Oil Prices and the Stock Markets: Evidence from High Frequency Data*

Sajjadur Rahman
Department of Accounting and Finance
Texas A&M University - San Antonio
San Antonio, Texas
USA 78231

and

Apostolos Serletis†
Department of Economics
University of Calgary
Calgary, AB, T2N 1N4

Forthcoming in: *The Energy Journal*

March 11, 2019

*We would like to thank Jonathan H. Wright for sharing his codes with us, and two referees for excellent comments that greatly improved the paper.

†Corresponding author. Phone: (403) 220-4092; Fax: (403) 282-5262; E-mail: Serletis@ucalgary.ca; Web: http://econ.ucalgary.ca/serletis.htm.

Abstract:

We use the highest frequency data that have ever been studied before to investigate the relationship between the price of oil and stock market returns. In the context of a bivariate (identified using heteroscedasticity in daily data) structural VAR in stock market returns and the change in the price of oil, we find evidence that positive oil price shocks have negative and statistically significant effects on stock market returns. Our results are robust to the use of different types of market returns, including aggregate and disaggregate U.S. market returns, aggregate and disaggregate U.S. excess returns, returns of the energy sector, returns of the major oil and gas companies, and global, eurozone, and some country specific stock market returns. They are also robust to the use of weekly data.

JEL classification: C32, E32, E52.
Keywords: Oil price shocks; Heteroscedasticity; VAR model.

1 Introduction

There is an ongoing debate in the macroeconomics literature about the macroeconomic effects of oil price shocks. See, for example, Hamilton (1983, 1996, 2011), Hooker (1996), Kilian (2008), Edelstein and Kilian (2009), Herrera *et al.* (2011), and Kilian and Vigfusson (2011a,b). As Serletis and Mehmandosti (2018) recently put it, "those of the view that positive oil price shocks have been the major cause of recessions in the United States (and other oil-importing countries) appeal to models that imply asymmetric responses of real output to oil price increases and decreases. These models are able to explain larger recessions is response to positive oil price shocks as well as smaller expansions in response to negative ones. On the other hand, those of the view that positive oil price shocks do not cause recessions appeal to theoretical models of the transmission of exogenous oil price shocks that imply symmetric responses of real output to oil price increases and decreases. These models cannot explain large declines in the level of economic activity in response to unexpected increases in the price of oil."

In this regard, Elder and Serletis (2010, 2011), Bredin *et al.* (2011), Rahman and Serletis (2011, 2012), Pinno and Serletis (2013), Jo (2014), Elder (2018), and Serletis and Xu (2019) reinvestigate the relationship between the price of oil and the level of economic activity, focusing on the role of uncertainty about oil prices. They appeal to the real options theory — see, for example, Bernanke (1983), Brennan and Schwartz (1985), Madj and Pindyck (1987), Brennan (1990), Gibson and Schwartz (1990), and Dixit and Pindyck (1994) — and use internally consistent simultaneous equations empirical models that accommodate an independent role for the effects of oil price volatility. They find that oil price uncertainty has had a negative and statistically significant effect on several measures of investment, durables consumption, and aggregate output, and that accounting for the effects of oil price uncertainty tends to exacerbate the negative dynamic response of economic activity to a negative oil price shock, while dampening the response to a positive oil price shock.

The link between oil prices and stock prices has also been investigated in the literature. See, for example, Jones and Kaul (1996), Park and Ratti (2008), Sadorsky (1999, 2001, 2012), and Alsalman and Herrera (2015). Also, Kilian and Park (2009) estimate the global crude oil market model of Kilian (2009), augmented with a stock market variable. They treat the price of crude oil as endogenous and model changes in the real price of crude oil as arising from three different sources: shocks to the global supply of crude oil, shocks to the global demand for all industrial commodities (including crude oil) that are driven by the global business cycle, and oil-market specific demand shocks (also referred to as precautionary demand shocks). They report that the response of stock prices to oil price shocks depends on the nature of the oil price shocks. In particular, they show that demand and supply shocks driving the global crude oil market jointly account for 22% of the long-run variation in U.S. real stock returns.

In this paper, we contribute to the literature by using the highest frequency data that have ever been studied before to investigate the relationship between the price of oil and the stock market. In investigating this relationship, we use an empirical approach that is widely different from those of others in the related literature, as we follow Rigobon and Sack (2003) and Wright (2012) to identify oil price shocks through heteroscedasticity of the high frequency dataset. We prefer to work with such dataset, as investors' decisions continuously change due to a wealth of information that is frequently available to them. Our modelling framework allows us to investigate the effects of oil price shocks on the stock market, after incorporating the rapidly changing information content of the high frequency dataset.

We estimate a bivariate structural VAR using daily data on the price of oil and stock market returns to identify oil price shocks and investigate the effects of these shocks on different types of stock market returns that include aggregate and disaggregate U.S. market returns, aggregate and disaggregate U.S. excess returns, the returns of the energy sector based on the Global Industry Classification Standard, and the returns of the major oil and gas companies following Kang *et al.* (2017). Although most of the previous studies primarily focus on U.S. market returns, we extend our analysis to include global, eurozone, and some country specific stock market returns. We find additional empirical evidence in support of the view that positive oil price shocks have negative and statistically significant effects on the stock market.

The outline of the paper is as follows. In section 2 we discuss the data and in section 3 we briefly present the empirical model. In section 4 we present the empirical results while in section 5 we check for robustness. The final section concludes.

2 The Data

We use daily data on two variables: changes in the price of oil (x_t) and stock returns (y_t). They are based on the spot price of West Texas Intermediate (WTI) crude oil and different types of returns that include aggregate and disaggregate U.S. stock market returns; aggregate and disaggregate U.S. excess returns; returns of the energy sector based on the Global Industry Classification Standard (GICS); returns of the major oil and gas companies following Kang *et al.* (2017)); and global, eurozone, and some country specific stock market returns that include emerging and advanced economies. In selecting these countries, we consider data availability, maturity of the stock market, as well as its relations with the rest of the world. However, we did not take into account the nature of their economies (whether these countries are exporting or importing crude oil), as we mainly focus on the movement of the stock market at a higher frequency due to sharp changes in the price of oil.

The data on the U.S. and international stock market returns, the returns of the GICS energy sector, and the returns on major oil and gas companies have been collected from NetAdvantage, a subscription only database hosted by Standard and Poor's, and some publicly available finance databases such as FRED, Google, and Yahoo. The data on excess returns are available on the data library that is published and maintained by Kenneth R. French (at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html). We have compiled a complete description of the data in Appendix Tables A1-A3.

3 Econometric Methodology

We investigate the dynamic effects of oil price shocks on stock market returns using the estimates of the parameters of the following reduced form bivariate VAR model

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \boldsymbol{C}_s + \sum_{j=1}^{p} \boldsymbol{\Phi}(j)\, \boldsymbol{z}_{t-j} + \boldsymbol{u}_t \tag{1}$$

where $\boldsymbol{C}_s$ is a 2×1 parameter vector, $\boldsymbol{\Phi}(j)$, $j = 1, \ldots, p$, is a 2×2 parameter matrix, and $\boldsymbol{u}_t \sim N(\boldsymbol{0}, \boldsymbol{\Omega})$, with $\boldsymbol{\Omega}$ being the variance-covariance matrix. In order to identify oil price shocks, we follow Wright (2012) and assume that the reduced form errors, $\boldsymbol{u}_t$, are related to a 2×1 vector of underlying independent structural shocks, $\boldsymbol{e}_t$, as follows

$$\boldsymbol{u}_t = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \boldsymbol{e}_t.$$

We identify two periods of volatility in the oil price series, high and low, and assume that the oil price shock has mean zero and variance σ_l^2 in low volatility periods and σ_h^2 in high volatility periods. Following Rigobon and Sack (2003), periods of high volatility are defined as when the 30 days rolling variance of the oil price residuals is more than one standard deviation above its average. We also assume that $\sigma_l^2 \neq \sigma_h^2$ and that the other structural shock is identically distributed with mean zero and variance one in all periods. If $\boldsymbol{\Omega}_l$ and $\boldsymbol{\Omega}_h$ are used to denote the variance-covariance matrix of the reduced form errors in low and high volatility periods, respectively, then (since we are interested in identifying the oil price shocks only)

$$\boldsymbol{\Omega}_h - \boldsymbol{\Omega}_l = \boldsymbol{B}\,(\sigma_h^2 - \sigma_l^2)$$

where

$$\boldsymbol{B} = \begin{bmatrix} b_{11}^2 & b_{11}b_{21} \\ b_{21}b_{21} & b_{21}^2 \end{bmatrix}. \tag{2}$$

Equation (2) identifies $\boldsymbol{B}$ if the normalization, $\sigma_h^2 - \sigma_l^2 = 1$, is imposed.

In order to estimate the parameters in $\boldsymbol{B}$, we estimate equation (1), construct the sample variance-covariance matrices, $\hat{\boldsymbol{\Omega}}_h$ and $\hat{\boldsymbol{\Omega}}_l$, and solve the following minimum distance problem

$$\widehat{\boldsymbol{B}} = \arg\min_{\boldsymbol{B}} \left[\text{vech}(\hat{\boldsymbol{\Omega}}_h - \hat{\boldsymbol{\Omega}}_l) - \text{vech}(\boldsymbol{B})\right]' \left[\widehat{\boldsymbol{V}}_l + \widehat{\boldsymbol{V}}_h\right]^{-1} \left[\text{vech}(\hat{\boldsymbol{\Omega}}_h - \hat{\boldsymbol{\Omega}}_l) - \text{vech}(\boldsymbol{B})\right]$$

where $\widehat{\boldsymbol{V}}_h$ and $\widehat{\boldsymbol{V}}_l$ are estimates of the variance-covariance matrices of vech($\hat{\boldsymbol{\Omega}}_h$) and vech($\hat{\boldsymbol{\Omega}}_l$), respectively. In solving the model, we use an autoregressive lag length of 20 days ($p = 20$) based on the Akaike information criterion (AIC).

The impulse response functions that show the effects of oil price shocks on stock market returns can be calculated in the usual way. We use the bootstrap procedure described in Wright (2012) to calculate the confidence intervals.

4 Empirical Evidence

In this section, we show the responses of stock market returns to an unanticipated increase in the price of crude oil due to one standard deviation oil price shock. They are calculated over an horizon of 60 days and include one standard deviation error bands. In general, these responses are slightly fluctuating around the mean level and show moderate level of persistence indicating transitory effects of oil price shocks on the financial markets. This is not highly surprising, as we use daily data compared to other studies that are primarily based on lower frequency data.

4.1 U.S. market returns

Figure 1 shows the effects of an oil price shock on the U.S. stock market returns. We find negative and statistically significant responses of market returns in the second and third week after the oil price shock, which indicates that a sudden increase in the price of oil has an overall negative impact on U.S. stock market returns.

In order to perform some disaggregate analysis on U.S. stock market returns, in Figure 2 we present the responses of industry returns to the same one standard deviation oil price shock, in the same fashion as in Figure 1 for the aggregate U.S. stock market returns. This disaggregate returns analysis shows that the oil price shock has significant effects on stock returns in most of the industries and that the initial effects are negative as reported for the aggregate U.S. stock market returns in Figure 1.

The negative effects of oil price shocks on stock market returns are consistent with how oil price shocks are transmitted into the financial market. If we consider oil as an important input in the production process, forward looking investors update their information set with an oil price hike, as it raises the cost of production and negatively affects the expected cashflows generated by the firms. Since stock prices can be expressed as the discounted sum of future cash flows, positive oil price shocks produce dampening effects on the financial market, by lowering the expected cashflows accruing to stockholders and, thus stock returns.

4.2 Returns of major oil and gas companies

In Figure 3 we asses the effects of an oil price shock on the aggregate returns of the GICS energy sector. Although aggregate returns in the energy sector decrease in the first week, they show considerable increases after the initial drop. Next, we extend our analysis of energy market returns by replacing aggregate returns with the returns of individual energy companies and show their responses in Figure 4. As can be seen in Figure 4, there are immediate strong positive responses of stock returns for Baker Hughes, British Petroleum, Chevron, Conocophillips, Halliburton, Occidental, and Schlumberger, indicating an increase in returns for these companies. Such responses are expected, as higher oil prices offer an opportunity for the energy companies to generate more profit, part of which is distributed as dividends to stockholders. On the other hand, stock returns initially drop for Exxon, Transcanada, and Valero due to a sudden oil price increase, but show significant increases after the first week. The delayed positive effects of oil price shocks on these oil and gas companies may be due to different types of activities (from oil exploration to refining and marketing of gasoline) that these companies are engaged in and their varying presence in countries around the world.

4.3 International evidence

As mentioned earlier, we are interested in cross country evidence of oil price shocks on stock returns. Hence, in Figure 5 we show the effects of a sudden oil price hike on global (panel A) and eurozone (panel B) returns. Again, we find steep significant drops in returns in the second week. In Figure 6 we also calculate the responses of stock market returns for some selected emerging and advanced countries. We find similar patterns of decreasing returns for most of the countries except Canada, Finland, Germany, Netherlands, and New Zealand. Based on our empirical model, there is no statistically significant relationship between oil price shocks and stock market returns for any of these countries. This empirical finding is puzzling, especially for Canada, which is primarily an oil exporting country, but it is consistent with the findings of Jones and Kaul (1996). They also reported a much weaker evidence on the relationship between oil price shocks and the Canadian stock market, without conditioning stock returns on other variables, such as real cashflows and expected returns.

5 Robustness Analysis

5.1 Excess returns

In this section we investigate the robustness of our empirical results by replacing global and U.S. aggregate stock market returns with the data on excess returns that were collected from Kenneth French's data library. As can be found in Figure 7, global excess returns significantly decrease within the first week in response to an unanticipated oil price increase. The U.S. excess returns also decrease following the oil price shock, but show a bit of a delayed response as they decrease by more than 0.06% in the second week.

We also calculate the responses of disaggregate excess returns to an oil price shock and present them in Figure 8. These return data include 49 major industry portfolios and are available in Kenneth French's data library. The portfolios are constructed by assigning Compustat four-digit SIC codes, or CRSP SIC codes if Compustat codes are not available, to each of the stocks listed in NYSE, AMEX, and NASDAQ. The complete list of the 4-digit SIC industries is available in French's website. As can be seen in Figure 8, returns of most of the industry portfolios (36 out of 49) significantly respond to the oil price shock. Similar to the world and U.S. excess returns, a number of those (30 out of 36) show negative responses within the first few days of the oil price shock, indicating that an increase in the price of oil reduces the returns of those portfolios. These portfolios include a range of energy intensive and non-intensive sectors such as agriculture, food, consumer goods, chemicals, construction, steel, machinery, autos, coal, mining, business services, manufacturing, transportation, and real estate. As it is expected, there is a significant increase in the excess returns of the oil sector following a positive shock to the price of crude oil.

5.2 Weekly returns

Finally, we further estimate our empirical model using weekly returns of the U.S. and international market, as well as the weekly returns of various U.S. industries and several major oil companies. In addition, we estimate our model using the data on weekly excess returns of the U.S. and a number of industry portfolios. These weekly returns are calculated from the daily returns by taking a simple average of the daily returns. For each of these return series, we calculated the impulse response functions to investigate if our previous results hold in the context of lower frequency returns. The results (not reported here but available on request) show that the responses are mostly similar to what we found for daily returns and, thus, support our earlier evidence that positive oil price shocks have negative effects on stock market returns.

6 Conclusion

This paper explores the relationship between the price of crude oil and the stock market, using high frequency oil price data that has largely been ignored in the literature. We use this high frequency dataset to identify oil price shocks in a simple bivariate structural model that fits to our dataset reasonably well. We use the model to investigate the effects of oil price shocks on different types of stock market returns that include aggregate and disaggregate U.S. market returns, aggregate and disaggregate U.S. excess returns, returns of the energy sector based on the Global Industry Classification Standard, returns of the major oil and gas companies, and global, eurozone, and some country specific stock market returns. We find empirical evidence in support of the view that positive oil price shocks have negative and statistically significant effects on the stock market.

References

[1] Alsalman, Z. and A. M. Herrera (2015). Oil Price Shocks and the U.S. Stock Market: Do Sign and Size Matter? *The Energy Journal 36*, 171-188.

[2] Bredin, D., J. Elder, and S. Fountas (2011) Oil volatility and the option value of waiting: An analysis of the G-7. *Journal of Futures Markets* 31, 679-702.

[3] Brennan, M. (1990) Latent assets. *Journal of Finance* 45, 709-730.

[4] Brennan, M. and E. Schwartz (1985) Evaluating natural resource investment. *Journal of Business* 58, 1135-1157.

[5] Dixit, A. and R.S. Pindyck (1994) *Investment under uncertainty*. Princeton, NJ: Princeton University Press.

[6] Edelstein, P. and L. Kilian (2009) How sensitive are consumer expenditures to retail energy prices? *Journal of Monetary Economics* 56, 766-779.

[7] Elder, J. (2018) Oil price volatility: Industrial production and special aggregates. *Macroeconomic Dynamics*(forthcoming).

[8] Elder, J. and A. Serletis (2010) Oil price uncertainty. *Journal of Money, Credit, and Banking* 42, 1138-1159.

[9] Elder, J. and A. Serletis (2011) Volatility in oil prices and manufacturing activity: An investigation of real options. *Macroeconomic Dynamics* 15 (Supplement 3), 379–395.

[10] Gibson, R. and E.S. Schwartz (1990) Stochastic convenience yield and the pricing of oil contingent claims. *Journal of Finance* 45, 959–976.

[11] Hamilton, J.D. (1983) Oil and the macroeconomy since World War II. *Journal of Political Economy*91, 228-248.

[12] Hamilton, J.D. (1996) That is what happened to the oil price macroeconomy relation. *Journal of Monetary Economics*38, 215-220.

[13] Hamilton, J.D. (2011) Nonlinearities and the macroeconomic effects of oil prices. *Macroeconomic Dynamics*15 (Supplement 3), 364-378.

[14] Herrera, A.M., L.G. Lagalo, and T. Wada (2011) Oil price shocks and industrial production: Is the relationship linear? *Macroeconomic Dynamics* 15 (Supplement 3), 472–497.

[15] Hooker, M.A. (1996) What happened to the oil price-macroeconomy relationship? *Journal of Monetary Economics* 38 (1996), 195-213.

[16] Jo, S. (2014) The effects of oil price uncertainty on global real economic activity. *Journal of Money, Credit and Banking* 46, 1113-1135.

[17] Jones, C. and G. Kaul (1996) Oil and the stock markets." *Journal of Finance* 51, 463-491.

[18] Kang, W., F.P. de Garcia, and R.A. Ratti (2017) Oil price shocks, policy uncertainty, and stock returns of oil and gas corporations. *Journal of International Money and Finance* 70, 344-359.

[19] Kilian, L. (2008) The economic effects of oil price shocks. *Journal of Economic Literature* 46, 871-909.

[20] Kilian, L. (2009) Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market.*American Economic Review* 99, 1053-1069.

[21] Kilian, L. and C. Park (2009) The impact of oil price shocks on the U.S. stock market. *International Economic Review* 50, 1267-1287.

[22] Kilian, L. and R.J. Vigfusson (2011a) Are the responses of the U.S. economy asymmetric in energy price increases and decreases? *Quantitative Economics* 2, 419-453.

[23] Kilian, L. and R.J. Vigfusson (2011b) Nonlinearities in the oil price–output relationship. *Macroeconomic Dynamics* 15 (Supplement 3), 337–363.

[24] Majd, S. and R.S. Pindyck (1987) Time to build, option value, and investment decisions. *Journal of Financial Economics* 18, 7-27.

[25] Park, J. and R. Ratti (2008) Oil price shocks and stock markets in the U.S. and 13 European countries. *Energy Economics* 30, 2857-2608.

[26] Pinno, K. and A. Serletis (2013) Oil price uncertainty and industrial production. *The Energy Journal* 34, 191-216.

[27] Rahman, S. and A. Serletis (2011) The asymmetric effects of oil price shocks. *Macroeconomic Dynamics* 15 (Supplement 3), 437–471.

[28] Rahman, S. and A. Serletis (2012) Oil price uncertainty and the Canadian economy: Evidence from a VARMA, GARCH-in-Mean, asymmetric BEKK model. *Energy Economics* 34, 603-610.

[29] Rigobon, R. and B. Sack (2003) Measuring the reaction of monetary policy to the stock market. *Quarterly Journal of Economics* 118, 639-669.

[30] Sadorsky, P. (1999) Oil price shocks and stock market activity. *Energy Economics* 21, 449-469.

[31] Sadorsky, P. (2001) Risk factors in stock returns of Canadian oil and gas companies. *Energy Economics* 23, 17-28.

[32] Sadorsky, P. (2012) Correlations and volatility spillovers between oil prices and the stock prices of clean energy and technology companies. *Energy Economics* 34, 248-255.

[33] Serletis, A. and E.A. Mehmandosti (2018) 150 years of the oil price-macroeconomy relationship. *Macroeconomic Dynamics* (forthcoming).

[34] erletis, A. and L. Xu (2019) Markov switching oil price uncertainty. *Oxford Bulletin of Economics and Statistics* (forthcoming).

[35] Wright, J.H. (2012) What does monetary policy do to long-term interest rates at the zero lower bound. *Economic Journal* 122, F447-F466.

Figure 1. Responses of the US stock market returns to a one standard deviation oil price shock.

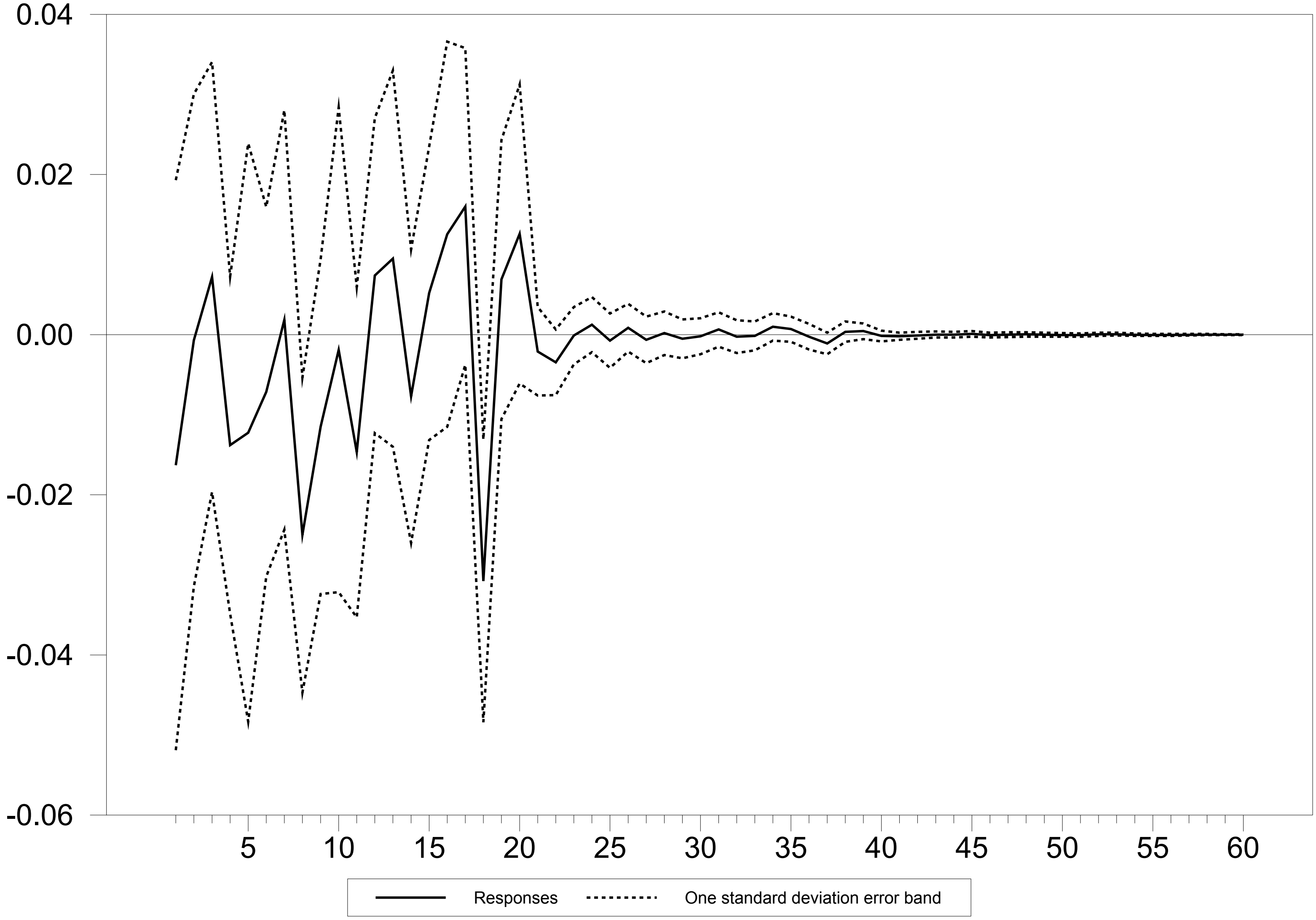


Figure 2. Responses of the U.S. industry returns to a one standard deviation oil price shock.

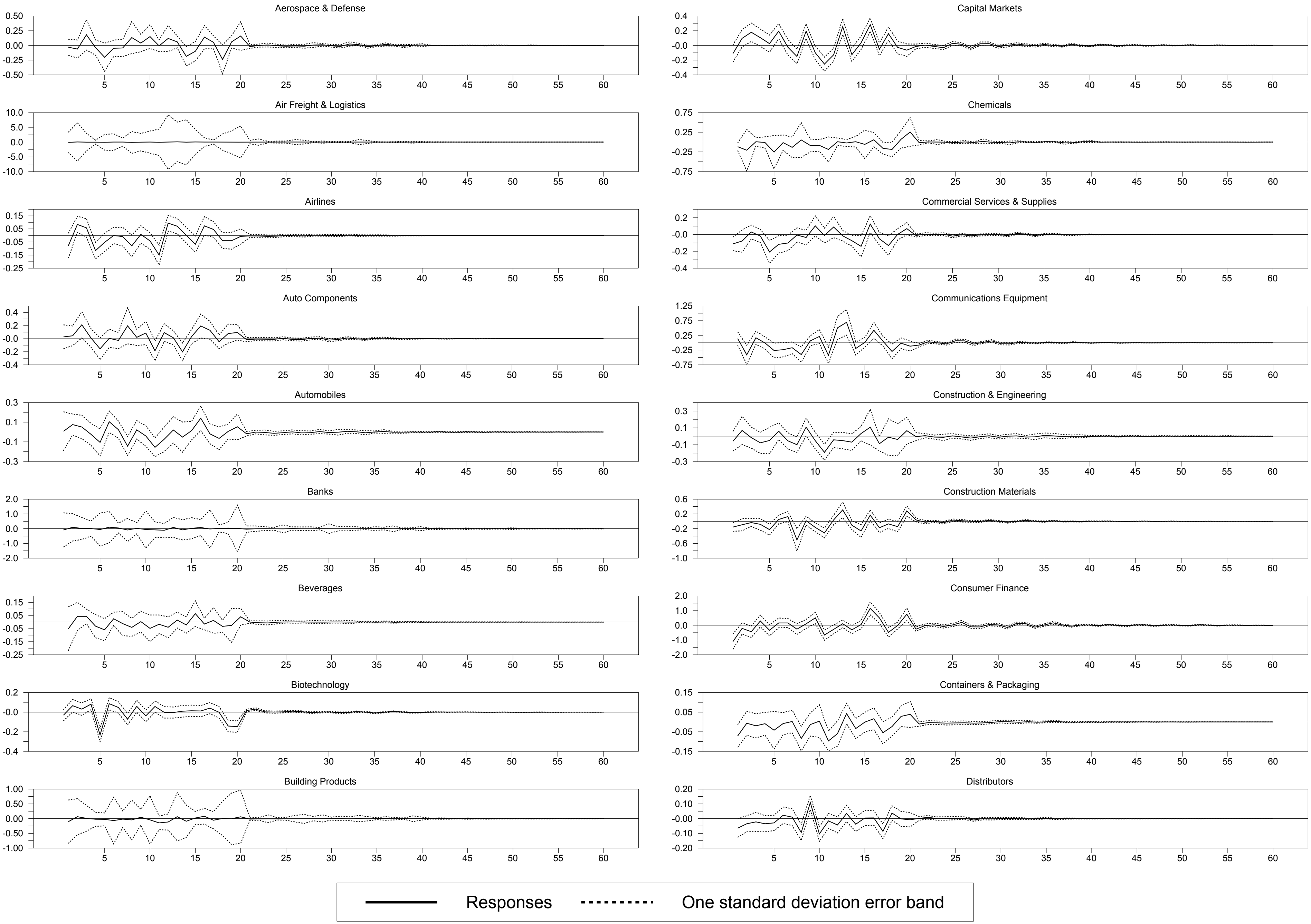


Figure 2 (Cont.) Responses of the U.S. industry returns to a one standard deviation oil price shock.

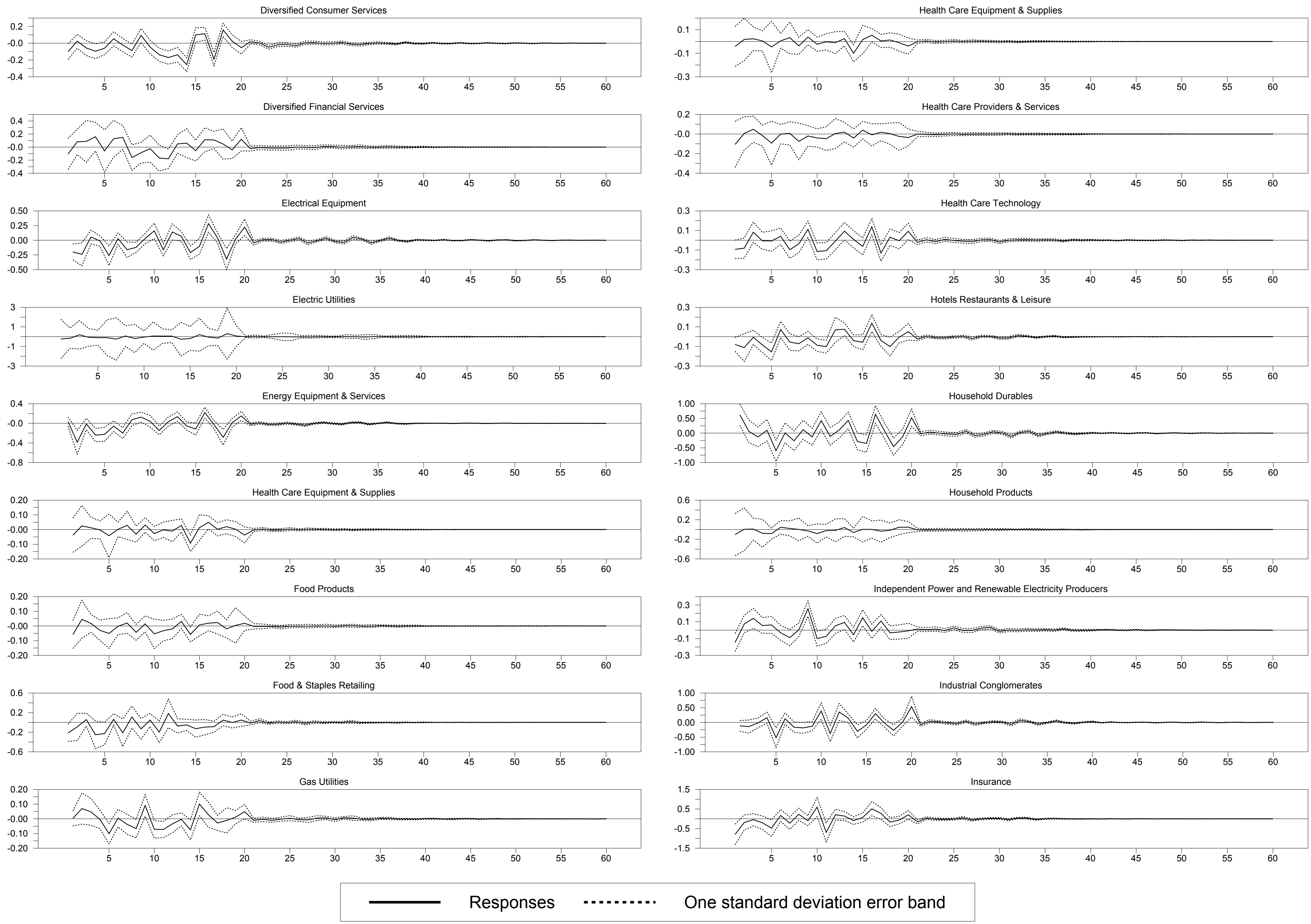


Figure 2 (Cont.) Responses of the U.S. industry returns to a one standard deviation oil price shock.

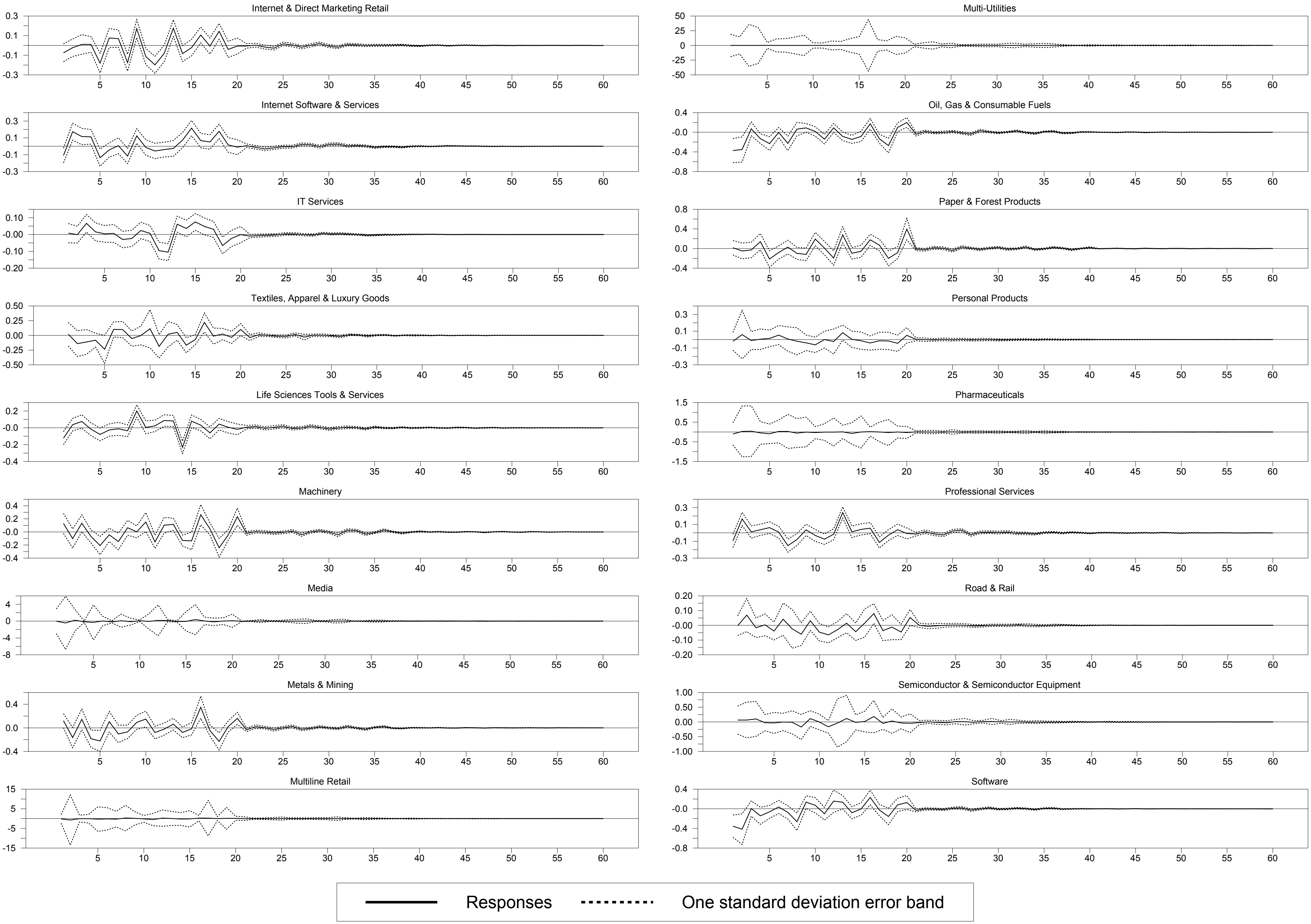


Figure 2 (Cont.) Responses of the U.S. industry returns to a one standard deviation oil price shock.

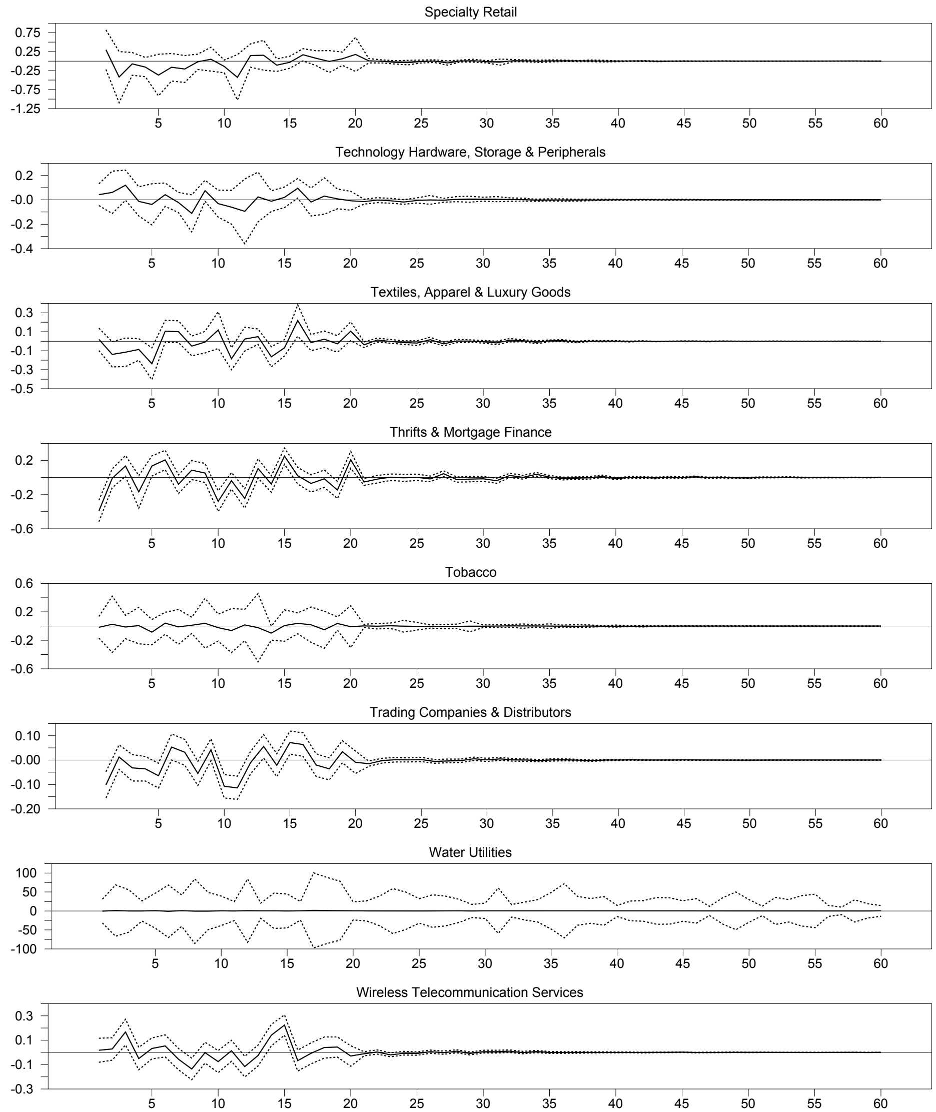


Figure 3. Responses of aggregate returns on GICS energy sector to a one standard deviation oil price shock.

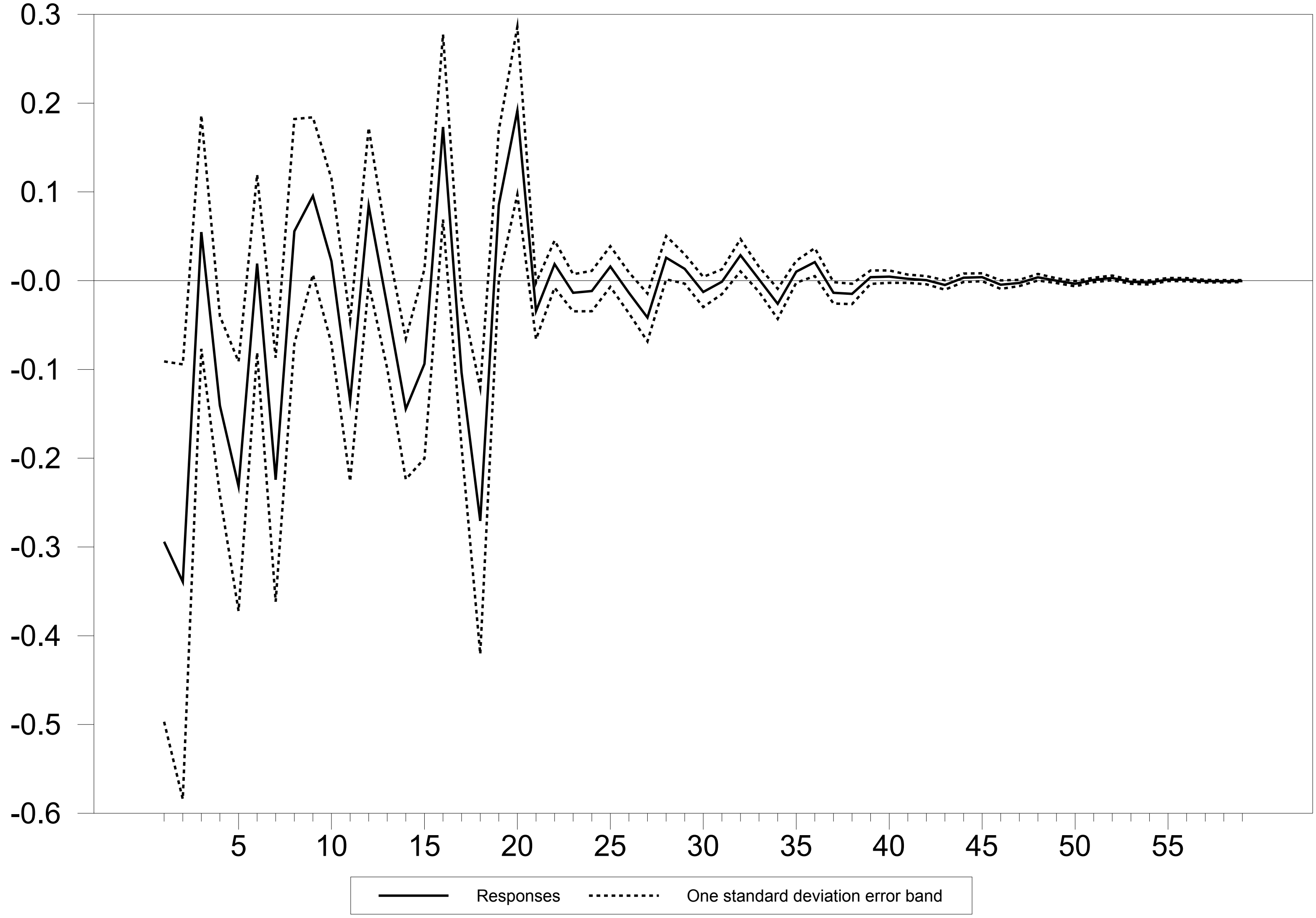


Figure 4. Responses of stock returns to a one standard deviation oil price shock for major energy companies.

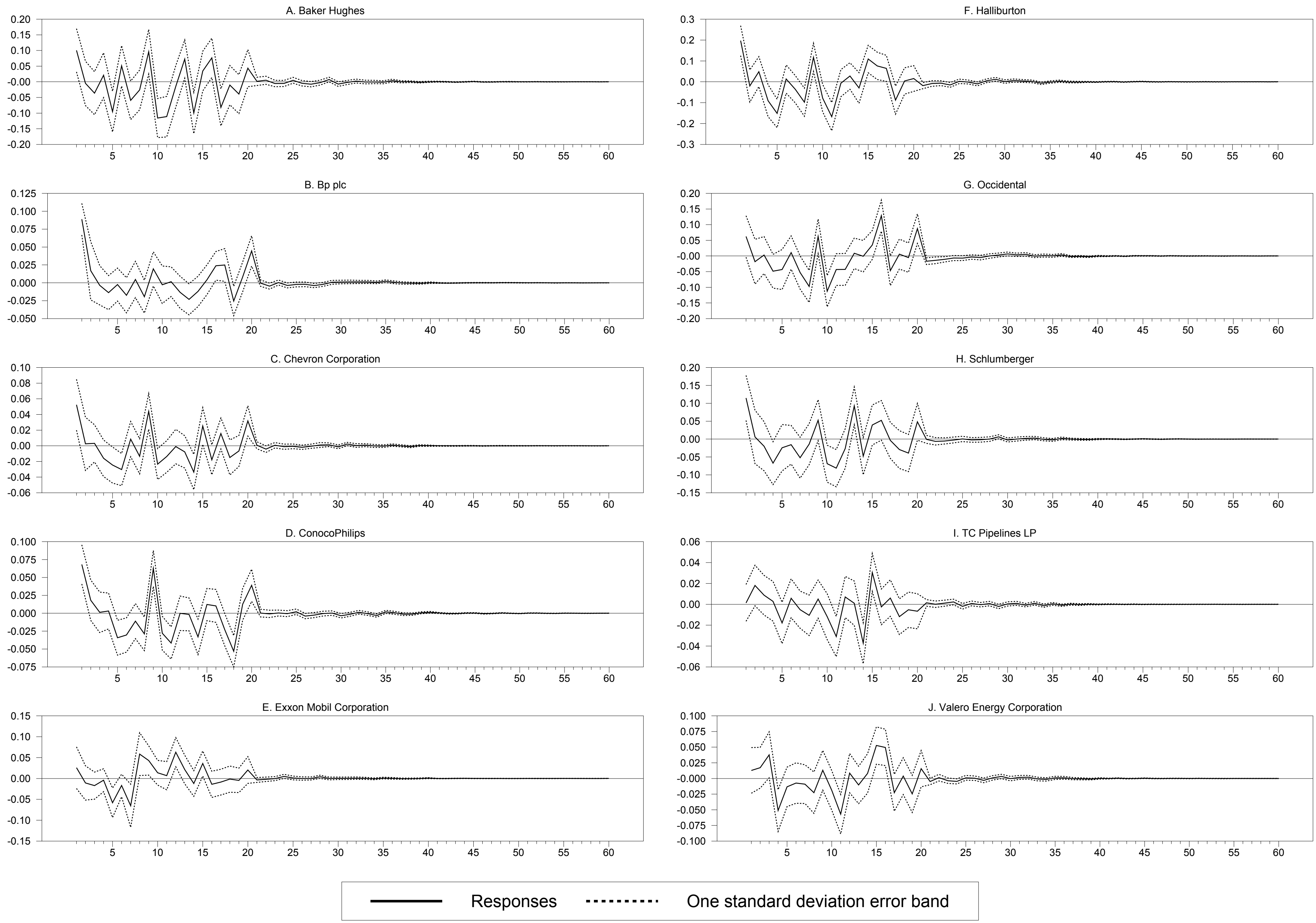


Figure 5. Responses of Global and Eurozone returns to a one standard deviation oil price shock.

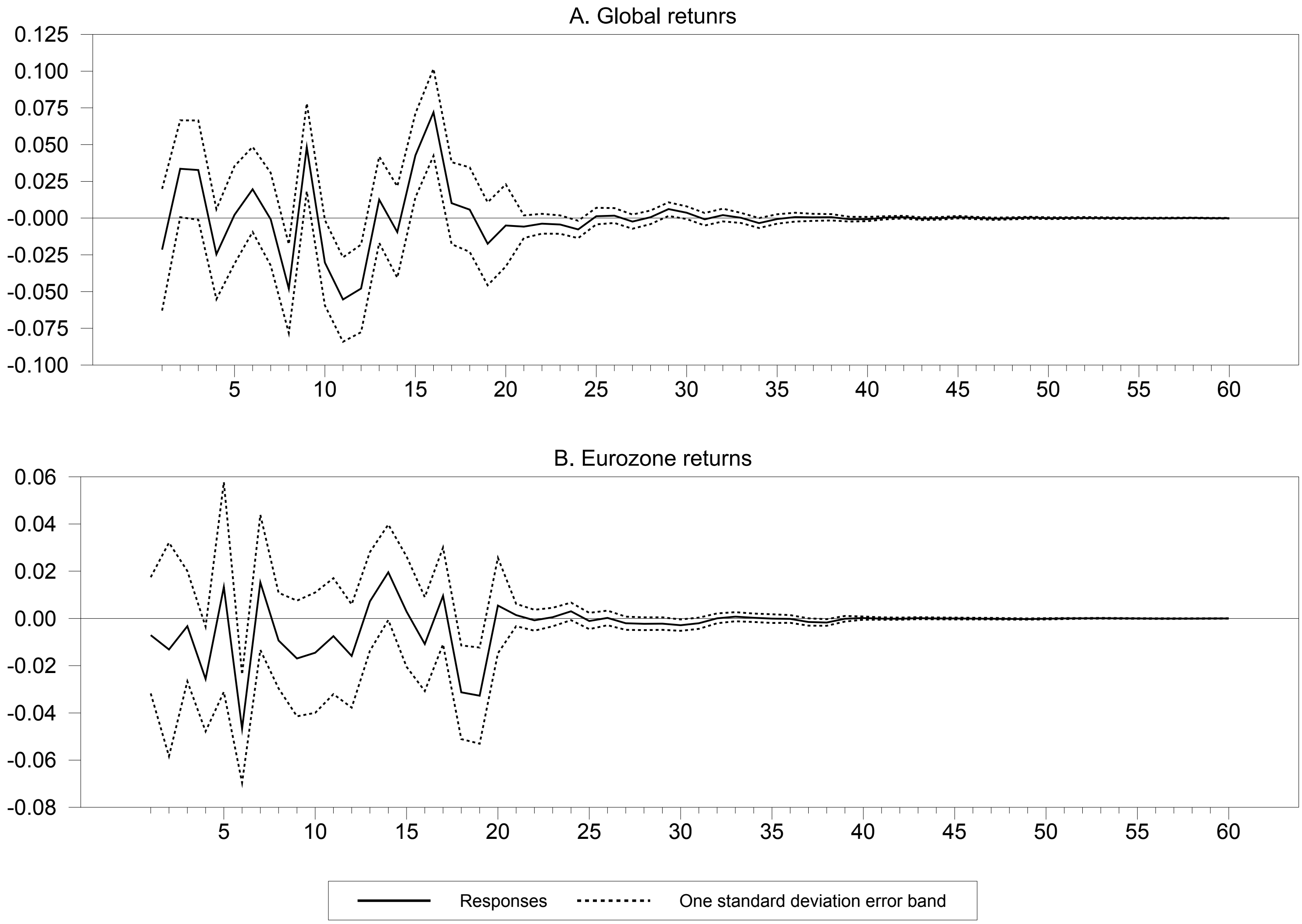


Figure 6. Responses of stock returns to a one standard deviation oil price shock for some selected countries.

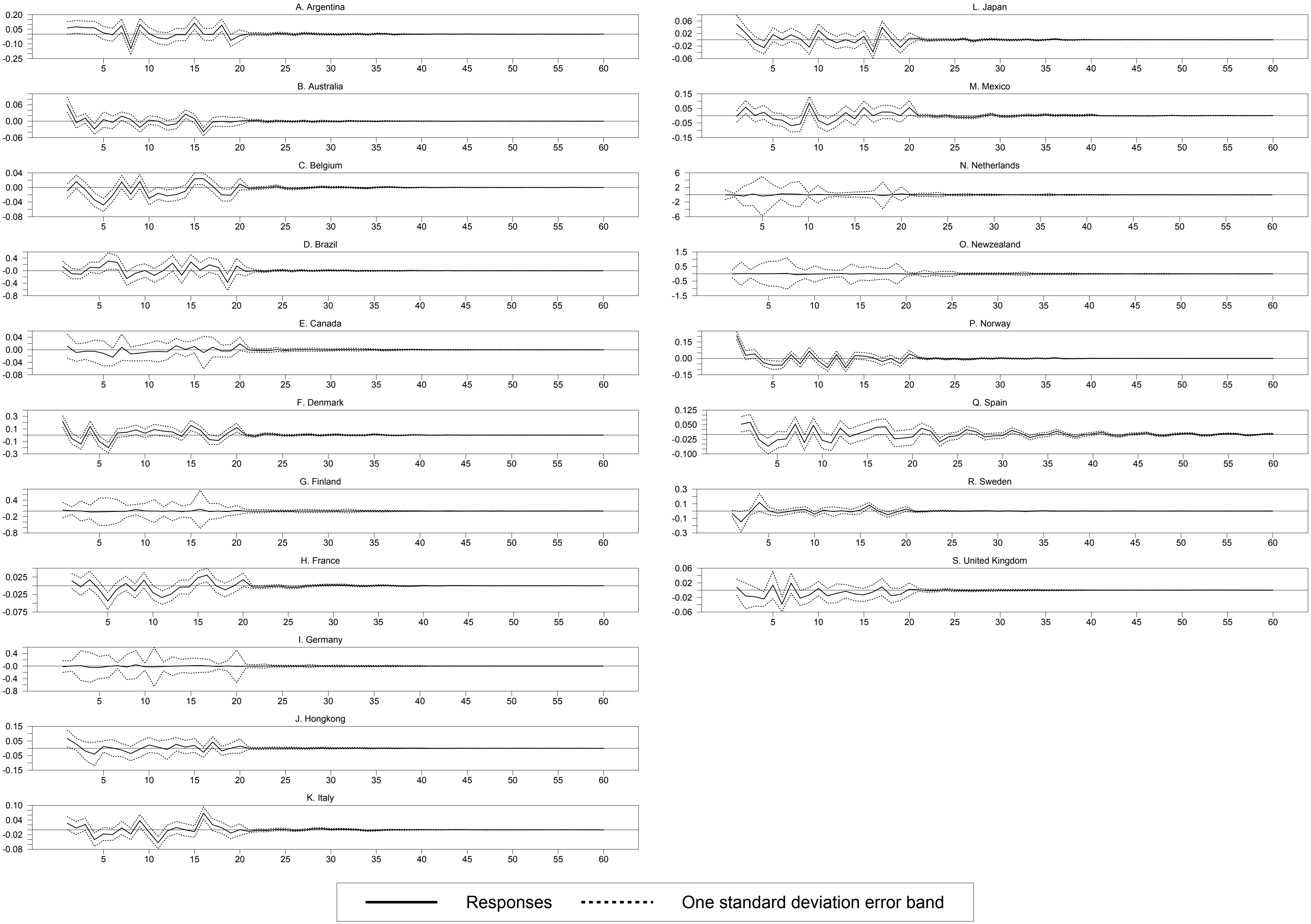


Figure 7. Responses of Global and U.S. excess returns to a one standard deviation oil price shock.

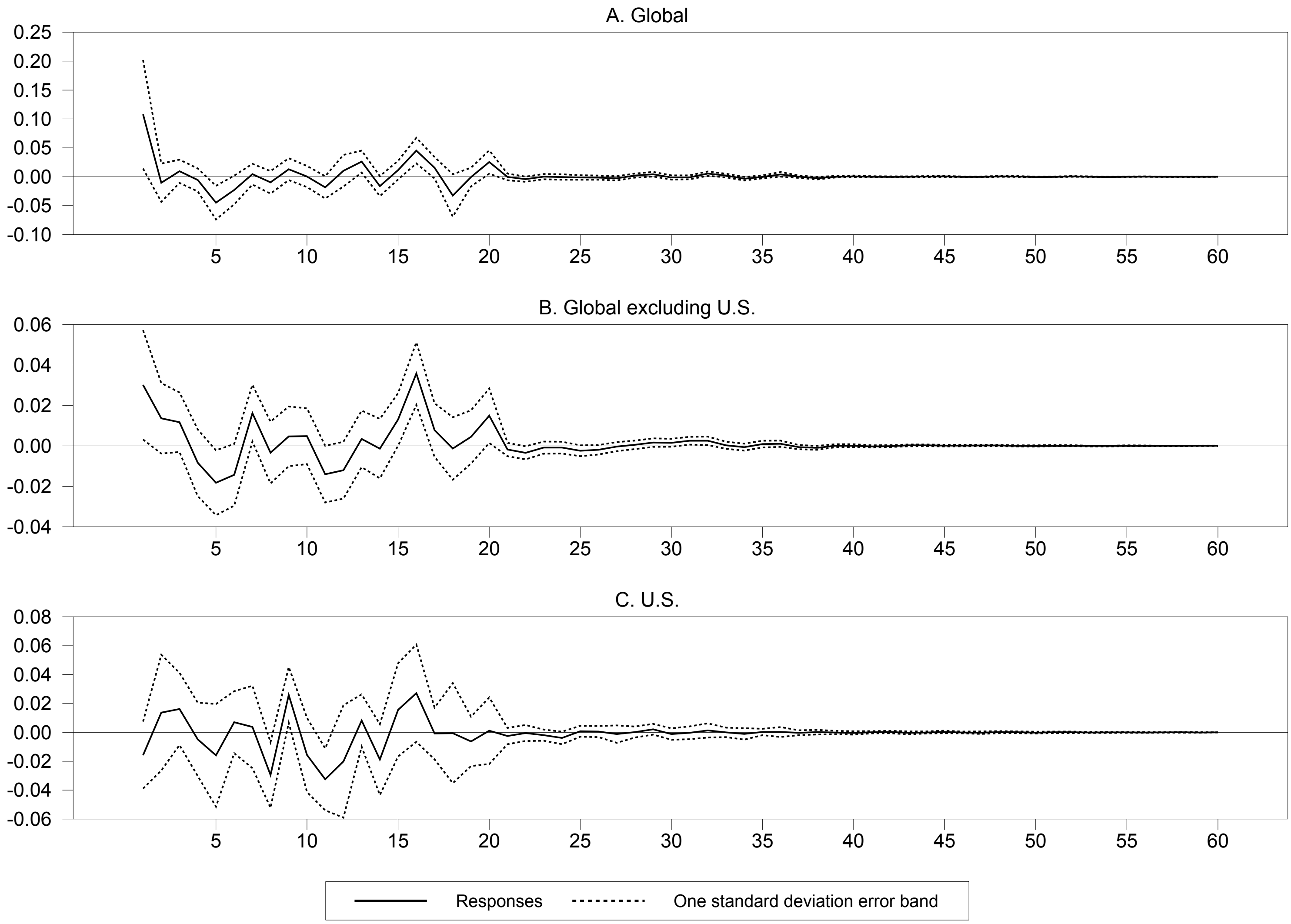


Figure 8. Responses of the U.S. excess returns on industry portfolios to a one standard deviation oil price shock.

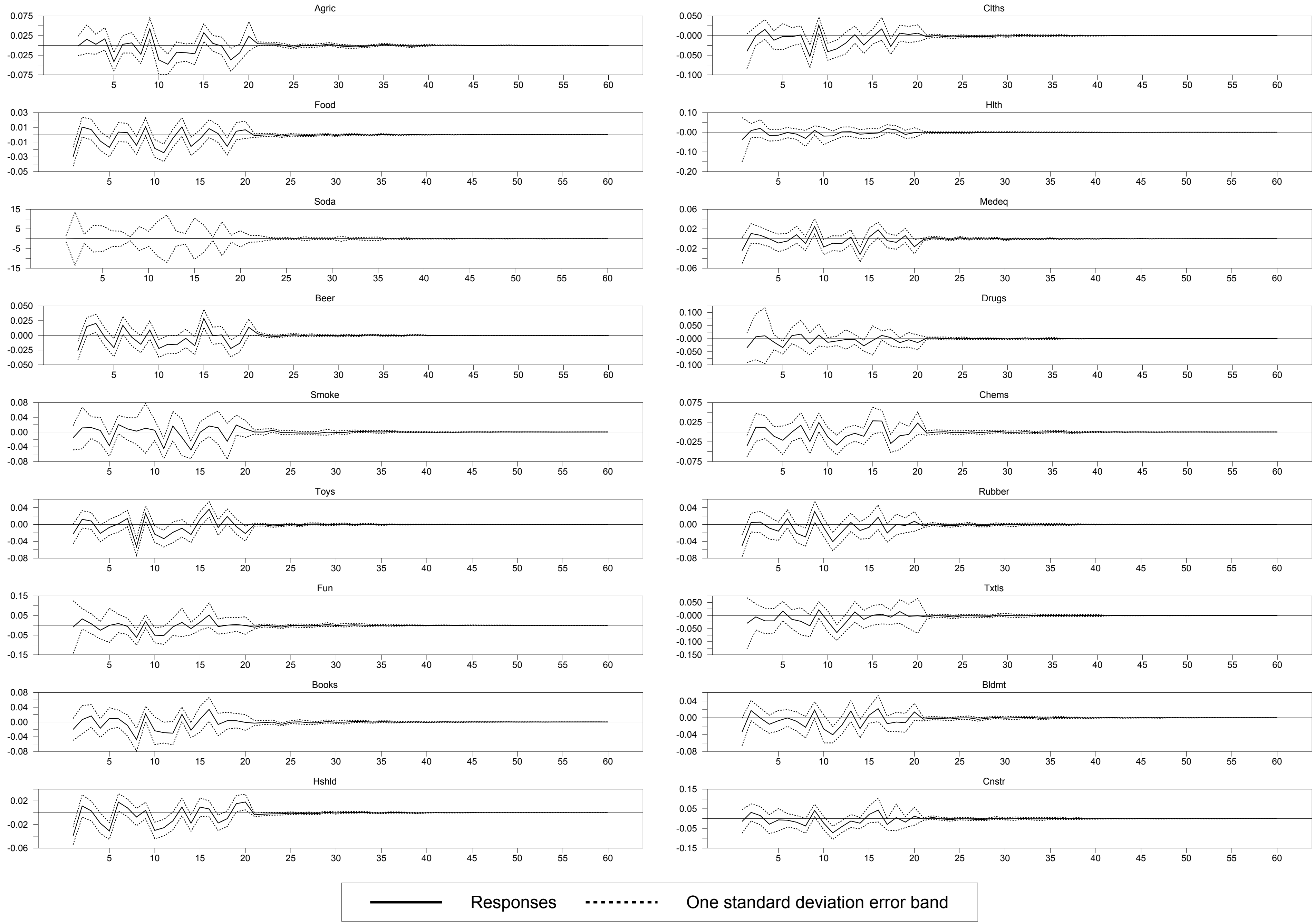


Figure 8 (Cont.) Responses of the U.S. excess returns on industry portfolios to a one standard deviation oil price shock.

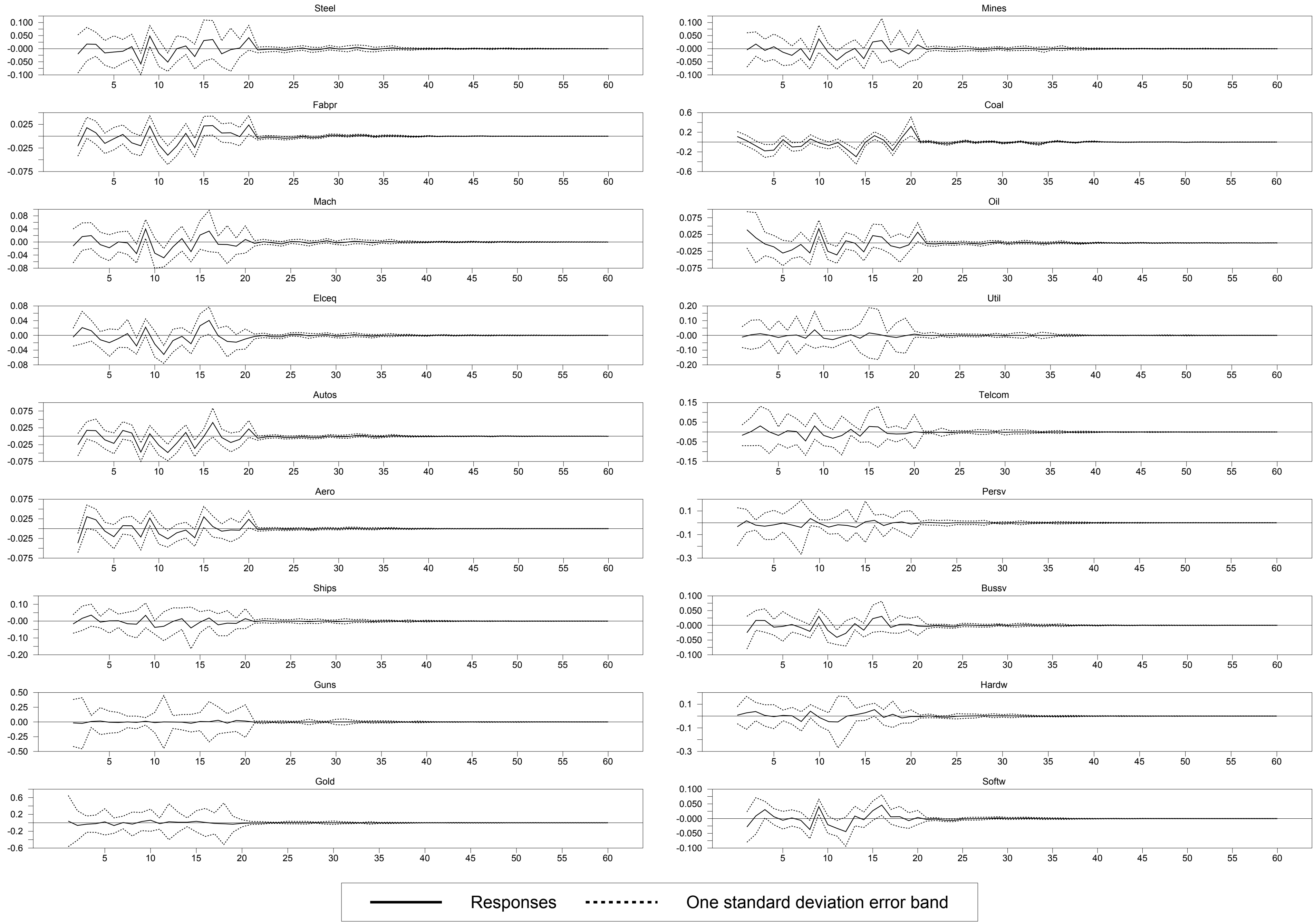
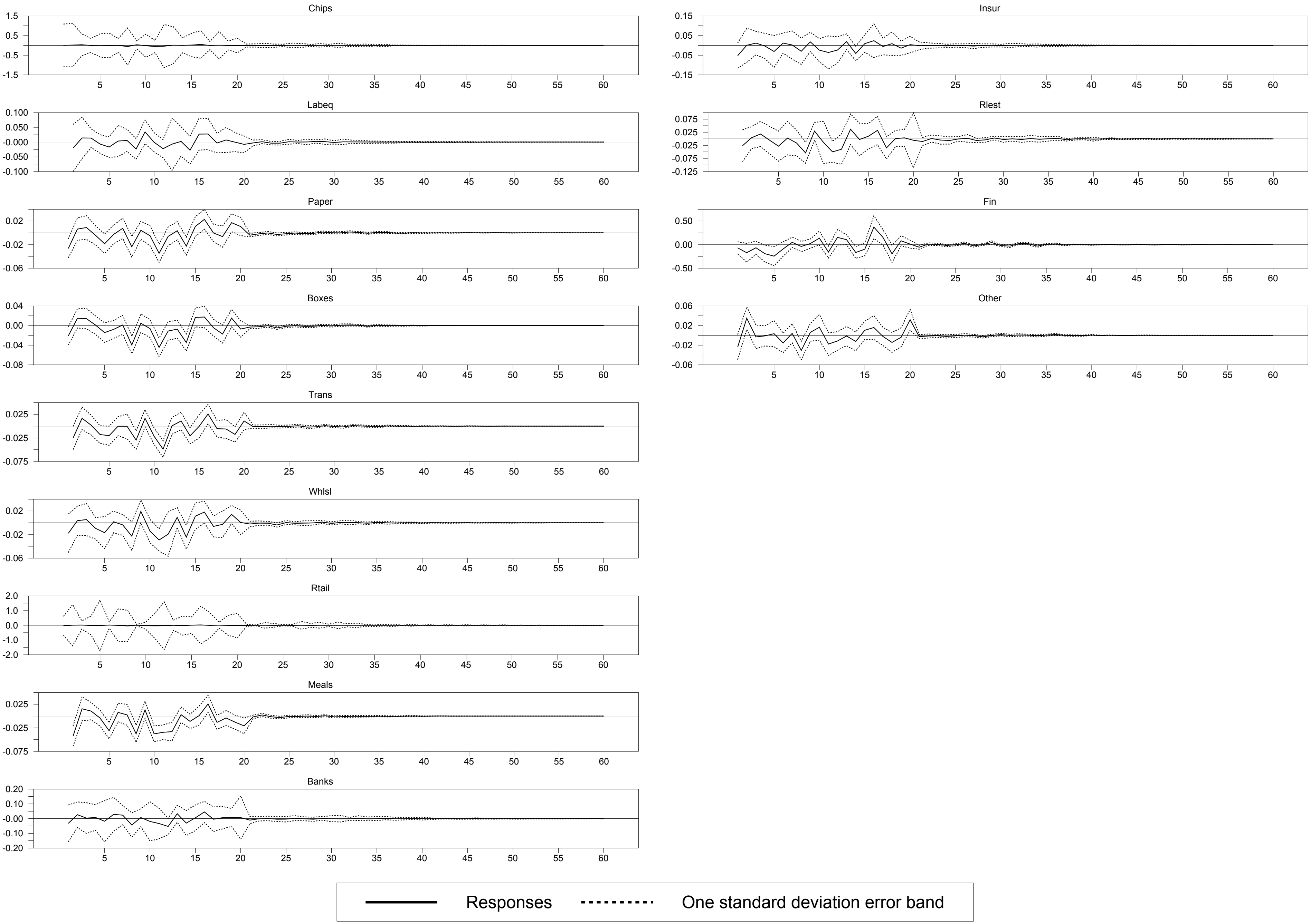


Figure 8 (Cont.) Responses of the U.S. excess returns on industry portfolios to a one standard deviation oil price shock.



Appendix Table 1. Details of U.S. Stock Market Data for Aggregate and Disaggregate Returns (Source:NetAdvantage)

Series Name	Symbol	Period
S&P 500 Index	^GSPC	01/9/1987–10/21/2016
Aerospace & Defense	^SP500-201010	09/11//1989–10/21/2016
Air Freight & Logistics	^SP500-203010	09/11//1989–10/21/2016
Airlines	^SP500-203020	09/11//1989–10/21/2016
Auto Components	^SP500-251010	09/11//1989–10/21/2016
Automobiles	^SP500-251020	09/11//1989–10/21/2016
Banks	^SP500-401010	09/11//1989–10/21/2016
Beverages	^SP500-302010	09/11//1989–10/21/2016
Biotechnology	^SP500-352010	09/11//1989–10/21/2016
Building Products	^SP500-201020	09/11//1989–10/21/2016
Capital Markets	^SP500-402030	04/30/2003–10/21/2016
Chemicals	^CEX	09/11//1989–10/21/2016
Commercial Services & Supplies	^SP500-202010	09/11//1989–10/21/2016
Communications Equipment	^SP500-452010	09/11//1989–10/21/2016
Construction & Engineering	^SP500-201030	09/11//1989–10/21/2016
Construction Materials	^SP500-151020	09/11//1989–10/21/2016
Consumer Finance	^SP500-402020	04/30/2003–10/21/2016
Containers & Packaging	^SP500-151030	09/11//1989–10/21/2016
Distributors	^SP500-255010	10/31/2002–10/21/2016
Diversified Consumer Services	^SP500-253020	04/29/2005–10/21/2016
Diversified Financial Services	^SP500-402010	09/11//1989–10/21/2016
Electrical Equipment	^SP500-201040	09/11//1989–10/21/2016
Electric Utilities	^SP500-551010	09/11//1989–10/21/2016

Appendix Table 1. Details of U.S. Stock Market Data for Aggregate and Disaggregate Returns (Continued)

Series Name	Symbol	Period
Energy Equipment & Services	^SP500-101010	09/11//1989–10/21/2016
Food Products	^SP500-302020	09/11//1989–10/21/2016
Food & Staples Retailing	^SP500-301010	09/11//1989–10/21/2016
Gas Utilities	^SP500-551020	09/11//1989–10/21/2016
Health Care Equipment & Supplies	^SP500-351010	09/11//1989–10/21/2016
Health Care Providers & Services	^SP500-351020	09/11//1989–10/21/2016
Health Care Technology	^SP500-351030	04/28/2006–10/28/2016
Hotels Restaurants & Leisure	^SP500-253010	09/11//1989–10/21/2016
Household Durables	^SP500-252010	09/11//1989–10/21/2016
Household Products	^SP500-303010	09/11//1989–10/21/2016
Independent Power and Renewable Electricity Producers	^SP500-551050	04/29/2005–10/21/2016
Industrial Conglomerates	^SP500-201050	09/11//1989–10/21/2016
Insurance	^SP500-403010	09/11//1989–10/21/2016
Internet & Direct Marketing Retail	^SP500-255020	07/19/2002–10/21/2016
Internet Software & Services	^SP500-451010	12/31/1998–10/21/2016
IT Services	^SP500-451020	09/11//1989–10/21/2016
Textiles, Apparel & Luxury Goods	^SP500-252030	09/11//1989–10/21/2016
Life Sciences Tools & Services	^SP500-352030	04/28/2006—-10/21/2016
Machinery	^SP500-201060	09/11//1989–10/21/2016
Media	^SP500-254010	09/11//1989–10/21/2016

Appendix Table 1. Details of U.S. Stock Market Data for Aggregate and Disaggregate Returns (Continued)

Series Name	Symbol	Period
Metals & Mining	^SP500-151040	09/11//1989–10/21/2016
Multiline Retail	^SP500-255030	09/11//1989–10/21/2016
Multi-Utilities	^SP500-551030	08/30/1999–10/21/2016
Oil, Gas & Consumable Fuels	^SP500-101020	09/11//1989–10/21/2016
Paper & Forest Products	^SP500-151050	09/11//1989–10/21/2016
Personal Products	^SP500-303020	09/11//1989–10/21/2016
Pharmaceuticals	^SP500-352020	09/11//1989–10/21/2016
Professional Services	^SP500-202020	08/29/2008–10/28/2016
Road & Rail	^SP500-203040	09/11//1989–10/21/2016
Semiconductor & Semiconductor Equipment	^SP500-453010	01/03/1994–10/21/2016
Software	^SP500-451030	09/11//1989–10/21/2016
Specialty Retail	–	09/11//1989–10/21/2016
Technology Hardware, Storage & Peripherals	^SP500-452020	09/11//1989–10/21/2016
Textiles, Apparel & Luxury Goods	^SP500-252030	09/11//1989–10/21/2016
Thrifts & Mortgage Finance	^SP500-401020	04/30/2003–10/21/2016
Tobacco	^SP500-302030	09/11//1989–10/21/2016
Trading Companies & Distributors	^SP500-201070	06/28/1996–10/21/2016
Water Utilities	–	03/03/2016–10/21/2016
Wireless Telecommunication Services	^SP500-501020	01/30/1993–10/21/2016

Appendix Table 2. Details of Stock Market Data for World, Eurozone, U.S, and some Selected countries

Country	Series Name	Symbol	Period	Source
Argentina	Argentina Merval Index	^MERV	06/06/1994–10/21/2016	NetAdvantage
Australia	S&P/ASX 200	^AXJO	11/22/1992–10/21/2016	Yahoo Finance
Belgium	BEL20	^BFX	04/09/1991–10/21/2016	Yahoo Finance
Brazil	Brazil IBOVESPA Index	IBOV	04/28/1994–10/21/2016	NetAdvantage
Canada	S&P/TSX Composite	^GSPTSE	01/09/1987–10/21/2016	NetAdvantage
Denmark	OMX Copenhagen 20	^OMXC20	08/13/1991–10/21/2016	Yahoo Finance
Eurozone	Euro Stoxx 50	^STOXX50E	01/09/1987–10/21/2016	Yahoo Finance
Finland	OMX Helsinki 25	^OMXH25	09/22/1999–10/21/2016	NetAdvantage
France	CAC 40	^FCHI	09/14/1990–10/28/2016	Yahoo Finance
Germany	DAX	^FCHI	09/14/1990–10/28/2016	Yahoo Finance
Hongkong	Hang Seng	^HSI	01/09/1987–10/21/2016	Yahoo Finance
Italy	FTSE MIB	^FTSEMIB.MI	01/01/1998–10/21/2016	Yahoo Finance
Japan	Nikkei 225 Index	^N225	01/09/1987–10/21/2016	NetAdvantage
Mexico	S&P/BMV IPC	ME	04/29/1985–10/21/2016	NetAdvantage
Netherlands	AEX-INDEX	^AEX	10/12/1992–10/21/2016	Yahoo Finance
Newzealand	S&P/NZX 50	^NZ50	01/02/2003–10/21/2016	Yahoo Finance
Norway	Oslo Bors Benchmark Index_GI	OSEBX.OL	03/21/1985–10/21/2016	Yahoo Finance
Spain	Madrid lbex 35 Index	^IBEX	04/12/1993–10/21/2016	NetAdvantage
Sweden	OMX Stockholm 30 Index	^OMX	07/09/1991–10/21/2016	NetAdvantage
United Kingdom	FTSE 100	INDEXFTSE:UKX	01/09/1987–10/21/2016	Googole Finance
World	Dow Jones	World Index	02/15/1994–10/21/2016	NetAdvantage

Appendix Table 3. Details of Stock Market Data for Energy Index and Major Oil Companies

Series Name	Symbol	Period	Source
S&P 500 Energy	^SP500-1010	09/11/1989–10/21/2016	NetAdvantage
Baker Hughes	NYSE:BHI	01/09/1987–10/21/2016	NetAdvantage
BP plc (ADR)	NYSE: BP	01/09/1987–10/21/2016	Google Finance
Chevron Corporation	NYSE: CVX	01/09/1987–10/21/2016	NetAdvantage
ConocoPhillips	NYSE: COP	01/09/1987–10/21/2016	NetAdvantage
Exxon Mobil Corporation	NYSE: XOM	01/09/1987–10/21/2016	NetAdvantage
Halliburton	NYSE:HAL	01/09/1987–10/21/2016	NetAdvantage
Occidental	NYSE:OXY	01/09/1987–10/21/2016	NetAdvantage
Schlumberger	NYSE:SLB	01/09/1987–10/21/2016	NetAdvantage
TC Pipelines LP	TSE: TRP	01/09/1987–10/21/2016	NetAdvantage
Valero Energy Corporation	NYSE: VLO	01/09/1987–10/21/2016	NetAdvantage