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ABSTRACT

The Impact of Oil Price Shocks on the U.S. Stock Market

While there is a strong presumption in the financial press that oil prices drive the stock market, the empirical evidence on the impact of oil price shocks on stock prices has been mixed. This paper shows that the response of aggregate stock returns may differ greatly depending on whether the increase in the price of crude oil is driven by demand or supply shocks in the crude oil market. The conventional wisdom that higher oil prices necessarily cause lower returns is shown to apply only to oil-market specific demand shocks such as increases in the precautionary demand for crude oil that reflect fears about the availability of future oil supplies. In contrast, positive shocks to the global aggregate demand for industrial commodities are shown to cause both higher real oil prices and higher stock prices. Shocks to the global production of crude oil, while not trivial, are far less important for understanding changes in stock prices than shocks to global aggregate demand and shocks to the precautionary demand for oil. Further insights can be gained from the responses of industry-specific stock returns to demand and supply shocks in the crude oil market. We identify the sectors most sensitive to these shocks and study the opportunities for adjusting one's portfolio in response to oil market disturbances.

JEL Classification: G12 and Q43
Keywords: demand shocks, oil prices, stock returns and supply shocks

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1. Introduction

Changes in the price of crude oil are often considered an important factor for understanding fluctuations in stock prices. For example, the *Financial Times* on August 21, 2006, attributed the decline of the U.S. stock market to an increase in crude oil prices caused by concerns about the political stability in the Middle East (including the Iranian nuclear program, the fragility of the ceasefire in Lebanon, and terrorist attacks by Islamic militants). The same newspaper on October 12, 2006, argued that the strong rallies in global equity markets were due to a slide in crude oil prices that same day.

Notwithstanding such widely held views in the financial press, there is no consensus about the relation between the price of oil and the stock price among economists. Chen, Roll and Ross (1986), for example, concluded that oil price changes have no effect on asset pricing. Jones and Kaul (1996) reported a stable negative relationship between oil price changes and aggregate stock returns. Huang, Masulis, and Stoll (1996), however, found no negative relationship between stock returns and changes in the price of oil futures. In related work, Wei (2003) concluded that the decline of stock prices after the 1973/74 oil crisis seems too large to be explained by the rise in oil prices.

This paper takes a fundamentally different approach than previous studies. One limitation of existing work on the link between oil prices and stock prices is that the price of crude oil is treated as exogenous with respect to the economy. It has become widely accepted in recent years that the price of crude oil since the 1970s has responded to some of the same economic forces that drive stock prices, making it necessary to control for reverse causality (see Barsky and Kilian 2002, 2004; Hamilton 2003, 2005; Kilian 2006a,b). This means that cause and effect are not well defined in regressions of stock returns on oil price changes.

A second limitation of the existing literature is the presumption that it is possible to assess the impact of higher crude oil prices without knowing the underlying causes of the oil price increase. To the extent that different shocks in the crude oil market have very different effects on the economy and on the real price of oil, as has been documented in Kilian (2006c), and to the extent that the relative importance of individual shocks for the price of oil evolves over time, regressions relating stock returns to innovations in the price of oil will be biased toward finding no significant statistical relationships and/or statistical relationships that are unstable over time.

In this paper, we address both of these limitations by relating U.S. stock returns to measures of demand and supply shocks in the global crude oil market, building on a structural decomposition of fluctuations in the real price of oil. We find that the response of aggregate stock returns may differ greatly depending on the cause of the oil price shock. The negative response of stock prices to oil price shocks, often referred to in the financial press, is found only when the oil price rises due to an oil-market specific demand shock such as an increase in precautionary demand driven by fears about the future availability of crude oil. In contrast, if higher oil prices are driven by a global economic expansion, we find persistent positive effects on cumulative stock returns. Shocks to crude oil production, on the other hand, have no significant effect on cumulative stock returns. Regardless of the nature of the shock, we can reject the hypothesis that the return response is driven by expected dividend growth alone. Shocks to the precautionary demand for crude oil also provide an explanation for the negative association between stock returns and inflation found in previous studies of the postwar period (see, e.g., Kaul and Seyhun 1990).

On average 14 percent of the variation in aggregate stock returns during 1975-2005 can be attributed to the shocks that drive the crude oil market. 90 percent of that contribution is driven by shocks to the demand for crude oil. Historical decompositions reveal that the cumulative effect of each demand and supply shock varies substantially over time, making it difficult to generalize from the effects of one oil price shock to those of another without explicitly breaking down the contribution of each shock.

Of additional interest from an investor's point of view is the response of industry-specific stock returns to demand and supply shocks in the crude oil market. We investigate the responses of stock returns to each type of shock for selected industries whose share prices a priori are likely to respond to disturbances in the oil market. Our analysis suggests that the appropriate portfolio adjustments in response to oil price shocks depend on the underlying cause of the oil price increase. We find, for example, that parts of the petroleum and natural gas industry as well as gold and silver mining enjoy a brief, but significantly positive response to a positive oil-market specific demand shock, while the automobile industry and the retail sector experience a persistent and significantly negative response to the same shock. In contrast, if the same increase in oil prices is driven by innovations to global real economic activity, the share prices of all four industries will increase.

Outside of the energy sector, the strongest responses to oil demand shocks are found in the automobile industry, in the retail industry, and in tourism-related sectors such as restaurants and lodging, consistent with the view that oil price shocks are primarily shocks to the demand for goods and services rather than supply shocks for the U.S. economy (see, e.g., Hamilton 1988). Our results also suggest that the total cost share of energy is not an important factor in explaining differences in the responses of real stock returns across manufacturing industries.

The remainder of the paper is organized as follows. Section 2 describes the empirical methodology and contains the results for aggregate stock returns. Section 3 focuses on the industry-level stock returns. Section 4 contains concluding remarks.

2. Dynamics of Aggregate Stock Return Responses to Structural Oil Shocks

2.1. Aggregate Stock Market Data

The aggregate real stock return is constructed by subtracting the BLS consumer price index (CPI) inflation rate from the log returns of the Center for Research in Security Prices (CRSP) value-weighted market portfolio.[1] The aggregate dividend-growth rate is constructed from monthly returns on the CRSP value-weighted market portfolio with and without dividends following Torous, Valkanov, and Yan (2005). The sample period is 1975.1-2005.9. Our choice of sample period is dictated by the limited availability of oil market data and by the constraints imposed by our methodology.

2.2. Empirical Methodology

Existing studies of the relationship between oil prices and real stock returns suffer from two limitations. First, previous empirical and theoretical models of the link between oil prices and stock prices have been constructed under the premise that one can think of varying the price of crude oil, while holding all other variables in the model constant. In other words, oil prices are treated as strictly exogenous with respect to the global economy. This premise is not credible (see, e.g., Barsky and Kilian 2002, 2004; Hamilton 2003). There are good theoretical reasons and there is strong empirical evidence that global macroeconomic fluctuations have influenced the price of crude oil since the 1970s (see Kilian 2006a, 2006c). For example, it is widely accepted that a global business cycle expansion (as in recent years) tends to raise the price of oil.[2] The fact

[1] The CRSP data were obtained from http://wrds.wharton.upenn.edu.
[2] As noted by Hamilton (2005), "it is clear … that demand increases rather than supply reductions have been the primary factor driving oil prices over the last several years."

that the same economic shocks that drive macroeconomic aggregates (and thus stock returns) also may drive the price of crude oil makes it impossible to separate cause and effect in studying the effect of higher oil prices on stock returns. This means that the question of how stock returns respond to an increase in the price of oil is not well defined.

Second, even if we could control for reverse causality, existing models postulate that the effect of an exogenous increase in the price of oil is the same, regardless of which underlying shock in the oil market is responsible for driving up the price of crude oil. Recent work by Kilian (2006c) has shown that the effects of demand and supply shocks in the crude oil market on U.S. macroeconomic aggregates are qualitatively and quantitatively different, depending on whether the oil price increase is driven by oil production shortfalls, by a booming world economy, or by shifts in precautionary demand for crude oil that reflect increased concerns about the availability of future oil supplies. It is quite natural to expect similar differences in the effect of these shocks on stock returns. In addition, oil price shocks historically have been driven by varying combinations of these demand and supply shocks, so their effect on stock returns is bound to be different from one episode to the next.

In this paper, we address both of these limitations by relating U.S. stock returns to measures of demand and supply shocks in the global crude oil market, building on a structural decomposition of the real price of oil. Our approach involves two steps. We first trace fluctuations in the real price of oil to the underlying structural demand and supply shocks in the crude oil market and then estimate the dynamic responses of U.S. stock market aggregates to these shocks. To the extent that shocks to the demand for and supply of crude oil are predetermined with respect to stock market aggregates, these responses (and the cumulative effect of each shock on U.S. stock market aggregates) can be estimated by standard regression methods.

2.2.1. Construction of the Demand and Supply Shocks in the Crude Oil Market

We begin by decomposing fluctuations in the real price of crude oil into orthogonal components that reflect demand and supply shocks in the market for crude oil. Since crude oil is traded in global markets, it is appropriate to study the determinants of the price of crude oil at the global level. Building on an approach developed by Kilian (2006c), we estimate a restricted structural near-VAR model based on monthly data for the vector time series z_t, consisting of a time series of the percent change in global crude oil production, a measure of real economic activity in global commodity markets, and the real price of crude oil. The sample period is 1973.1-2005.9.[3] The model allows for up to two years worth of lags. The structural representation of this restricted VAR model is

$$A_0 z_t = \alpha + \sum_{i=1}^{24} A_i z_{t-i} + \varepsilon_t ,$$

where some of the elements of A_i, $i = 1,...,24,$ are restricted to zero and ε_t denotes the vector of serially and mutually uncorrelated structural innovations. Let e_t denote the reduced form VAR innovations such that $e_t = A_0^{-1}\varepsilon_t$. The structural innovations are derived from the reduced form innovations by imposing exclusion restrictions on A_0^{-1}. As in Kilian (2006c), we assume that (1) oil supply will not respond to oil demand shocks within the month, given the costs of adjusting oil production and the uncertainty about the state of the crude oil market; (2) increases in the real price of oil driven by shocks that are specific to the oil market will not lower global real economic activity within the month; and (3) innovations to the real price of oil that cannot be

[3] For a detailed description of the data and methodology see Kilian (2006c). The starting date is dictated by the availability of crude oil production data.

explained by oil supply shocks or shocks to the aggregate demand for industrial commodities must be demand shocks that are specific to the oil market. The latter shocks can be shown to capture primarily fluctuations in precautionary demand for oil driven by fears about the availability of future oil supplies.

These assumptions allow us to attribute fluctuations in the real price of crude oil to three structural shocks: ε_{1t} denotes shocks to global oil supply (including production shortfalls driven by political events as well as other crude oil producers' response to such shortfalls); ε_{2t} captures shocks to the aggregate demand for industrial commodities in global commodity markets. These shocks affect all industrial commodities (including crude oil) and are driven by changes in global real economic activity; finally, the oil-market specific demand shock ε_{3t} captures shifts in precautionary demand for crude oil that reflect increased concerns about the availability of future oil supplies that are by construction orthogonal to the other shocks. In the analysis below, we will use the terms *oil-market specific demand shock* and *precautionary demand shock* interchangeably. Although in principle there may be other demand shocks that are specific to the crude oil market and orthogonal to demand shocks in other industrial commodity markets, Kilian (2006c) provided evidence that the timing of the oil price fluctuations driven by ε_{3t} is largely consistent with fluctuations in precautionary demand.

As shown in Figure 1, these structural shocks have very different effects on the real price of oil. For example, an unexpected increase in precautionary demand for oil causes an immediate and persistent increase in the real price of oil, an unexpected increase in aggregate demand for all industrial commodities causes a delayed, but sustained increase in the real price of oil, whereas unanticipated oil production disruptions cause a transitory increase in the real price of oil within the first year.

The historical decomposition of fluctuations in the real price of oil in Figure 2 suggests that oil price shocks historically have been driven mainly by a combination of aggregate demand shocks and precautionary demand shocks, rather than oil supply shocks, as is commonly believed. For example, the increase in the real price of oil after 1979 was primarily driven by the superimposition of strong global demand and a sharp increase in precautionary demand in 1979 with only minor contributions from oil supply shocks. Likewise the build-up in the real price of oil after 2003 was driven entirely by the cumulative effects of positive global demand shocks.[4]

2.2.2. Estimation of the Dynamic Effects on Aggregate Real Stock Returns

In what follows we treat the structural residuals of the near-VAR model described above as proxies for the demand and supply shocks in the global crude oil market. Let r_t denote real stock returns. Under the identifying assumption that $\hat{\varepsilon}_{s,t}$, $s = 1,2,3,$ is predetermined with respect to real U.S. stock returns, one can examine the dynamic effects of these shocks on real stock returns based on the regressions:

(1) $$r_t = \alpha + \sum_{i=0}^{h} \psi_i \hat{\varepsilon}_{s,t-i} + u_t, \quad s = 1,2,3$$

where u_t is a potentially serially correlated error, h is the maximum horizon, and $\hat{\varepsilon}_{st}$ is a serially uncorrelated shock. By definition the impulse response is $dr_{t+1}/d\,\hat{\varepsilon}_{s,t}$. Differentiation implies that $dr_t/d\,\hat{\varepsilon}_{s,t-i} = \psi_i$. By stationarity we know that $dr_t/d\,\hat{\varepsilon}_{s,t-i} = dr_{t+i}/d\,\hat{\varepsilon}_{s,t} = \psi_i$. The impact multiplier is $dr_t/d\,\hat{\varepsilon}_{s,t} = \psi_0$.

Regression model (1) allows consistent estimation of the impulse responses under minimal assumptions. An alternative approach would have been to fit a recursively identified bivariate

[4] These results are broadly consistent with other evidence and theoretical accounts of the history of the crude oil market. For further discussion see Barsky and Kilian (2002, 2004) and Kilian (2006a,b,c).

VAR model to $(\hat{\varepsilon}_s \quad r_t)'$, $s = 1,2,3.$ Apart from being more restrictive, the main disadvantage of the VAR model compared to regression model (1) is that it tends to be less parsimonious. Given our short sample this is an important concern. All of our empirical results in this paper therefore will be based on model (1). The maximum horizon of the impulse responses is 12 months.[5]

2.3. Impulse Responses of U.S. Real Stock Returns

Figure 3 shows the cumulative impulse responses of the CRSP value-weighted stock returns to each of the three demand and supply shocks in the crude oil market. The oil supply shock has been normalized to represent a negative one percent shock, while the aggregate demand shock and oil-market specific demand shock have been normalized to represent a positive one percent shock such that all three shocks would tend to raise the real price of oil. One-standard error and two-standard error bands are indicated by dashed and dotted lines. All intervals have been computed based on appropriate bootstrap methods (see Kilian 2006c).[6]

Figure 3 underscores the point that the responses of aggregate stock returns may differ substantially, depending on the underlying cause of the oil price increase. The left panel of Figure 3 shows that disruptions of crude oil production do not have a significant effect on cumulative U.S. stock returns at the 10 percent level. In contrast, an unexpected increase in the global demand for industrial commodities driven by increased global real economic activity will cause a sustained increase in U.S. stock returns that persists for 11 months and is significant at the 10 percent level for the first 8 months. Finally, an increase in the precautionary demand for oil reflecting sudden increased uncertainty about the political stability of the Middle East all else

[5] Yet another approach would have been to estimate a structural VAR jointly in $(z_t \; r_t)'$ with the stock returns ordered last in the recursive identification. Unlike our regression model, such a model would have imposed linearity. In addition, the inclusion of a large number of additional lags may cause over-fitting of the stock return data.

[6] The confidence intervals are constructed based on block bootstrap methods and account for serial correlation and conditional heteroskedasticity, but not for the generated-regressor nature of the VAR shocks.

equal would cause persistently negative U.S. stock returns that are significant at the 10 percent level for the first 6 months, as shown in the right panel.

Perhaps the most striking result in Figure 3 is the fact that, even after 12 months, oil supply disruptions have no significant effect on cumulative stock returns. The lack of a significant response of cumulative returns is consistent with the weak response of the real price of oil shown in Figure 1; yet it raises the question of what – if not adverse oil supply shocks – accounts for the anecdotal evidence of large declines in stock prices associated with major political disturbances in the Middle East. The answer lies in sharp increases in precautionary demand. As shifts in precautionary demand are ultimately driven by expectations about the availability of future oil supplies and such expectations can change almost instantaneously in response to political shocks in the Middle East, such shocks may trigger an immediate and sharp increase in precautionary demand that is reflected in an immediate jump in the real price of oil (see Figure 1) as well as an immediate drop in stock prices (see Figure 3).

The latter situation is consistent with the August 21, 2006, *Financial Times* quote used in the introduction. However, this does not mean that higher oil prices will always be bad news for the stock market. Specifically, an unexpected global aggregate demand expansion will cause both cumulative real stock returns and the real price of crude oil to rise. This may be seen by comparing the second panel of Figure 3 with the response of the real price of oil to the same shock in Figure 1. Hence, the October 12 quote in the *Financial Times*, linking falling oil prices to rising stock prices, is not obviously true. In fact, without knowing why oil prices fell that day, we cannot attribute the rise in stock prices to the price of oil. If there had been a sudden influx of good news about the Middle East that day, the *Financial Times* might have been on target. If the observed fall in crude oil prices instead had reflected an unexpected slowdown of the global economy (which seems not entirely unlikely given the slowdown of the U.S. economy around this time), all else equal, Figure 3 would have predicted a decline in stock prices. In that case, the true reason for the rise in stock prices that day would have been something else entirely. Thus, there are no simple and stable rules linking oil prices and stock prices. The nature of this relationship depends on which of the three shocks are driving the price of oil.

The apparent lack of a systematic relationship between oil production disruptions and real U.S. stock returns is consistent with the view that much of the systematic effect of exogenous political events in the Middle East operates not through physical cutbacks of crude oil production but rather through shifts in precautionary demand driven by concerns about the future availability of oil supplies (also see Kilian 2006c). As Figure 2 shows, the latter expectation shifts tend to have almost instantaneous effects on the demand for crude oil (and hence on the price of oil) and need not be reflected in actual changes to future crude oil production.

The results in Figure 3 suggest caution in interpreting empirical results based on reduced form regressions of real stock returns on oil price changes. Figure 2 shows that the relative importance for the real price of crude oil of any one shock in the crude oil market tends to vary over time. Clearly, if over a given sample period one of the three shocks is more prevalent, it will dominate the average responses to the oil price increase estimated for that period. Whether or not one finds a stable negative relationship in the data then really becomes a question of how important aggregate demand shocks are for that period relative to precautionary demand shocks. This fact may help explain in part why existing empirical evidence using reduced-form regressions has been mixed.

2.4. Historical Decompositions of U.S. Real Stock Returns

While impulse responses help us assess the timing and magnitude of the response to a one-time demand or supply shock in the crude oil market, historical episodes of oil price shocks are not limited to a one-time shock. Rather they involve a sequence of shocks, often with different signs at different points in time. If we want to understand the cumulative effect of such a sequence of shocks, it becomes necessary to construct a historical decomposition of the effect of each of these shocks on real U.S. stock returns. This may be accomplished by simulating the path of stock returns from model (1) under the counterfactual assumption that a given shock is zero throughout the sample period. The difference between this counterfactual path and the actual path of stock returns measures the cumulative effect of the shock at each point in time.

Figure 4 plots the cumulative effect of each of the three shocks on real U.S. stock returns. The first panel shows the cumulative effect of oil supply shocks on the evolution of the aggregate stock returns. Oil supply shocks played an important role in the 1970s and 1980s, but since the early 1990s have clearly become less important. The second panel shows that aggregate demand shocks have consistently contributed to the variability of stock returns throughout this sample, although their importance seems to have declined somewhat since 1985. Interestingly, the third panel of Figure 4 shows that the importance of oil-market specific demand shocks has increased since the late 1980s. Thus, using regressions of real stock returns on oil price changes one would expect to find a negative statistical relationship more likely in the second part of our sample than in the first.[7]

We also computed the overall effect of all these shocks combined (the results are not shown to conserve space). While shocks in the crude oil market played some role throughout the sample, there is no evidence that major upheavals in oil markets and the resulting "geopolitical

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[7] This evidence of persistent changes in the conditional variance is reflected in a decline of the variance of the data in the first panel from 0.59 prior to 1991 to 0.15 thereafter. Similarly, there is a decline in the variance of the data in the second panel from 1.70 prior to 1984 to 0.69 after 1984. In contrast, the variance of the data in the third panel increases from 0.41 prior to 1986 to 2.08 after 1986.

angst", to use the term employed by the *Financial Times*, exerted large effects on real U.S. stock returns after the Iranian Revolution of 1978/79, after the outbreak of the Iran-Iraq War in late 1980, after the outbreak of the Persian Gulf War in mid-1990 or during the Iraq War of early 2003. For example, the combined effect of oil demand and oil supply shocks in 1979 was mainly positive, no doubt reflecting strong positive aggregate demand shocks during this episode. There is no evidence either that the negative returns in the second half of 1990, after the invasion of Kuwait by Iraq, were driven mainly by shocks in the oil market, although some of the subsequent recovery was driven by shocks in the crude oil market.

Having seen how the relative importance of each shock evolves over time, it is useful to quantify how important these shocks have been on average. Table 1 shows the R^2 of the regressions:

$$r_t = \alpha + \sum_{j=0}^{12} \psi_j \hat{\varepsilon}_{st-j} + u_t, \; s = 1, 2, 3,$$

expressed in percent. With 8% by far the largest contributor to the variability of returns are oil-market specific demand shocks. This reflects the importance of expectations-driven shifts in precautionary demand for crude oil. Aggregate demand shocks account for about 5%. Oil supply shocks only account for about 2% of the variability of returns. Overall, demand shocks in the crude oil market account for 12%, whereas supply shocks only account for 2% of the variation in aggregate real stock returns. Table 1 also shows the R^2 from the regression:

$$r_t = \alpha + \sum_{j=0}^{12} \psi_{1j} \hat{\varepsilon}_{1t-j} + \sum_{j=0}^{12} \psi_{2j} \hat{\varepsilon}_{2t-j} + \sum_{j=0}^{12} \psi_{3j} \hat{\varepsilon}_{3t-j} + \sum_{j=0}^{12} \psi_{4j} \hat{\varepsilon}_{4t-j} + u_t$$

Jointly, structural shocks in the real oil price can explain about 14% of stock return variability. As these shocks are constructed to be orthogonal to one another, the R^2 of the combined regression is very close to the sum of the R^2 from the individual regressions.

2.5. Impulse Responses of U.S. Dividend Growth

We also investigated the response of dividend growth rates to demand and supply shocks in the crude oil market. The underlying regressions are the same as those in section 2.2 except for the dependent variable:

$$\Delta d_t = \beta + \sum_{i=0}^{h} \delta_i \hat{\varepsilon}_{s,t-i} + e_t, \quad s = 1, 2, 3, \tag{2}$$

where e_t is a potentially serially correlated error, h is the maximum horizon, and $\hat{\varepsilon}_{st}$ is a serially uncorrelated shock. The cumulative responses of the dividend-growth rate to each shock are shown in Figure 5. There is strong evidence that different shocks have different effects on dividends. Oil supply disruptions lower dividends. The response is significantly negative at the 10 percent level after 2 months. Positive aggregate demand shocks raise dividends persistently. The response is significant at the 10 percent level for all horizons. Finally, positive shocks to precautionary demand persistently lower dividends. The response is significant for all horizons at the 10 percent level. Figure 5 once again confirms that shocks in the global crude oil market matter for the U.S. stock market.

Table 2 shows that about 15% of the variation in real dividend growth can be accounted for by shocks in the crude oil market, two thirds of which are associated with demand shocks. Thus, shocks to the supply of crude oil are somewhat more important than in the case of returns, while the overall importance of shocks in the crude oil market is similar.

2.6. What is Driving The Response of U.S. Real Stock Returns?

Whether real stock returns are driven by changes in expected dividend-growth rates or by changes in expected returns has been a long-standing question in financial economics. Following Campbell (1991), unexpected changes in log real stock returns can be approximated by:

(3) $$r_t - E_{t-1}(r_t) = E_t\left(\sum_{j=0}^{\infty}\rho^j \Delta d_{t+j}\right) - E_{t-1}\left(\sum_{j=0}^{\infty}\rho^j \Delta d_{t+j}\right) - \left[E_t\left(\sum_{j=1}^{\infty}\rho^j r_{t+j}\right) - E_{t-1}\left(\sum_{j=1}^{\infty}\rho^j r_{t+j}\right)\right],$$

where Δd_t is the dividend-growth rate at time *t*, $\rho \equiv 1/(\log(1+\exp(\overline{d-p}))$, and $\overline{d-p}$ is the average log dividend-price ratio. Equation (3) states that unanticipated changes in real stock return from period $t-1$ to period t must be due to revised expectations about future dividend growth and/or revised expectations about future expected returns. Using VAR-based tests, Campbell (1991) concluded that real stock returns were more closely related to fluctuations in expected future returns than to fluctuations in expected dividend growth. In this paper, we focus on the related, but different and more specific question of whether the responses of stock returns to specific demand and supply shocks in the crude oil market are driven by fluctuations in expected future returns or by fluctuations in expected dividend growth.

This requires a reinterpretation of equation (3) in terms of the responses to unanticipated disturbances in the crude oil market. Without loss of generality, suppose that we normalize all expectations as of period $t-1$ in equation (3) to zero. Let ψ_j and δ_j denote the response of real stock returns and real dividend growth in models (1) and (2), respectively, at horizon j to a given shock in the crude oil market. These response coefficients represent departures from the baseline induced by a given shock. Hence, changes in expected returns and changes in expected dividend growth relative to the baseline in response to an unexpected disturbance in the crude oil market can be written as:

$$r_t - E_{t-1}(r_t) = E_t(r_t) - E_{t-1}(r_t) = \psi_0 - 0 = \psi_0,$$

$$E_t(\rho^j \Delta d_{t+j}) - E_{t-1}(\rho^j \Delta d_{t+j}) = \rho^j \delta_j - 0 = \rho^j \delta_j,$$

$$E_t(\rho^j r_{t+j}) - E_{t-1}(\rho^j r_{t+j}) = \rho^j \psi_j - 0 = \rho^j \psi_j.$$

Recall that ψ_0 denotes the response of r_t to a shock in the oil market in month t, as measured by the first element of the impulse response function of real stock returns. Similarly, the revisions of the expected future values of real dividend growth and real stock returns are given by the additional elements of the impulse response functions already estimated in section 2.3. This allows us to test formally whether the impact change in real stock returns arising from a given demand or supply shock in the global crude oil market can be attributed in its entirety to revisions of expected real dividend growth. This null hypothesis can be stated as:

$$H_0: \ \psi_0 = \sum_{j=0}^{\infty} \rho^j \delta_j \approx \sum_{j=0}^{36} \rho^j \delta_j \ ,$$

where the discount factor $\rho \equiv 1/(\log(1+\exp(\overline{d-p}))$ may be estimated from the data and the infinite sum is truncated at horizon 36.[8] The null hypothesis is consistent with the hypothesis of constant expected returns. The alternative hypothesis is that the response of stock returns at least in part reflects revisions of expected returns. In addition, we also may test the null hypothesis

$$H_0 : \psi_0 = -\sum_{j=1}^{\infty} \rho^j \psi_j \approx -\sum_{j=1}^{36} \rho^j \psi_j \ .$$

which states that the impact response of real stock returns is fully explained by changes in expected returns. Table 3 shows that the first null hypothesis is rejected at conventional significance levels for all three shocks, whereas the second null hypothesis is not rejected even at the 10 percent level for any of the three shocks in the crude oil market. These test results are consistent with the view that the response of stock returns to disturbances in the crude oil market reflects at least in part changes in expected returns. This finding is consistent with that of Campbell (1991) that much of the variability of stock returns is driven by news about future expected returns. It differs from the conclusion of Jones and Kaul (1996) that the reaction of U.S.

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[8] The results are insensitive to increasing the horizon.

stock prices to oil shocks can be completely accounted for by the impact of these shocks on real cash flows alone.

2.7. Does the Oil Market Drive the Negative Relationship between Real Stock Returns and Inflation?

It may seem natural to think that real stock returns should have no relation with inflation. However, many studies have found a negative relation between real stock returns and inflation in the postwar period (see, e.g., Jaffe and Mandelker 1976, Fama and Schwert 1977). To explain this finding, it is common to appeal to real output shocks (see Fama 1981, 1983; Kaul 1987; Hess and Lee 1999). Thus, a leading candidate for explaining this relationship is provided by disturbances in the crude oil market (see Kaul and Seyhun 1990). In this subsection, we examine which – if any – of the demand and supply shocks in the crude oil market cause negative comovement between stock returns and inflation. We employ a statistical measure of the conditional covariance based on Den Haan (2000) and Den Haan and Summer (2004):

$$C(h) = r_h^{imp} \pi_h^{imp}$$

where r_h^{imp} denotes the response of real stock returns at horizon *h* to a given shock, and π_h^{imp} denotes the corresponding response of consumer price inflation. Falling stock prices and rising consumer prices in response to shocks in the crude oil market will cause $C(h)$ to be negative. Figure 6 shows the point estimates of $C(h)$ together with 80% and 90% bootstrap confidence intervals. The upper tails of these intervals correspond to a one-sided test with 10% and 5% rejection probabilities, respectively.

Figure 6 shows that oil-market specific demand shocks such as shocks to precautionary demand will generate a significantly negative relationship between real stock returns and inflation. That effect starts on impact, reaches a peak in the first month after the shock, is large in magnitude and significant even at the 5 percent level. There also is some evidence that aggregate demand shocks cause a negative covariance after 8 months, but that effect is smaller and rarely statistically significant. In contrast, oil supply shocks do not generates a negative covariance.

3. Differences in U.S. Real Stock Return Responses across Industries

This section examines how different the responses of stock returns are across industries. During periods of changing crude oil prices, this question is of immediate interest to investors. For example, if the value of automobile stocks declines in response to a disturbance in the crude oil market while the value of petroleum stocks increases, investors would want to adjust their portfolios accordingly. What makes this exercise interesting is that the appropriate portfolio adjustment may depend on the nature of the disturbance in the crude oil market, as shown below.

3.1. Heterogeneity in Responses of Stock Returns

Our analysis is based on the industry-level data made available by Kenneth French.[9] These data are constructed from CRSP database and hence consistent with our aggregate stock return data. The sample period is 1975.1-2005.9. A detailed definition of the industries in terms of their Standard Industry Classification Code (SIC) is provided in the appendix. Rather than reviewing all 49 industries considered by French we focus on industries that a priori are most likely to respond to disturbances in the crude oil market. The results below are based on running regression model (1) on selected industry-level stock returns and summarized in Figures 7a, 7b and 7c.

Energy Markets

A natural starting point in assessing the industry-specific responses is the petroleum and

[9] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. We use the file containing 49 industry portfolios.

natural gas industry. It is not clear a priori whether this industry would gain or lose from disturbances in the oil market. In part, the answer will depend on the extent to which oil companies own crude oil (or close substitutes) in addition to their other activities. The first column of Figure 7a shows that oil supply disruptions cause raise petroleum and natural gas stock prices for the first four months, but the effect is small and not statistically significant. After seven months, the response turns negative and becomes statistically significant. This pattern (which is also shared by other energy stocks) seems consistent with reduced demand for crude oil from increased energy conservation, as there is no evidence that oil supply disruptions lower stock returns across the board, as would be the case in conjunction with a general economic slowdown.

In contrast, unanticipated global aggregate demand expansions cause a large, persistent and highly significant increase in the value of petroleum and natural gas stocks. Oil-market specific demand shocks also persistently boost the value of these stocks, but this effect is much smaller and less statistically significant. Figure 7a thus shows that a given oil price increase could be good, bad or largely immaterial for the value of oil stocks, depending on the cause of that oil price increase. The relatively small increase in cumulative returns in response to precautionary demand shocks and the ultimate decline in the price of oil stocks in response to oil supply disruptions further suggest that the share price of energy companies does not benefit much from political disturbances in the Middle East, although it does benefit from unanticipated increases in global demand.

An interesting question is whether stocks in alternative fuels such as coal benefit from adverse shocks in the crude oil market. The second column of Figure 7a shows that, while the responses are less precisely estimated, stocks of coal companies behave similarly to petroleum and natural gas stocks. There is evidence of a large long-run appreciation in response to precautionary demand increases. Aggregate demand expansions persistently and significantly raise the value of coal stocks, but oil supply shocks tend to cause coal stocks to decline in value. Thus coal stocks do not provide a hedge against fluctuations in petroleum and natural gas stocks during oil price increases. This pattern is consistent with coal price increases closely tracking oil price increases.

Yet another interesting comparison is provided by public utilities which deal with the final users of energy. Since public utilities tend to be regulated, not surprisingly, their responses to crude oil market disturbances are more muted. This is especially true for the response to unanticipated aggregate demand shocks. There is little response to these shocks at all, but some evidence of a decline in share prices following unanticipated oil supply disruptions and a temporary decline following an unanticipated precautionary demand increase.

Automobile Sector

It is widely believed that the industry most susceptible to disturbances in the crude oil market is the automobile industry. The fourth column of Figure 7a confirms that an increase in precautionary demand causes a dramatic and persistent decline in automobile shares at all horizons. That decline is significant at the 5 percent significance level for all horizons. An expansion of global aggregate demand, on the other hand, causes automobile shares to appreciate at the 10 percent level for most of the first year after the shock. The response to oil supply disruptions is negative, but small and insignificant. This evidence suggests that it matters little whether an investor holds automobile shares or petroleum shares when the oil price increase is driven by global aggregate demand shocks, but that petroleum shares provide a hedge when the same increase is driven by an increase in precautionary demand for crude oil (see Figure 7a).

Other Transportation Equipment: Ships, Railroads and Aircraft

It seems natural to conjecture that builders of ships and railroad equipment and more importantly aircraft builders would be affected by disturbances in the crude oil market not unlike the automobile industry, although aircraft, ships and the rolling stock of railroads all have a longer life span than cars, so these stock prices may be less responsive to short-term fluctuations in the price of oil. Both of these sectors show a decline in share prices in response to oil supply disruptions, but the response is far more significant for the aircraft industry. Share prices in both industries decline in the short run following an increase in precautionary demand (although the responses are largely insignificant). Both share prices rise in response to a global increase in aggregate demand, but the response of ships and railroad equipment is larger and much more statistically significant. Overall the responses are qualitatively similar to those for automobiles and trucks, except that the response to precautionary demand shocks is much more pronounced in the automobile industry.

Retail Trade Sector

A common perception in the popular and financial press is that higher oil prices hurt the retail sector. In this view falling oil prices cause stronger retail sales, as consumers have more money to spend on other items, because they will be paying less for gasoline and heating oil (see, e.g., *The New York Times*, September 14, 2006). Column 1 of Figure 7b examines the evidence for this view. Indeed, there is strong evidence that retail shares depreciate sharply, persistently and significantly in response to precautionary demand increases. Responses to oil supply shocks, in contrast, are small and insignificant. Aggregate demand expansions tend to raise the value of retail shares at least temporarily, although the response is not as strong and persistent as for other industries.

Consumer Goods Sector

The reason for the decline of retail company stocks presumably is a fall in consumer confidence and consumer purchasing power. A natural benchmark is provided by the behavior of stocks of companies producing consumer goods. For example, the *Wall Street Journal* on September 13, 2006, noted that "the recent drop in oil prices could provide a welcome and surprising boost to consumer pocketbooks" and "helped spur stock prices to a 4-month high". What is the evidence? Column 2 of Figure 7b shows essentially no significant response of the share prices of manufacturers of consumer goods to oil supply shocks, but a clear and fairly significant decline in share prices in response to precautionary demand increases and a temporary, but insignificant increase in the response to global aggregate demand expansions.

It makes sense to push this argument further. If consumers have to cut back expenditures given rising costs of heating oil and gasoline, they presumably will cut first nonessential expenditures for entertainment and travel. For example, CNN.COM on May 24, 2006, reported that about one third of consumers in a survey intended to reduce their spending on restaurants in response to rising oil prices. Columns 3 of Figure 7b show no significant response of the share values of the restaurant and lodging industry (restaurants, motels and hotels) in response to supply shocks, but a large, sustained and highly significant decline in response to increases in precautionary demand. In contrast, aggregate demand expansions will temporarily raise the value of these shares, at least at the 10 percent significance level. Column 4 of Figure 7b shows the corresponding results for the entertainment industry. There is not much evidence of significant responses to oil supply shocks, but of a temporary decline in share prices in response to precautionary demand increases and of a temporary increase in share prices in response to aggregate demand expansions.

Transportation Sector

The effect of higher oil prices on the transportation sector is ambiguous. On the one hand, the transportation sector will be subject to higher fuel costs; on the other hand, higher gasoline costs may push some businesses and households toward alternative modes of transportation such as rail transport. Column 5 of Figure 7b shows the expected persistent appreciation of transportation shares in response to an aggregate demand expansion. Oil-market specific demand increases cause a persistent depreciation of these shares. The response to oil-supply shocks is generally insignificant and close to zero.

Energy-Intensive Producers

Oil price increases also matter through their effect on the cost of producing energy-intensive goods. For example, stock prices of companies in the chemical industry are often expected to be sensitive to disturbances in the crude oil market because they rely on oil products as raw materials. Likewise, the steel industry seems a natural candidate in that energy is a major input in the production of steel. As Lee and Ni (2002) observe, there is an important distinction between the direct cost share of energy and the total cost share that also takes into account the energy content of intermediate products used in production. Based on input-output table data from the Survey of Current Business, the chemical industry ranks second only to petroleum refineries both in terms of direct and total cost shares. Based on the total cost share, the paper industry ranks third, rubber and plastics ranks fourth and steel ranks only sixth (see Table 2 of Lee and Ni 2002). Although typically there is little overlap between the industry classification in input-output tables and that used by Fama and French, we were able to match approximately these four high energy-intensity industries.

Figures 7b and 7c shows that the conjecture that higher energy intensity in production is associated with larger responses is not supported by the data. There is little evidence that oil supply disruptions lower the share value of chemical companies, and there is only a small and barely significant decline in response to precautionary demand increases in the short run. The paper industry in the first column of Figure 7c (whose energy cost share is less than a third of that of the chemical industry) shows very similar responses. In contrast, for rubber and plastics producers with essentially the same energy intensity as paper producers, somewhat stronger and more statistically significant negative responses to precautionary demand increases are found than for either the chemical industry or the paper industry. Finally, for the steel industry with an only marginally lower energy cost share, there is no evidence of a significant decline in share prices in response to oil supply shocks or for that matter to an increase in precautionary demand. Share prices do increase persistently and significantly in response to an unanticipated global aggregate demand expansion, however.

Not only are there no appreciable differences in the cumulative return responses among high-energy cost industries, but, as will be shown below, the cumulative return responses of these four high-energy cost industries to oil supply and precautionary demand shocks do not differ systematically from those in industries with low total energy cost shares such as electrical equipment or machinery.

Precious Metals

There is a common perception that investors in times of political uncertainty increase their demand for precious metals such as gold or silver. This suggests that the share prices of companies that produce gold or silver should increase when political turmoil contributes to high oil prices. Likewise unanticipated global demand expansions may be taken as signals of inflation risks, resulting in an appreciation of precious metals. Column 4 of Figure 7c shows that indeed share prices in the precious metal sector increase significantly in the short run following an increase in precautionary demand. There also is some evidence of a significant response to oil supply shocks, at least at the 10 percent level. There even is evidence of a positive response to unanticipated increases in global aggregate demand that is significant in the short run.

Manufacturing

Finally, we consider two typical manufacturing industries: machinery and electrical equipment. In both industries, share prices do not respond significantly to oil supply disruptions, but there is a persistent response to aggregate demand shocks (larger and more significant for machinery) and a significant short-run decline in response to a precautionary demand shock (larger and more significant for electrical equipment).

4. Conclusion

Our main finding in this paper is that responses of real U.S. stock returns to oil price shocks differ substantially, depending on the underlying causes of the oil price increase. Building on recent work by Kilian (2006c), we considered one supply and two demand shocks in the crude oil market that jointly account for the historical evolution of real crude oil prices. The negative response of stock prices to oil price shocks, often referred to in the financial press, is found only when the oil price rises due to an oil-market specific demand shock such as an increase in precautionary demand driven by fears about the future availability of crude oil. In contrast, if higher oil prices are driven by a global economic expansion, we find persistent positive effects on cumulative stock returns. Shocks to crude oil production have no significant effect on cumulative stock returns.

Our analysis suggests that the traditional approach to thinking about oil price changes and stock markets must be rethought. Shocks to the production of crude oil, while not trivial, are far less important for understanding changes in the real price of oil as well as stock prices than shocks to aggregate demand and shocks to the precautionary demand for oil that reflect fears about future oil supplies. In particular, precautionary demand shocks can account for the anecdotal evidence of large declines in stock prices in the wake of major political disturbances in the Middle East. As shifts in precautionary demand are ultimately driven by expectations about the availability of future oil supplies and such expectations can change almost instantaneously in response to political events in the Middle East, such political disturbances may trigger an immediate and sharp increase in precautionary demand that is reflected in an immediate jump in the real price of oil as well as an immediate drop in stock prices. Our findings both complement and reinforce the evidence in Kilian (2006c) about the response of U.S. real GDP growth and consumer price inflation to demand and supply shocks in the global crude oil market.

We demonstrated that the estimated stock return responses cannot be explained based on changes to expected dividend growth alone. The finding that oil demand and supply shocks do not affect the stock market primarily through their effect on expected real dividends, but rather through their effect on expected returns differs from the previous literature and is of interest in its own right (see, e.g., Jones and Kaul 1996). We also showed that shocks to the precautionary demand for crude oil provide an explanation for the negative association between stock returns and inflation found in previous studies of the postwar period (see, e.g., Kaul and Seyhun 1990, Hess and Lee 1999), whereas other shocks in the crude oil market do not.

On average, 14 percent of the variation in aggregate stock returns can be attributed to the shocks that drive the crude oil market (much of which is driven by demand shocks), but the contribution of each shock varies over time, making it necessary to understand the origins of a given oil price increase before its consequences on aggregate U.S. stock returns can be assessed. The same point applies with equal force to the problem of adjusting one's portfolio in response to an increase in oil prices. Our analysis suggests that investors need to understand the origins of a given crude oil price increase. We find, for example, that the petroleum and natural gas industry as well as gold and silver mining will enjoy significantly positive responses to a positive oil-market specific demand shock, while the automobile industry and the retail sector will experience a persistent and significantly negative response to the same shock. In contrast, if the same increase in the price of crude oil is driven by innovations to global real economic activity, the cumulative returns of all four industries will increase, but especially that of petroleum and natural gas stocks.

We provided a comprehensive analysis of industry returns that one would expect on a priori grounds to be susceptible to shocks in the crude oil market. In all cases we found considerably stronger and often more significant responses to demand shocks for oil than to oil supply shocks, although the degree of sensitivity varied across industries. Outside of the energy sector, the strongest responses to demand shocks were found in the automobile industry, in the retail industry, and in tourism-related sectors such as restaurants and lodging, consistent with the view that oil price shocks are primarily shocks to the demand for goods and services rather than their supply. Our results suggested that the energy intensity of firms is not an important factor in explaining differences in the responses of real stock returns across manufacturing industries.

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Table 1: Percent Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of Real U.S. Stock Returns

	Other oil supply shocks	Aggregate demand shocks	Oil-market specific demand shocks	All shocks together
R^2	0.019	0.047	0.075	0.136

NOTES: This table shows the R^2 of the regressions:

$$r_t = \alpha + \sum_{j=0}^{12} \psi_j \hat{\varepsilon}_{st-j} + u_t,\ s = 1, \dots, 3$$

$$r_t = \alpha + \sum_{j=0}^{12} \psi_{1j} \hat{\varepsilon}_{1t-j} + \sum_{j=0}^{12} \psi_{2j} \hat{\varepsilon}_{2t-j} + \sum_{j=0}^{12} \psi_{3j} \hat{\varepsilon}_{3t-j} + u_t$$

Table 2: Percent Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of U.S. Real Dividend Growth

	Other oil supply shocks	Aggregate demand shocks	Oil-market specific demand shocks	All shocks together
R^2	0.051	0.053	0.057	0.153

NOTES: This table shows the R^2 of the regressions:

$$\Delta d_t = \beta + \sum_{j=0}^{12} \delta_j \hat{\varepsilon}_{st-j} + e_t,\ s = 1, \dots, 3$$

$$\Delta d_t = \beta + \sum_{j=0}^{12} \delta_{1j} \hat{\varepsilon}_{1t-j} + \sum_{j=0}^{12} \delta_{2j} \hat{\varepsilon}_{2t-j} + \sum_{j=0}^{12} \delta_{3j} \hat{\varepsilon}_{3t-j} + e_t$$

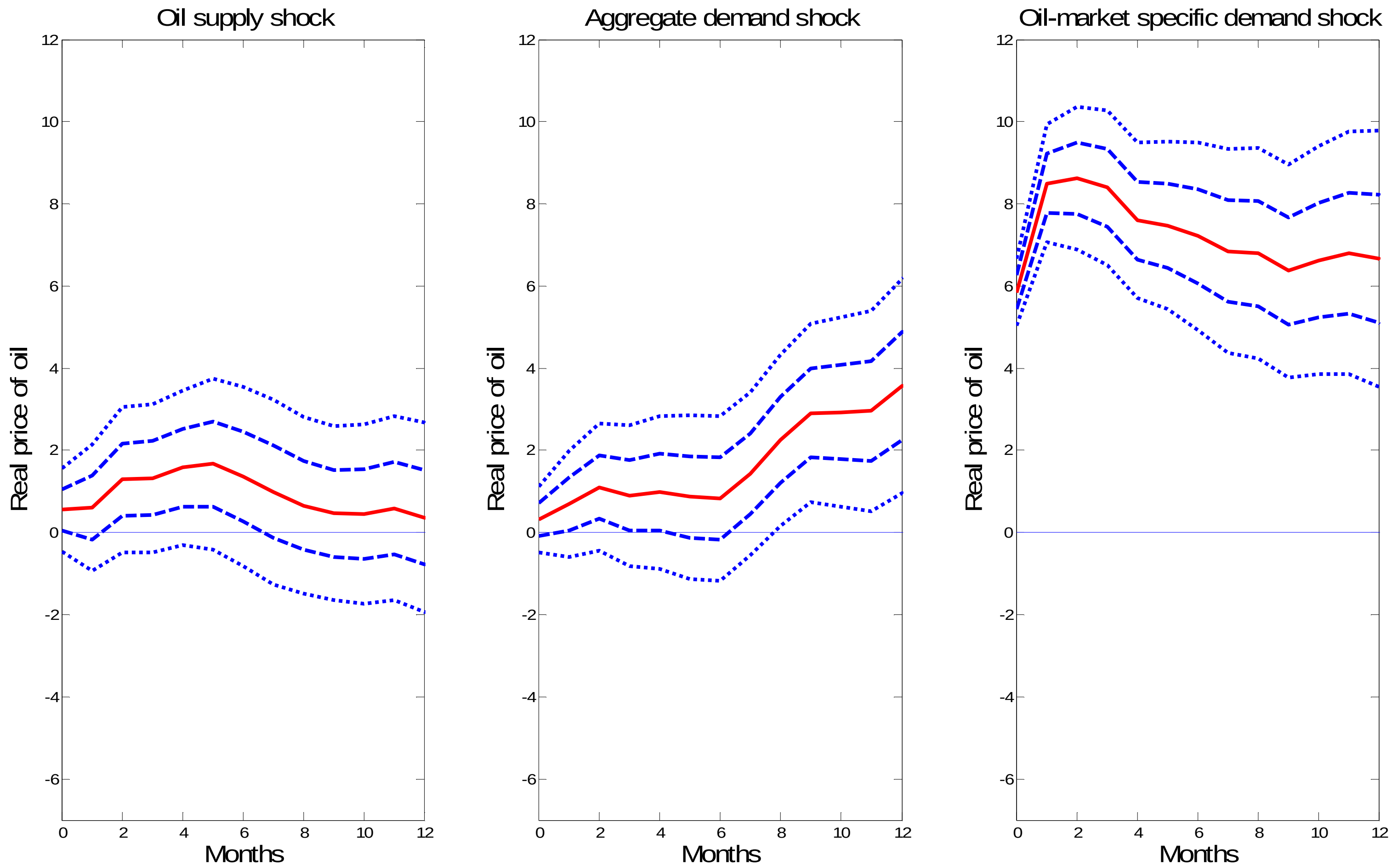
Table 3: Tests of Return Responses

	Wald test statistic $H_0: \psi_0 = \sum_{i=0}^{36} \rho^i \delta_i$	*p* -value
Oil supply shocks	4.0208	**0.0449**
Aggregate demand shocks	4.5257	**0.0334**
Oil-market specific demand shocks	10.8262	**0.0010**

	Wald test statistic $H_0: \psi_0 = -\sum_{i=1}^{36} \rho^i \psi_i$	*p* -value
Oil supply shocks	0.1189	0.7303
Aggregate demand shocks	0.0193	0.8895
Oil-market specific demand shocks	2.4633	0.1165

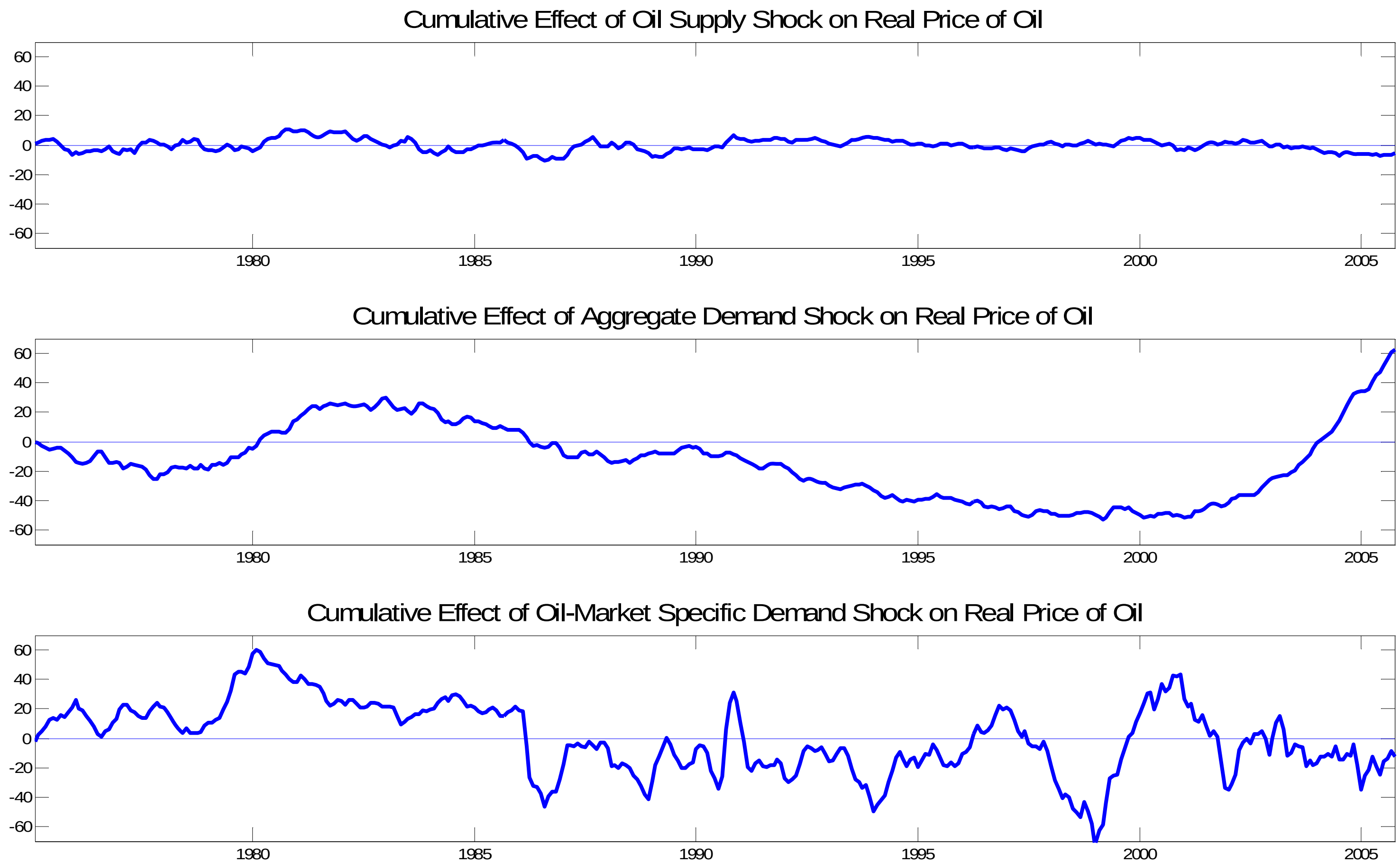
Notes: The Wald test statistics are based on robust standard errors. The first test is for the null hypothesis that the contemporaneous return response is fully explained by changes in expected dividend growth; the second test is for the null hypothesis that the contemporaneous return response is fully explained by fluctuations in expected returns. Results that are significant at the 5% level are shown in boldface.

Figure 1: Responses of the Real Price of Crude Oil to One-Standard Deviation Structural Shocks
OLS Point Estimates with One and Two-Standard Error Bands



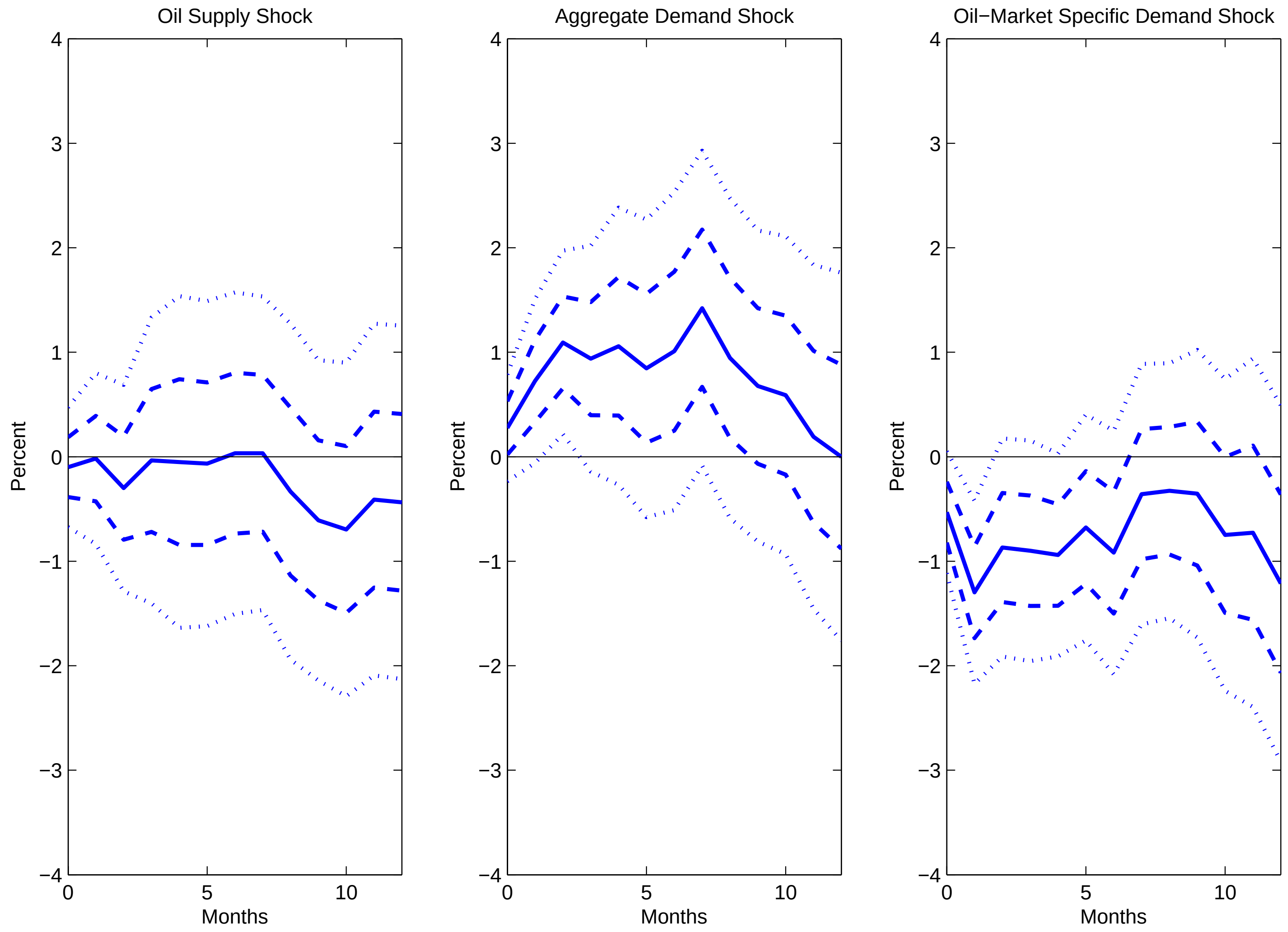
NOTES: Estimates based on the restricted VAR(24) system described in text The confidence intervals were constructed using a fixed-design wild bootstrap (see Gonçalves and Kilian 2004).

Figure 2: Historical Decomposition of Real Price of Oil
1975.1-2005.9



NOTES: Estimates based on restricted VAR(24) system described in text.

Figure 3: Cumulative Impulse Reponses of Real U.S. Stock Returns with One and Two-Standard Error Bands



NOTES: Estimates based on equation (1) described in text.

Figure 4: Cumulative Effect on Real U.S. Stock Returns by Shock

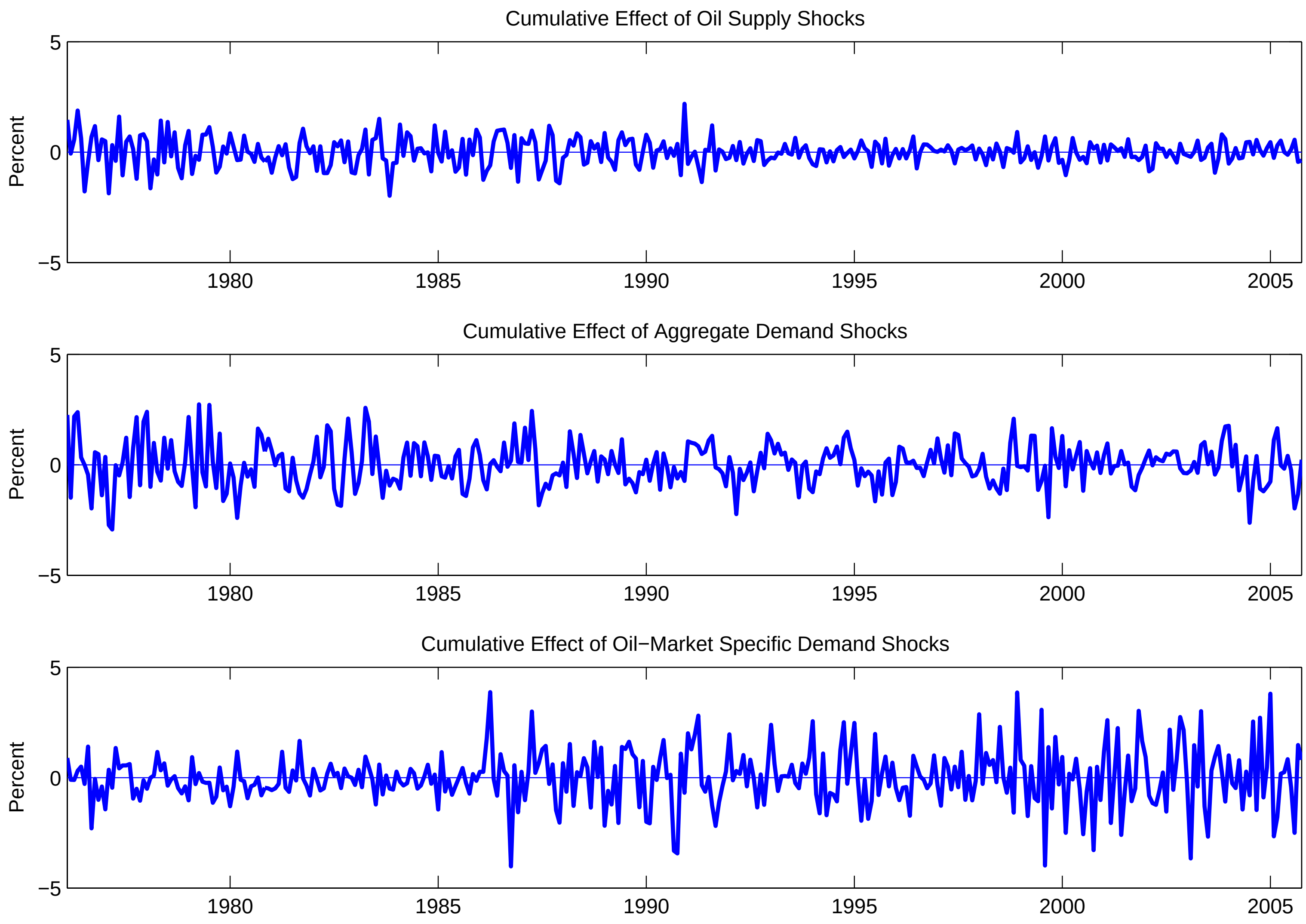
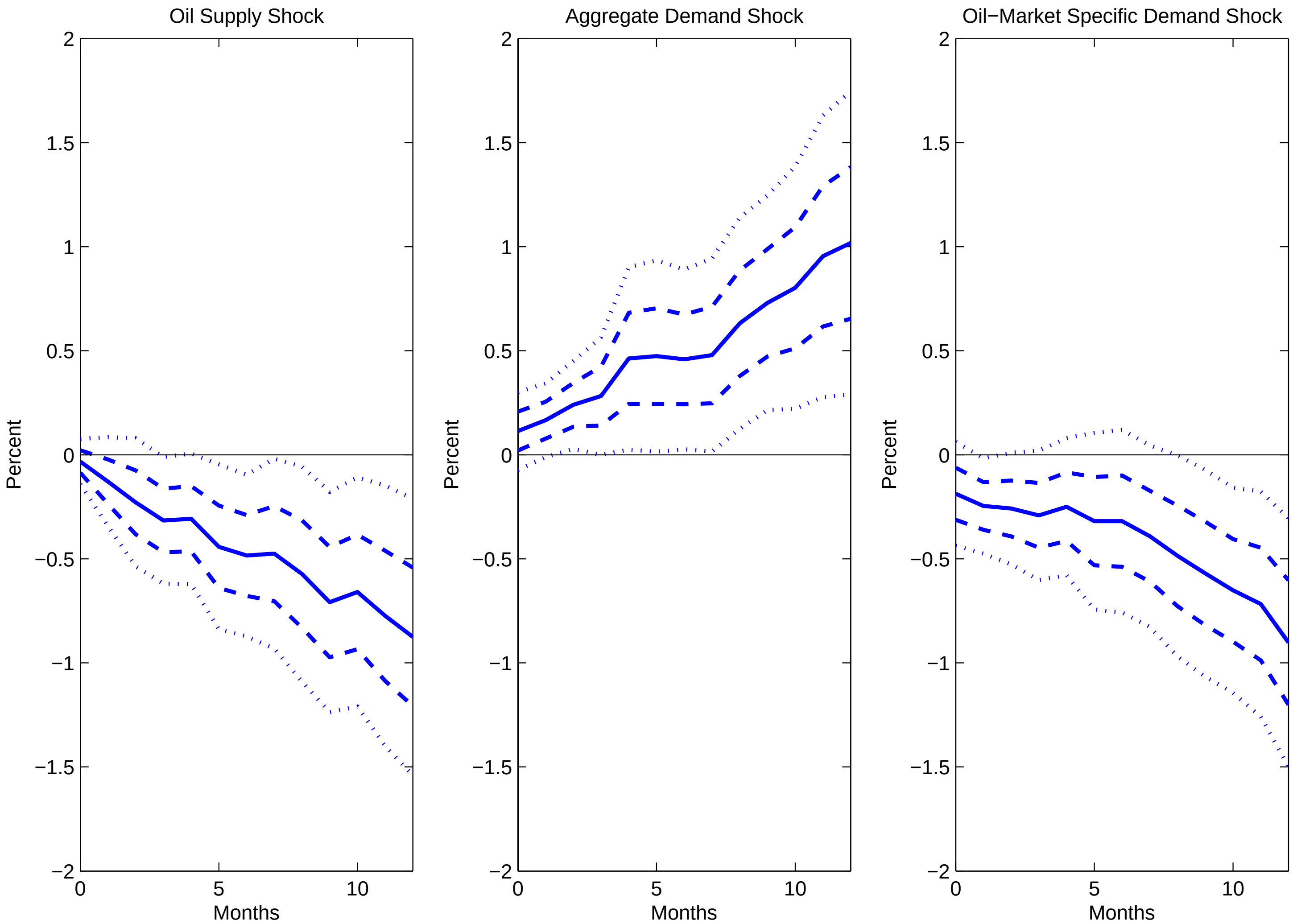


Figure 5: Cumulative Reponses of the U.S. Dividend-Growth Rate with One and Two-Standard Error Bands



NOTES: Estimates based on equation (2) described in text.

Figure 6: Conditional Covariance between Responses of Real U.S. Stock Returns and Inflation with 80% and 90% Confidence Bands

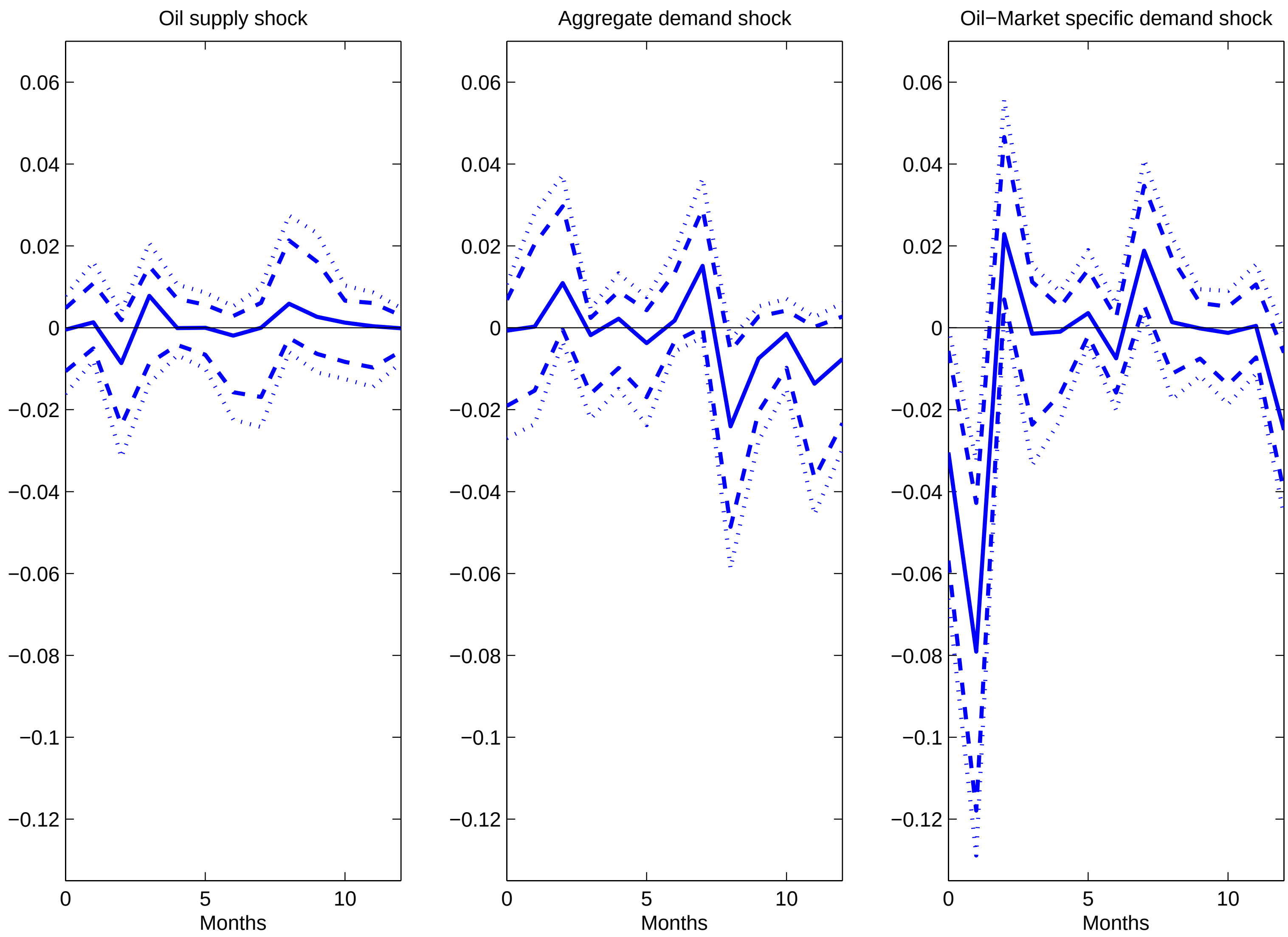


Figure 7a: Cumulative Impulse Reponses of U.S. Industry Returns with One and Two-Standard Error Bands

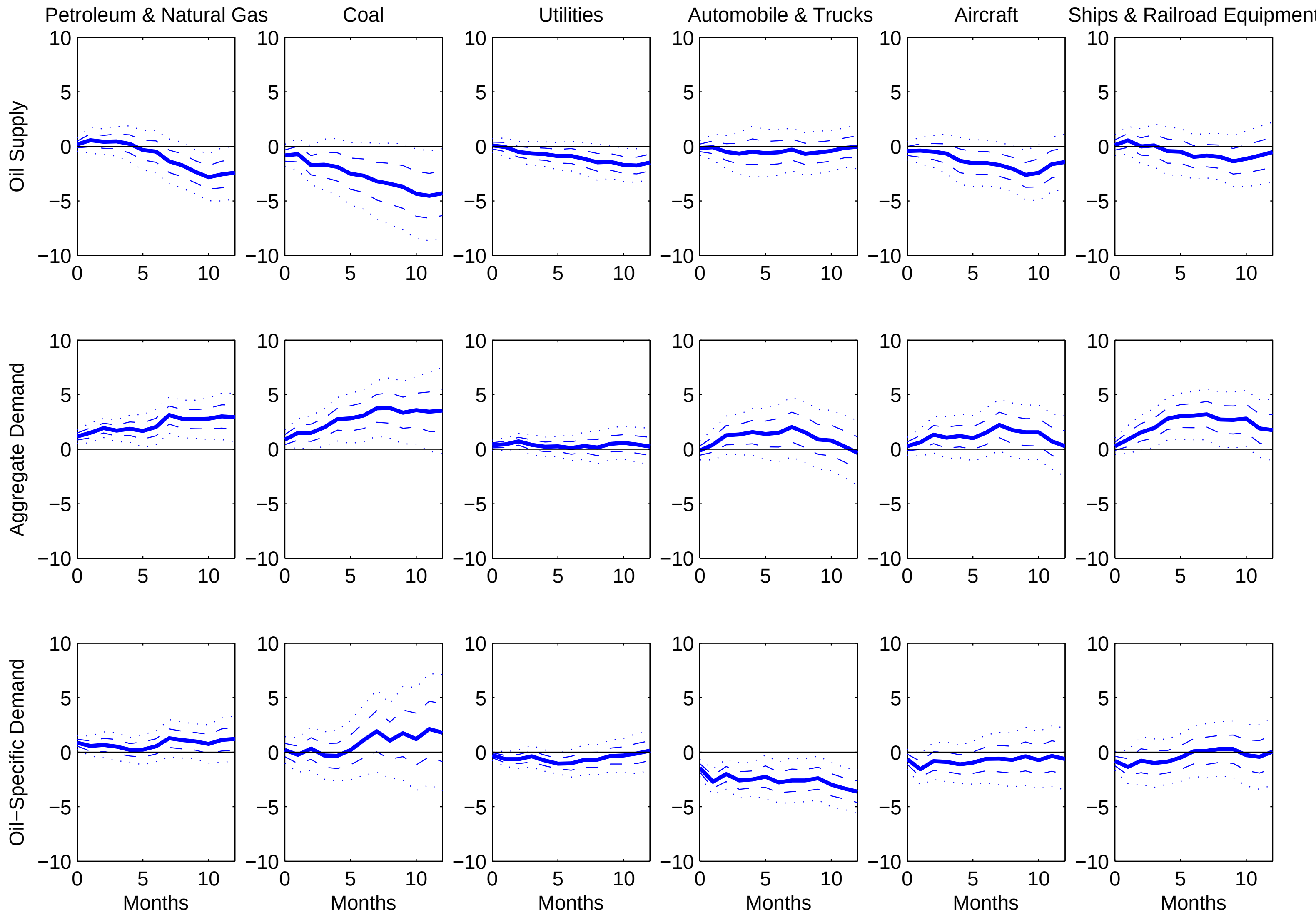


Figure 7b: Cumulative Impulse Reponses of U.S. Industry Returns with One and Two-Standard Error Bands

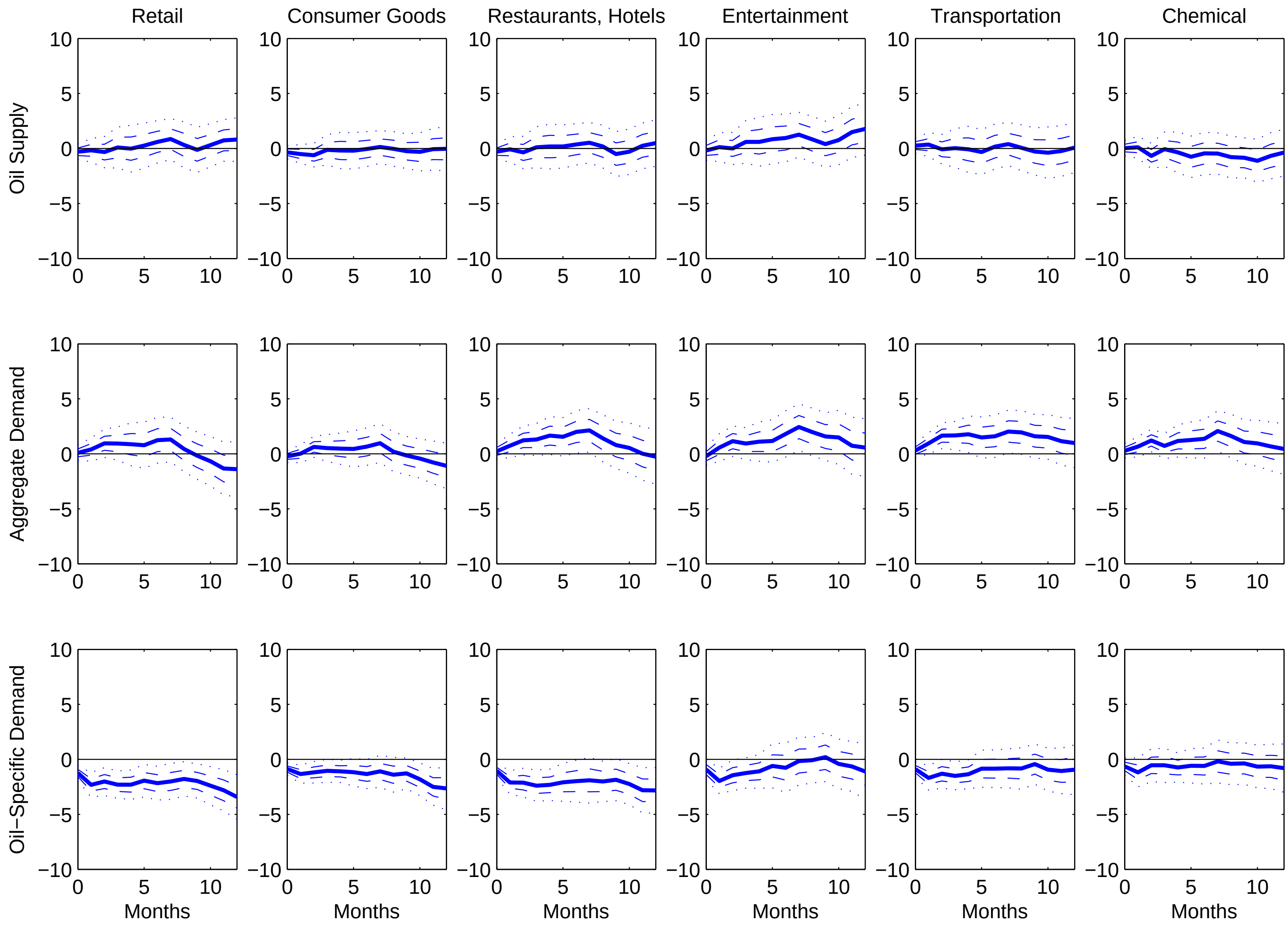
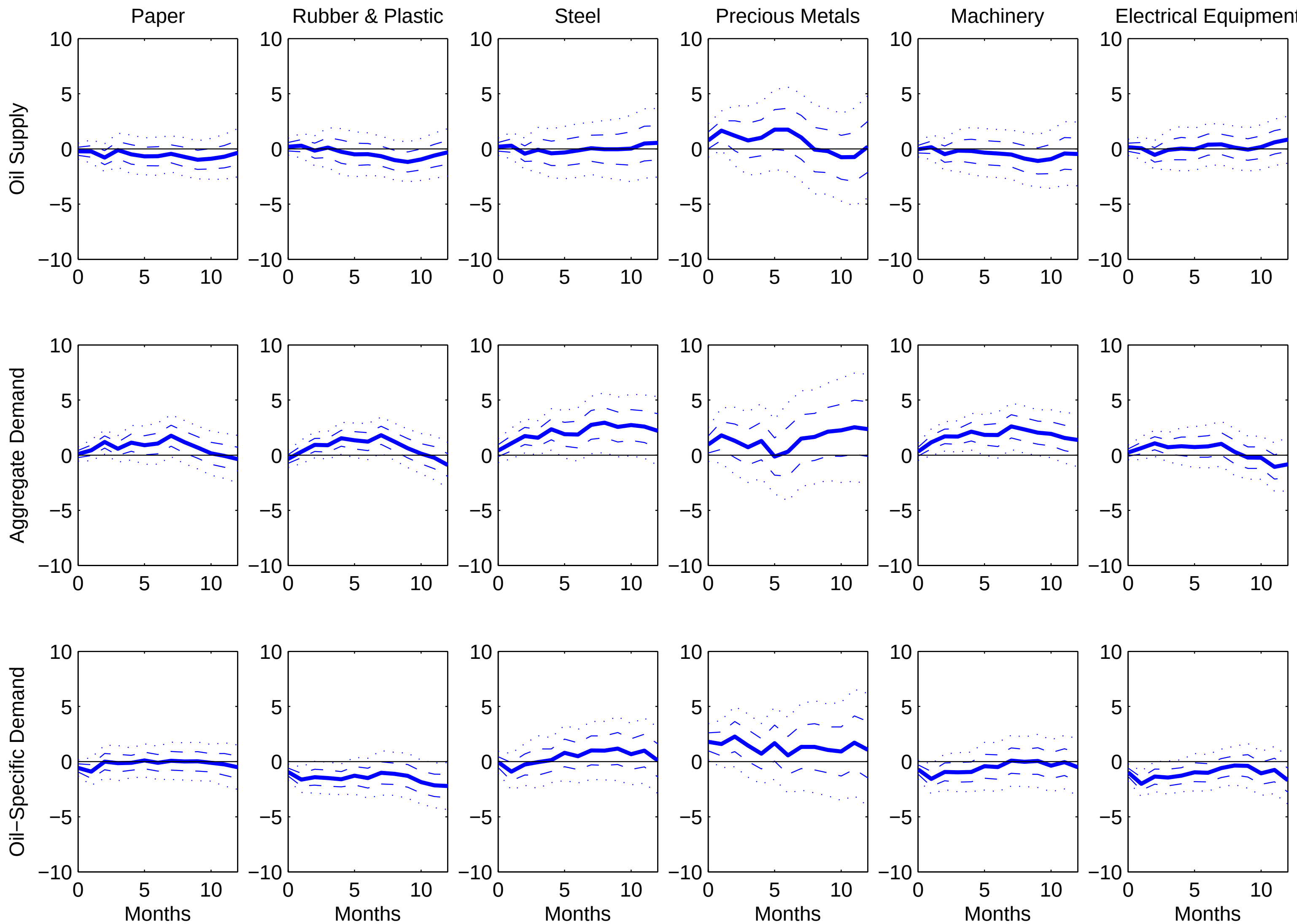


Figure 7c: Cumulative Impulse Reponses of U.S. Industry Returns with One and Two-Standard Error Bands



Appendix: Standard Industrial Classification (SIC) Codes for Industries

Petroleum and Natural Gas
- 1300-1300 Oil and gas extraction
- 1310-1319 Crude petroleum & natural gas (well operation)
- 1320-1329 Natural gas liquids
- 1330-1339 Petroleum and natural gas
- 1370-1379 Petroleum and natural gas
- 1380-1380 Oil and gas field services
- 1381-1381 Drilling oil & gas wells
- 1382-1382 Oil-gas field exploration
- 1389-1389 Oil and gas field services
- 2900-2912 Petroleum refining
- 2990-2999 Miscellaneous petroleum products

Coal
- 1200-1299 Bituminous coal

Utilities
- 4900-4900 Electric, gas, sanitary services
- 4910-4911 Electric services
- 4920-4922 Natural gas transmission
- 4923-4923 Natural gas transmission-distribution
- 4924-4925 Natural gas distribution
- 4930-4931 Electric and other services combined
- 4932-4932 Gas and other services combined
- 4939-4939 Combination utilities
- 4940-4942 Water supply

Automobiles and Trucks
- 2296-2296 Tire cord and fabric
- 2396-2396 Auto trim
- 3010-3011 Tires and inner tubes
- 3537-3537 Trucks, tractors, trailers
- 3647-3647 Vehicular lighting
- 3694-3694 Electric equipment, internal combustion engines
- 3700-3700 Transportation equipment
- 3710-3710 Motor vehicles and motor vehicle equipment
- 3711-3711 Motor vehicles & car bodies
- 3713-3713 Truck & bus bodies
- 3714-3714 Motor vehicle parts
- 3715-3715 Truck trailers
- 3716-3716 Motor homes
- 3792-3792 Travel trailers and campers
- 3790-3791 Miscellaneous transportation equipment
- 3799-3799 Miscellaneous transportation equipment

Aircraft
- 3720-3720 Aircraft & parts
- 3721-3721 Aircraft
- 3723-3724 Aircraft engines, engine parts
- 3725-3725 Aircraft parts
- 3728-3729 Aircraft parts

Ships, Railroad Equipment
- 3730-3731 Ship building and repair
- 3740-3743 Railroad Equipment

Retail
- 5200-5200 Retail - building material, hardware, garden
- 5210-5219 Retail - lumber & other building materials
- 5220-5229 Retail

5230-5231 Retail - paint, glass, wallpaper
5250-5251 Retail - hardware stores
5260-5261 Retail - nurseries, lawn, garden stores
5270-5271 Retail - mobile home dealers
5300-5300 Retail - general merchandise stores
5310-5311 Retail - department stores
5320-5320 Retail - general merchandise stores
5330-5331 Retail - variety stores
5334-5334 Retail - catalog showroom
5340-5349 Retail
5390-5399 Retail - Miscellaneous general merchandise stores
5400-5400 Retail - food stores
5410-5411 Retail - grocery stores
5412-5412 Retail - convenience stores
5420-5429 Retail - meat, fish market
5430-5439 Retail - fruit and vegetable markets
5440-5449 Retail - candy, nut, confectionary stores
5450-5459 Retail - dairy product stores
5460-5469 Retail - bakeries
5490-5499 Retail - miscellaneous food stores
5500-5500 Retail - auto dealers and gas stations
5510-5529 Retail - auto dealers
5530-5539 Retail - auto and home supply stores
5540-5549 Retail - gasoline service stations
5550-5559 Retail - boat dealers
5560-5569 Retail - recreational vehicle dealers
5570-5579 Retail - motorcycle dealers
5590-5599 Retail - automotive dealers
5600-5699 Retail - apparel & accessory
5700-5700 Retail - home furniture and equipment stores
5710-5719 Retail - home furnishings stores
5720-5722 Retail - household appliance stores
5730-5733 Retail - radio, TV and consumer electronic stores

Retail (continued)

5734-5734 Retail - computer and computer software stores
5735-5735 Retail - record and tape stores
5736-5736 Retail - musical instrument stores
5750-5799 Retail
5900-5900 Retail - Miscellaneous
5910-5912 Retail - drug & proprietary stores
5920-5929 Retail - liquor stores
5930-5932 Retail - used merchandise stores
5940-5940 Retail - Miscellaneous
5941-5941 Retail - sporting goods stores, bike shops
5942-5942 Retail - book stores
5943-5943 Retail - stationery stores
5944-5944 Retail - jewelry stores
5945-5945 Retail - hobby, toy and game shops
5946-5946 Retail - camera and photo shop
5947-5947 Retail - gift, novelty
5948-5948 Retail - luggage
5949-5949 Retail - sewing & needlework stores
5950-5959 Retail
5960-5969 Retail - non-store retailers (catalogs, etc)
5970-5979 Retail
5980-5989 Retail - fuel & ice stores
5990-5990 Retail - retail stores
5992-5992 Retail - florists
5993-5993 Retail - tobacco stores
5994-5994 Retail – news dealers
5995-5995 Retail - computer stores

5999-5999 Retail stores

Consumer Goods

2047-2047 Dog and cat food
2391-2392 Curtains, home furnishings
2510-2519 Household furniture
2590-2599 Miscellaneous furniture and fixtures
2840-2843 Soap & other detergents
2844-2844 Perfumes cosmetics
3160-3161 Luggage
3170-3171 Handbags and purses
3172-3172 Personal leather goods, except handbags
3190-3199 Leather goods
3229-3229 Pressed and blown glass
3260-3260 Pottery and related products
3262-3263 China and earthenware table articles
3269-3269 Pottery products
3230-3231 Glass products
3630-3639 Household appliances
3750-3751 Motorcycles, bicycles and parts
3800-3800 Miscellaneous instrument, photo goods, watches
3860-3861 Photographic equipment
3870-3873 Watches clocks and parts
3910-3911 Jewelry-precious metals
3914-3914 Silverware
3915-3915 Jewelers' findings, materials
3960-3962 Costume jewelry and notions
3991-3991 Brooms and brushes
3995-3995 Burial caskets

Restaurants, Hotels, Motels

5800-5819 Retail - eating places
5820-5829 Restaurants, hotels, motels
5890-5899 Eating and drinking places
7000-7000 Hotels, other lodging places
7010-7019 Hotels motels
7040-7049 Membership hotels and lodging
7213-7213 Services - linen

Entertainment

7800-7829 Services - motion picture production and distribution
7830-7833 Services - motion picture theatres
7840-7841 Services - video rental
7900-7900 Services - amusement and recreation
7910-7911 Services - dance studios
7920-7929 Services - bands, entertainers
7930-7933 Services - bowling centers
7940-7949 Services - professional sports
7980-7980 Amusement and recreation services
7990-7999 Services - Miscellaneous entertainment

Transportation

4000-4013 Railroads-line haul
4040-4049 Railway express service
4100-4100 Transit and passenger transportation
4110-4119 Local passenger transportation
4120-4121 Taxicabs
4130-4131 Intercity bus transportation
4140-4142 Bus charter
4150-4151 School buses
4170-4173 Motor vehicle terminals, service facilities
4190-4199 Miscellaneous transit and passenger transportation

4200-4200 Motor freight transportation, warehousing
4210-4219 Trucking
4230-4231 Terminal facilities - motor freight
4240-4249 Transportation
4400-4499 Water transport
4500-4599 Air transportation
4600-4699 Pipelines, except natural gas
4700-4700 Transportation services
4710-4712 Freight forwarding
4720-4729 Travel agencies, etc
4730-4739 Arrange transportation - freight and cargo
4740-4749 Rental of railroad cars
4780-4780 Miscellaneous services incidental to transportation
4782-4782 Inspection and weighing services
4783-4783 Packing and crating
4784-4784 Fixed facilities for vehicles, not elsewhere classified
4785-4785 Motor vehicle inspection
4789-4789 Transportation services

Chemicals
2800-2809 Chemicals and allied products
2810-2819 Industrial inorganical chemicals
2820-2829 Plastic material & synthetic resin
2850-2859 Paints
2860-2869 Industrial organic chemicals
2870-2879 Agriculture chemicals
2890-2899 Miscellaneous chemical products

Paper Business Supplies
2520-2549 Office furniture and fixtures
2600-2639 Paper and allied products
2670-2699 Paper and allied products
2760-2761 Manifold business forms
3950-3955 Pens, pencils and office supplies

Rubber and Plastic Products
3031-3031 Reclaimed rubber
3041-3041 Rubber & plastic hose and belting
3050-3053 Gaskets, hoses, etc
3060-3069 Fabricated rubber products
3070-3079 Miscellaneous rubber products
3080-3089 Miscellaneous plastic products
3090-3099 Miscellaneous rubber and plastic products

Steel
3300-3300 Primary metal industries
3310-3317 Blast furnaces & steel works
3320-3325 Iron & steel foundries
3330-3339 Primary smelting & refining nonferrous metals
3340-3341 Secondary smelting & refining nonferrous metals
3350-3357 Rolling & drawing nonferrous metals
3360-3369 Non-ferrous foundries and casting
3370-3379 Steel works etc
3390-3399 Miscellaneous primary metal products

Precious Metals
1040-1049 Gold & silver ores

Machinery
3510-3519 Engines & turbines
3520-3529 Farm and garden machinery
3530-3530 Construction, mining material, handling machinery

3531-3531 Construction machinery
3532-3532 Mining machinery, except oil field
3533-3533 Oil field machinery
3534-3534 Elevators
3535-3535 Conveyors
3536-3536 Cranes, hoists
3538-3538 Machinery
3540-3549 Metalworking machinery
3550-3559 Special industry machinery
3560-3569 General industrial machinery
3580-3580 Refrigeration & service industry machines
3581-3581 Automatic vending machines
3582-3582 Commercial laundry and drycleaning machines
3585-3585 Air conditioning, heating, refrigeration equipment
3586-3586 Measuring and dispensing pumps
3589-3589 Service industry machinery
3590-3599 Miscellaneous industrial and commercial equipment and machinery

Electrical Equipment
3600-3600 Electrical machinery equipment & supply
3610-3613 Electrical transmission
3620-3621 Electrical industrial apparatus
3623-3629 Electrical industrial apparatus
3640-3644 Electric lighting, wiring
3645-3645 Residential lighting fixtures
3646-3646 Commercial lighting
3648-3649 Lighting equipment
3660-3660 Communication equipment
3690-3690 Miscellaneous electrical machinery and equipment
3691-3692 Storage batteries
3699-3699 Electrical machinery and equipment

NOTES: This list of industries corresponds to the industries studied in Figure 7. The source is: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/ changes_ind.html.