework explored by Bernanke, Gertler and Watson (1997) and incorporated in subsequent DSGE models has outlived its usefulness. In fact, it is not clear whether this framework ever was an adequate description of central bank behavior. Nor is the textbook distinction between exogenous transitory (i.e., white noise) and exogenous permanent (or, more precisely, random walk) oil price shocks useful. First, the persistence of the oil price response depends on nature of the underlying shocks and on the policy reaction and is not exogenously given. Second, the degree of persistence of the responses to oil demand and oil supply shocks in general evolves along a continuum. Neither limiting case seems empirically relevant. Empirical evidence suggests that oil price responses are persistent, but ultimately transitory. Third, once we recognize that oil demand shocks may have direct effects on the economy not operating through the real price of oil, it becomes clear that the persistence of the responses may differ from one variable to the next and there is no particular interest in the oil price response.

The appropriate policy response to oil price shocks will depend on the composition of the underlying oil demand and oil supply shocks. In the specific case of the 2003-08 oil price shock, the fundamental problem was one of oil demand growing faster than oil supplies. The extent to which global demand pressures translate into increases in industrial commodity prices depends on how elastically those commodities can be supplied. Although all industrial commodity prices increased substantially in recent years and metals prices, for example, more than tripled in real terms, the real price of crude oil more than quadrupled. This outcome reflects the evolution of the supply of crude oil. Table 3 shows that a substantial increase in global crude oil production took place between mid-2001 and mid-2008. Production of crude oil increased by 12.5% compared with 14.5% in the six years following 1974.1. Growth in global oil production,

however, all but ceased after 2005, which helps explain the steep rise in the price of oil in 2007/08 in particular. A likely explanation of this pattern is not so much that the world is running out of oil in the foreseeable future, but that the threat of expropriation in many oil producing countries has prevented the flow of much needed investments.

Figure 9 illustrates based on the analysis in Kilian (2009b) that the observed increase in the real price of oil since 2003 can be attributed almost exclusively to unanticipated positive global aggregate demand shocks.[9] In contrast, the sharp decline after mid-2008, while preceded by a slowing of world real activity, also reflects historically unprecedented expectations shifts associated with the global financial crisis. Since the 2003-08 oil price shock reflected a shift in the real scarcity of resources, there is nothing a central bank could or should have done in response beyond making sure that inflation expectations remain anchored in the face of inflationary pressures arising from both oil and industrial commodity prices. In particular, a monetary easing would not have been appropriate, since the global demand pressures appeared highly persistent.

8. Conclusion

The analysis in this paper suggested that neither diminished real wage rigidities nor improved monetary policy responses to oil price shocks are a plausible explanation of the increased resilience of the U.S. economy to oil price shocks and of the absence of stagflationary responses since the mid-1980s. As we discussed, the increased resilience of the U.S. economy can be traced to changes in the composition of the demand and supply shocks underlying the real price of oil. The likely explanation of the absence of stagflation is the choice of a monetary policy regime that emphasizes the price stability objective. Central bankers are rightly proud that they have learned the lesson provided by the experience of the 1970s. This should not make us complacent, however. Armed with the insights of decades of research, it is easy to forget that central bankers in the 1970s had the best intentions and were fully aware of the potential dangers of inflation. When faced with major structural changes in the global economy, they did their best to sustain employment. Their perception was that for the time being inflation was the lesser risk compared with unemployment.

[9] There is no empirical evidence to support the view that speculation was behind this oil price shock (see Kilian 2009c).

A common view at the time was that the economy did not work the way it used to. There was a need for experimentation. Given the complexity of the economy and the near-simultaneous occurrence of several different shocks, it proved difficult for policy makers to determine the relative importance of alternative explanations of the macroeconomic data in real time. All these ingredients could be used to describe the current situation amidst the global financial crisis. There is the same urgency that something must be done, the same need to experiment, and the same uncertainty about the best approach. There also is a sense that for now the employment objective must have priority, and that moderate inflation seems like a small price to pay for avoiding a financial collapse. Finally, there is again great uncertainty about the level of potential output.

This is not to say that policy makers have lost sight of the inflation objective. In fact, there is a consensus that the Federal Reserve must withdraw the capital infusions currently needed to keep the financial system from collapsing, once the economy recovers. In practice, however, determining the right time for withdrawing this excess liquidity is about as difficult as guessing when the stock market will recover. In both cases, the right timing depends on business and consumer confidence. There will be a tendency to downplay the risks of inflation relative to those of high unemployment in the event of a financial collapse and to delay the removal of infusions of capital and liquidity, all the more so as business and consumer confidence are fragile. If the economy moves closer to potential than envisioned, one could easily imagine a situation that looks not so different from that faced by policy-makers after the breakdown of Bretton Woods. Especially a situation that may require higher interest rates, higher taxes, and less spending to deal with the fiscal deficit could prove challenging. Thus, the real test of whether we have learned the lessons of the 1970s is yet to come.

References

Alquist, R., and L. Kilian (2009), "What Do We Learn from the Price of Crude Oil Futures?" forthcoming: *Journal of Applied Econometrics*.

Balke, N.S., S.P.A. Brown, and M.K. Yücel (2009), "Oil Price Shocks and U.S. Economic Activity: An International Perspective," mimeo, Federal Reserve Bank of Dallas.

Barsky, R.B., and L. Kilian (2002), "Do We Really Know that Oil Caused the Great Stagflation? A Monetary Alternative," in: *NBER Macroeconomics Annual 2001*, B.S. Bernanke and K. Rogoff (eds.), MIT Press: Cambridge, MA, 137-183.

Barsky, R.B., and L. Kilian (2004), "Oil and the Macroeconomy Since the 1970s," *Journal of Economic Perspectives*, 18(4), 115-134.

Blanchard, O.J., and J. Galí (2008), "The Macroeconomic Effects of Oil Shocks: Why are the 2000s so Different from the 1970s?" Forthcoming in: J. Galí and M. Gertler (eds.), *International Dimensions of Monetary Policy*, University of Chicago Press: Chicago, IL.

Bodenstein, M., Erceg, C.J., and L. Guerrieri (2007), "Oil Shocks and U.S. External Adjustment," mimeo, Federal Reserve Board.

Bohi, D.R. (1989), *Energy Price Shocks and Macroeconomic Performance*, Resources for the Future: Washington, DC.

Bruno, M., and J. Sachs (1982), "Input Price Shocks and the Slowdown in Economic Growth: The Case of U.K. Manufacturing," *Review of Economic Studies*, 49, 679-705.

Den Haan, W.J. (2000), "The Comovement between Output and Prices," *Journal of Monetary Economics*, 46, 3-30.

Den Haan, W.J., and S.W. Summer (2004), "The Comovement between Real Activity and Prices in the G7," *European Economic Review*, 48, 1333-1347.

Dvir, E., and K. Rogoff (2009), "The Three Epochs of Oil," mimeo, Department of Economics, Harvard University.

Edelstein, P., and L. Kilian (2007a), "How Sensitive Are Consumer Expenditures to Retail Energy Prices?" forthcoming: *Journal of Monetary Economics*.

Edelstein, P., and L. Kilian (2007b), "The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses About the Transmission of Energy Price Shocks," *B.E. Journal of Macroeconomics*, 7(1) (Contributions).

Hamilton, J.D. (2009), "Causes and Consequences of the Oil Shock of 2007-08," in preparation for the *Brookings Papers on Economic Activity*.

Kilian, L. (2008a), "The Economic Effects of Energy Price Shocks," *Journal of Economic Literature*, 46(4), 871-909.

Kilian, L. (2008b), "Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the U.S. Economy?" *Review of Economics and Statistics*, 90, 216-240.

Kilian, L. (2008c), "A Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries," *Journal of the European Economic Association*, 6, 78-121.

Kilian, L. (2009a), "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," forthcoming: *American Economic Review*.

Kilian, L. (2009b), "Comment on 'Causes and Consequences of the Oil Shock of 2007-08' by James D. Hamilton," in preparation for the *Brookings Papers on Economic Activity*.

Kilian, L. (2009c), "Explaining Fluctuations in Gasoline Prices: A Joint Model of the Global Crude Oil Market and the U.S. Retail Gasoline Market," mimeo, Department of Economics, University of Michigan.

Kilian, L., and B. Hicks (2009), "Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003-2008?" mimeo, Department of Economics, University of Michigan.

Kilian, L., and L. Lewis (2009), "Does the Fed Respond to Oil Price Shocks?" mimeo, Department of Economics, University of Michigan.

Kilian, L., and C. Park (2009), "The Impact of Oil Price Shocks on the U.S. Stock Market," forthcoming: *International Economic Review*.

Kilian, L., A. Rebucci and N. Spatafora (2009), "Oil Shocks and External Balances," *Journal of International Economics*, 77, 181-194.

Kilian, L., and C. Vega (2009), "Do Energy Prices Respond to U.S. Macroeconomic News? A Test of the Hypothesis of Predetermined Energy Prices," mimeo, Department of Economics, University of Michigan.

Kilian, L., and R. Vigfusson (2009), "Pitfalls in Estimating Asymmetric Effects of Energy Price Shocks," mimeo, Department of Economics, University of Michigan.

Nakov, A., and A. Pescatori (2007), "Inflation-Output Gap Trade-off with a Dominant Oil Supplier," mimeo, Federal Reserve Bank of Cleveland.

Rotemberg, J., and M. Woodford (1996), "Imperfect Competition and the Effects of Energy Price Increases on Economic Activity," *Journal of Money, Credit, and Banking*, 28, 550-77.

Table 1: Real GDP Growth Rates Relative to Long-Run Average in the G7 Countries Selected Episodes of Oil Price Shocks

	1973.IV-1975.II	1978.IV-1980.III	1980.IV-1983.I	1990.III-1993.III
United States	-3.84	-2.64	-1.87	-1.30
Italy	-2.01	2.10	-1.66	-1.96
France	-1.06	-0.24	-0.37	-1.72
Germany	-3.38	0.15	-2.01	2.33
U.K.	-3.50	-2.45	-1.14	-2.02
Canada	-0.24	-0.41	-2.56	-2.71
Japan	-1.75	1.00	0.17	-1.19

SOURCE: Kilian (2008c).

Table 2: Average Forecast Surprises (Percentage Points)

	2000.12-2003.5	2003.6-2008.6	2008.7-2008.12
United States	-0.05	0.02	-0.08
Germany	-0.12	0.00	-0.33
Japan	-0.10	0.08	-0.27
Brazil	-0.10	0.03	0.07
Russia	0.06	0.12	-0.42
India	-0.06	0.03	-0.17
China	-0.04	0.12	-0.17

SOURCE: Kilian and Hicks (2009). Average forecast surprises computed based on successive annual forecasts of real GDP growth reported by the *Economist Intelligence Unit*.

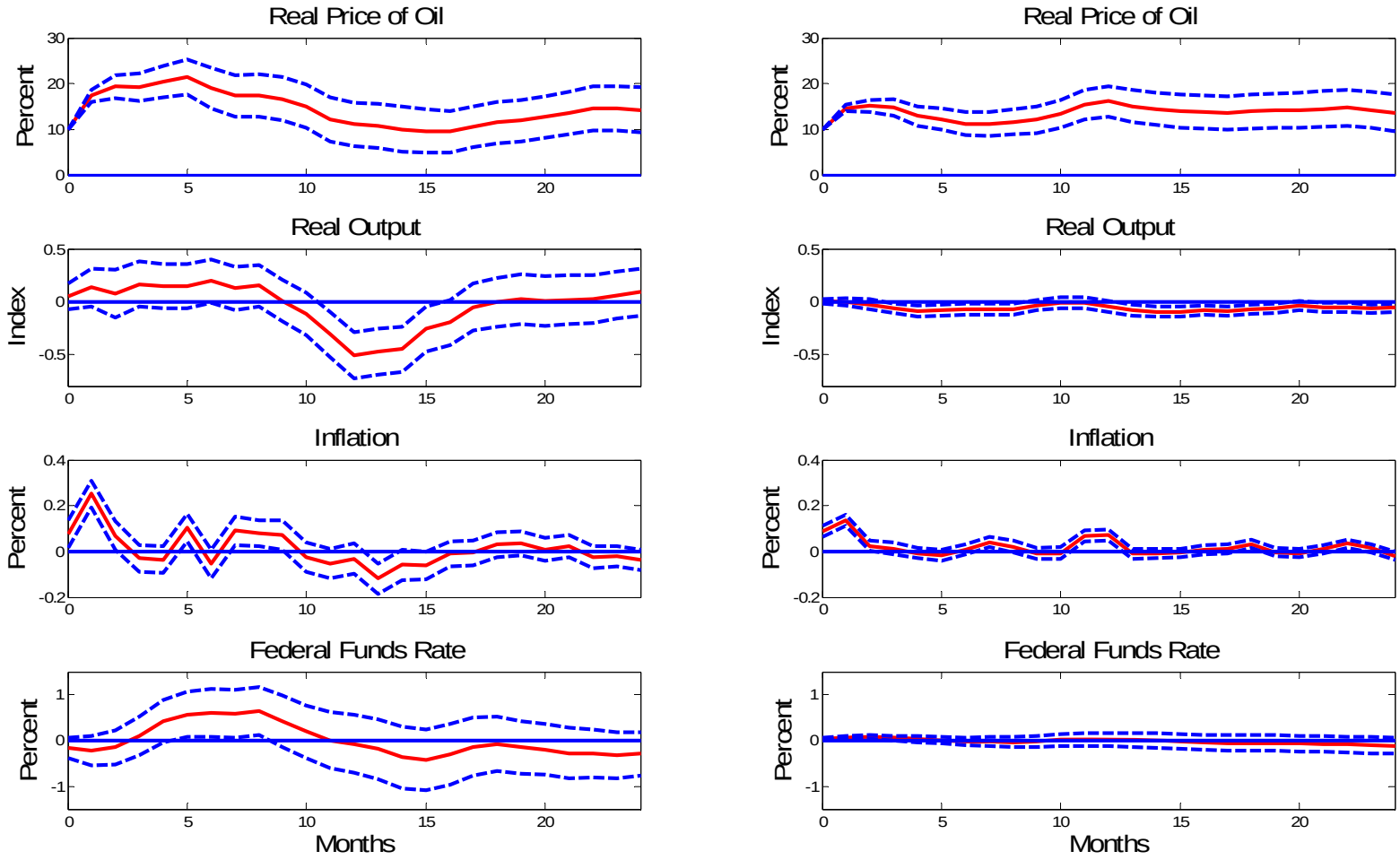
Table 3: Cumulative Growth Rates of Crude Oil Production in Percent: Selected Periods

	1974.1-1979.12	2001.6-2008.5
World	14.5	12.5
Persian Gulf	4.0	23.7
OPEC	0.6	19.0
Non-OPEC, Non-U.S.	51.6	11.0
United States	-3.6	-10.4

SOURCE: Computed based on data from *Monthly Energy Review* of the U.S. Department of Energy.

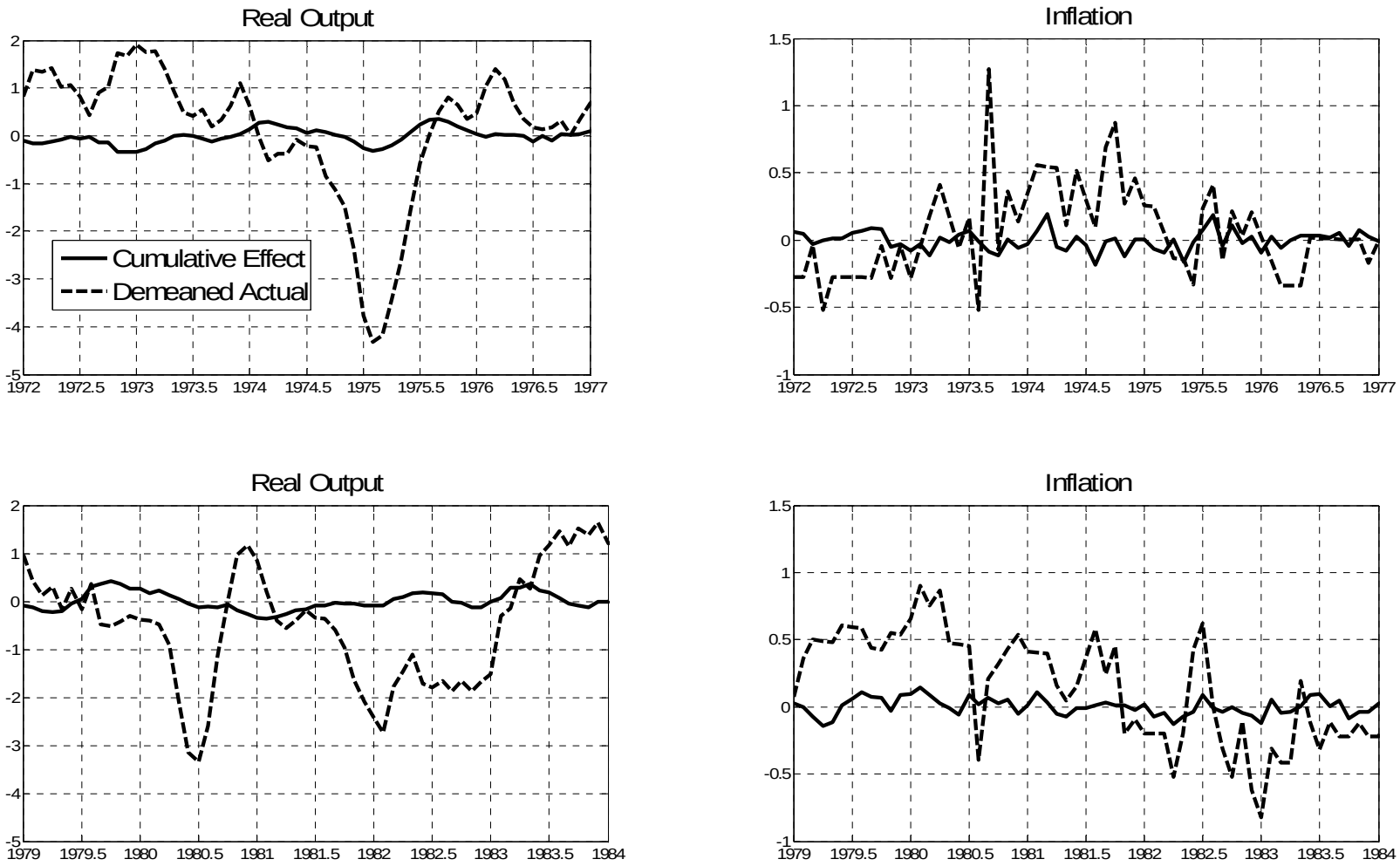
Figure 1: U.S. Responses to Real Oil Price Shocks (with One-Standard Error Bands)

1967.5-1987.7 **1987.8-2008.6**



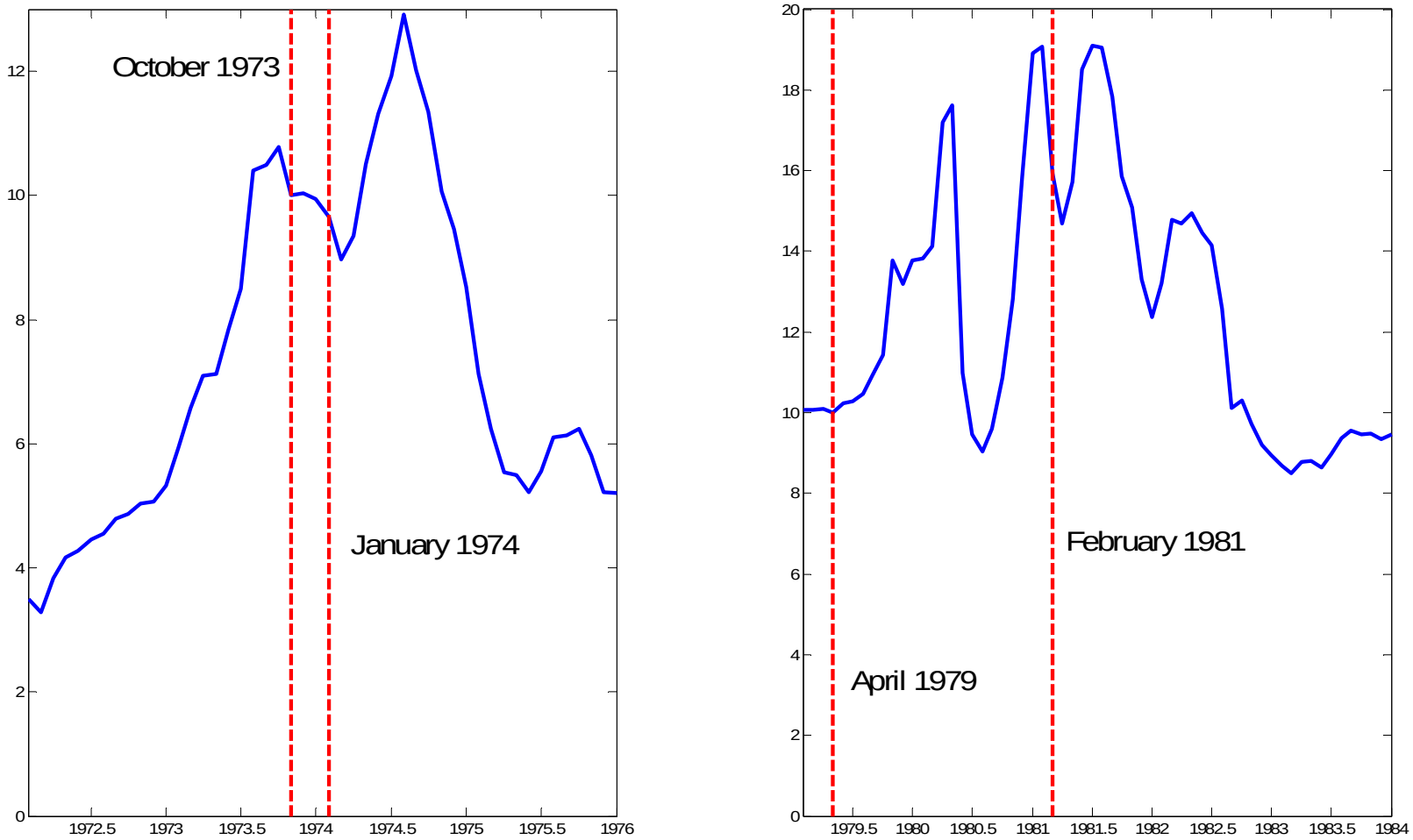
SOURCE: Kilian and Lewis (2009). Real output refers to the CFNAI principal components business cycle index. Estimates based on recursively identified VAR(12) model for the percent change in real CRB commodity prices, the percent change in the real price of oil, CFNAI, CPI inflation and the Federal Funds rate.

Figure 2: Cumulative Effect of Real Oil Price Shocks on U.S. Real Output and Inflation: Selected Episodes



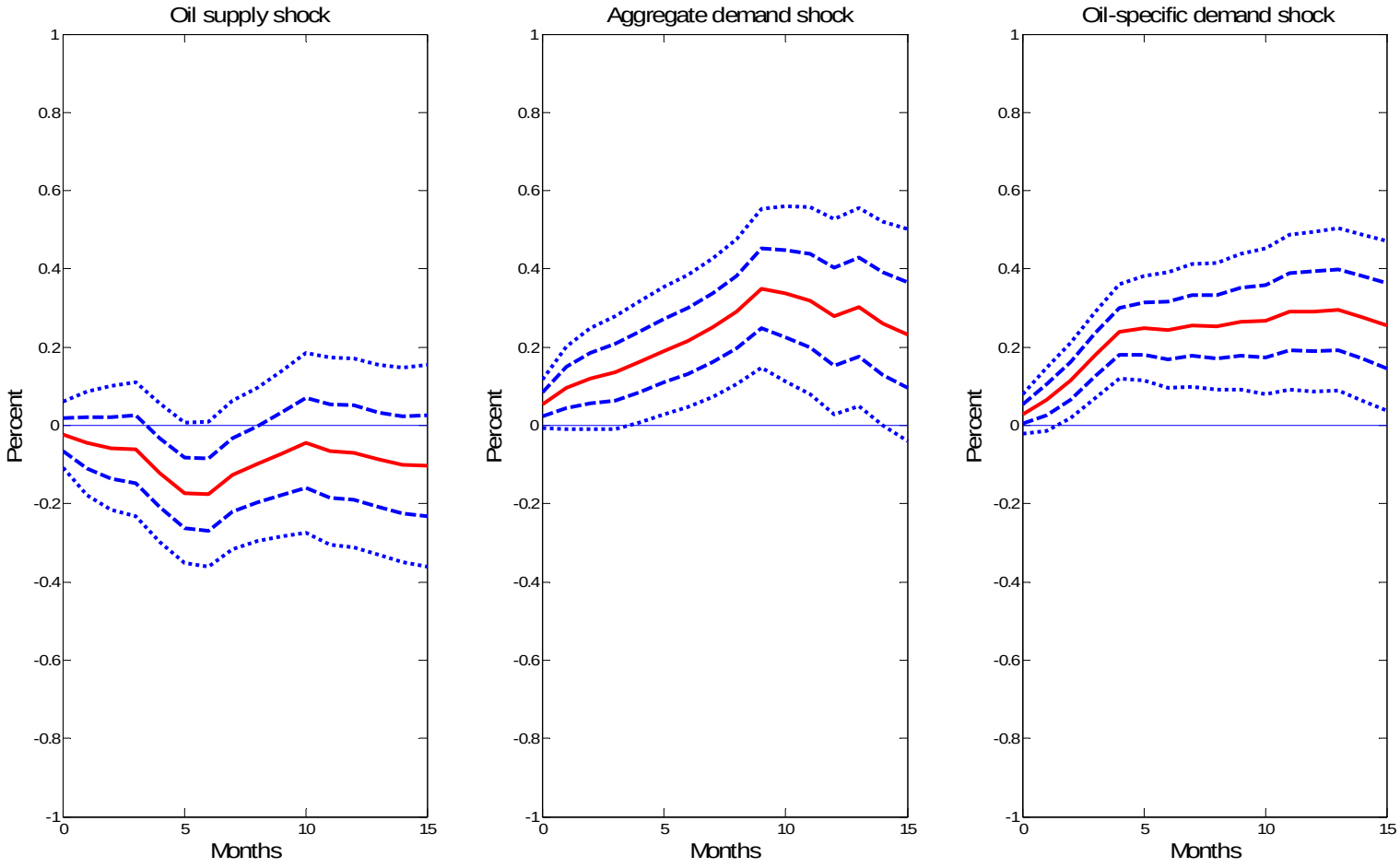
SOURCE: Kilian and Lewis (2009). See Figure 1.

Figure 3: The Evolution of the Federal Funds Rate during the Oil Price Shocks of the 1970s and Early 1980s



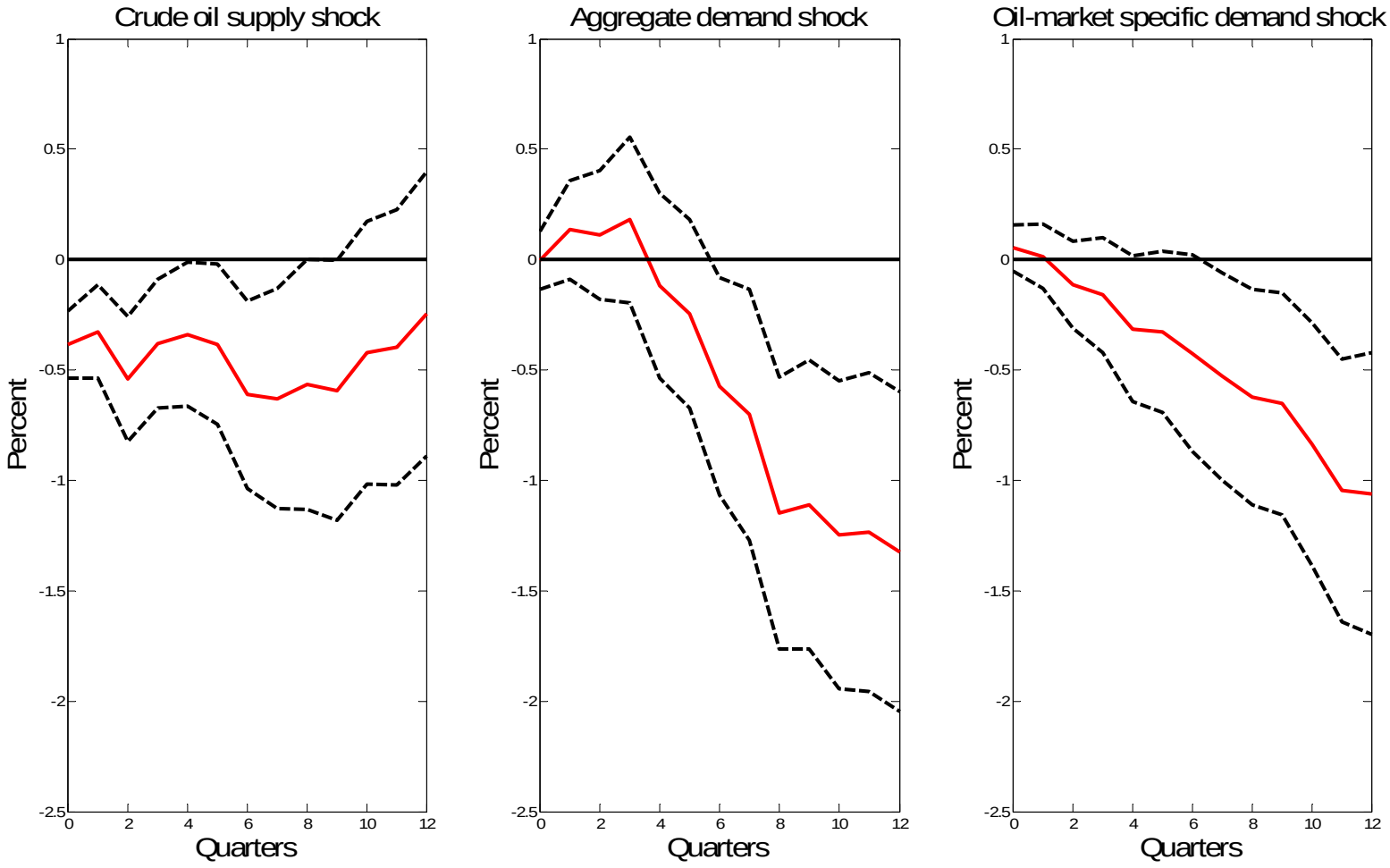
NOTES: In October of 1973 and January of 1974 the price of oil doubled. April 1979 marks the beginning of the 1979 oil price surge; in February of 1981 the price of imported crude oil peaks.

Figure 4: Response of Change in the Effective Federal Funds Rate to Oil Demand and Oil Supply Shocks (with One- and Two-Standard Error Bands)



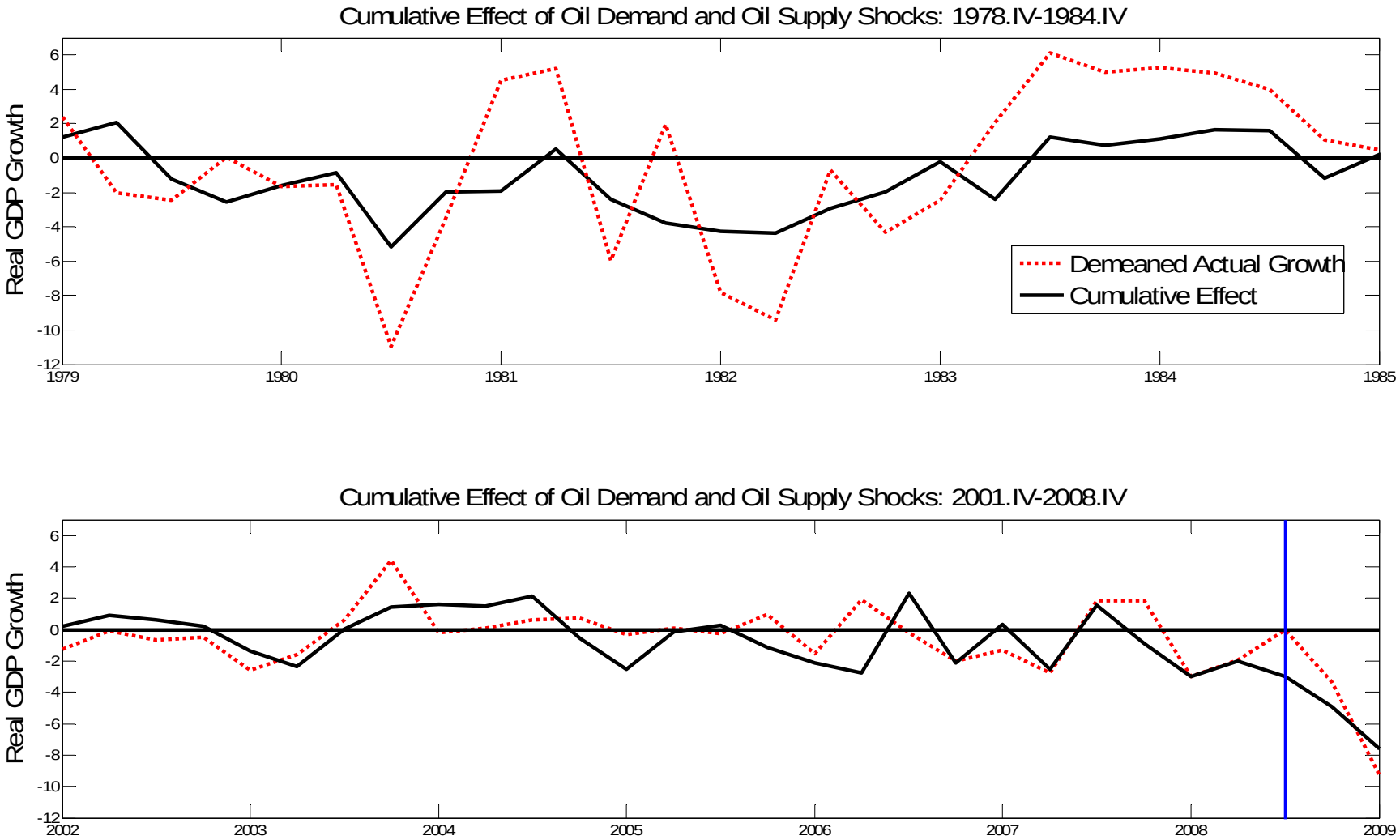
SOURCE: Kilian and Park (2009).

Figure 5: Response of U.S. Real GDP to Oil Demand and Oil Supply Shocks (with One-Standard Error Bands)



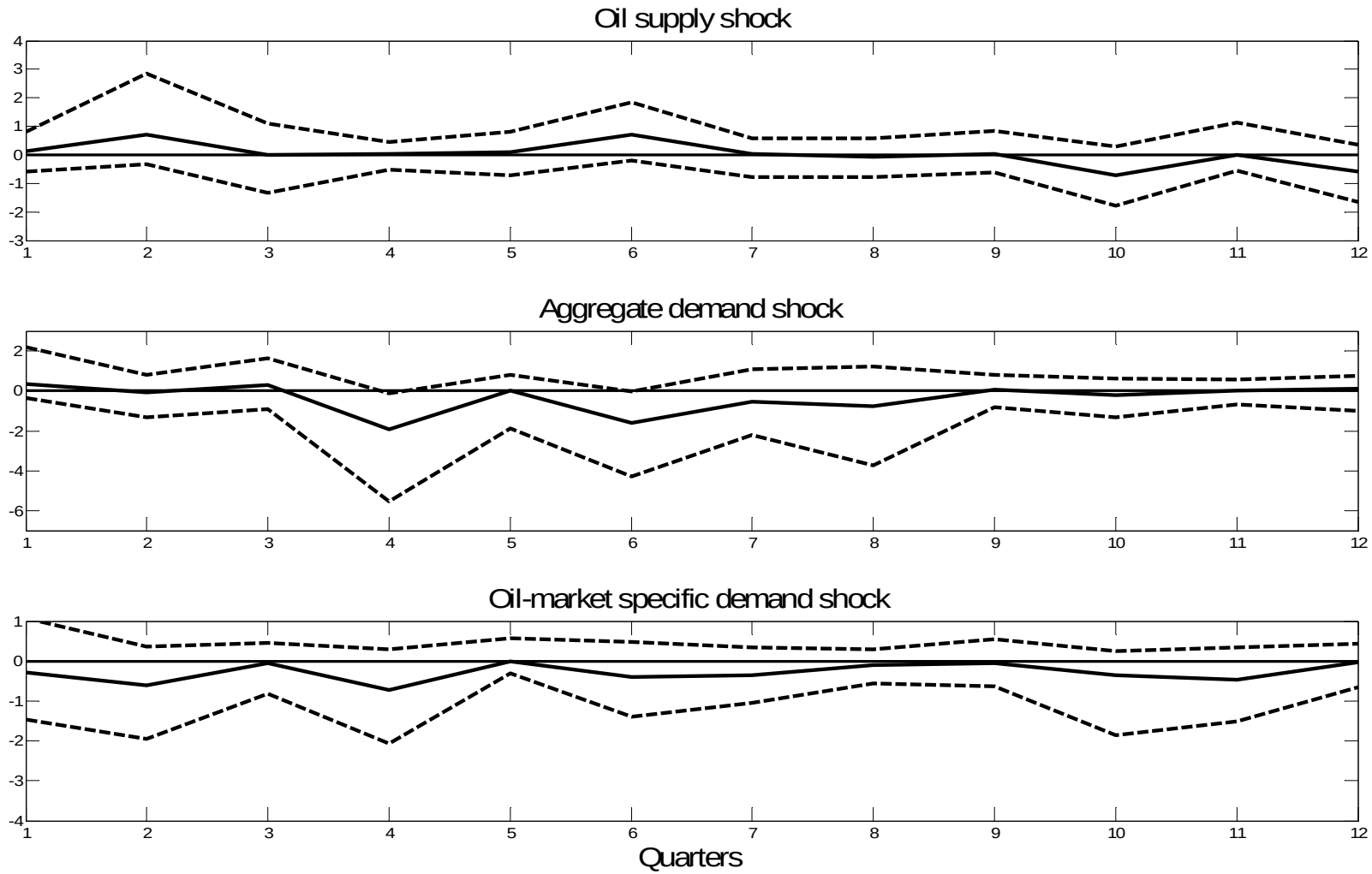
SOURCE: Kilian (2009a).

Figure 6: Explanatory Power of Oil Demand and Oil Supply Shocks Combined for U.S. Real GDP Growth



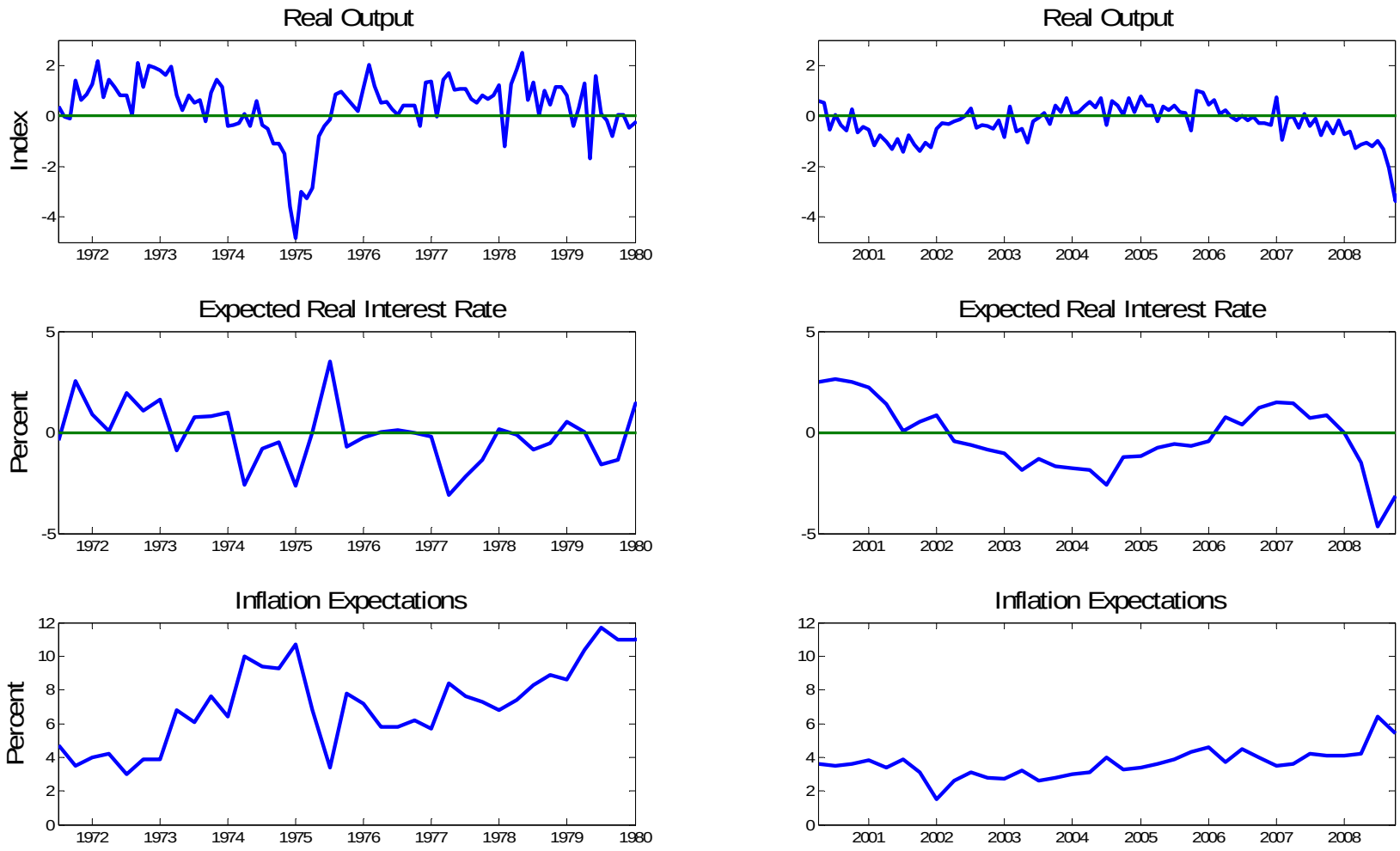
SOURCE: Based on Kilian (2009b). The vertical line marks mid-2008 when global real economic activity peaked.

Figure 7: Stagflationary Effects of Oil Supply and Oil Demand Shocks
Conditional Covariance of Inflation and Real GDP Growth with 90% Confidence Bands



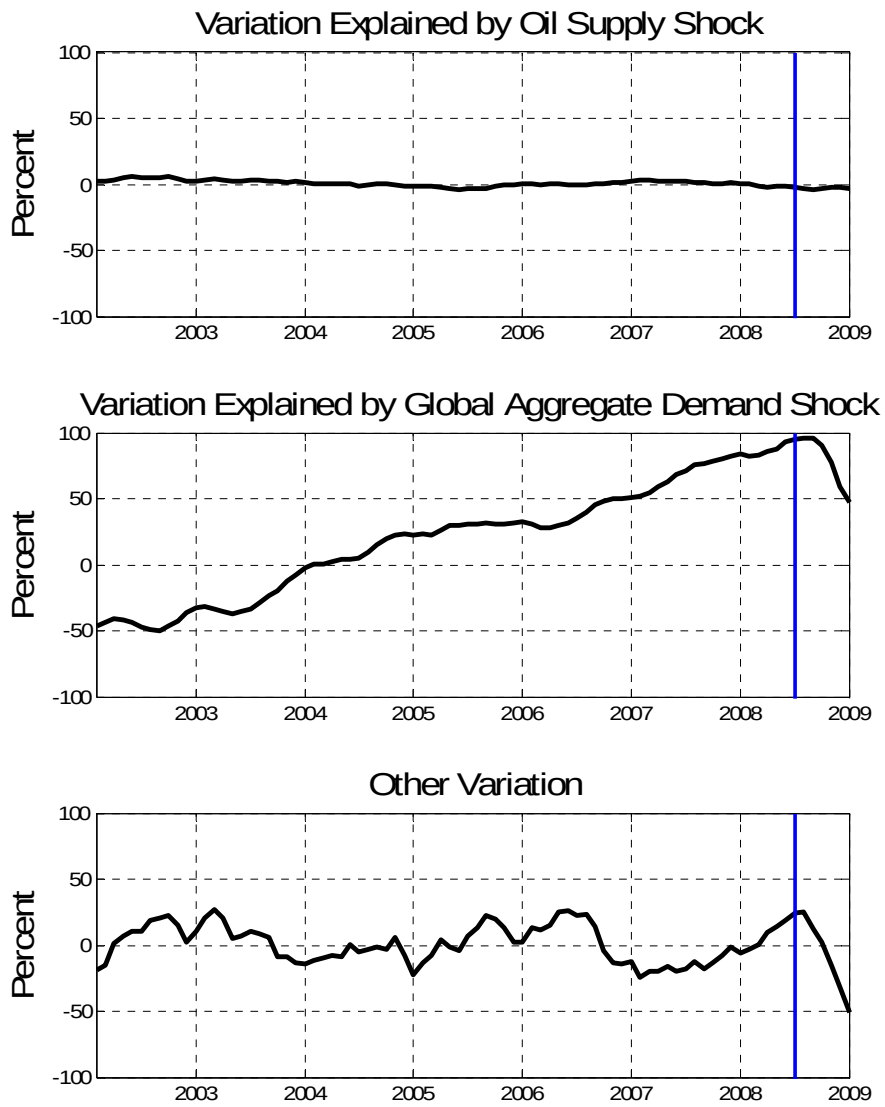
NOTES: Estimates based on Kilian (2009a). The plot shows a statistical measure of the conditional co-movement between real GDP growth and CPI inflation, as defined in Den Haan (2000). Stagflation in the form of rising prices and falling output means that this measure will be negative.

Figure 8: Indicators of the Stance of U.S. Monetary Policy
1971.II-1979.IV versus 2000.I-2008.III



NOTES: CFNAI, 1-year-ahead inflation expectations from the Michigan Survey of Consumers, and the corresponding ex ante 1-year real T-Bill rate.

Figure 9: Explanatory Power of Oil Demand and Oil Supply Shocks for the Real Price of Oil: 2002.1-2008.12



SOURCE: Kilian (2009b). The vertical line marks mid-2008 when global real economic activity peaked.