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Oil Price Volatility: Origins and Effects

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EXECUTIVE SUMMARY

In recent years, our understanding of the nature of energy price shocks and their effects on the economy has evolved dramatically. Only a few years ago, the prevailing view in the literature was that at least the major crude oil prices increases were exogenous with respect to the OECD economies and that these increases were caused by oil supply disruptions triggered by political disturbances in the Middle East. This view has little empirical support. Likewise, the popular notion that OPEC constitutes a cartel that controls the price of oil has not held up to scrutiny. At the same time, there has been increasing recognition of the importance of shifts in the demand for oil. Recent research has provided robust evidence that oil demand shocks played a central role in all major oil price shock episodes since the 1970s.

There is no consensus in the literature on how to model the global market for crude oil. One strand of the literature views oil as an asset, the price of which is determined by desired stocks. In this interpretation, shifts in the expectations of forward-looking traders are reflected in changes in the real price of oil and changes in oil inventories. The other strand of the literature views the price of oil as being determined by shocks to the flow supply of oil and flow demand for oil with little attention to the role of inventories in smoothing oil consumption.

Recent research shows that shocks to the flow supply of crude oil overall have had little impact on the real price of oil since 1973. In contrast, shocks to the flow demand for oil associated with the global business cycle have been responsible for long swings in the real price of oil, notably in 1973/74, 1979/80 and 2003-2008. In addition, speculative demand shocks defined as any demand shock that reflects forward looking behavior by traders played an important role in 1979 (following the Iranian Revolution), in 1986 (following the collapse of OPEC), in 1990/91 (following the invasion of Kuwait), in 1997-2000 (following the Asian crisis) and in late 2008 (during the global financial crisis). Unlike shocks to the flow demand or flow supply, speculative demand shocks can cause large immediate effects on the real price of oil, for example in response to geopolitical events.

Although speculative trading appears to have played an important role in some historical episodes, there is no evidence that it caused the surge in the real price of oil during 2003-06 and only very limited evidence that it helps explain the 2007-08 oil price surge. Instead, the bulk of the 2003-08 increase in the real price of oil was caused by fluctuations in the global business cycle, driven in large part by unexpected growth in emerging Asia superimposed on strong growth in the OECD. As the world economy collapsed in late 2008, so did the real price of oil. More than half of the observed decline in the real price of oil, however, was driven by expectations about a prolonged global recession. The gradual recovery of the real price of oil in 2009 can be attributed equally to a partial reversal of these expectations and to a recovery of the demand for industrial commodities, reflecting the improved state of the global economy.

The distinction between different oil demand and oil supply shocks has far-reaching implications because each shock has different effects on the U.S. economy and on the real price of oil. In addition, not all such shocks are unambiguously harmful to oil importing economies. For example, shocks to the global flow demand for oil have both a stimulating effect on the U.S. economy and adverse effects on economic growth working through higher oil prices in particular and higher industrial commodity prices more generally. Empirical estimates suggest that, in the short run, the positive effects on the U.S. economy are strong enough to sustain growth, while global commodity prices are slow to respond and the world economy is booming. Only subsequently U.S. real GDP gradually declines, as commodity price increases gain momentum

and the economic stimulus from higher global demand weakens. This response pattern differs sharply from the typical effect of higher energy prices driven by shocks to the speculative demand for crude oil, for example, or by shocks to the flow supply of crude oil, but it helps explain why the 2003-08 surge in the real price of oil did not create a major recession long before the global financial crisis.

One direct implication of recent models of the endogenous determination of the real price of oil is that conventional estimates of the response to unanticipated oil price changes are best thought of as the response to an average oil price shock and in practice may be sensitive to the sample period, as the composition of the underlying demand and supply shocks evolves over time. This helps understand why regressions of macroeconomic aggregates on oil prices tend to be unstable over time and in particular why the average effect of oil price shocks appears to have diminished since the late 1980s.

A second implication is that it is not logically possible to attribute the macroeconomic effects associated with an oil price shock to the observed change in the real price of oil. This would be misleading because the ceteris paribus assumption is violated. It is more appropriate to think of oil price fluctuations as symptoms of the underlying oil demand and oil supply shocks. This calls for a fundamental change in the way policymakers and economists think about the relationship between oil price volatility and economic outcomes. For example, one cannot assess the causal effects of the oil price increase of 2003-08 on the global economy because much of that oil price increase was caused by strong growth in the global demand for industrial commodities in the first place. In contrast, a better-posed question would be how the growth in emerging Asia has affected the economic performance of OECD economies both directly through trade and financial asset market channels and indirectly through rising commodity prices.

Third, standard theoretical models of the transmission of oil price shocks that maintain that everything else remains fixed, as the real price of imported crude oil increases, are misleading and must be replaced by models that allow for the endogenous determination of the price of oil rather At this point we are only beginning to understand the theoretical implications of endogenizing the real price of oil.

1. Introduction

There is widespread concern that large fluctuations in the real price of oil are harmful to the economies of oil importers in particular. In addition, the volatility of the real price of oil also poses challenges for policy makers in oil-exporting economies. Figure 1 provides two alternative measures of oil price volatility. The upper panel shows the percent deviation of the real price of oil from its average value since 1973.2. It is evident that the real price of oil repeatedly has undergone large and persistent fluctuations that must have put stress on the global economy. Large sustained oil price increases occurred in particular in 1973/74, in 1979/80, in 1990, after 1999, between 2003 and mid-2008, and starting in 2009. Major sustained oil price declines occurred, for example, in the early and mid 1980s, in 1991, after the Asian financial crisis, and in late 2008.

The lower panel shows the corresponding month-to-month percent change in the real price of oil. It reveals that with rare exceptions the fluctuations in the real price of oil have been smooth rather than sudden. The most glaring exception is the spike in the real price of oil following the invasion of Kuwait in August of 1990. The spike in late 1973 following the Yom Kippur War and the Arab oil embargo at first glance looks similar, but appearances can be deceiving. As discussed in Barsky and Kilian (2002, 2004) and in Kilian (2008a, 2009a), much of that increase in the real price of oil would have occurred earlier and more gradually, had the price of Middle Eastern oil not effectively been fixed by contractual agreement after 1971. As global demand for oil and other industrial commodities expanded after 1971, the shadow price of oil increased, while the actual price remained low. With the abandonment of these contractual agreements in late 1973, the real price of oil jumped, but much of that increase represented a correction of the market disequilibrium rather than a response to the geopolitical events of late 1973.

Figure 1 also reveals two sudden drops in the real price of oil. The first occurred in early 1986, following the collapse of OPEC. The second coincided with the financial crisis of late 2008. All other fluctuations in the real price of oil appear gradual and smooth, consistent with economic forces driving the real price of oil rather than sudden geopolitical events. Figure 1 also reveals that not all geopolitical events are associated with large changes in the real price of oil. For example, the outbreak of the Iran-Iraq War in late 1980 did not cause a major oil price spike, nor did the Iraq War of early 2003. We defer a more detailed discussion of the forces determining the real price of oil to section 4.

Section 2 discusses how the fluctuations in the real price of oil documented in Figure 1 might affect oil-importing economies. There is a large literature on why oil price fluctuations matter for oil-importing economies. Much of that literature postulates a change in the real price of oil, holding everything else constant. This *exogeneity* assumption is highly unrealistic, as will be discussed later, but it simplifies the exposition, so we will follow that convention for now. Sections 3 and 4 explain how the analysis in section 2 must be modified when taking account of the endogenous determination of the real price of oil by market forces and what we can learn about the causes of the oil price fluctuations shown in Figure 1. Section 5 discusses how oil price volatility affects oil exporters. Section 6 focuses on how oil price shocks affect trade and external financial flows both from an oil importer's and an oil exporter's point of view. Section 7 concludes with some remarks about the longer-run effects of oil price volatility.

2. The Effect of Oil Price Shocks on Oil-Importing Economies

2.1. The Supply-Side Channel

An exogenous increase in the real price of imported crude oil from the point of view of an oil-importing economy is a terms-of-trade shock. Such terms-of-trade shocks traditionally have been thought to matter for the oil-importing economy through their effects on production decisions (see, e.g., Kim and Loungani 1992; Backus and Crucini 2000). In this view, oil is treated as an intermediate input in domestic production. How imported oil enters the production function for domestic value added is one of the most studied and least resolved issues in empirical macroeconomics. There are well-known problems in explaining a decline in real GDP based on this intermediate input cost or supply channel.

The first problem is that the interpretation of crude oil as an intermediate input in the value added production function is questionable if we think of oil as an imported commodity. Under standard assumptions, imported oil enters the production function of domestic gross output, but it does not enter the production function of domestic value added (see, e.g., Rotemberg and Woodford 1996). Since gross output is separable in value added and imported energy, holding capital and labor fixed, oil price shocks do not move value added. Hence, oil price shocks by definition cannot be interpreted as productivity shocks for real GDP (see Barsky and Kilian 2004). Rather they affect the domestic economy by changing domestic capital and labor inputs.

The second problem is that, to the extent that oil prices affect domestic output, under standard assumptions their impact should be bounded by the cost share of oil in domestic production, which is known to be very small. For example, for the United States, the ratio of imported and domestically produced crude oil in GDP has been fluctuating between 1 and 5 percent (see Edelstein and Kilian 2007). Thus, if oil price shocks are viewed as cost shocks for the oil-importing economy, their effect by construction cannot be very large. Indeed, Backus and Crucini (2000) have demonstrated that standard production-based general equilibrium models of the transmission of oil price shocks are not capable of explaining large fluctuations in real GDP.

This type of result came as a surprise to many researchers who expected oil price shocks to be a major determinant of the business cycle. This spurred interest in the development of less conventional macroeconomic models that would be able to explain large effects of oil price shocks on real GDP. There are three such proposals in the literature. The first proposal by Rotemberg and Woodford's (1996) relies on large and time-varying markups to generate large effects of oil price shocks on real GDP. The second proposal is Atkeson and Kehoe's (1999) putty-clay model which appeals to capital energy complementarities in production. The third proposal is due to Finn (2000). Finn establishes that in a perfectly competitive model, in which energy is essential to obtaining a service flow from capital, there is a large effect of oil price shocks on real GDP. In all three models, the supply channel of the transmission of oil price shocks may be quantitatively important, yet there is no consensus which, if any, of these models has empirical support. For example, it remains to be shown that mark-ups in the U.S. economy are as large and as time-varying as required for the Rotemberg and Woodford model. Likewise, it has yet to be shown that changes in capacity utilization in response to oil price shocks are indeed as important and pervasive in the real world as they are in Finn's model. Similarly, the microeconomic evidence on the existence and quantitative importance of capital-energy complementarities is mixed at best. A second unresolved issue is whether these models can account for a large share of business cycle fluctuations in real GDP. A third issue is that all three models postulate that oil prices follow an exogenous stochastic process, an assumption that is at odds with both the data and standard economic models of the oil market. It is fair to say that these alternative explanations are fragile in that they depend on very specific modeling assumptions, that they have never become universally accepted, and that their quantitative importance is open to debate. For example, Wei (2003) concluded that an extended version of Atkeson and Kehoe's model is unable to explain stock market fluctuations following the 1973/74 oil price shock episode.

2.2. The Demand-Side Channel

In the absence of an empirically supported model of the supply channel, there is no reason to expect global oil price shocks to exert major effects on oil-importing economies. In part in response to these challenges, another branch of the literature has developed that focuses on the reduction in the demand for goods and services triggered by energy price shocks rather than treating energy price shocks as aggregate supply shocks for the oil-importing economy (or as cost shocks for domestic production). In this alternative view, the primary channel of transmission is on the demand side of the economy. For example, in a recent survey on the effects of energy price shocks, Hamilton (2008) stresses that a key mechanism whereby energy price shocks affect the economy is through a disruption in consumers' and firms' spending on goods and services other than energy. This view is consistent with evidence from industry sources of how oil price shocks affect U.S. industries. Most U.S. firms perceive energy price shocks as shocks to the demand for their products rather than shocks to the cost of producing these products (see Lee and Ni 2002). Related results based on sectoral stock return responses are in Kilian and Park (2009).

This alternative view is also shared by many policymakers. There is a widespread perception that an increase in energy prices slows economic growth primarily through its effects on consumer spending (see, e.g., Bernanke 2006). The remainder of this subsection outlines the economic rationale for this demand channel of transmission and assesses its empirical support. The demand channel by construction relates to retail energy price shocks rather than crude oil price shocks. In practice, that distinction is often ignored on the grounds that in the long-run there is strong comovement between the prices of crude oil and retail energy.[1]

[1] In practice, retail energy prices are dominated by the evolution of gasoline prices (see Edelstein and Kilian 2009). A formal model of the joint determination of U.S. gasoline prices and global crude oil prices that makes the relationship between these prices explicit has recently been proposed in Kilian (2010). Kilian demonstrates that at times the prices of crude oil and gasoline have moved in the opposite direction and explains the economic rationale of these price movements.

There are four complementary mechanisms by which energy price changes may directly affect consumer expenditures (see Edelstein and Kilian 2009). First, higher energy prices reduce discretionary income, as consumers have less money to spend after paying their energy bills.[2] All else equal, this *discretionary income effect* will be the larger, the less elastic the demand for energy, but even with perfectly inelastic energy demand the magnitude of the effect of a unit change in energy prices is bounded by the energy share in consumption. For the United States, for example, the share of energy in consumer expenditures fluctuates between 4% and 10% (see Edelstein and Kilian 2009). Although this expenditure share is higher than the corresponding share on the production side, it is still too low to explain very large effects on real GDP by itself.

Second, changing energy prices may create uncertainty about the future path of the price of energy, causing consumers to postpone irreversible purchases of consumer durables (see Bernanke 1983, Pindyck 1991). Unlike the first effect, which applies to all forms of consumption, this *uncertainty effect* is limited to irreversible purchases. It is usually thought to apply to consumer durables, especially energy-using consumer durables.[3]

Third, even when purchase decisions are reversible, consumption may fall in response to energy price shocks, as consumers increase their *precautionary savin*gs. This response may arise if consumers smooth their consumption because they perceive a greater likelihood of future unemployment and hence future income losses. By construction, this effect will embody general equilibrium effects on employment and real income. In addition, the precautionary savings effect may also reflect greater uncertainty about the prospects of remaining gainfully employed, in which case any unexpected change in the price of energy would lower consumption.

Finally, consumption of durables that are complementary in use with energy (in that their operation requires energy) will tend to decline even more, as households delay or forego purchases of energy-using durables. This operating cost effect is more limited in scope than the uncertainty effect in that it only affects specific consumer durables. It should be most

[2] Implicit in this view is the assertion that higher energy prices are primarily driven by higher prices for imported energy goods, and that at least some of the discretionary income lost from higher prices of imported energy goods is transferred abroad and is not recycled in the form of higher exports. In the case of a purely domestic energy price shocks (such as a shock to domestic refining capacity), it is less obvious that there is an effect on aggregate discretionary income. First, the transfer of income to the refiner may be partially returned to the same consumers in the form of higher wages or higher stock returns on domestic energy companies. Second, even if the transfer is not returned, higher energy prices simply constitute an income transfer from one consumer to another that cancels in the aggregate.

[3] In addition, one might expect durables consumption to fall in response to a positive energy price shock, as consumers wait for more energy-efficient technologies to become available.

pronounced for motor vehicles (see Hamilton 1988).[4]

Although these four effects are usually discussed in the context of consumer expenditures, similar arguments apply to investment expenditures by firms. For example, Bernanke's (1983) and Pindyck's (1991) analysis of the uncertainty effect was originally intended to explain firm's investment decisions. Similarly, the operating cost effect applies to firm's purchases of vehicles.

The four direct effects on consumption and investment expenditures have in common that they imply a reduction in aggregate demand in response to unanticipated energy price increases. In addition, there may be indirect effects related to the changing patterns of consumption and investment expenditures. A large literature has stressed that shifts in expenditure patterns driven by the uncertainty effect and operating cost effect amount to allocative disturbances that are likely to cause sectoral shifts throughout the economy (see, e.g., Davis (1987) and Hamilton (2008) for a review). For example, it has been argued that reduced expenditures on energy-intensive durables such as automobiles may cause the reallocation of capital and labor away from the automobile sector. As the dollar value of such purchases may be large relative to the value of the energy they use, even relatively small changes in energy prices (and hence in the purchasing power of consumers) can have large effects on output and employment (see Hamilton 1988). A similar reallocation may occur within the same sector, as consumers switch toward more energy efficient durables (see Hamilton 1988; Bresnahan and Ramey 1993).

In a standard neoclassical model, reallocations driven by relative price changes will be smooth and instantaneous. In the presence of frictions in capital and labor markets, however, these intersectoral and intrasectoral reallocations will cause resources to be unemployed, thus causing further cutbacks in consumption and amplifying the effect of higher energy prices on the real economy. For example, it does not seem feasible to ship machinery or relocate workers from automobile manufacturers in Detroit to software producers in Silicon Valley when the real price of oil increases, short of substantial retraining and retooling. Thus, these resources will remain idle for extended periods in response to major oil price increases, causing private consumption to fall and tax revenues to erode, followed by cutbacks in public consumption. This indirect effect

[4] This last effect need not involve a reduction in the number of automobiles sold. It can also take the form of consumers substituting small energy-inefficient automobiles for large energy-inefficient automobiles. If the latter automobiles tend to be lower priced, aggregate real consumption of automobiles may fall, even when the number of automobiles sold does not (see, e.g., Bresnahan and Ramey 1993).

could be much larger than the direct effects listed earlier, and is considered by many economists to be the primary channel through which energy price shocks affect the economy (see, e.g., Davis and Haltiwanger (2001) and Lee and Ni (2002) and the references therein). Concerns over reallocation effects also help explain the preoccupation of policy makers with the effects of energy price shocks on the automobile sector (see, e.g., Bernanke 2006).

2.3. The Role of Asymmetry in the Responses to Oil Price Shocks

In standard models of the transmission of energy price shocks, the response of real output to a negative energy price shock will be the exact mirror image of the response to a positive energy price of the same magnitude. Unlike the discretionary income effect, the uncertainty effect and the reallocation effect necessarily generate asymmetric responses of macroeconomic aggregates to unanticipated energy price increases and decreases, as does the component of the precautionary savings effect driven by uncertainty. The asymmetry arises because these effects amplify the response of macroeconomic aggregates to energy price increases, but reduce the corresponding response to falling energy prices. Such mechanisms allow us to explain much larger recessions in response to positive oil price shocks than conventional models, while being consistent with the perception that negative oil price shocks of the same magnitude do not generate expansions of comparable magnitude. The fact that theoretical models embodying asymmetries are capable of explaining much larger recessions in response to positive oil price shocks than conventional models has attracted much attention.

In fact, models of the transmission of oil price shocks involving asymmetries have been popular in empirical research since the 1990s (see, e.g., Mork 1989; Lee, Ni and Ratti 1995; Hamilton 1996, 2003; Davis and Haltiwanger 2001; Lee and Ni 2002). Initially, researchers experimented with models in which only oil price increases matter. Subsequent research has refined this idea and introduced measures of net oil price increases. The net increase measure of oil price shocks was based on the (untested) premise that consumers and firms only respond to oil prices if the current oil price is larger than its maximum in recent history. An obvious advantage of this class of empirical models is that they do not require the researcher to take a stand on the mechanism generating the asymmetry of the response to oil price shocks. Finally, these models were considered more credible than conventional models because they generated much larger responses to positive oil price shocks, in line with subjective beliefs about the importance of oil price shocks for the economy (see, e.g., Bernanke, Gertler and Watson 1997).

Recent research, however, has shown that the response estimates reported in this literature are spurious because this type of asymmetric models of the transmission of energy price shocks is fundamentally misspecified (see Kilian and Vigfusson 2009). By construction these models yield inconsistent parameter estimates. In addition, the responses of output and employment to energy price shocks in these models were routinely computed incorrectly, causing the estimated responses to positive oil price shocks to look larger than they really are. Finally, the statistical tests used in support of allowing for asymmetric responses to energy price shocks were inappropriate for this task. More appropriate tests proposed in Kilian and Vigfusson (2009) reveal no statistically significant evidence of asymmetric responses to energy price shocks for the United States.

If the linear symmetric model provides a good approximation, as the results in Kilian and Vigfusson (2009) show, then what caused sharply higher energy prices in 1979 to be followed by a major recession, whereas sharply lower energy prices in 1986 were not followed by a major economic expansion? Edelstein and Kilian (2007, 2009) demonstrate that much can be learned from decomposing real GDP growth in 1986. They show that the lackluster performance of real GDP in 1986 despite falling oil prices can be traced to nonresidential investment expenditures. There actually is no evidence of asymmetries in consumption growth or in residential investment growth. The reason nonresidential investment expenditures did not increase more in 1986 appears to be due in part to an exogenous decline in business investment in 1986, related not to the fall in energy prices but arguably to the 1986 Tax Reform Act. This effect was exacerbated by the response of investment in the petroleum and natural gas industry to the collapse of OPEC in late 1985, which far exceeded the response one would have expected to a decline in energy prices alone. Moreover, composition effects from aggregating investment expenditures related to petroleum, coal and natural gas mining and all other investment expenditures helped generate an apparent asymmetry in the growth of aggregate investment. Hence, the asymmetry in the real GDP growth data seems to be largely a statistical artifact.

The growing body of evidence against asymmetric effects of energy price shocks is important in that it allows us to remove from consideration all theoretical models of the transmission of oil price shocks that imply asymmetries. Because it is precisely these models that are required to rationalize a strong recessionary effect of oil price shocks, we conclude that the effect of oil price shocks on the economy historically has tended to be only fairly moderate. Oil price shocks have not been one of the key driving forces of postwar recessions. This does not mean that oil price shocks do not matter as a contributing factor. Edelstein and Kilian (2007, 2009) based on a detailed analysis of U.S. consumer and business investment expenditures documented that the demand channel of the transmission of oil prices is actually more important than the small share of energy in expenditures would suggest. A one percent increase in energy prices is associated with a reduction of real consumption and real nonresidential investment of -0.15 and -0.16 percent, respectively, after one year. This is about four times as high as the energy share argument would suggest. Nevertheless, the overall responses are still fairly small and of limited importance in explaining U.S. business cycle fluctuations. For nonresidential investment in equipment and structures, the corresponding estimate is -0.16 percent.

Suppose, for example, that gasoline prices unexpectedly and permanently increased by 25 cents per gallon (which translates into a 6.85% increase in the overall price of energy, assuming all other energy prices remain unchanged). If a typical household spends $200 a month on gasoline at the January 2007 price of $2.29 per gallon, this would raise the household’s gasoline bill by almost $22 a month. Assuming an average household expenditure of $4000 per month and given the share of consumption in GDP of about 72%, the estimates in Edelstein and Kilian (2009) imply that, all else equal, real GDP will fall by 0.63% on average one year after the shock. This example illustrates that it takes repeated surprise increases in gasoline prices to generate large effects on household consumption, but over time the effects will add up.

Evidence of larger responses can be found only for specific expenditure items. Residential housing purchases and automobile purchases are particularly sensitive to unexpected fluctuations in oil prices. Edelstein and Kilian’s analysis has been extended to 2008 by Hamilton (2009). Hamilton concludes that reduced demand in these sectors was an important contributing factor to the recession of 2008, quite independently of the financial crisis.

2.4. The Monetary Policy Channel

Another channel that may help amplify the effects of oil price shocks on real output is the endogenous policy response of the central bank to oil price shocks. Bernanke, Gertler and Watson (1997), henceforth referred to as BGW, stipulated that the Federal Reserve, when faced with potential or actual inflationary pressures triggered by a positive oil price shock, responds by raising the interest rate, amplifying the decline in real output associated with oil price shocks. In assessing the effect of this policy response from vector autoregressive (VAR) models, BGW postulated a counterfactual in which the Federal Reserve holds the interest rate constant. In other words, the Fed is not responding to any of the effects of the oil price shock on the economy. BGW concluded that the Fed's systematic and anticipated response to oil price shocks is the main cause of the recessions that tend to follow oil price shocks and that these recessions could have been avoided (at the cost of higher inflation) by holding the interest rate constant.

BGW’s results have not remained unchallenged. For example, Hamilton and Herrera (2004) showed that the estimates in BGW are sensitive to the choice of the VAR lag order. Allowing for additional lags undermines the importance of the policy response. They also demonstrated that implementing a constant interest rate policy would have required policy changes so large to be unprecedented historically and hence not credible in light of the Lucas critique, a point acknowledged by Bernanke, Gertler and Watson (2004). This evidence has done little to diminish the appeal of BGW’s results among economists, however.

BGW’s empirical results also have motivated a theoretical literature that examines the potential macroeconomic impact of monetary policy responses to oil price shocks using dynamic stochastic general equilibrium (DSGE) models. The conclusions reached in this literature very much depend on the specification of the DSGE model. Whereas Leduc and Sill (2004), for example, concluded that in their DSGE model monetary policy contributes about 40 percent to the drop in real output following a rise in the price of oil, Carlstrom and Fuerst (2006), found that under alternative assumptions the entire decline in U.S. real output following an oil price shock may be due to oil and none attributable to monetary policy. Thus, the key question remains of how plausible the original empirical estimates in BGW are.[5]

The empirical analysis in BGW, however, is based on the class of asymmetric empirical models that Kilian and Vigfusson (2009) showed to be inconsistent. Moreover, as discussed earlier, the data appear to be fully consistent with symmetric responses to oil price shocks.
Kilian and Lewis (2009) therefore recently have reestimated the BGW model under the assumption of symmetry. They show that there is no evidence that monetary policy responses to oil price shocks are to blame for the recessions of the 1970s and early 1980s, contrary to the conclusion of BGW. This result should not be surprising. Although few researchers have questioned the narrative in BGW, the rationale for the policy response they stipulated is not self-

[5] For related work see Blanchard and Gali (2009), Rotemberg (2009), Harris, Kasman, Shapiro and West (2009), and Kilian (2009b) among others.

evident. As discussed in Kilian and Lewis (2009), there are three problems.

First, it is widely accepted that the Federal Reserve in the 1970s was as much concerned with maintaining output and employment as it was concerned with containing inflation. In fact, it has been argued that the Federal Reserve was overly concerned with the output objective during this period (see, e.g., Barsky and Kilian 2002). To the extent that oil price shocks are recessionary, in the absence of a policy response one would have expected the Fed to ease rather than tighten monetary policy in response; and even if one were to grant that oil price shocks also have inflationary effects, it would not be obvious that the appropriate policy response on balance would be to raise the interest rate. In fact, BGW's notion of a policymaker responding aggressively to inflationary pressures seems more consistent with the Volcker era than with U.S. monetary policy in the 1970s.

Second, while a robust theoretical finding is that oil price shocks are at least mildly recessionary in the absence of a monetary policy response, it is not clear that oil price shocks are necessarily inflationary. For simplicity suppose that a one-time oil price shock occurs, while everything else is held constant. As discussed earlier, 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, as discussed earlier. Empirical evidence suggests that the supply channel of transmission is weak and that the demand channel of transmission dominates in practice (for a review see, e.g., Kilian 2008b). On that basis, one would expect an exogenous oil price shock, if it occurs in isolation, to be recessionary and deflationary, suggesting that there is no reason for monetary policy makers to the raise interest rate at all. 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 under the price stability mandate. Thus, unless a good case can be made for the risk of a wage-price spiral, oil price shocks would not be expected to cause sustained inflation. This analysis shows that BGW implicitly take the rather extreme view that oil price shocks necessarily represent adverse aggregate supply shocks that are both recessionary – if only mildly so because otherwise there would be no need for an amplifier – and inflationary.[6]

The third problem is BGW's premise that innovations to the price of oil are exogenous with respect to the U.S. economy. The recent literature has established that oil price shocks do not take place in isolation, violating the premise of the analysis in BGW. This point matters. Kilian and Lewis (2009) showed that the Federal Reserve on average has been responding differently to oil price shocks driven by global demand pressures than to oil price shocks driven by oil supply disruptions, for example. In response to positive oil demand shocks, it tended to raise the interest rate in response, whereas in response to negative oil supply shocks it tended to lower the interest rate. Thus, the Federal Reserve's policy response appears to have been much more sophisticated than BGW's model gives it credit for. These findings suggest that DSGE models of monetary policy responses in particular must account for a variety of structural shocks in the crude oil market, each of which may necessitate a different policy response. For example, the policy response required for dealing with oil price shocks reflecting shifts in the global demand for oil driven by unexpected growth in emerging Asia should look different from the response required in dealing with oil price shocks triggered by oil supply disruptions in the Middle East. In short, it does not make sense for a central banker to respond to all oil price shocks the same way without regard to the causes of the oil price shock. This point has been established rigorously in Nakov and Pescatori (2009). Within the context of a stylized DSGE model they show that it is suboptimal from a welfare point of view for a central bank to respond to oil price shocks rather than to the underlying causes of these oil price shocks.

3. The Declining Importance of Oil Price Shocks since the 1990s

The term oil price shock has been used to refer to two very different phenomena. Sometimes it denotes an unpredictable change in the real price of oil, for example, on a month-to-month basis. This usage is consistent with the notion of a shock in an econometric model. At other times, it is used to refer to episodes of large cumulative changes in the real price of oil, often extending over several years. An oil price shock in the latter sense need not involve any large unpredictable changes. It may be driven entirely by many small unpredictable changes in real price of oil in the same direction.

[6] Undoubtedly the oil price increases of the 1970s, unlike more recent oil price increases, coincided with rising inflation. As discussed in Barsky and Kilian (2002) and Kilian (2009c), however, there is good reason to believe that this inflation for the most part was not driven by higher oil prices, but rather that higher oil prices and higher inflation were jointly caused by shifts in monetary policy (for a related argument also see Gillman and Nakov 2009).

An interesting observation in the recent literature is that the effects of oil price shocks in the former sense have apparently weakened since the late 1980s. For example, the response of real U.S. consumption to an unexpected increase in the price of energy of 1% has dropped from -0.30% prior to 1987 to only -0.08% after 1987. It can be shown that this phenomenon is not primarily associated with the evolution of the share of energy in consumer expenditures or in value added nor is it caused by a decline in the volatility or magnitude of energy price shocks (see Edelstein and Kilian 2009). Likewise, there is no compelling evidence that reduced real-wage rigidities, as suggested by Blanchard and Gali (2009), or improved monetary policy responses can explain the declining importance of oil price shocks (see Kilian and Lewis 2009). Rather this phenomenon can be primarily explained by changes in the nature of the oil price shocks. It is important to keep in mind that oil price shocks are merely symptoms of deeper oil demand and oil supply shocks, each of which affects oil importers differently.

One interpretation proposed by Hamilton (2009) is that the oil price increase between 2003 and mid-2008 was driven by global demand shocks, whereas earlier oil price shocks were primarily driven by exogenous oil supply shocks in the Middle East. This interpretation is not consistent with a wide range of evidence, however, that indicates a central role for oil demand shocks in all previous oil price shock episodes since 1972 except the oil price shock triggered by the outbreak of the Iran-Iraq War in late 1980 (for a review see, e.g., Kilian 2009a). Rather the relative importance of different oil demand shocks, some of which are speculative in nature, and some of which are associated with fluctuations in the global business cycle, has evolved in ways that explains the declining importance of oil price shocks.

Of central importance in this regard is the feedback from the global economy to the real price of oil. In the discussion of section 2, we have ignored that feedback by assuming that the price of oil is exogenous. There has been much speculation, for example, as to why the recent surge in the price of crude oil did not cause a major recession even after years of rising oil prices. Part of the answer is that much of that increase was driven by unexpected strong global demand for industrial commodities (see, e.g., Kilian 2009c; Kilian and Hicks 2009). It can be shown that such global demand shocks have both a stimulating effect on the U.S. economy and adverse effects on economic growth working through higher oil prices in particular and higher industrial commodity prices more generally. Empirical estimates suggest that, in the short run, the positive effects on the U.S. economy are strong enough to sustain growth, as global commodity prices are slow to respond and the world economy is booming. Only subsequently U.S. real GDP gradually declines, as energy price increases gain momentum and the economic stimulus from higher global demand weakens. This response pattern differs sharply from the typical effect of higher energy prices driven by shocks to the speculative demand for crude oil, for example, or by shocks to the flow supply of crude oil, but helps explain why the 2003-08 surge in the real price of oil did not create a major recession long before the global financial crisis.

The distinction between different oil demand and oil supply shocks has far-reaching implications, as each shock has different effects on the U.S. economy and on the real price of energy. Kilian (2009c) and Kilian and Park (2009) illustrate this point for several U.S. macroeconomic aggregates including real GDP, consumer prices and real stock returns, for example. One direct implication of their analysis is that conventional estimates of the response to unanticipated energy price changes are best thought of as the response to an average energy price shock and in practice may be sensitive to the sample period, as the composition of the underlying demand and supply shocks evolves over time. This helps understand why regressions of macroeconomic aggregates on oil prices tend to be unstable over time, and in particular why the average effect of oil price shocks appears to have diminished since the late 1980s.

A second implication is that it is not logically possible to attribute the macroeconomic effects associated with an oil price shock to the observed change in the real price of oil. This would be misleading because the ceteris paribus assumption is violated. It is more appropriate to think of oil price fluctuations as symptoms of the underlying oil demand and oil supply shocks. This calls for a fundamental change in the way policymakers and economists think about the relationship between oil price volatility and economic outcomes. For example, one cannot assess the causal effects of the oil price increase of 2003-08 on the global economy because much of that oil price increase was caused by strong growth in the global demand for industrial commodities in the first place. In contrast, a better-posed question would be how the growth of emerging Asia has affected the economic performance of OECD economies both directly through trade and financial asset market channels and indirectly through rising industrial commodity prices.

Third, existing theoretical models of the transmission of oil price shocks must be revised. In particular, we can no longer maintain that everything else remains fixed, as the real price of imported crude oil increases. We need to model the endogenous determination of the price of oil rather than assume that the price of oil is exogenous, as most existing macroeconomic models of the transmission of oil price shocks have done. Recent examples of such work include Bodenstein, Erceg and Guerrieri (2008), Nakov and Pescatori (2009) and Balke, Brown, and Yücel (2008). None of these models, however, is detailed enough at this point to provide guidance about the macroeconomic effects of oil demand and oil supply shocks in practice. At this point, we are only beginning to understand the theoretical implications of endogenizing the real price of oil.

4. The Endogenous Determination of the Real Price of Oil

In recent years, our understanding of the nature of energy price shocks and their effects on the economy has evolved dramatically. Only a few years ago, the prevailing view in the literature was that at least the major crude oil prices increases were exogenous with respect to the U.S. economy and that these increases were caused by oil supply disruptions triggered by political disturbances in the Middle East. This view has little empirical support. Today, we know that simple statistical transformations of the price of oil are not sufficient to identify oil price increases driven by exogenous crude oil supply shocks. Moreover, it has been shown that direct measures of exogenous shocks to the production of crude oil have low explanatory power for the real price of crude oil (see Kilian 2008a,b). Likewise, the popular notion that OPEC constitutes a cartel that controls the price of oil has not held up to scrutiny (see, e.g., Smith 2005; Almoguera and Herrera 2007). In fact, there are few periods when OPEC attempted to act as a cartel, notably in the early 1980s, and its success as a cartel has been limited to slowing down the decline in the real price of oil during that period (also see Skeet 1988). Moreover, cartels respond endogenously to macroeconomic conditions, so cartel prices cannot be considered exogenous (see, e.g., Barsky and Kilian 2002, 2004).

While traditional supply side explanations of the real price of oil have come under scrutiny, there has been increasing recognition of the importance of shifts in the demand for oil for the determination of the real price of oil. When Barsky and Kilian (2002) stressed the existence of reverse causality from global macroeconomic aggregates to the real price of oil, that result was generally met with skepticism among macroeconomists. The surge in the real price of crude oil after 2003 has demonstrated once and for all that large and sustained increases in oil prices may be driven primarily by the demand for crude oil, especially when the ability to increase crude oil production in the near future is limited. Recent research has provided robust evidence that demand shocks played a central role in all major oil price shock episodes since the 1970s (see, e.g., Kilian 2009a,c).

There is no consensus in the literature on how to model the global market for crude oil. One strand of the literature views oil as an asset, the price of which is determined by desired stocks. In this interpretation, shifts in the expectations of forward-looking traders are reflected in changes in the real price of oil and changes in oil inventories. The other strand of the literature views the price of oil as being determined by shocks to the flow supply of oil and flow demand for oil with little attention to the role of inventories in smoothing oil consumption. Much of the research on oil supply shocks is in that tradition, as are economic models linking the real price of oil to fluctuations in the global business cycle. The model proposed in Kilian (2009c) integrates these two strands of the literature into a comprehensive model of the global market for crude oil that allows us to assess the relative contribution of each type of shock to the variability of the real price of oil. Extensions of this model can be found in Fukunaga, Hirakata, and Sudo (2009), Kilian, Rebucci and Spatafora (2009), Kilian (2010) and Kilian and Park (2009), for example. Similar frameworks that distinguish between oil demand and oil supply shocks have been used in Baumeister and Peersman (2009), Lippi and Nobili (2009), and Kilian and Murphy (2009a,b), among others.

4.1. The Determinants of the Real Price of Oil

It is useful to classify the demand and supply shocks that determine the real price of oil as follows. First, there are shocks to the current flow supply of crude oil. The flow supply of crude oil is measured by the global production of crude oil. An unexpected disruption of that flow (embodied in a shift to the left of the contemporaneous oil supply curve along the oil demand curve) will raise the real price of crude oil. Second, there are shocks to the current flow demand for crude oil. The flow demand for crude oil is driven by unexpected fluctuations in global real activity. These represent shifts in the demand for all industrial commodities including crude oil. An unanticipated increase in global real activity (embodied in a shift to the right of the contemporaneous oil demand curve along the oil supply curve) will raise the real price of oil and will tend to stimulate global oil production. The latter stimulus, however, is bound to be small on impact, given the consensus in the literature that the short-run price elasticity of oil supply is near zero (see, e.g., Hamilton 2009a,b; Kilian 2009a,c).

This standard view of the global crude oil market is incomplete, however. Given that crude oil is storable, it may also be viewed as an asset, the real price of which is determined by the demand for inventories, if we view crude oil inventories as predetermined (see, e.g., Frankel and Rose 2009; Alquist and Kilian 2010). This means that the price of oil may jump in response to any news about *future* oil supply or oil demand. This type of expectations-driven shock represents a speculative demand shock. For example, upward revisions to expected future demand for crude oil (or downward revisions to expected future production of crude oil), all else equal, will increase the demand for crude oil inventories in the current period, resulting in an instantaneous shift of the contemporaneous demand curve for oil along the oil supply curve and an increase in the real price of oil.[7] News about future oil production and future demand for crude oil are but one example of shocks to expectations in the global market for crude oil. An unexpected increase in the uncertainty about future oil supply shortfalls would have the much same effect. This point has been demonstrated formally in a general equilibrium model by Alquist and Kilian (2010). The key difference is that uncertainty shocks would not be associated with expected changes in future oil production or real activity.

One of the striking findings of the recent literature is that speculative demand shocks, unlike shocks to the flow demand for and flow supply of oil, may have large immediate effects on the real price of oil. In many ways, these speculative demand shocks resemble the types of shocks that the earlier literature associated with exogenous political events in the Middle East. There is evidence that these geopolitical events indeed matter, but not so much through their effect on crude oil production, but through their effect on expectations of future crude oil production disruptions.[8]

[7] It is important to stress that expected supply disruptions alone are not enough to cause speculative demand to increase. It is tight supply in conjunction with strong demand for crude oil that causes expectations shifts. For example, at times in the 1980s about 30 oil tankers were attacked in the Persian Gulf in a given month, yet the price of oil continued to fall, reflecting the abundant supply of crude oil elsewhere in the world and the low state of global demand for crude oil.

[8] A case in point is the invasion of Kuwait in 1990. The reason the price of crude oil skyrocketed in mid-1990 was not merely the cessation of crude oil production in Iraq and Kuwait, but also the concern that Iraq may invade Saudi Arabia and occupy the Saudi oil fields, causing a much larger oil supply disruption. This risk never materialized, but helps explain the sharp increase in the price of oil in mid-1990 (over and above what would have been expected based on the physical reduction of crude oil supply at that point), and it explains the subsequent sharp fall in crude oil prices after the U.S. had moved enough troops to Saudi Arabia in late 1990 to forestall the occupation or destruction of the Saudi oil fields.

4.2. Empirical Evidence on the Determinants of Oil Price Volatility

Figure 2 presents a decomposition of the variation in the real price of oil relative to its mean for 1978.6-2009.8 based on an updated version of the structural VAR model estimated in Kilian (2009a,c) that builds on the classification of oil demand and oil supply shocks discussed above. Each panel plots the time series of the cumulative effect of a given type of shock on the real price of oil. The top panel shows that shocks to the flow supply of crude oil had little impact on the real price of oil throughout this sample. In contrast, shocks to the flow demand for oil explain long swings in the real price of oil. They played a central role both in the 1978-86 and the 2003-2008 oil price shock episodes.[9]

To the extent that the underlying measures of flow supply and flow demand are accurate, we can interpret the residual shock as a measure of speculative demand shocks. Speculation here refers to any demand shock that reflects forward looking behavior by traders, as defined earlier. The bottom panel in Figure 2 shows that such shocks played an important role in 1979 (following the Iranian Revolution), in 1986 (following the collapse of OPEC), in 1990/91 (following the invasion of Kuwait), in 1997-2000 (following the Asian crisis) and in late 2008 (during the global financial crisis). Interestingly, there is no evidence that speculative trading in oil markets played a major role in driving the surge in the real price of oil during 2003-06 and only very limited evidence in support of that notion for 2007-08. The bulk of these oil price increases was caused by fluctuations in the global business cycle, driven in large part by unexpected growth in emerging Asia superimposed on solid growth in the OECD. As the world economy collapsed in late 2008, so did the real price of oil. More than half of the observed decline in the real price of oil, however, was driven by expectations about a prolonged global recession. The gradual recovery of the real price of oil in 2009 can be attributed equally to a partial reversal of these expectations and a recovery of the demand for industrial commodities, reflecting the improved state of the global economy.

5. The Effect of Oil Price Volatility on Oil-Exporting Economies

Most oil exporters rely on oil revenues as their main source of revenue. While falling oil prices can put serious strains on oil producers' fiscal balances and on their ability to borrow from

[9] Although the historical decomposition does not extend back to 1973, related evidence in Barsky and Kilian (2002, 2004) and in Kilian (2008a, 2009a) suggests that the 1973/74 oil price shock episode to a large extent can also be explained based on the cumulative effects of flow demand shocks.

abroad, rising oil prices can typically be accommodated easily by oil producers. Some of the additional revenues due to rising oil prices tend to be used to finance imports from the rest of the world, helping to stabilize oil-importing economies. In addition, there are good reasons for oil exporters to recycle some of these oil revenues into the global financial system. First, there is an incentive for oil producers to smooth expenditures in anticipation of future declines in the real price of oil. Second, if the oil producer decides to use the extra revenue to diversify the domestic economy, the ability of the domestic economy of oil exporters to absorb infusions of capital is limited. Thus, inevitably, oil exporters must save the revenue that cannot be invested domestically. Given the absence of savings and investment opportunities in the region, these petro dollars must be invested in oil-importing economies. A good example is the sovereign wealth funds maintained by many oil-producing countries.

One obvious concern for some oil producers is that they face a risk of their assets being frozen or expropriated, if they pursue foreign policies at odds with the interests of the countries in which they invest. For most oil producers that risk is negligible. More importantly, oil producers' investments abroad are subject to foreign exchange risk and inflation risk, as the experience of the 1970s demonstrated. To the extent that oil producers import goods from countries other than the United States, a fall in the value of the dollar and unexpected U.S. inflation will erode the oil revenues invested in the United States, creating an incentive for oil producers to diversify their foreign asset holdings. Opportunities for purchasing liquid financial assets other than U.S. Treasury bills are limited, however, which has led many OPEC oil producers to invest in stocks of major European manufacturing companies.

In practice, suitable opportunities for investments abroad often are limited, causing oil revenue funds to be parked in international banks. This influx of deposits tends to create conditions of easy global credit. In the 1970s, this problem was resolved by banks lending the capital they received from OPEC countries to borrowers in oil-importing developing countries without much regard to creditworthiness. While this petro-dollar recycling successfully helped many oil-importing countries cope with external deficits in the short-run, the reliance on short-term financing of longer-term deficits ultimately caused the global debt crisis of the 1980s, when credit dried up as global interest rates increased.

In addition, banks discovered oil producers as likely prospects for making loans, as high oil prices seemed to guarantee the creditworthiness of this new clientele. Given the lack of productive investment opportunities in oil producing countries, these loans tended to finance higher imports and higher domestic consumption levels. This proved a miscalculation because oil prices did not remain high forever, causing even oil-rich countries such as Mexico to go into default and threatening the stability of the international financial system. This problem of overborrowing by oil producers during oil price booms has by no means been resolved, as the recent experience of Dubai shows. The next section explores in more detail the transmission of oil demand and oil supply shocks and the interdependencies between oil exporters and oil importers created by the international financial system.

6. The External Transmission of Oil Demand and Oil Supply Shocks

In many studies of the transmission of oil price shocks, the external transmission of oil demand and oil supply shocks is not discussed, although this aspect clearly is central to understanding the implications of oil price shocks. The distinction between demand and supply shocks in the global crude oil market again is important for the analysis. The most detailed theoretical analysis of this problem is provided in Bodenstein et al. (2008), who in turn build on the open economy model of Backus and Crucini (1998). Also relevant is recent empirical and theoretical work that stresses the role of valuation effects in the external adjustment of economies. Whereas the traditional "trade" (or macroeconomic) channel of adjustment to oil price shocks works through changes in the quantities and prices of goods exported and imported and is reflected in the response of the trade accounts, the "financial" (or valuation) channel of adjustment stressed in the recent literature works through changes in total asset return differentials and is reflected in income flows and in valuation changes, conditional on an economy's initial gross foreign asset and foreign liability position. Both channels matter for the transmission of oil demand and oil supply shocks. Because of the limitations of the income data, empirical work to date has concentrated on the capital gains and losses.

6.1. The Trade Channel

Economic theory suggests that different demand and supply shocks in the global market for crude oil have different effects on the oil trade balance and the non-oil trade balance of oil exporters and oil importers.

Shocks to the Flow Supply of Oil

For example, an exogenous oil supply disruption causes a temporary increase in the real price of oil, consistent with the estimated response of the real price of oil. For a given oil supply shock, the smaller the oil share in production and the larger the elasticity of substitution between oil and other factors of production, the flatter the overall response of the real price of oil will be. Under incomplete markets, an oil supply disruption generates an oil trade deficit in the oil-importing country, the magnitude and persistence of which depends on the response of the real price of oil. An oil supply disruption also generates a non-oil trade surplus, the magnitude of which depends on the extent to which markets are incomplete. Under complete markets, the non-oil trade balance of oil importers remains unaffected by oil supply disruptions. The response of the oil-exporting economy will be the exact mirror image of that of the oil-importing economy by construction.

Speculative Oil Demand Shocks

The effects of speculative oil-demand shocks on the real price of oil and on trade flows are qualitatively the same as in the case of oil supply shocks, except to the extent that they may also affect future global real activity or production. The key difference is that such shocks may have more immediate, larger and more persistent effects on the real price of oil, and therefore are associated with larger and more persistent oil trade and non-oil trade responses.

Shocks to the Flow Demand of Oil

Flow demand shocks can take different forms. For example, a productivity shock in oil-importing countries would raise demand not only for crude oil, but for all other industrial commodities. Such flow demand shocks in the data are associated with a hump-shaped response of the real price of oil. Flow demand shocks are different from other oil demand or oil supply shocks from a theoretical perspective. The response of the non-oil trade balance to an unanticipated increase in the flow demand for oil depends on two opposing effects. On the one hand, such a shock represents a short-run stimulus for the oil-importing economy (independently of the oil share), which will tend to cause a non-oil trade deficit. On the other hand, it has adverse consequences for oil-importing economies in that it raises the price of oil, causing an oil trade deficit and hence a non-oil trade surplus under incomplete markets. Which of these two effects dominates is an empirical question. Related research by Kilian (2009c) and Kilian and Park (2009) suggests that within the first year of such a shock, the stimulating effect on the U.S. economy dominates, whereas subsequently the adverse effect associated with higher oil prices does. On this basis, one would predict an oil trade deficit in oil-importing economies, but theory is consistent with either a non-oil trade surplus or a non-oil trade deficit.

6.2. The Valuation Channel

The valuation channel of adjustment relies on changes in asset prices in response to oil demand and oil supply shocks. The magnitude and the nature of these capital gains and losses depends on the size of the initial gross foreign asset holdings and liabilities of oil importers and exporters, as well as their precise composition by financial instrument and currency. Standard diversification arguments suggest that oil-exporters should hold some of their wealth in the form of assets in oil importing economies (and vice versa). This diversification of asset holdings plays an important role. Under the additional assumption that an increase in the price of oil all else equal will cause profits and asset prices to increase in the oil-exporting economy (and to fall in the oil-importing economy), some of the increased wealth associated with higher oil prices will be transferred from oil exporters to oil importers. Thus, positive oil-specific demand shocks and negative oil supply shocks should be associated with a temporary capital loss in oil exporting countries (and a corresponding capital gain in the rest of the world). In the long-run, asset prices return to their steady state level and the valuation channel vanishes. Of course, as discussed earlier, aggregate demand shocks have additional effects not operating through the real price of oil, which may temper or reverse the ensuing capital gains and losses. This simple prediction of a capital loss at least in response to negative oil supply shocks and positive oil-specific demand shocks ignores likely asymmetries in oil exporters' and oil importers' gross asset and liability positions. Given the relative weight of oil exporters and oil importers in world GDP (about 10% and 90%, respectively, in purchasing power parity terms), one would expect the share of oil exporters' asset holdings in the total asset holdings of oil importing economies to be rather small, whereas that of oil importers in the total asset holdings of oil exporting economies may be much larger. This reasoning suggests that the valuation effect should be larger for oil exporters than for oil importers, all else equal. Even this prediction, however, ignores the important role of relative exchange rate adjustments triggered by oil demand and oil supply shock. In general, one would not expect the stylized bilateral and symmetric model to generate accurate predictions for specific oil-importing economies

6.3. Empirical Evidence

Although economic theory provides a useful framework for thinking about the external transmission of oil demand and supply shocks, it typically does not pin down the magnitude of the responses. For example, economic theory is informative about the direction and overall pattern of the response of the oil trade balance to an oil supply shock, but it is quiet about the magnitude of the response in question. Likewise, depending on the degree of financial market integration, the non-oil trade balance may not respond at all to an oil supply shock or the response could be potentially quite large. In addition, to date there has been no theoretical analysis of global aggregate demand shocks in industrial commodity markets. The effect of such shocks on external balances tends to be rather complicated, making it difficult to generate any theoretical predictions. This makes empirical studies of the response of external balances all the more relevant. Kilian, Rebucci, and Spatafora (2009), building on the analysis in Kilian (2009c), provide some tentative results:

(1) Global business cycle demand shocks and oil-market specific demand and supply shocks are important for the determination of external balances. For example, they jointly account for 86% of the variation in the current account of an aggregate of oil exporters and for 82% of the corresponding changes in net foreign asset (NFA) positions (all expressed as a share of GDP). For an aggregate of major oil importers the corresponding shares are lower, but still large.

(2) Each oil demand and oil supply shock has different effects on external balances. For example, the effect of an oil supply disruption on the oil trade balance of oil importers tends to be small, short-lived and statistically insignificant, consistent with the small estimate of the response of the real price of oil. In contrast, an unexpected increase in the demand for crude oil causes a persistent, large and statistically significant oil trade deficit in oil-importing economies (with a corresponding surplus in oil-exporting economies).

(3) Oil exporters tend to run non-oil trade deficits in response to positive oil demand shocks in particular, but not enough to prevent an overall trade surplus and current account surplus with the rest of the world. Whereas the theoretical literature has tended to focus on the limiting cases of financial autarky or complete markets, the estimates of the responses of the non-oil trade balance provide evidence of considerable, but not perfect international financial market integration.

(4) There is evidence of large and systematic valuation effects in response to these shocks for broad aggregates of oil importers and oil exporters. These valuation effects tend to cushion the effect of oil demand and supply shocks on oil exporters' and oil importers' change in NFA positions, making it necessary to consider the degree of international financial integration of a country and the composition of its foreign asset holdings and liabilities in predicting the effect of shocks in the oil market on a given country.

7. Conclusion

The analysis in this review has focused on relatively short horizons, consistent with the focus in much of the literature on the link between oil price volatility and the business cycle. Although it has long been conjectured that oil price shocks may affect aggregate productivity and thereby long-run economic growth, the evidence in this regard is weak (see, e.g. Barsky and Kilian 2004). What we know is that 1974-1985 was a period in which high average oil prices coincided with low average total factor productivity, but whether there is a causal link remains to be shown. One alternative view is that both low productivity and high oil prices may have been caused by poor domestic policy choices. Given the short time span of available data, any conclusions about this question are likely to be at best speculative.

Likewise, little work has been done on how trends in the global economy affect the market for crude oil. A notable exception is Dvir and Rogoff (2009) who – based on data for 1861-2008 – make the case that historically the real price of oil has tended to be both more persistent and more volatile whenever rapid industrialization in the world economy coincided with uncertainty regarding access to supply. That characterization applies in particular to the period starting in the early 1970s that has been the focus of this review.

Finally, little is known about the process by which households and firms conserve energy or adapt new, more energy efficient technologies and about the extent to which this process is reversible. In particular, it is not clear what the optimal rate of the adoption of energy saving technologies is in a world of uncertain and fluctuating energy prices and whether it makes sense for the government to intervene in an effort to overcome potential market failures. Answers to these questions are important in assessing the effect of fluctuations in the real price of oil on the use of energy, which in turn matters for the long-run price of oil.

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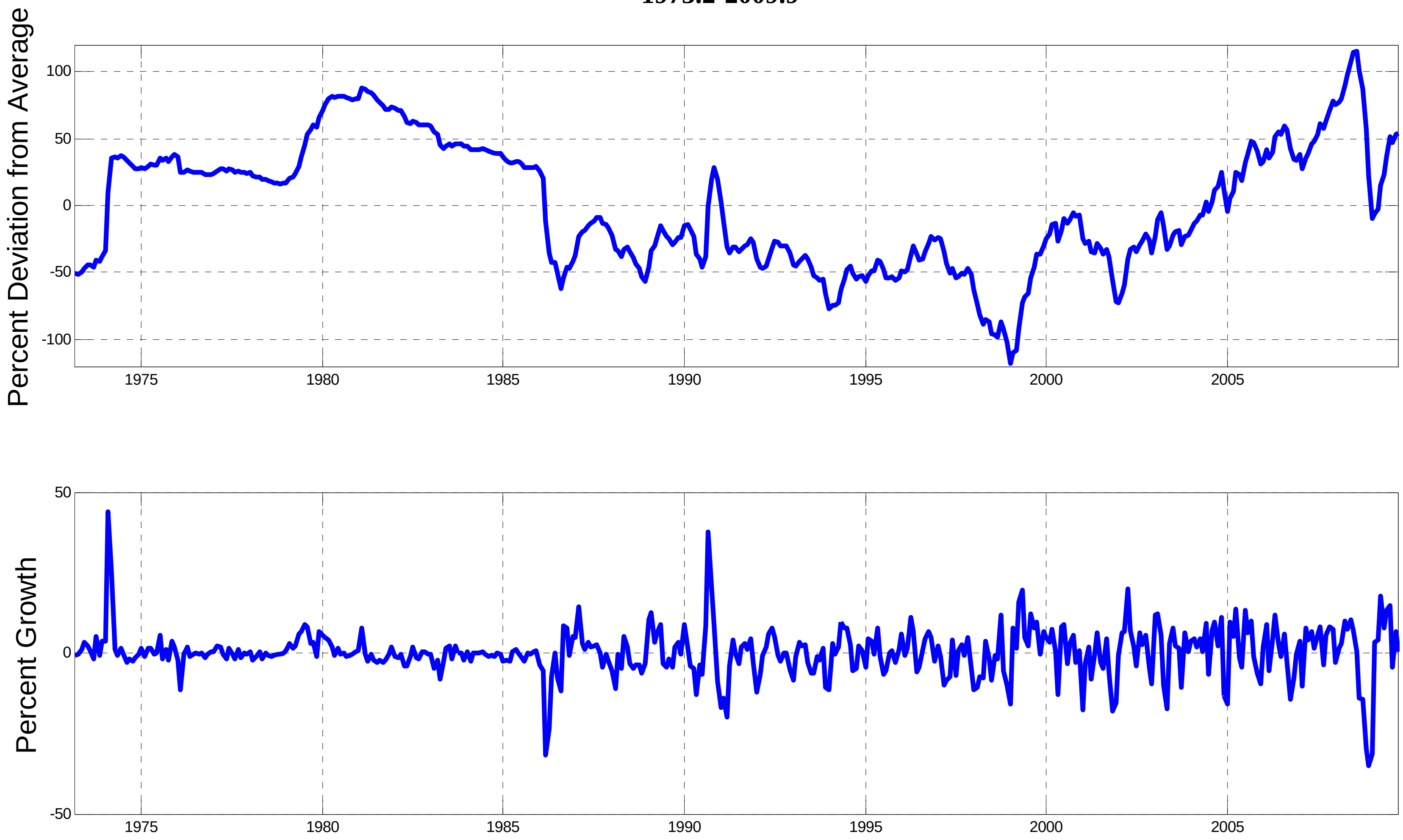
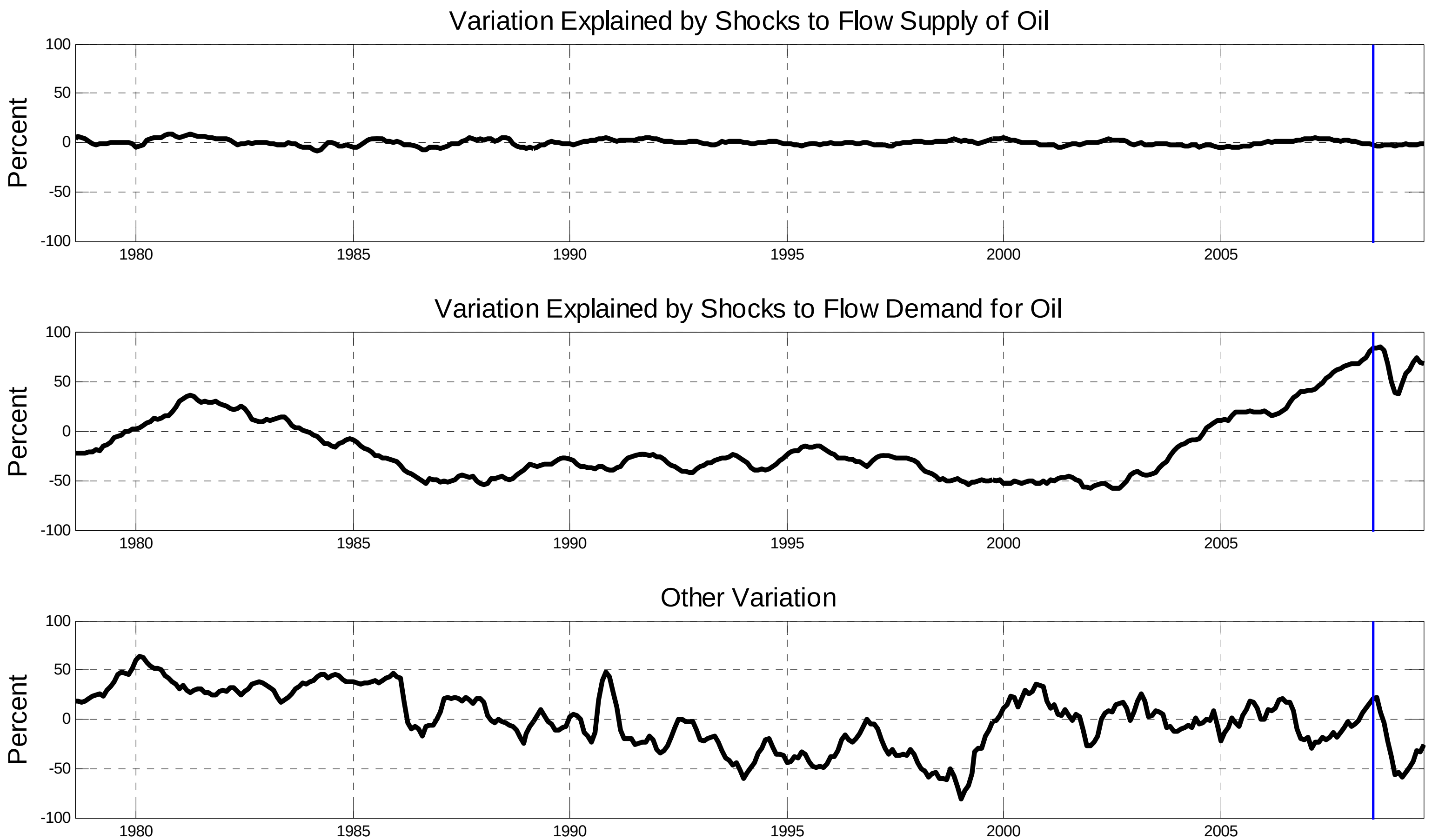
Figure 1: Volatility of the Real Price of Oil
1973.2-2009.9



Source: U.S. refiners' acquisition cost for imported crude oil as reported in the Monthly Energy Review of the U.S. Energy Information Administration, extrapolated backwards from 1974.1 as in Barsky and Kilian (2002) and deflated by the U.S. CPI for all urban consumers.

Figure 2: Determinants of the Volatility of the Real Price of Oil
1978.6-2009.8



Source: Historical decompositions based on an updated version of the structural VAR model in Kilian (2009c). Flow supply shocks are defined as shocks to the global production of crude oil. Flow demand shocks are defined as shocks to the demand for all industrial commodities including crude oil driven by the global business cycle. The residual shock captures speculative oil demand shocks. The vertical line indicates the peak of the global business cycle in mid-2008 as measured by the global real activity index of Kilian (2009c).