The Macroeconomics of Oil Shocks

BY KEITH SILL

For various reasons, oil-price increases may lead to significant slowdowns in economic growth. Five of the last seven U.S. recessions were preceded by significant increases in the price of oil. In this article, Keith Sill examines the effect of changes in oil prices on U.S. economic activity, focusing on how runups in the price of oil can affect output growth and inflation. He also discusses the channels by which oil-price increases might affect the economy and the historical evidence on the relationship between oil prices, economic growth, and inflation.

During the first quarter of 2002, the price of crude oil averaged $19.67 per barrel. Four years later, in the first quarter of 2006, the average price of oil had risen to $63 per barrel. Indeed, the high price of oil may not be a short-lived phenomenon: Futures markets indicate that investors expect the price of oil to remain above $70 per barrel through 2008. For the postwar U.S. economy, the data show a clear tendency for oil-price spikes to precede economic downturns. Though most of these episodes occurred at a time when oil's share as an input into U.S. production was larger than it is today, there is still much debate about how oil prices affect the economy. How concerned should we be about the economic consequences of persistently high oil prices?

Oil prices matter for the economy in several ways. Changes in oil prices directly affect transportation costs, heating bills, and the prices of goods made with petroleum products. Oil-price spikes induce greater uncertainty about the future, which may lead to firms' and households' delaying purchases and investments. Changes in oil prices also lead to reallocations of labor and capital between energy-intensive sectors of the economy and those that are not energy-intensive.

For these reasons and others, oil-price increases may lead to significant slowdowns in economic growth. In the postwar U.S. data, the correlation between oil-price spikes and economic downturns is not perfect — some oil-price increases are not followed by recessions. But five of the last seven U.S. recessions were preceded by significant increases in the price of oil. The most recent rise in the price of oil has not led (at least not yet) to an economic recession, but history nonetheless suggests that oil prices are an important element in assessing the economy's near-term prospects.

Keith Sill is a senior economist in the Research Department of the Philadelphia Fed. This article is available free of charge at: www.philadelphiafed.org/econ/br/index.html.

OIL PRICES

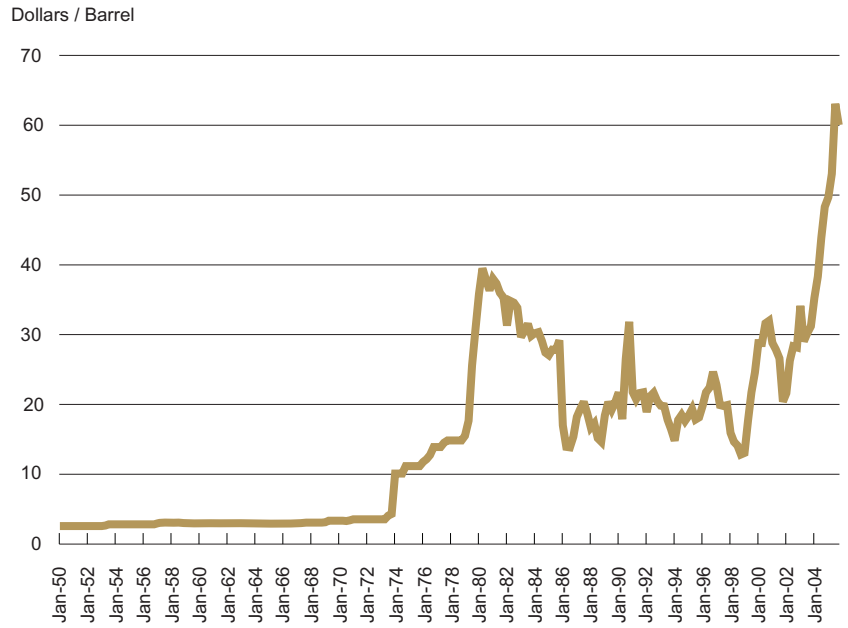
From the late 1940s to the early 1970s, the price of oil was very stable, moving up only slightly.[1] From the early 1970s to the early 1980s, the price of oil rose dramatically in a sequence of steps associated with the rise of OPEC and disruptions in the supply of oil from the Middle East oil-producing countries (Figure 1).[2]

[1] From 1948 to 1972, the price of oil produced in the U.S. was influenced by the production quotas set by the Texas Railroad Commission (TRC). Each month, the TRC (and other state regulatory agencies like it) made forecasts of petroleum demand for the upcoming month and set production quotas to meet the forecasted demand. Since the quantity of oil produced was adjusted to meet forecasted demand, the price of oil remained fairly stable. However, in the face of growing world demand for oil relative to supply, and the peaking of U.S. domestic oil production in 1970, the TRC set the production quotas at 100 percent in March 1971.

[2] The Organization of Petroleum Exporting Countries (OPEC) was formed in 1960 with five founding members: Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. By the end of 1971, Qatar, Indonesia, Libya, the United Arab Emirates, Algeria, and Nigeria had joined.

FIGURE 1

Nominal Price of Crude Oil



Source: Haver Analytics. Price of West Texas Intermediate.

OPEC first experienced the power it had over the price of oil during the Yom Kippur War, which started in October 1973. As a result of U.S. and European support of Israel, OPEC imposed an oil embargo on western countries. Oil production was cut by 5 million barrels a day (though about 1 million barrels a day in production was made up by other countries). The cutback amounted to about 7 percent of world production, and the price of oil increased 400 percent in six months.

From 1974 to 1978 crude-oil prices were relatively stable, ranging from $12 to $14 per barrel. The next big round of oil-price increases came with the Iranian revolution and Iran-Iraq war in 1979 and 1980. World production fell 10 percent, and this resulted in the price of oil rising from $14 to $35 per barrel. However, the high price of oil was leading consumers and firms to conserve energy. Homeowners insulated their houses. Commuters bought more fuel-efficient cars. Firms bought equipment that was more energy efficient. High oil prices also led to increased exploration and production of oil from countries outside of OPEC. From 1982 to 1985 OPEC sought to stabilize the price of oil through production quotas, but conservation efforts, a global recession, and cheating on production quotas by OPEC members eventually led to a plummeting of oil prices to below $10 per barrel by 1986.[3]

Since the mid-1980s the frequency of oil-price changes has been much greater than in the past. OPEC continued to influence the price using production quotas, but it has been unable to stabilize it. In fact, OPEC's share of world oil production has fallen from a peak of 55 percent in 1973 to about 42 percent today. U.S. imports of oil from OPEC, as a share of total petroleum imports, peaked at 70.3 percent in 1977 and have since fallen to about 43 percent.[4] Today, the major suppliers of imported oil for the U.S. are Canada and Mexico, followed by Saudi Arabia and Venezuela.

Oil Prices, Recessions, and Inflation. We can plot the real price of oil, that is, the price of oil adjusted for inflation, the rate of inflation as measured by the consumer price index (CPI), and U.S. recessions as defined by the National Bureau of Economic Research (Figure 2). The figure indicates that even with the substantial runup in the nominal price of oil since 1999, oil remains cheaper, in real terms, than it was during the late 1970s.

A striking aspect of the postwar history of oil prices and the economy is that oil prices spike upward right around the time of recessions. A clear relationship between oil prices and inflation is harder to discern. During some episodes, such as 1973-74 and 1980, it appears that inflation rises at the same time that the price of oil rises. At other times, such as 2002 to the present, oil prices rise while inflation remains stable. The figure suggests that the relationship between oil-price increases and the real economy might be stronger than the relationship between oil prices and inflation.

A characteristic of the oil-price spikes that occur around recessions is that they tend to be both large and

[3] Over the period 1982-86, Saudi Arabia acted as the marginal oil producer, cutting its production in an effort to keep oil prices from falling. In August 1982, the Saudis abandoned that strategy and linked their oil price to the spot market for crude.

[4] U.S. oil production peaked at 9.6 million barrels a day in 1970 and has since fallen to about 5.4 million barrels a day. Even at that rate, the U.S. remains one of the world's largest oil producers. In fact, only Saudi Arabia and Russia produce more oil in a year than the U.S.

abrupt. By abrupt, we mean that the price changes are sharp upward movements rather than slow and gradual upward drifts. Historically, the pre-recession spikes are associated with disruptions in supply from the Middle East. These supply disruptions tend to be associated with wars that led to significant reductions in the amount of oil exports by the affected countries (see the table). The table shows that Middle East conflicts led to rather large reductions in the world supply of oil. Absent a large drop in demand, such large supply disruptions could lead to large increases in the world price of oil. The table confirms that U.S. business-cycle peaks also tended to occur close in time to the dates of the conflicts. Note, though, that the length of time between the oil-supply disruption and the business-cycle peak varies, ranging from about contemporaneously to a little over one year. What the table and Figure 2 by themselves cannot tell us is whether oil-price increases or Middle East conflicts or some other factor, such as monetary policy, led to recessions in 1957, 1973, 1980-81, and 1990. However, the data suggest the possibility of a link between oil and the macroeconomy.

WHY MIGHT OIL-PRICE SPIKES CAUSE RECESSIONS?

Is it plausible that an increase in the price of oil leads to recession when oil represents such a small (and declining) share of U.S. output? Oil consumption as a share of gross domestic output (GDP) was slightly below 4.5 percent in the early 1970s, but it has since declined steadily to a little over 2 percent in 2004 (Figure 3).[5] How could a change in the price of an input that represents such a small share of the economy have such a dramatic economic effect?

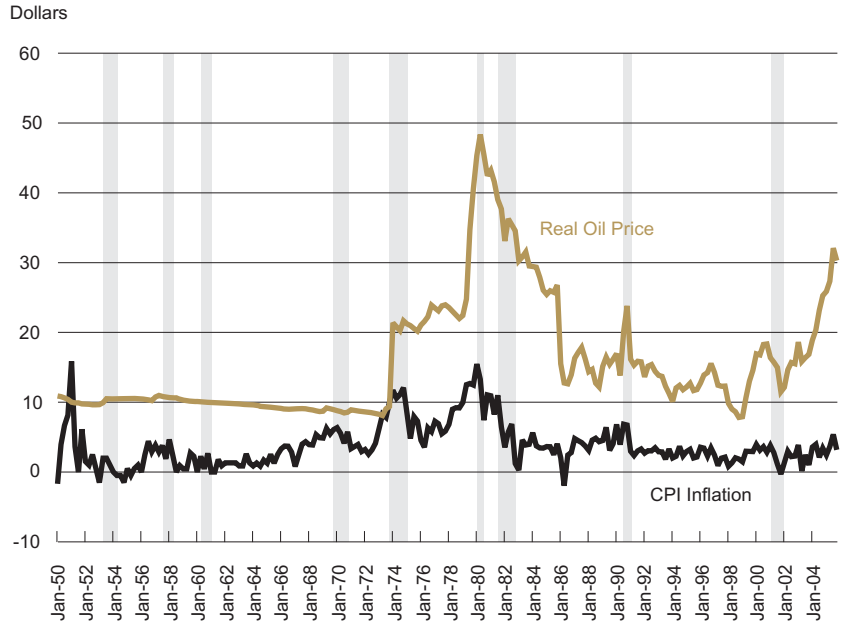
Oil prices affect the economy through a multitude of channels. When all of these effects are added up, oil prices could have a larger impact than what might be expected from oil's small share in the economy. The key is that oil-price changes affect both supply and demand. Changes in oil prices affect supply because they make it more costly for firms to produce goods; they affect demand because they influence wealth and can induce uncertainty about the future.

First, let's consider this: An oil-price increase acts like a tax on firms and households. The United States imports a large fraction of the oil it uses from other countries, and the payments we make to foreign countries for oil represent an outflow of funds from the U.S. Higher payments to foreigners for oil reduce income available for spending on other goods and services. The lower demand for domestically produced goods and services might mean lower production of goods and services. The demand effect is stronger if the foreign countries to which we make payments for oil do not trade much with the U.S. That means that the dollars spent on oil do not get recycled to the U.S. economy in the form of foreign purchases of U.S. goods and services.[6]

A second channel by which a jump in the price of oil can reduce output growth comes from the manner in which energy and capital, such as machines, are used in production. Energy and capital are largely complements in production, which means that to

FIGURE 2

Real Oil Price & CPI Inflation



Source: Haver Analytics. Real oil price is West Texas Intermediate price divided by CPI inflation.

[5] Oil consumption is measured using the Energy Information Administration's data on U.S. total crude oil and petroleum products supplied to U.S. households, firms, and government.

[6] However, dollars may get recycled back to the U.S. economy if petroleum-producing countries purchase U.S. assets. Such purchases could drive down U.S. interest rates and boost consumption and investment.

TABLE

Middle East Conflicts and Effects on Oil Supply

Date	Event	World Supply Disruption	Recession Date	Months from Disruption to Cycle Peak
Nov. 1956	Suez Crisis	10.1%	Aug. 1957	8
Nov. 1973	Yom Kippur War	7.8%	Nov. 1973	0
Nov. 1978	Iranian Revolution	8.9%	Jan. 1980	13
Oct. 1980	Iran-Iraq War	7.2%	July 1981	8
Aug. 1990	Persian Gulf War	8.8%	July 1990	-1

Source: Hamilton (2003). The table lists the major Middle East conflicts since 1950, the amount by which the conflict reduced the world supply of oil, and the number of months to the onset of the nearest U.S. recession.

run machines you need energy, and to run machines more intensively takes more energy. If energy becomes more expensive, firms may have to purchase new energy-efficient machines if they want to maintain profit margins. Firms stuck with less fuel-efficient machines see their profit margins suffer, and so they may invest less in capital and labor. Firms may also delay or change their investment plans in response to a rise in the price of oil. These various investment factors slow both demand in the economy as a whole and the economy's rate of output growth.

In addition, oil-price changes might have reallocative effects on the economy. Some sectors use energy more intensively than others. For example, the transportation sector is a heavy user of petroleum products compared with the trade sector. When the price of oil rises, the transportation sector is affected relatively more, leading to flows of capital and labor out of transportation and into other sectors of the economy. This labor and capital reallocation has a short-term negative effect on output as unemployed and underemployed resources seek new uses.

Empirical studies have attempted to quantify the extent of reallocation in response to changes in the price of oil. Research by Steven Davis and John Haltiwanger found that oil-price increases account for about 20 to 25 percent of the variability of employment growth in the manufacturing sector. Furthermore, firms that had higher capital intensity and higher energy intensity made greater adjustments to their workforces in response to oil-price increases.

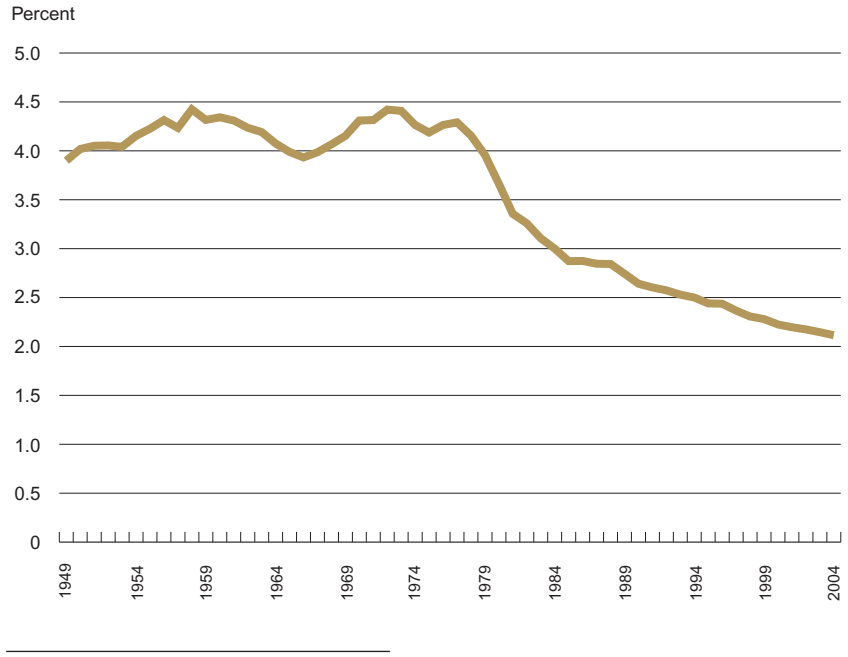
Oil-price increases may also lead consumers and firms to delay their purchases of certain types of goods. For example, a household may decide that it wants to purchase an SUV. If oil prices jump up, the household might decide to hold off on the purchase until it becomes clearer how long-lasting the oil price increase is likely to be. Similarly, firms may delay investing in certain types of equipment until uncertainty about the future price of oil is somewhat resolved. Thus, whether an oil-price hike is perceived as temporary — lasting only a month or two — or long-lasting can potentially have a significant impact on spending decisions by consumers and businesses.

The Asymmetric Effect of Oil-Price Changes. How can we pin down the link between oil prices and the macroeconomy? As we saw in Figure 2, some oil-price increases could lead to recessions. What about oil-price decreases? Do they lead to faster output growth? Interestingly enough, the answer is no. A significant feature of the empirical relationship between oil prices and real output is that oil prices have an asymmetric effect on output: Oil-price increases slow output growth, but oil-price decreases do not boost output growth.

A possible reason behind this asymmetric effect of oil prices on growth is the interaction of the supply, demand, and reallocation effects. Rising oil prices affect supply because firms now find it more expensive to

FIGURE 3

Share of Oil Consumption in GDP



Source: U.S. Energy Information Administration and Haver Analytics.

produce goods because of higher energy costs. Demand may be affected as well, since consumers and firms are likely to be uncertain about how long oil prices will remain high and what the implications are for investment and purchases of durable goods. Both of these factors decrease real output. In addition, the reallocation of resources across sectors of the economy in response to higher oil prices slows economic growth.

Now consider what happens when oil prices fall. Again, there is a supply effect: Firms now find it cheaper to produce goods, which encourages increased production. Lower oil prices are likely to increase demand as well. But the reallocation effect still slows growth as resources move across sectors in response to lower oil prices. On net, all of these factors may wash out, so that the effect of a decrease in the price of oil is just about nil. This might explain the asymmetric effect of oil-price changes on the economy.

The asymmetric effect of oil-price shocks on output growth is key to understanding a second prominent feature of the link between oil and the macroeconomy: The relationship between oil-price changes and real output growth is much stronger before 1985 compared with after 1985.[7] Before 1985, there is strong statistical evidence that oil-price changes predicted real output growth. After 1985, this relationship breaks down. What has happened?

Recall from Figure 2 that before 1980, large changes in the price of oil were upward. If increases in oil prices lead to slower economic growth (asymmetry), the pre-1980 data contain many instances of oil-price increases to examine that hypothesis. Indeed, before 1980, there is a strong prediction that oil-price increases lead to slower growth. After 1980, oil-price changes are both positive and negative. If only positive oil-price changes affect economic growth, all of the negative price changes in the data make it more difficult to uncover the effect of oil-price changes on output, since the negative price changes would attenuate the measured effect of the positive price changes. The net result of the asymmetric effect of oil-price increases coupled with lots of oil-price decreases in the data after 1985 would lead to a much weaker measured relationship between oil prices and economic growth.

Of course, just because oil-price increases appear to *predict* slower real output growth does not mean that oil-price increases *cause* slower real output growth. It could be the case that when the economy is strong and real output growth is high, resulting high demand for oil pushes up the price of oil. (When the economy weakens and demand for oil slows, there is downward pressure on the price of oil.) This type of feedback from the economy to oil prices could end up looking a lot like oil-price increases causing recessions, even though it is really the economy that is driving up oil prices, because oil prices would be high prior to a slowdown in growth. If we want to understand whether oil-price increases actually cause recessions, we have to control for the feedback effect of the economy and demand on oil prices.

OIL-PRICE INCREASES CAUSED BY EXTERNAL FACTORS

Research by James Hamilton discusses the problem of feedback from the economy to oil prices and poses a solution. If we want to control for the

[7] Economists use the term shock to refer to unanticipated changes in economic variables. Examples include unanticipated changes in monetary and fiscal policy, extreme environmental conditions, and events that alter the world price of energy.

feedback from real output growth to oil prices, we should identify jumps in the price of oil that are not caused by U.S. economic conditions.[8] That is, we want to identify oil-price increases that are external to U.S. economic conditions and then investigate whether these oil-price increases caused by external factors predict slower output growth.[9] We can then plausibly argue that since those oil-price increases are not a result of U.S. economic conditions, any relationship between these price increases and slower real output growth is in the direction *from* oil-price increases *to* real output growth. This would be a key piece of evidence in arguing that oil-price increases can lead to economic downturns.

How can we find external oil-price increases in the data? Recall from the table that Middle East conflicts have historically been associated with oil-price increases. It can reasonably be argued that these conflicts were not an immediate result of U.S. economic conditions. That is, the overall state of the U.S. economy at the time did not influence the unfolding of the Middle East conflicts and the associated rise in oil prices listed in the table. Hamilton has argued that these conflicts can indeed be thought of as external to the U.S. economy, and so they can be used to measure a causal effect of oil-price shocks on output growth. Statistical analysis that examines the effect of these external episodes that led to oil-price increases finds that these episodes do precede economic slowdowns. This evidence argues that oil-price increases cause slower output growth.

Of course, there are many more oil-price increases in the data than just the five or so associated with Middle East conflicts. Researchers have used a variety of methods to isolate the important oil-price changes for predicting real output growth. One early method was to use only oil-price increases in statistical analyses and ignore oil-price decreases. However, researchers have subsequently found that more sophisticated measures of oil-price increases have a more stable relationship with real output growth. In particular, a measure of the *net increase in oil price* is often used. This series is constructed as follows: Compare oil prices in the current period with the highest oil price over a previous period, say, the last 36 months. If the current price is higher than the preceding 36-month peak, calculate the percentage difference between the two. If the current price is lower than the preceding 36-month peak, set the series to zero. This measure of net oil-price increases, in effect, says that if the current price of oil is increasing only because it is moving back up to a previous peak (over the last three years), we don't expect it to have an effect on real output growth. However, if the current price is *higher* than it has been over the last three years, we can expect an effect on real output growth.[10]

Figure 4 shows that the net increase in oil prices, measured quarterly, tends to rise significantly before U.S. recessions, and this series does a good job of picking up the price movements associated with the Middle East conflicts reported in the table.[11] Note that this series is quite often zero. In fact, from the early 1950s until the end of 2004, there are about 700 months of data. But in only about 75 of those months is the net oil-price increase positive; the rest of the time it is zero. By this measure, oil shocks are fairly infrequent events. In his 2004 article, Hamilton demonstrates that net oil-price increases basically capture the historical tendency of the U.S. economy to do poorly after the five major Middle East conflicts listed in the table.

So far, we have talked about the effect of oil prices on the economy. However, we could alternatively look directly at the quantity of oil produced each year and ask how changes in the world supply of oil affect the economy. Lutz Kilian, in a 2006 working paper, did just that. He examined data on the quantity of oil produced by the world's suppliers, focusing principally on suppliers from the Middle East. To develop a series of data on the effects of external shocks on oil quantities, Kilian posed the question of what oil production would have been had a country not experienced a conflict such as a war. The difference between the amount of oil a country would have produced had there been no conflict and the quantity that was produced during the conflict gives a measure of supply shortfall that is external to developments in the U.S. economy (Figure 5). The Middle East supply disruptions listed in the table show up as large downward movements in the quantity of oil. As with the net oil-price series, we see that dramatic movements in the series preceded U.S. recessions. In this case, it is a dramatic falloff in the supply of oil. Interestingly, note that there is no sharp falloff in supply that helps explain the dramatic post-1999 increase in the price of oil. This suggests that the latest upward movement in the price of oil is a con-

[8] See the two articles by James Hamilton. Hamilton's 2003 article contains many references to the literature on quantifying the effect of oil shocks on the U.S. economy.

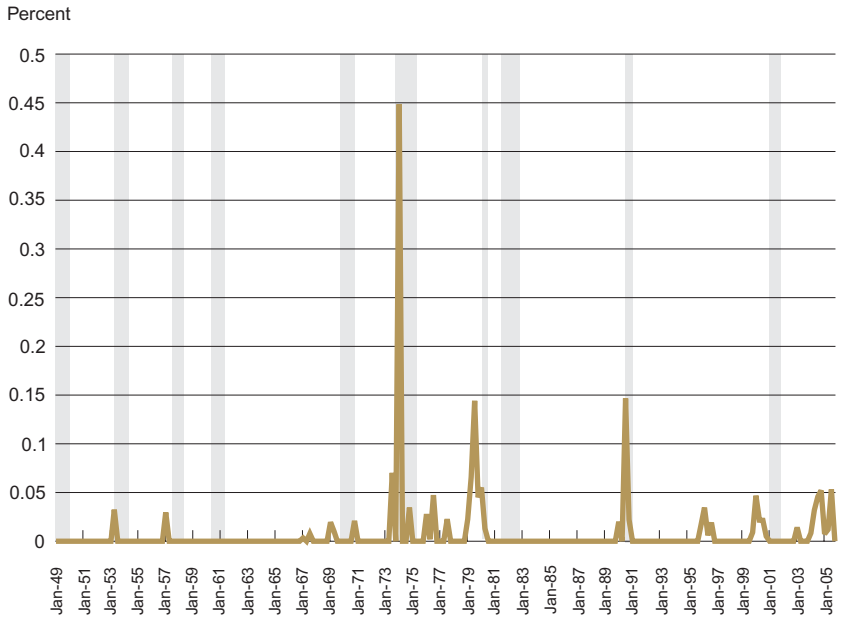
[9] By external we mean events that are not caused by U.S. economic conditions. Economists use the term exogenous to describe such external events.

[10] In his 2004 article, Hamilton argues that the net oil-price increase over a 36-month period has good statistical properties and summarizes well a complicated nonlinear link between oil prices and real output growth.

[11] The quarterly measure of a net oil-price increase is constructed by averaging the monthly net oil-price increase series.

FIGURE 4

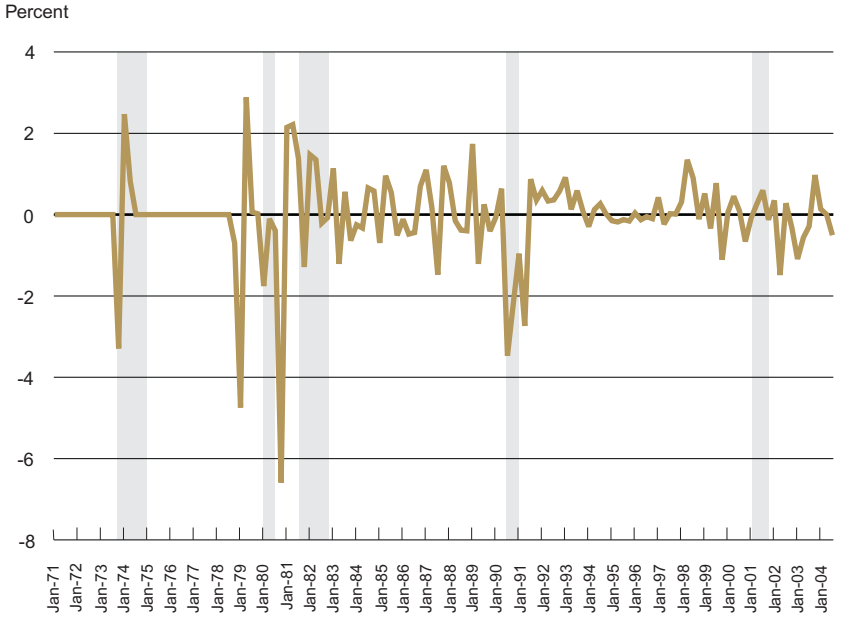
Net Oil-Price Increase



Source: Author's calculations

FIGURE 5

Exogenous Oil Supply Shocks



Source: Lutz Kilian's web page at *http://www-personal.umich.edu/~lkilian/*

sequence of growth in demand for oil outpacing growth in supply.

EMPIRICAL EVIDENCE ON HOW MUCH OIL SHOCKS MATTER

The evidence presented so far indicates that oil shocks, in the form of higher oil prices or reduced supplies of the quantity of oil, have a negative effect on U.S. real output growth. How strong is this negative relationship? We can use statistical analysis to estimate how much an increase in the price of oil caused by external factors reduces real output growth.

The effect of oil-price shocks caused by external factors on real output growth can be measured by running a statistical analysis (called a regression) of real output growth on lagged real output growth and lags of the net oil-price increase. The estimated regression is described more fully in *Quantifying the Effect of Oil-Price Shocks*. We can estimate this regression and get meaningful results because Hamilton's measure of net oil-price increases has been shown to be a good proxy for changes in oil price caused by external factors.[12] Thus, we don't have to worry so much about feedback from the U.S. economy to the increase in net oil prices when interpreting the results.[13]

[12] See, for example, the 2003 paper by James Hamilton and the 2006 paper by Lutz Kilian.

[13] While oil prices spike prior to U.S. recessions, interest rates also spike prior to recessions. Thus, in their study, Ben Bernanke, Mark Gertler, and Mark Watson conjecture that it is really monetary policy responding to oil-price shocks that causes recessions, since their model implies that an alternative policy could have greatly mitigated the effect of oil shocks. However, the article by James Hamilton and Ana Maria Herrera and my article with Sylvain Leduc argue that it is unlikely that alternative monetary policies would have completely avoided recessions in the face of the historical oil shocks that hit the U.S. economy. See also the *Business Review* article by Sylvain Leduc.

Quantifying the Effects of Oil-Price Shocks

The dynamic effect of an exogenous oil shock on real output growth can be analyzed by running a regression of real output growth on its own lags and lags of the oil-shock measure. A key to interpreting the regression is that the oil-shock measure is exogenous, which means it is not itself influenced by real output growth. To measure exogenous oil shocks, we use the measure of net oil-price increases discussed in the text. This measure is calculated as the greater of zero and the percentage difference of the current oil price from its previous 36-month peak. To measure real output growth, we use real GDP. The regression uses quarterly data and is estimated over the period 1948:4 to 2005:4. To capture the dynamics of the relationship, we included four lags of output growth and the net oil-price increase. The regression takes the form:

$$y_t=\beta_0+\beta_1 y_{t-1}+\beta_2 y_{t-2}+\beta_3 y_{t-3}+\beta_4 y_{t-4}+\beta_5 o_{t-1}+\beta_6 o_{t-2}+\beta_7 o_{t-3}+\beta_8 o_{t-4}$$

where y_t is quarterly real GDP growth at time t and o_t is the net oil-price increase in quarter t.

The equation can be estimated by ordinary least squares. The estimated coefficients, t-statistics, and probabilities that the coefficients are zero are:

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Estimate	0.01	0.25	0.10	-0.10	-0.12	-0.02	-0.04	-0.02	-0.04
t-stat	7.54	3.74	1.39	-1.48	-1.90	-0.99	-2.20	-1.18	-2.41
Prob	0.00	0.00	0.16	0.13	0.06	0.32	0.03	0.23	0.01

The regression results indicate that the coefficients on the net oil-price increase are negative and statistically significant at lags two and four and that the maximal impact of the oil shock occurs at lag four (when using three decimal places). We can test whether the oil shocks have joint significance in the regression, which is a test of whether, statistically, we get just as good a fit if the oil shocks are dropped. When we test that hypothesis, it is strongly rejected, which means that oil-price increases have predictive power for real GDP growth.

A similar regression of headline CPI inflation on the net oil-price increase gives the following estimates:

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Estimate	0.66	0.65	-0.02	0.39	-0.19	2.61	5.09	2.88	-4.64
t-stat	3.22	9.45	-0.37	5.17	-2.90	0.71	1.37	0.77	-1.25
Prob	0.00	0.00	0.71	0.00	0.00	0.48	0.17	0.44	0.21

The coefficient estimates on the net oil-price increase variable are not significantly different from zero, which indicates that oil shocks are not helping to explain the path of inflation. Indeed, a formal statistical test of whether the net oil-price increase variable helps predict CPI inflation finds that it does not.

The analysis indicates that the largest effect of an oil-price shock occurs about four quarters after the shock, indicating that it takes some time for the maximal effect of an oil shock to hit the economy. The implied path of an oil shock on real output growth can be calculated using an *impulse response function*. This type of graph shows how real output growth responds over time to a one-time increase in the price of oil caused by external factors. More specifically, this type of graph can tell us how much real output growth rises or falls over time in response to a temporary 10 percent increase in the net price of oil that lasts only one period. In our case, we use quarterly data to estimate the regression and generate the impulse response. We can see how much real output growth is affected an arbitrary number of quarters in the future, given a one-quarter increase in the net price of oil today (Figure 6).

Figure 6 shows that an increase in the net price of oil leads to a drop in real output growth that gradually increases over time until it reaches a maximum four quarters after the shock hits. After that, the growth rate of real output gradually recovers, so that after about three years, the effect of the oil shock has largely worn off and real output growth is back on its trend path (in the figure, the trend growth rate of real output has been removed). The impulse response function indicates that a 10 percent increase in the price of oil results in real output growth falling 0.55 percent at its maximum impact. This translates into about a 1.4 percent permanent reduction in the level of real output. Even a modest external increase in the net price of oil has a significant impact on real output, according to our analysis.

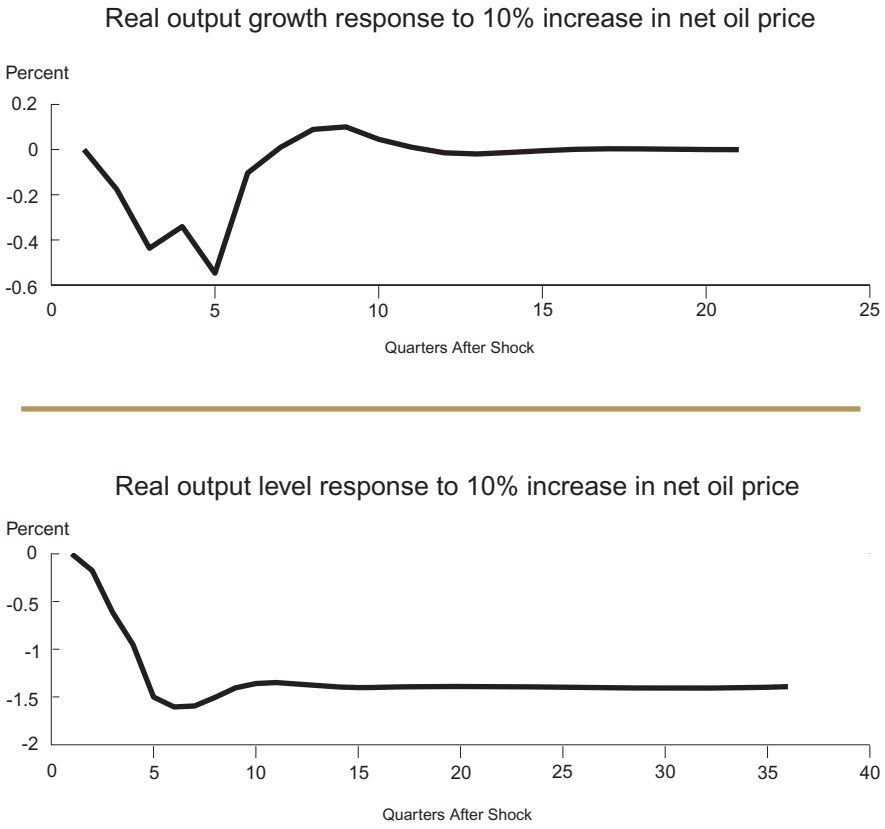
A similar analysis can be performed to investigate the effect of oil-price shocks on CPI inflation. The results from that regression are also reported in the box on page 28. In this case, though, it turns out that oil-price shocks do not have a statistically significant effect on inflation. In the context of our analysis, this means that a jump in oil prices does not help predict the path of future CPI inflation. It appears then that net oil-price increases affect real output growth and not inflation.

We can also examine how changes in the quantity of oil caused by external factors affect output growth and inflation using the data series put together by Lutz Kilian. Recall that Kilian developed a series of external shocks to oil quantity that measure supply disruptions in the Middle East. Kilian's analysis indicates that a 10 percent decrease in the oil supply caused by external factors (which is about the magnitude of the disruptions documented in the table) leads to about a 2 percent drop in real GDP growth about five quarters after the shock hits. Kilian also investigated the effect of external oil-supply disruptions on CPI inflation. His analysis indicates that the effect on CPI inflation is negligible. Inflation is up only about 0.75 percent three quarters after the shock hits (which is the maximal impact of oil shocks on inflation).

The data on both oil-price shocks and oil-quantity shocks give a similar impression of what happens to

FIGURE 6

Real Output Response to Increase in Oil Prices



the economy after an oil shock that reduces supply and raises the price of oil. Real output declines steadily for several quarters, reaching a maximum decline about one year after the shock hits. Output then recovers gradually, and after a few years, the shock has largely worn off. Oil shocks appear to have little if any effect on CPI inflation.

THE INTERNATIONAL PERSPECTIVE

Is the U.S. unique in its response to oil shocks, or do other developed countries display similar behavior? A 2005 working paper by Lutz Kilian examines this question using data on real output growth, inflation, and his series on external oil production shocks. The sample of countries investigated includes the United States, the United Kingdom, Japan, Germany, Italy, Canada, and France.[14]

Using regressions similar to those reported in *Quantifying the Effect of Oil-Price Shocks*, Kilian finds a fair degree of similarity in the real output response of G7 countries to negative oil production shocks. A 10 percent external disruption in oil supply typically leads to about a 2 percent reduction in real output growth that occurs between one and two years after the shock hits. The weakest response among the G7 countries is in Japan, but when the data are analyzed on the basis of cumulative inflation and real growth responses, Italy and France also have fared well historically when confronted with oil supply shocks.

For inflation, Kilian finds that oil supply disruptions do not lead to sustained inflation in the G7 countries. There is some evidence for stagflation (a simultaneous rise in inflation and fall in real output growth) for the U.S., the U.K., and Italy. There is no such evidence for stagflation in response to oil shocks for Germany, Japan, and Canada.

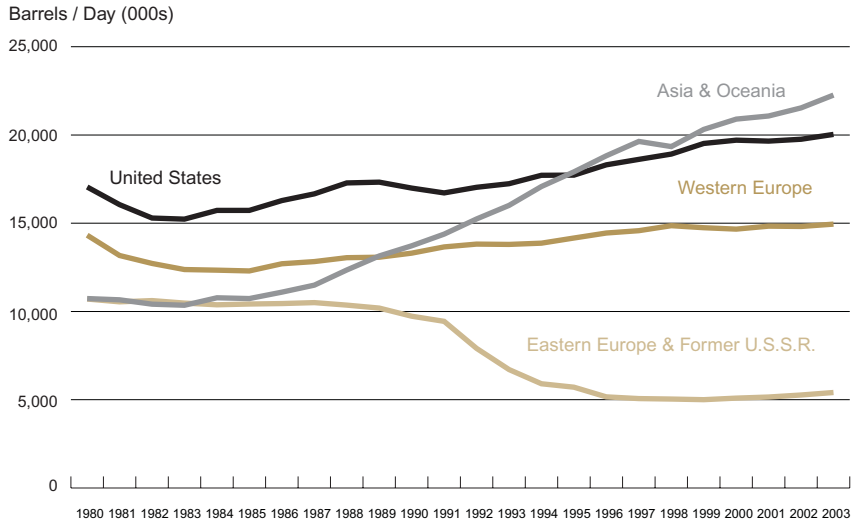
Thus, the evidence from other developed countries is broadly similar to what we have described for the U.S. Oil shocks caused by external factors that lower supply and raise price do appear to have a negative effect on real output growth. The evidence for oil shocks' effects on inflation is more varied, but it is largely consistent with the view that oil shocks do not have strong inflation effects.

Recent Developments. The principal reason for recent increases in the price of oil is strong world demand as developing countries increase their oil consumption (Figure 7). What is striking about the figure is the recent strength in demand for oil coming from Asian countries. Principally, this demand growth is from China, India, and Indonesia. As these countries become wealthier, their demand for goods such as automobiles is rising, which leads to increased oil consumption. Note as well that U.S. demand has been strong recently as the economy has experienced strong real output growth.

Interestingly enough, strong demand for oil from regions of the world such as Asia can, from the perspective of the U.S., look very similar to an oil-price shock. To the extent that trade ties between the U.S. and Asia are weak, strong growth or weak growth in the U.S. may have little effect on economic growth in Asia. Consequently, Asian demand for oil that boosts the worldwide price of oil, and hence the price the U.S. pays for oil, is external to U.S. economic conditions and so may be no different from a conflict in the Middle East that results in a higher price for oil. In the case of the post-1999 oil-price increases, though, the rise in price has been fairly gradual compared with the external price increases we have talked about. Consumers and firms have had time to

FIGURE 7

World Oil Demand



Source: Energy Information Administration

[14] These countries are known as the Group of 7, or the G7.

adjust to the price increase and, given the strength of the U.S. economy, certainly part of the oil-price increase has been due to strong U.S. demand for oil. As a consequence, the effect on the economy of the most recent rise in the price of oil may not be as strong as predicted based on the periods of Middle East crises.

Nonetheless, we can conduct a back-of-the-envelope simulation using the estimated relationship between real output and net oil-price increases that generated the impulse responses in Figure 6. If we simulate the model using the net oil-price increases that occurred between 2004Q1 through 2006Q2, the prediction is that the level of real GDP (holding all else constant) is currently about 3.2 percent lower than what it would have been had there been no oil shocks over that period.

CONCLUSION

Historically, the U.S. economy has tended to perform poorly following major disruptions in the supply of oil that coincide with large increases in the price of oil. Typically, these disruptions have been associated with conflicts in the Middle East that significantly affected the world supply of oil. The nature of these conflicts is that they are external to developments in the U.S. economy. Consequently, these episodes provide evidence that oil-price increases may directly cause slower real output growth, both for the U.S. and for the other major industrial countries.

The empirical evidence suggests that a 10 percent increase in the price of oil is associated with about a 1.4 percent drop in the level of U.S. real GDP. Interestingly, increases in oil prices have no significant effect on U.S. inflation, a finding that largely holds up when we look at the major industrial economies.

Since 1999, there has been a dramatic increase in the world price of oil. The evidence suggests that this increase is driven not so much by supply disruptions as by strong demand from the U.S., Western Europe, and Asia, especially China, India, and Indonesia. From the perspective of the U.S., some of this price increase is tantamount to an external oil shock. However, because the rise in price has been gradual and has occurred in the face of strong growth, the U.S. economy has not experienced an oil-induced recession. Nevertheless, the evidence suggests that the recent rise in oil prices has worked to restrain domestic output growth.

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