Oil Prices and Consumer Spending

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Although a large body of empirical research indicates that oil price increases have a significant negative effect on real GDP growth, considerable debate exists about both the strength and stability of the relation between oil prices and GDP. In particular, some analysts contend that the estimated linear relations between oil prices and several macroeconomic variables appear much weaker since the 1980s (Hooker 1996).[1]

The evidence of a weakening effect of an oil price change on the macroeconomy in data since the 1980s happens to coincide with another change in the nature of oil price movements: Before 1981, most big oil price movements were positive. Since then, however, oil prices have moved significantly in both directions, reflecting the influences of endogenous macrodevelopments on oil prices. The choppy nature of oil price movements since the 1980s has led some analysts to argue that evidence indicating that oil price changes do not have much of an effect on real GDP is spurious and that the evidence arises from the use of endogenous oil price series. Hamilton (2003), in fact, posits that the relation between oil price changes and real GDP growth is nonlinear, namely, that oil price increases matter but oil price declines do not. Furthermore, oil price increases that occur after a period of stable oil prices matter more than those increases that simply reverse earlier declines. He shows that if the true relation is nonlinear and asymmetric as described above, then the standard linear regression that relates real growth to oil price changes would

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[1] Hooker (1996) reports evidence that oil price changes no longer predict many U.S. macroeconomic indicator variables in data after 1973 and that the estimated linear relations between oil price increases and real economic activity indicator variables do appear weaker since the 1980s. Hooker (2002) also reports evidence of weakening of the link between oil prices and inflation since the 1980s.

spuriously appear unstable over a sample period spanning those two subperiods of different oil price movements.

In order to capture the above-noted hypothesized nonlinear response of GDP growth to oil price changes, Hamilton has proposed a nonlinear transformation of oil price changes. In particular, he uses a filter that weeds out oil price drops and measures increases relative to a reference level, yielding what he calls "net oil price increases."[2] This nonlinear filter, when applied to oil price changes, is supposed to weed out short-term endogenous fluctuations in oil prices, leaving big oil price increases that may reflect the effect of exogenous disruptions to oil supplies. He then shows that the estimated linear relation between net oil price increases and real growth is strong and depicts no evidence of parameter instability over the period 1949 to 2001.[3]

In discussing why oil price shocks have an asymmetric effect on real GDP growth, Hamilton, among others, has emphasized both the "demand-side" and "allocative" channels of influence that oil price shocks have on the real economy. On the demand side, a big disruption in energy supplies has the potential to temporarily disrupt purchases of large-ticket consumption and investment goods that are energy-intensive because it raises uncertainty about both the future price and availability of energy, as in Bernanke (1983).[4] Both households and firms may find it optimal to postpone purchases until they have a better idea of where energy prices are headed after an oil price shock, leading to potential changes in the mix of consumption and investment goods they demand. This postponement and/or shift in the mix of demand may have a nonlinear effect on the economy working through the so-called "allocative" channels that become operative when it is costly to reallocate capital and labor between sectors affected differently by oil price changes. In particular, both

[2] Quite simply, his series of net oil price increases is defined as the percentage change from the highest oil price change over the past four, eight, or twelve quarters, if positive, and zero otherwise. This procedure yields net oil price increases measured relative to past one-, two-, and three-year peaks.

[3] Worth noting is that Hamilton (1996, 2003) was not the first to provide evidence of an asymmetric response to oil price increases and oil price declines. Mork (1989) provided evidence indicating that oil price increases had a negative effect on real GNP growth whereas oil price declines did not. However, Hamilton's (2003) paper is the first "rigorous" statistical test of nonlinearity, using flexible functional forms.

[4] The basic argument is that oil price uncertainty may be as important of a determinant of economic activity as the level of oil prices. In case of investment, Bernanke (1983) shows it is optimal for firms to postpone irreversible investment expenditures when they face an increased uncertainty about the future price of oil. When the firm is faced with a choice between adding energy-efficient or energy-inefficient capital, increased uncertainty raises the option value associated with waiting to invest, leading to reduced investment. Hamilton (2003, 366) makes a similar argument for the postponement of purchases of consumer goods which are intensive in the use of energy.

oil price increases and decreases may have a negative effect on GDP growth if oil price effects work primarily through allocative channels.[5]

Of course, oil price increases may affect aggregate spending through other widely known channels. For instance, because oil price increases lead to income transfers from countries that are net importers of oil, such as the United States, to oil-exporting countries, it is plausible for the oil-importing countries to exhibit a reduction in spending. Since an increase in the price of oil would lead to an increase in the overall price level, real money balances held by firms and households would be reduced through familiar monetary channels including the Federal Reserve's counter-inflationary monetary policy response.[6] These income-transfer and real-balance channels, however, imply a symmetric relation between oil price changes and GDP growth.

The asymmetric effect of oil price changes on GDP growth may arise if we consider oil price effects generated through all three channels described above because oil price effects, working through allocative channels, are asymmetric with respect to oil price changes. However, that is not the case for oil price effects working through other channels. Thus, an oil price increase is likely to depress GDP because all three channels (income-transfer, real-balance, and allocative) work to depress aggregate demand in the short run. In contrast, an oil price decline may not stimulate GDP because the positive effect of lower oil prices on aggregate demand generated through the real-balance and income-transfer channels is offset by the negative effect on demand generated through the so-called allocative channels. Another potential contributory factor is the asymmetric response of monetary policy to oil prices—the Federal Reserve tightening policy in response to oil price increases but not pursuing expansionary policies in the face of oil price declines.

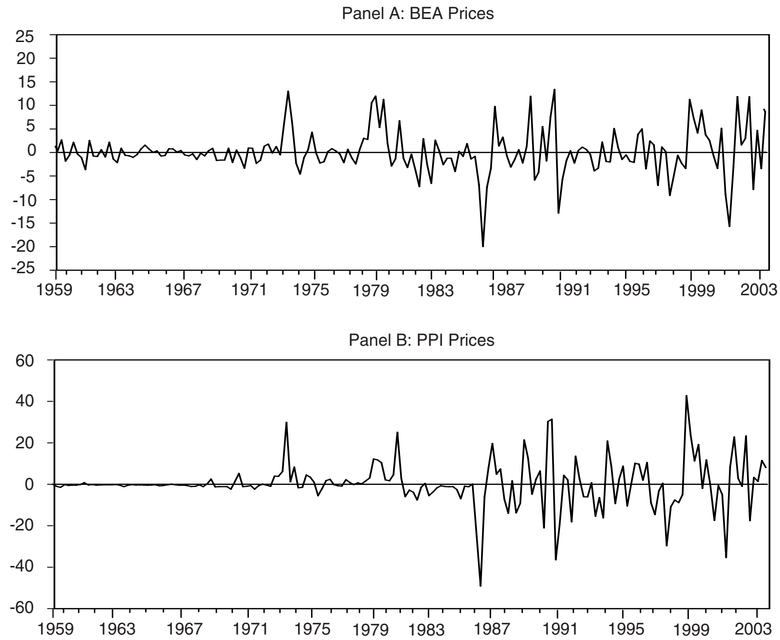
This article investigates how much of the negative effect of an oil price increase on real GDP growth works through the consumption channel. As noted above, many analysts have emphasized that big spikes in oil prices affect real growth because they may lead consumers to postpone purchases of large-ticket, energy-guzzling consumption goods. Of course, oil price increases may affect consumer spending, working through other widely known income-transfer and real-balance channels. Another issue investigated here is whether the asymmetric relation between oil prices and real GDP growth found in data holds at the consumption level.

The empirical methodology used to identify the effect of an oil price increase on consumer spending is straightforward: We test for the direct effect of an oil price change on spending that is beyond what can be accounted for by

[5] Hamilton (1988) provides a theoretical model in which oil price increases and declines may adversely affect real economic activity because of the high cost of reallocating labor or capital among sectors affected differently by oil price changes.

[6] A good review of these channels appears in Mork (1994).

Figure 1 Quarterly Changes in Oil Prices



Notes: The BEA oil price series is an index of gas and oil, normalized to 100 in 1982, and deflated. The PPI oil price series is an index of crude oil, normalized to 100 in 1982, deflated, and not seasonally adjusted. The quarterly changes represent the first difference of the log of the prices, multiplied by 100.

other economic determinants of spending, such as households' labor income and net worth. We alternatively measure oil price shocks as "positive oil price increases" (Mork 1989) or "net oil price increases" (Hamilton 1996, 2003). The sample period studied is 1959:Q1 to 2004:Q2.

The empirical work presented here finds evidence of a nonlinear relation between oil price changes and growth in real consumer spending: Oil price increases have a negative effect on spending whereas oil price declines have no effect. The estimated negative effect of an oil price increase on consumer spending is large if oil price increases are measured as net increases, suggesting oil price increases that occur after a period of stable oil prices matter more than those increases that simply reverse earlier declines. Furthermore, the estimated negative effect on spending is also large if consumer spending is broadly defined to include spending on durable goods, suggesting the possible negative influence of oil price increases on the purchase of big-ticket consumption goods. Finally, the estimated oil price coefficients in the consumption equation do not show parameter instability during the 1980s, the period when oil prices moved widely for the first time in both directions.

This article is organized as follows. Section 1 examines the behavior of two oil price series to highlight the choppy nature of oil price changes since 1981 and to derive estimates of oil shocks as defined in Hamilton (1996, 2003). Section 2 presents the aggregate empirical consumer spending equation that underlies the empirical work here and reviews theory about how oil price shocks may affect the macroeconomy. Section 3 presents the empirical results, and Section 4 contains concluding observations.

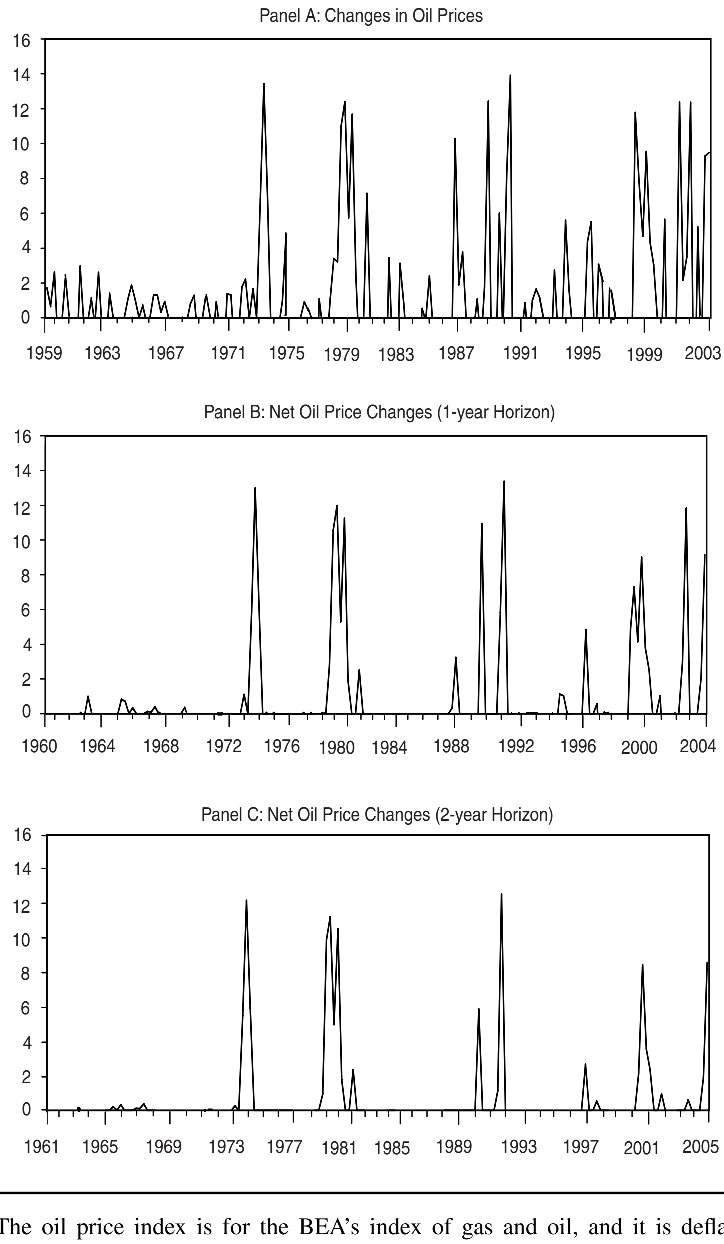
1. A PRELIMINARY REVIEW OF OIL PRICE CHANGES AND NET OIL PRICE INCREASES

In this section we first examine the behavior of two oil price series and then review the rationale behind the construction of net oil price increases as measures of oil price shocks, as in Hamilton (1996, 2003). The first series, prepared by the Bureau of Economic Analysis (BEA), measures gas and oil prices paid by consumers. The second series is the Producer Price Index (PPI) for crude petroleum prepared by the Bureau of Labor Statistics (BLS). In estimating the impact of oil price increases on real GDP growth, analysts have commonly focused on the oil price series for crude petroleum. We, however, focus on the consumer oil price series because changes in consumer spending are likely to be correlated with changes in oil prices actually faced by consumers rather than with changes in the producer price of crude petroleum.

Figure 1 plots the first differences of logs of these two oil price indexes. (The reported differences are multiplied by 100.) This figure highlights one key change in the time-series behavior of oil price changes over 1959 to 2004: Before 1981, big oil price movements were mostly positive. Since then, however, oil prices have moved widely in both directions. Hamilton argues that this change in the time-series behavior of oil price changes reflects the growing influence of endogenous macroeconomic developments on oil prices, namely that oil prices during the 1980s had been influenced dramatically by demand conditions. As a result of the increased endogenous nature of oil price movements, the estimated linear relation between oil price changes and real GDP growth appears unstable over the sample period that includes pre- and post-1980s oil price changes.

Hamilton proposes a nonlinear transformation of oil price changes in order to uncover the relation between the exogenous oil price movements and GDP growth. As indicated at the outset, he uses a filter that leaves out oil price declines and measures increases relative to a reference level, yielding what he calls net oil price increases. Briefly, a net oil price increase series is the percentage change from the highest oil price reached over the past four, eight, or twelve quarters, if positive, and zero otherwise.

Figure 2 Using BEA's Oil Price Index



Notes: The oil price index is for the BEA's index of gas and oil, and it is deflated. The net oil price increase is the maximum of (a) zero and (b) the difference between the log level of the oil price index for quarter *t* and the maximum value for the level achieved during the previous four (Panel B) or eight (Panel C) quarters.

Figure 2 plots oil price increases using the consumer oil price series. Panel A of Figure 2 plots only quarterly increases, whereas Panels B and C plot net oil price increases measured relative to past one- and two-year peaks, respectively. If we compare Panels A, B, and C, we may note that the use of a nonlinear filter results in weeding out certain increases in oil prices that were simply corrections to earlier declines. For example, the big spike in oil prices observed during the first quarter of 2003 does not show up in the net oil price increases measured relative to two-year peaks because it followed the big decline of oil prices in 2001. If we focus on net oil price increases measured over two-year peaks, we get relatively few episodes of oil price spikes, occurring in 1973–1974, 1979–1980, 1990, 1999–2000, and 2004. Hamilton argues that these oil price spikes can be attributed to disruptions in oil supplies associated with military conflicts and, hence, exogenous to the U.S. economy, with one exception.[7] The most recent spike in oil prices may be attributed mainly to the surge in world oil demand (Hamilton 2004).

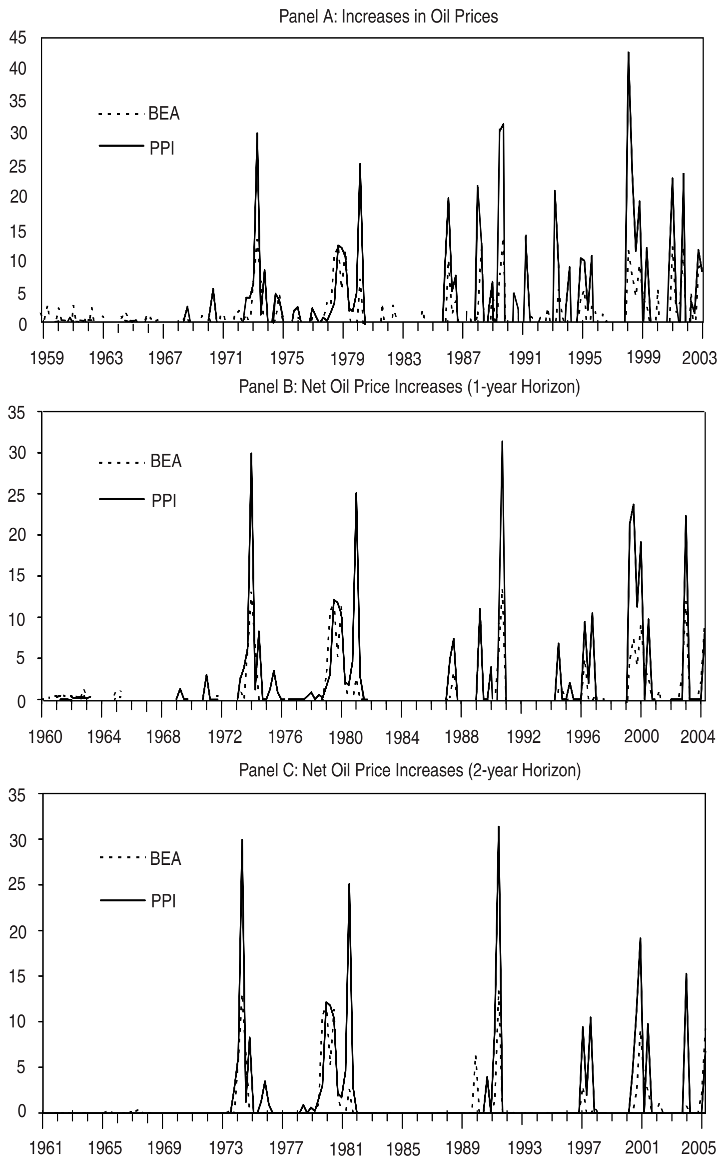
Figure 3 plots net oil price increases using both oil price series. Two observations stand out. The first is that the net oil price increase series for crude petroleum gives qualitatively similar inferences about the nature of oil price movements as does the consumer price series for gas and oil. However, net oil price increases measured using the consumer oil price series are significantly smaller than those derived using the producer price of crude petroleum. The empirical work presented below uses the net oil price increases created using the consumer oil price series.

2. EMPIRICAL AGGREGATE CONSUMER SPENDING EQUATIONS

The empirical strategy used to identify the consumption effect on an oil price increase is to look for the direct impact of a "net oil price increase" on consumer spending beyond that which can be accounted for by other economic determinants of consumption. We use as control variables economic determinants suggested by the empirical "life-cycle" aggregate consumption equations estimated in Mehra (2001). The empirical work in Mehra (2001) identifies income and wealth as the major economic determinants of consumer spending, and the "life-cycle" aggregate consumption equations provide sensible estimates of income and wealth elasticities, besides predicting reasonably well the short-term behavior of consumer spending. In particular, the empirical short-term consumption equation used here is based on the following consumption equations:

[7] The dates of military conflicts that led to declines in world production of oil are November 1973 (Arab-Israel War), November 1978 (Iranian Revolution), October 1980 (Iran-Iraq War), and August 1990 (Persian Gulf War). See Hamilton (2003, 390).

Figure 3 Comparison of Oil Price Increases



Notes: The oil price series are identical to those of Figures 1 and 2.

$$C_t^p = a_0 + a_1 Y_t + a_2 Y_{t+k}^e + a_3 W_t, \text{ and} \tag{1}$$

$$\Delta C_t = b_0 + b_1 \left(C_{t-1}^p - C_{t-1}\right) + b_2 \Delta C_t^p + \sum_{s=1}^{k} b_{3s} \Delta C_{t-s} + \mu_t, \tag{2}$$

where C_t^p is planned current consumption, C_t is actual current consumption, Y_t is actual current-period labor income, W_t is actual current-period wealth, and Y_{t+k}^e is average anticipated future labor income over the earning span (k) of the working-age population.

Equation 1 simply states that aggregate planned consumption depends upon the anticipated value of lifetime resources, which equals current and anticipated future labor income and current value of financial assets. This equation identifies income and wealth as the main economic determinants of aggregate planned consumption.

Equation 2 allows for the possibility that actual consumption in a given period may not equal planned consumption, reflecting the presence of adjustment lags and/or habit persistence. In this specification, changes in current-period consumption depend upon changes in current-period planned consumption, the gap between last period's planned and actual consumption, and lagged actual consumption. The disturbance term μ in (2) captures the short-run influences of unanticipated shocks to actual consumer spending. If we substitute (1) into (2), we get the short-run dynamic consumption equation (3):

$$\begin{aligned}\Delta C_t \;=\; & b_0 + b_1(C_{t-1}^p - C_{t-1}) + b_2(a_1 \Delta Y_t + a_2 \Delta Y_{t+k}^e + a_3 \Delta W_t) \\ & + \sum_{s=1}^{k} b_{3s} \Delta C_{t-s} + \mu_t. \end{aligned} \tag{3}$$

The key feature of equation (3) is that changes in current-period consumption depend upon changes in income and wealth variables, besides depending upon the last period's gap between the level of actual and planned consumption.

We estimate the "direct" influence of oil price changes on consumer spending by including lagged values of net oil price increases in the short-term consumption equation (3). As another control variable, we also include lagged values of changes in the nominal federal funds rate in order to capture the possible additional influence of changes in short-term interest rates on consumer spending. The inclusion of a short-term nominal interest rate in the consumption equation also controls for the potential influence of oil price increases on spending that work through the monetary policy channel, arising as a result of the Federal Reserve's monetary policy response to oil shocks.[8]

The empirical work below makes two additional assumptions. The first is that expected future labor income is simply proportional to expected current labor income. The second assumption is that current-period values of income and wealth variables are not observed, and, hence, planned consumption depends upon their known past values. Under these assumptions, the estimated short-consumption equation is

$$\begin{aligned} \Delta C_t &= \beta_0 + \beta_1 (C^p_{t-1} - C_{t-1}) + \beta_2 \Delta Y_{t-1} + \beta_3 \Delta W_{t-1} \\ &\quad + \sum_{s=1}^{6} \beta_{4s} \Delta C_{t-s} + \sum_{s=1}^{3} \beta_{5s} \Delta Oil\,Prices_{t-s} + \sum_{s=1}^{3} \beta_{6s} \Delta FR_{t-s}, \end{aligned} \tag{4}$$

where

$$C^p_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 W_t.$$

In the empirical, short-term consumption equation (4), changes in current consumer spending depend on lagged values of changes in income, net worth, the short-term nominal interest rate, and oil prices, besides depending on lagged changes in consumption and the gap between the level of actual and planned consumption.

3. OIL PRICE EFFECT CHANNELS AND THE REDUCED-FORM EMPIRICAL EVIDENCE

In this section, we review theory on how oil price increases may affect the real economy and discuss its implications for interpreting the evidence of a relation between oil price changes and consumer spending found using the aggregate consumer spending equation (4).

How do oil prices, in theory, affect the macroeconomy? A simple answer is that previous research does not offer any dominant theoretical mechanism.[9] Researchers have emphasized several different theoretical mechanisms through which oil may affect the macroeconomy. One of those mechanisms focuses on the inflation effect of oil price increases and its associated consequences that work through the so-called real-balance and monetary policy

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[8] A debate exists about whether the contractionary consequences of oil price shocks are due to oil price shocks themselves or to the monetary policy that responds to them. The evidence so far is not very conclusive. See, for example, Leduc and Sill (2004) who investigate this question in a calibrated general equilibrium model in which oil use is tied to capital utilization. Their findings suggest that while the monetary policy rule in place can contribute to the magnitude of the negative output response to an oil-price shock, the "direct" effect of the oil-price increase is the more important factor.

[9] See Hooker (2002), Hamilton (2003), and references cited in both.

channels. The real-balance channel posits that oil price increases lead to inflation, lowering real money balances held by the households and firms in the economy and thereby depressing aggregate demand through familiar monetary channels. The monetary policy channel becomes operative if the Federal Reserve tightens policy in response to inflation induced by oil prices, which may exacerbate further the negative output effect associated with oil shocks.

Another theory of how oil may affect the macroeconomy arises out of viewing an oil price as an import price. In particular, oil price increases lead to income transfers from countries that are net importers of oil, such as the United States, to oil-exporting countries. The first-round effect of this reduction in income is to cause economic agents in oil-importing countries to reduce their spending, leading to reduced aggregate demand. [10]

Some other channels through which oil may affect the macroeconomy arise when oil is modeled as another input in the production function. If oil and capital are complements in the production process, then oil price increases lead to a decline in the economy's productive capacity as agents respond to higher oil prices by reducing their utilization of both oil and capital. In this case, oil price increases lead to negative transitional output growth as the economy moves to a new steady-state equilibrium growth path. To the extent oil price increases raise uncertainty about both its future price and availability, oil price increases may also lead to the postponement of purchases of large-ticket consumption and investment goods, as in Bernanke (1983).[11] Hence, oil price increases have the potential to affect real growth by reducing both potential output and aggregate demand.

Another theoretical mechanism that links oil to the macroeconomy has emphasized the allocative effects of oil price shocks (Hamilton 1988, 2003). An oil price increase is likely to reduce demand for some goods but possibly raise demand for some others. For example, demand for inputs is likely to fall in sectors that use energy but likely to increase in sectors that produce energy. If it is costly to reallocate capital or labor between sectors affected differently by an oil price increase, then aggregate employment and output will decline in the short run. In this framework, an oil price decrease may also lower demand for some goods (demand for inputs used in energy-producing sector) and, hence, may be contractionary if labor or capital could not be moved to favorably affected sectors.

[10] The second-round effects arise from, among others, the recycling of income transfers, which is increased income of oil-exporting countries that leads to increased demand for products of the oil-importing countries, thereby offsetting the initial fall in aggregate demand. A recent empirical study, however, finds that among most oil importing countries, including the United States, oil price increases have a negative effect on economic activity (Jimenez-Rodriguez and Sanchez 2004).

[11] See footnote 4.

The discussion above implies that oil price increases may, in theory, affect real growth through several different channels, as emphasized by different researchers. This review then raises another question: Does the empirical evidence reported in previous research support any dominant theoretical mechanism? The answer to this question again appears to be "no" because most of the empirical evidence is based on estimated reduced-form regressions that relate changes in GDP growth to changes in oil prices, controlling for the influences of some other variables on real growth such as lagged real GDP growth, short-term interest rate, import price inflation, etc. As is well known, the evidence based on reduced-form regressions indicating that oil price increases have a significant effect on the macroeconomy may be consistent with several different theoretical mechanisms.

However, analysts who have reported the empirical evidence of the nonlinear and asymmetric relation between oil prices changes and real GDP growth assert that such evidence does appear to favor mechanisms in which oil shocks affect real GDP through the so-called uncertainty and allocative channels, as in Hamilton (2003). The main reason for the emphasis on allocative channels is that other channels, such as income-transfer and real-balance, imply a symmetric relationship between oil price changes and GDP growth. The asymmetry may arise because oil price effects that work through allocative channels differ from those that work through other channels already mentioned. Thus, an oil price increase is likely to depress GDP because all three channels described above (income-transfer, real-balance, and allocative) work to depress aggregate demand. In contrast, an oil price decline may not stimulate GDP because the positive effect of lower oil prices on aggregate demand generated through the real-balance and income-transfer channels is offset by the negative effect on demand generated through the so-called allocative channels. Another factor that may augment the asymmetric response of oil prices to GDP is the asymmetric response of monetary policy to oil prices—the Federal Reserve tightening policy in response to oil price increases but not pursuing expansionary policies in face of oil price declines.[12]

Given the considerations noted above, we investigate whether oil price increases directly affect consumer spending and whether the nonlinear and asymmetric relation between oil prices and real GDP found in previous research hold at the consumption level.

[12] Some analysts have argued that during the 1980s and 1990s the Federal Reserve followed an "opportunistic" disinflation policy in the sense that if actual inflation declined due to some shocks, the Federal Reserve lowered its inflation target and adjusted policy to maintain the lower inflation rate. Since oil price shocks have been an important source of movements in inflation, the Federal Reserve following an opportunistic disinflation policy may not follow an expansionary policy if actual inflation falls below its short-term target in response to an oil price decrease. In that regime, a relatively tight policy offsets the expansionary effect of an oil price decrease on the real economy. The quantitative importance of this oil-price policy interaction channel remains a subject of future research.

4. EMPIRICAL RESULTS

In this section, we present and discuss the evidence regarding the effect of oil price changes on consumer spending, using estimated reduced-form consumer spending equations as shown in (4). The consumption equations are estimated using quarterly data over 1962:Q1 to 2004:Q2 and measurement of variables as in Mehra (2001).[13]

Estimates of Oil Price Effects

Table 1 reports coefficients from the short-term consumption equation (4) estimated using total consumer spending and three different measures of oil price changes: quarterly oil price changes, positive increases in oil price, and net oil price increases. We report the sum of coefficients that appear on the oil price variable and the t-value for a test of the null hypothesis that the sum of oil price coefficients is zero. Since the consumption equation is estimated including lagged consumption, the cumulative response of spending to an oil price increase is likely to differ from its short-term response. Hence, we also report the cumulative size of the coefficient that appears on the oil price variable, which is just the short-term oil price coefficient divided by one minus the sum of estimated coefficients on lagged consumption. We also report estimated coefficients on other control variables that appear in the short-term consumption equation, including lagged consumption, labor income, household net worth, and the short-term interest rate.

The columns labeled (1) through (5) in Table 1 contain coefficients from the short-term consumption equation estimated using different measures of oil price changes. The estimates with quarterly oil price changes are in column (1), those with positive oil price changes are in column (2), and those with net oil price increases measured relative to one-, two-, and three-year peaks are in columns (3), (4), and (5), respectively. If we focus on the oil price coefficient, the estimated coefficient on the oil price variable has a negative sign and is statistically different from zero only when oil price changes are measured either as oil price increases or net oil price increases (compare t-values on the oil price change variable in different columns of Table 1). The estimated coefficient on the quarterly oil price change variable is small and not statistically different from zero. The small t-value of the null hypothesis that the estimated coefficient on oil price declines when added into the short-term consumption equation containing oil price increases, given in column (2), suggests that oil

[13] Consumption is measured as per capita consumption of durables, nondurables, and services in 2000 dollars (C). Labor income is measured as per capita disposable labor income, in 2000 dollars (Y). Household wealth is measured as per capita household net worth in 2000 dollars. The short-term interest rate is the nominal federal funds rate. The oil price series measures gas and oil prices paid by consumers, prepared by the BEA.

Table 1 Empirical Aggregate Consumer Spending Equations

$$c_t = \beta_0 + \beta_1 \left(c_{t-1} - c^p_{t-1}\right) + \beta_2 \Delta y_{t-1} + \beta_3 \Delta w_{t-1} + \sum_{s=1}^{6} \beta_{4s} \Delta c_{t-s} + \sum_{s=1}^{3} \beta_{5s} \Delta oilprices_{t-s} + \sum_{s=1}^{3} \beta_{6s} \Delta FR_{t-s}$$

$$\text{where } c^p_t = f_0 + f_1 y_t + f_2 w_t + f_3 TR_t$$

Independent Variables	(1)	(2)	(3)	(4)	(5)
Δc_{t-s}	0.660 (4.6)	0.560 (4.2)	0.580 (4.5)	0.540 (4.2)	0.530 (4.0)
Δy_{t-1}	0.110 (2.4)	0.120 (2.5)	0.100 (2.1)	0.100 (2.0)	0.100 (2.1)
$\Delta w1$	0.050 (2.5)	0.050 (2.9)	0.040 (2.6)	0.040 (2.6)	0.040 (2.3)
ΔFR_{t-s}	−0.003 (4.5)	−0.003 (4.3)	−0.003 (4.3)	−0.003 (4.1)	−0.003 (4.1)
$c_{t-1} - c^p_{t-1}$	−0.130 (3.3)	−0.120 (3.0)	−0.120 (3.1)	−0.130 (3.3)	−0.130 (3.2)
Δoil_{t-s}	−0.100 (0.4)				
$P\Delta oil_{t-s}$		−0.030 (1.6)			
$NP\Delta oil_{t-s}$					
1-year			−0.050 (1.8)		
2-year				−0.070 (2.1)	
3-year					−0.070 (2.1)
Adj.R^2	0.3600	0.3800	0.3700	0.3800	0.3800
SER	0.0055	0.0054	0.0054	0.0053	0.0053
Cumulative oil price coefficient	−0.0200	−0.0800	−0.1200	−0.1600	−0.1600

Notes: The coefficients (t-values in parentheses) reported above are ordinary least squares estimates of the short-term consumption equation. Δc is change in real consumer spending, Δy is change in labor income, Δw is change in net worth, ΔFR is change in the nominal federal funds rate, c^p is planned consumption, Δoil is change in oil prices, $P\Delta oil$ is positive changes in oil prices, $NP\Delta oil$ is net oil price increases measured relative to one-, two-, and three-year peaks, Adj.R^2 is the adjusted R-squared, and SER is the standard error of regression.

The coefficient reported on Δc_{t-s} is the sum of coefficients that appear on six lagged values of consumer spending and the coefficient on the oil price variable is the sum of coefficients that appear on three lagged values of the oil price variable. The cumulative oil price coefficient is the coefficient on lagged oil divided by one minus the coefficient on lagged consumption. The effective sample period is 1961:Q1 to 2004:Q2.

price declines have no effect on consumer spending. Together these estimates suggest only oil price increases have a negative effect on consumer spending, implying the presence of an asymmetric relation between oil price changes and consumer spending.

The estimated size of the cumulative oil price response coefficient is -0.08 when oil price changes are measured as oil price increases and ranges between -0.12 to -0.16 when oil price changes are measured as net oil price increases.

Those estimates imply that a 10 percent increase in oil prices is associated with the level of consumer spending at the end of six quarters being anywhere between 0.80 percent to 1.60 percent lower than what it otherwise would be. This effect includes the direct effect of the net oil price increase and the indirect effect that comes through lagged consumption. Given that consumer spending is two-thirds of GDP, the above estimates imply that a 10 percent increase in the price of oil working through the consumption channel will be associated with the level of GDP that is anywhere between one-half to one percentage point lower than what it otherwise would be. In Hamilton (2003), a 10 percent increase in the price of oil is associated with the level of GDP that is 1.4 percent lower than what it otherwise would be, which is above the estimated range, suggesting oil price increases may also affect real GDP working through investment and other components of aggregate demand.

It is worth pointing out that estimated coefficients on other variables such as household labor income, net wealth, and changes in the short-term nominal interest rate have theoretically correct signs and are statistically different from zero (see t-values for those variables in different columns in Table 1). Furthermore, the estimated coefficient on the so-called error-correction variable, which measures the effect on current spending of last period's gap between actual and planned spending, as in (4), is correctly negatively signed and statistically different from zero.

Table 2 presents some robustness analysis of oil price effects with respect to few changes in the specification of the aggregate consumer spending equation. The estimates of oil price effects discussed above are derived using consumer spending that includes spending on durable goods because oil price shocks are hypothesized to affect spending on big-ticket consumer goods that are intensive in the use of energy. But since oil price increases may affect consumer spending by working through other channels, we also estimate the short-term consumption equations that include spending only on nondurable goods and services. Furthermore, we also estimate the aggregate consumer spending equation without controlling for the direct effect of changes in the short-term nominal interest rate on spending. Many analysts have argued that the negative effect of oil price shocks observed on real GDP growth may be due not to oil price shocks themselves but to the monetary policy response to them. Although this issue can not be examined in a rigorous manner using reduced-form spending equations, we offer some preliminary evidence by examining whether the magnitude of oil price effects on consumer spending is sensitive to the exclusion of the interest rate variable.

Table 2 reports estimates of the cumulative oil price coefficient found using consumer spending on nondurable goods and services with and without the interest rate. It also includes results of total consumer spending. Three observations stand out: The first is that the estimated negative effect of an oil price increase on consumer spending is large if spending is broadly defined to

Table 2 Sensitivity Analysis

	Cumulative Oil Price Coefficient			
Measures of Consumer Spending	$P\Delta oil$	1-year	$NP\Delta oil$ 2-year	3-year
Consumer spending including durables				
with ΔFR_{t-s}	−0.08*	−0.12*	−0.16*	−0.16*
without ΔFR_{t-s}	−0.09*	−0.13*	−0.18*	−0.17*
Consumer spending without durables				
with ΔFR_{t-s}	−0.03	−0.05	−0.09*	−0.08*
without ΔFR_{t-s}	−0.04	−0.06	−0.09*	−0.09*

Notes: See notes in Table 1.

* significant at the 0.05 level

include spending on durable goods (compare the size of the oil price coefficient estimated using alternative measures of spending with and without spending on durables, as shown in Table 2). The second observation is that the magnitude of the oil price effect on spending estimated here is not overly sensitive to the exclusion of the interest rate variable from the short-term consumption equation. The third point to note is that the estimated negative effect on spending of net oil price increases is larger than that of positive increases in oil prices, suggesting those increases that occur after a period of stable oil prices affect spending more than oil price increases that simply reverse earlier declines (compare the relative magnitude of the oil price coefficient on oil price increases and net oil price increases, as shown in Table 2). Together these results are consistent with the view that oil price increases affect spending by influencing spending on durable goods and that oil price increases have a direct effect on spending that is beyond what could occur through the monetary policy response to oil prices.

Stability of Oil Price Coefficients

Hamilton (2003) has argued that if we focus on exogenous oil price increases, then the estimated linear relation between exogenous oil price shocks and real GDP growth remains stable. We follow Hamilton in measuring exogenous oil price shocks as net oil price increases believed to be associated with major disruptions to world oil supplies. We now examine whether such a result holds at the consumption level. As indicated before, oil prices have swung widely in both directions since 1981. Hence, we investigate whether oil price coefficients in the aggregate consumer spending equation (4) have changed since 1981.

We implement the test of stability of oil price coefficients using a dummy variable approach with the break date around 1981. We also implement the stability test treating the break date unknown in the 1980s. In particular, consider the following aggregate consumption equation:

$$\Delta C_t = \beta_0 + \sum_{s=1}^{3} \beta_{1s} \Delta OilPrices_{t-s} + \sum_{s=1}^{3} d_{1s} (\Delta OilPrices^{*} DU)_{t-s} + \beta_{2s} X_{t-s} + \varepsilon_t, \quad (5)$$

where DU is a dummy variable, defined as unity over the period since the break date and zero otherwise; X is the set of other control variables including lagged values of consumer spending, labor income, household net worth, and changes in the nominal interest rate, as in (4). In (5), the test of the null hypothesis of stable oil price coefficients against the alternative that they have changed at date t_1 is that all slope dummy coefficients are zero, i.e., $d_{1s} = 0, s = 1, 2, 3$. Under this null hypothesis, the standard F statistic F_{t1} would have a chi-squared distribution with three degrees of freedom, $\chi^2(3)$, asymptotically.[14]

We calculate the value of the statistic for every possible value of the break date between 1981:Q1 to 1990:Q4, using oil price increases and net oil price increases as alternative measures of oil price changes. Panel A in Figure 4 plots the p-value from this test as a function of the break date t_1 using oil price increases, whereas panels B through D do so using net oil price increases. As can be seen, the p-value from this test is above the 0.05 p-value for all the break dates and for all measures of oil price increases. These test results suggest that the nonlinear relations between oil price changes and growth in consumer spending do not depict any parameter instability during the 1980s.[15]

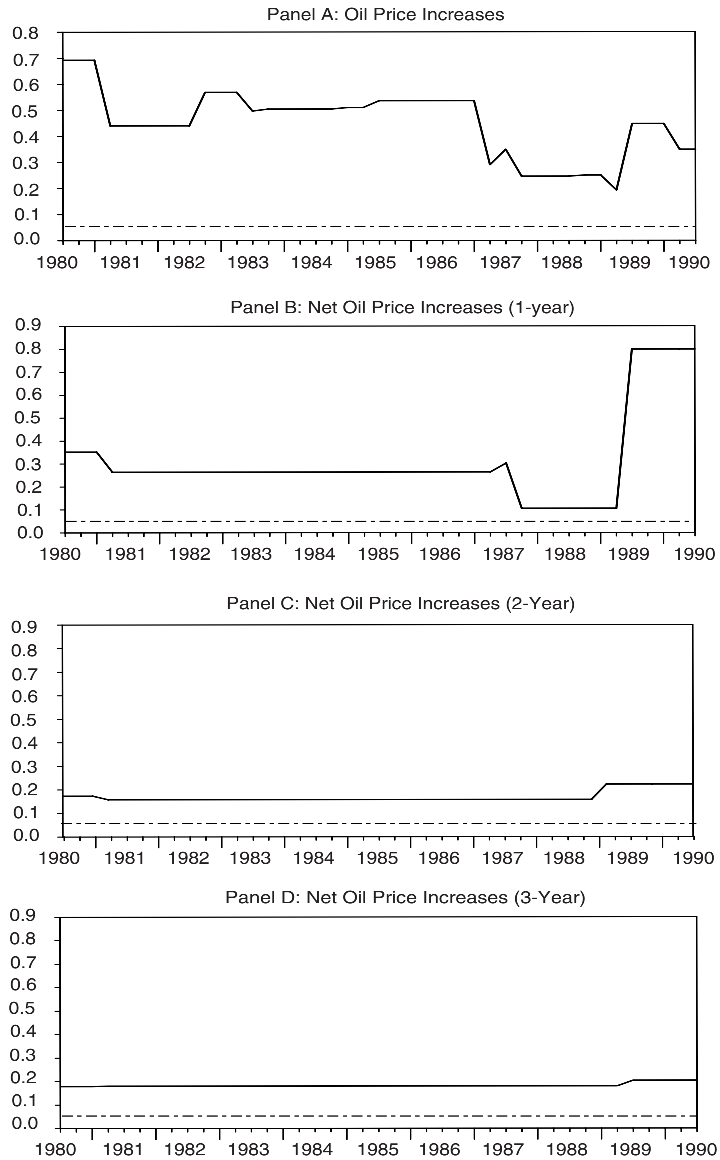
5. CONCLUDING OBSERVATIONS

This article reports empirical evidence indicating that oil price increases have a negative effect on consumer spending whereas oil price declines do not. Furthermore, oil price increases that occur after a period of stable oil prices matter more than oil price increases that reverse earlier declines. This finding of a

[14] The aggregate consumption equations have been estimated allowing for the presence of a heteroscedastic disturbance term, and, hence, the standard F statistic has a chi-squared, not F, distribution.

[15] The inference regarding stability of oil price coefficients does not change if we were to treat the break date from 1981:Q1 to 1990:Q4 as unknown and compare the largest value of the F statistic over possible break dates with the 5 percent critical value, as in Andrews (1993). The largest value of the F statistic is 4.7 when oil price changes are measured as oil price increases, which is below the 5 percent critical value of 9.29 given in Andrews (1993, Table 1, using $\pi = 0.48$, $p = 3$ restrictions). The largest F takes values 6.1, 5.2, and 4.9 for net oil price increases measured relative to one-, two-, and three-year peaks, respectively. For these alternative measures of oil price changes, the largest F remains below the 5 percent critical value, suggesting that oil price coefficients do not depict any parameter instability during the 1980s.

Figure 4 Chow Test for Stability of Oil Price Coefficients



Notes: Each figure plots the p-value of a Chow test where the null hypothesis is that oil price coefficients are stable against an alternative that they have changed at the given date. The dashed lines indicate a p-value of 0.05.

nonlinear and asymmetric relation between oil price changes and consumer spending is in line with what other analysts have found existing between oil price changes and aggregate real economic activity such as real GDP growth.

The results reported here also indicate that oil price increases have a stronger effect on consumer spending if spending is broadly defined to include spending on durables, suggesting oil price increases may be affecting consumer spending by affecting demand for consumer durable goods. However, oil price increases may be affecting consumer spending by working through other channels as well because oil price increases continue to have a significant effect if spending includes only nondurables and services.

The evidence indicating that oil price decreases have no effect on consumer spending is derived using reduced-form consumer spending equations and, hence, may be consistent with several different theoretical mechanisms. One explanation of why an oil price decrease does not have a significant effect on spending is that the positive effect of an oil price decrease generated through the real-balance and income-transfer channels offsets the negative effect on spending generated through allocative channels. Furthermore, if the Federal Reserve does not lower the funds rate in response to oil price declines but raises it in response to oil price increases, we may also find that oil price decreases have no significant effect on spending whereas oil price increases do. Without help from a structural model, we cannot determine which of these two mechanisms is dominant in generating the asymmetry found in data.

The empirical work here focuses on the effect of "exogenous" oil price increases (measured by net oil price increases) on consumer spending, namely, oil price increases caused by exogenous events such as those resulting from disruptions to oil supplies caused by military conflicts. However, increases in oil prices that are due to a rising world demand for oil may not necessarily raise uncertainty about future energy supplies and prices and thus may not adversely affect demand for durable consumption goods, as emphasized in this literature. To the extent that oil price increases affect spending by working through other channels, however, oil price increases, even if due to rising world oil demand, could still adversely affect consumer spending in the short run.

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