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Stock Market Reaction to Oil Price Shocks: A Comparison between an Oil-exporting Economy and an Oil-importing Economy *

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Abstract In this study, we assess the responses of aggregate stock returns and their volatility in the face of oil price shocks in the Norwegian and Korean markets. Both Norway and Korea are small open economies; the former exports oil, and the latter imports it. We determine herein that the responses of aggregate stock returns and volatility differ substantially, depending on the underlying cause of the oil price rise and depending on whether an economy exports or imports oil. Additionally, a larger portion of stock return variations in small open economies can be explained by the world crude oil market as opposed to the US market; this implies that the small open economies have more oil-dependent technology and limited access to the global financial market. Finally, the results of our analysis of the conditional covariance measure indicate that the responses of stock returns and volatility are not based on a risk-return tradeoff relationship.

Keywords Stock returns, Volatility, Oil prices, Oil demand shocks, Oil supply shocks

JEL Classification G12, Q43

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1. Introduction

Oil prices, which rose precipitously in the early 2000s, dropped substantially during the global financial crisis and have begun to rise again due to the recovery of global economy and the recent political turmoil in the Middle East. There is a fear among economists and policymakers that oil prices may continue to rise rapidly, as economies such as the BRIC group of nations (Brazil, Russia, India, China) increasingly develop and the political instability in the Middle East lasts for a long period. Based on the tight relationship between the oil price and past macroeconomic performance, stock market investors also harbor concerns regarding future oil price movements. In fact, many studies have examined thus far the effects of oil price shocks on the stock market. However, these studies have focused largely on responses of the US stock market to oil price shocks, although the response of the stock market in a small open economy may differ from that in the US.[1]

There are reasons why the reaction of the stock market in a small open economy differs from that in the US. First, although the US is the world's largest oil-importing economy, the reaction of the stock market in a small open economy could differ greatly, depending on whether the small open economy exports or imports oil. Second, a small open economy could be more oil-dependent in terms of production technology, but have limited access to the global financial market relative to the US. As a consequence, when oil price shocks exert a negative impact, the response of the stock market in a small open economy may be more pronounced than the response of the US stock market. Therefore, this study was conducted to investigate the reactions of the stock market in small open economies to oil price shocks, and then to compare those responses according to whether the small open economies export or import oil.

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[1] Limited examples for the studies on the US stock market include the works of Jones and Kaul (1996), Wei (2003), and Kilian and Park (2009).

To achieve this goal, we have selected and compared the stock markets in Norway and Korea deliberately. Although Canada and the UK also export oil, studies such as those of Bjørnland (2009) and Jimenez-Rodriguez and Sanchez (2005) reported that Canada and the UK behaved in a manner more consistent with that of the oil-importing economies. The Middle Eastern countries and Russia have been exporting oil, but very limited data is available regarding their stock markets. Unlike those countries, Norway has been a net oil exporter for the past three decades, has behaved much more like the oil-exporting economies, and also has a relatively long history of available stock market data. By way of contrast, Korea has imported almost 100% of the oil it has consumed, and has a reasonably well-developed stock market owing to its rapid economic growth.

Recent studies such as those of Kilian (2009) and Kilian and Park (2009) have demonstrated that the effect of oil price shocks on the macroeconomy or stock market differs profoundly, depending on the source of the rise in the oil price. Furthermore, the recent approach of Kilian (2009) and Kilian and Park (2009) would predict that this effect may not be symmetric between oil-exporting and oil-importing economies, depending on the source of the oil price shocks. More specifically, when oil prices rise in response to global economic activities, the stock markets boom initially in both the oil-exporting and oil-importing economies, but that the effects of oil price shocks will be far more persistent in the oil-exporting economies than in the oil-importing economies. This is because a positive innovation to the world economic activity directly stimulates both oil-exporting and oil-importing economies; however, as the oil price rises, the initial direct effect will be offset in the oil-importing economy. However, the initial rise in the oil price owing to the aggregate demand shock (the shock to the global business cycle) further increases aggregate wealth, consumption, and investment, and strengthens the initial effects in the oil-exporting economy. Also, when oil prices rise due to the oil-specific demand shock (the demand induced by the fear that oil prices will rise more in the future), this effect could evolve into a persistent negative effect on economic activity and the stock market in oil-importing economies. By way of contrast, the same oil price shock may initially exert a positive effect (increase in wealth due to the increase in the oil price), although that effect may be dampened out quickly in the oil-exporting economy as the oil-specific demand shock slows global economic activity. The results obtained herein demonstrate that not only the sign of the effects of oil price shocks, but also the duration of those shocks strongly depends on the sources of oil price shocks; this implies the importance of identifying the cause of the increase in the oil price in attempting to understand stock market movements.

In addition to the stock return response, we have also evaluated the response of the stock return volatility to the oil price shock. We find that the responses of the volatility also depend on the cause of the oil price rise and the oil export/import status. Furthermore, when we combine the responses of returns and the responses of volatility, our results show the difficulty inherent to explaining the comovements between the responses of returns and the responses of volatility based on the risk-return tradeoff relation.

This paper is organized as follows. Section II provides a brief presentation of the econometric methodology used herein. The main results from stock markets in Norway and Korea are presented in Section III. Section IV offers some concluding remarks.

2. Data and Econometric Methodology

2.1. Data Description

Our analysis requires global crude oil market data and financial market data for Norway and Korea. The data regarding world crude oil production and its price are obtained from the website of the US Department of Energy,[2] and an indicator of real global activity, which were constructed from the shipping rates of dry cargo, are obtained from Kilian's homepage.[3] The shipping rate has been considered as having a strong correlation with world economic activity in many previous studies (see Kilian (2009) and references therein). The reason would be that the most important demand for transport service is the global economic activity whereas the supply for shipping service becomes very steep at the full capacity level (at the level where all ships are utilized). As a result, fluctuations of shipping rate can reflect the global economic activity in the short-run.

All financial market data are obtained from Datastream, and the financial data include the dividend yield, price index, exchange rate, and Consumer Price Index (CPI) for both Norway and Korea. Stock returns are constructed after recovering the level of dividends from the product of the dividend yield and price. Stock returns are deflated by the CPI inflation rate and the real exchange rates are constructed using individual countries' exchange rates, the CPI, and the US CPI. All data employed in this study are monthly data, and the sample period for Norway is 1980.1 – 2008.12, whereas the sample period for Korea is 1987.9 – 2008.12. The sample periods are dictated by data availability at Datastream.

2.2. Econometric Methodology

Although the conventional approach such as Hamilton (1983, 2003) and Mork (1989) assumes that the oil price shocks can be considered as exogenous and that the effect of oil price shocks would remain the same regardless of the source of the oil price rise, recent studies such as Barsky and Kilian (2002, 2004) demonstrate that the oil price moves endogenously. Furthermore, Kilian (2009) and Kilian and Park (2009) show that the

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[2] The web address is http://www.eia.doe.gov.
[3] The web address is http://www-personal.umich.edu/~lkilian/.

effects of oil price shocks differ profoundly depending on the source of the rise in the oil price. In order to incorporate these results, we employe the Structural VAR approach, which is similar to that demonstrated by Kilian and Park (2009). The SVAR in the present paper includes the growth rate of world oil production, a measure for global economic activities, the real price of crude oil, the real exchange rate, and the stock returns. The exchange rate is added because firms in a small open economy are interested in oil prices in terms of their local currency, whereas the global crude oil price is denoted in US dollars. In other words, firms in a small open economy, whether they export or import oil, are concerned not only about changes in the world crude oil price denoted in US dollars, but also changes in the exchange rate, which converts the oil price from US dollars to the local currency.[4]

Before presenting the SVAR, Table 1 shows summary statistics and the results of the unit root test for the variables included in the SVAR. As shown in Table 1, the unit root null hypothesis can be rejected for all variables at the 10% level. The exceptions are the real exchange rates for both Norway and Korea. The failure of the rejection of the null hypothesis is the well-known purchasing power parity puzzle, for which various reasons are provided in the literature. Since one of those explanations is the lack of power in the unit root test, we assume the real exchange rates are stationary and have included them in the SVAR.

The SVAR we have employed in this study can be expressed as follows:

$$A_0 Z_t = \alpha + \sum_{i=1}^{24} A_i Z_{t-i} + \varepsilon_t \qquad (1)$$

The order of variables in Z_t is the growth rate of global oil production, a measure for global economic activities, the real price of crude oil, the real exchange rate, and stock

[4] Stock returns are also denoted in the local currency for both Norway and Korea.

returns. This ordering inherently implies the following identification assumption:

$$e_t = \begin{pmatrix} e_{1t}^{\Delta\text{global oil supply}} \\ e_{2t}^{\text{global economic activity}} \\ e_{3t}^{\text{real price of crude oil}} \\ e_{4t}^{\text{exchange rate}} \\ e_{5t}^{\text{stock returns}} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \begin{pmatrix} \varepsilon_{1t}^{\text{oil supply shock}} \\ \varepsilon_{2t}^{\text{global demand shock}} \\ \varepsilon_{3t}^{\text{oil-specific demand shock}} \\ \varepsilon_{4t}^{\text{shocks to exchange rate}} \\ \varepsilon_{5t}^{\text{shocks to stock returns}} \end{pmatrix} \quad (2)$$

The underlying identification strategy is that the global crude oil price is changing because of oil supply shocks (ε_{1t}), global demand shocks (ε_{2t}), and oil-specific demand shocks (ε_{3t}). These structural shocks are assumed to be orthogonal to one another. We assume, further, that i) it takes at least one month for the crude oil supply to respond to demand shocks (the shock to the global economic activity or the shock driven by fear about future oil supply), ii) it also requires at least one month for the oil-specific demand shock to influence global economic activity. In addition to these identifying assumptions used by Kilian and Park (2009), we also assume that changes in the exchange rate in a small open economy cannot affect the world crude oil price within one month. However, the shock to the exchange rate (ε_{4t}), which is an innovation to the exchange rate that is not driven by the global crude oil market, can influence the oil price in terms of the local currency faced by domestic firms in a small open economy, and are assumed to affect the stock market in the small open economy through this channel. Finally, shocks to stock returns (ε_{5t}) include all innovations that affect the stock market in a small open economy, in addition to the demand and supply shocks in the global crude oil market and shocks to the exchange rate. Under our identifying assumptions, all shocks can be recursively identified, as shown in equation (2).

With the replacement of the stock returns with the stock return volatility, we additionally investigate the response of the volatility to oil price shocks. The monthly stock return volatility can be measured by the sum of the squared daily stock returns within one month--this is frequently referred to as the realized volatility. Since the realized volatility measure is a consistent estimate for the volatility of stock returns, the realized volatility is expected to reflect the average uncertainty in the stock market for a given month.[5]

3. Results from Structural VAR

3.1. The Response of the Crude Oil Price to Crude Oil Demand and Supply Shocks

We first examine the response of the real crude oil price to oil demand shocks and oil supply shocks under the SVAR specifications described in the previous section. The oil supply shock (ε_{1t}) is normalized to represent a negative one standard deviation shock, and the oil demand shocks (ε_{2t} and ε_{3t}) are normalized to represent a positive one standard deviation shock, such that all these shocks are supposed to raise the crude oil price. The responses of the real crude oil price to each of these shocks are shown in Figure 1 using the data for Korea.[6] The dotted lines show two-standard error bands, whereas the dashed lines indicate one-standard error bands. These confidence intervals are computed via the recursive design wild bootstrap method as described by Gonçalves and Kilian (2004).

As is shown in Figure 1, the oil supply shock can only temporarily raise the real price of oil, and the magnitude of this rise is never significant at the 5% level over the two-year horizon. Unlike the effect of the oil supply shock, oil demand shocks (ε_{2t} and ε_{3t}) exert much larger and longer effects, in terms of their magnitude and duration. The global demand shock can raise significantly the real price of oil at the level of 5%, and its effect lasts for approximately one year at the 5% level, or for longer than two years at the 10% level. The oil-specific demand shock also has a significant effect on raising the real price of oil at the 5% level over several months, although its effect gradually tapers off and peters out. The

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[5] See Andersen, Bollerslev, and Diebold (2010) and references therein for properties of the realized volatility.

[6] Since the data for Korea has slightly shorter sample period, we utilized the data for Korea to show the impulse responses of oil price to three structural shocks for the common sample period (1987.9-2008.12). However, the impulse responses of oil price to those structural shocks with the Norwegian data during the common sample period are qualitatively similar to those in Figure 1. The results are available upon request.

impact of the oil-specific demand shock becomes negative after approximately 15 months which may be related to the usual increase in the oil supply in response to the oil price hike by Saudi Arabia. Different structural shocks exert different impacts on the price of crude oil. All these responses are generally consistent with those reported by Kilian (2009) or Kilian and Park (2009), although the sample period in this study was 1987.9-2008.12, which corresponds to the common sample period for Norway and Korea.

3.2. Responses of Stock Returns: Norway vs. Korea

Figures 2 and 3 show the responses of stock returns to oil price shocks for Norway (an oil-exporting economy) and Korea (an oil-importing economy), respectively. It is apparent that different causes of oil price increases have heterogeneous effects on stock returns in terms of the sign and duration of the effect. The effects also differ according to whether an economy exports or imports oil. The upper left panels in Figures 2 and 3 show the responses of stock returns to the oil supply shock. Since the oil supply shock exerts no significant impact on the crude oil price, as shown in Figure 1, it exerts no significant effect on stock returns for either Norway or Korea. The impulse response never becomes significant at the 5% level. By way of contrast, the shock originated from the global business cycle exerts a significantly positive impact on the stock returns for both Norway and Korea, based on two-standard error bands. Although the sign of the immediate effect from the aggregate demand shock is the same for both Norway and Korea, the magnitude and duration of this effect differs greatly across those two economies. The aggregate demand shock has a much more profound and persistent effect on Norway than on Korea. For example, the impact of the global demand shock is persistent for approximately 15 months at the 5% level in Norway, whereas its effect becomes insignificant after 3 months in Korea. The aggregate demand shock initially raises the stock price and oil price simultaneously. However, the increase in the oil price results in lower demand and higher production costs in Korea. Hence, the effect becomes insignificant shortly following the shock. In Norway, the increase in the oil price raises consumption and investment further from the oil industry to the rest of the industries, which dominates the side-effect of the increase in the oil price. As a consequence, the positive effect from the aggregate demand shock persists for far longer in Norway than in Korea.

The effect of the oil-specific demand shock, which is shown in the lower left panels in Figures 2 and 3, also differs substantially between Norway and Korea. The increase in the oil price resulting from the oil-specific demand shock raises stock returns on impact and one month after the shock occurrence in Norway, but becomes insignificant for the remaining horizons (up to two years). This might be because the initial positive effect derived primarily from the oil industry is offset by the increase in the production cost or reduction in the demand from other industries or from other oil-importing countries. However, the increase in the crude oil price owing to the oil-specific demand shock has a negative effect only in Korea, since the majority of industries therein are expected to experience lower demand and higher production costs from the rise in the oil price deriving from the oil-specific demand shock. As a consequence, the effect of the oil-specific demand shock becomes significantly negative following the impact until at least the 16-month horizon.

The dynamics of the effect of the exchange rate shock also differs between oil-exporting and oil-importing economies. The exchange rate shock has a significantly positive effect for the first three months in Norway, whereas it has a negative impact for the first 10 months, becomes insignificant, and exerts a positive impact after 20 months in Korea. In Norway, the increase in the oil price owing to the exchange rate shock initially raises oil industry earnings, but reduces demand and increases costs in other industries. Owing to this conflicting channel, the effect of the exchange rate shock is significant at short horizons only in Norway. In Korea, however, the increase in the exchange rate initially lowers domestic demand and raises production costs for most industries. As time elapses, the weak exchange rate stimulates exports from Korea, which gradually dominates the negative effects from higher domestic oil prices and generates a positive impact on stock returns. All plots in Figures 2 and 3 suggest strongly that identifying the cause of higher oil prices is particularly important when the effects of oil price shocks on stock returns are discussed for an oil-exporting small open economy or for an oil-importing small open economy.

Finally, the variance decomposition in Tables 2 and 3 quantifies the average importance of each of the relevant structural shocks on Norwegian and Korean stock returns. Whereas approximately 6-7% of the variations in stock returns from both countries can be explained by structural shocks in the world crude oil market on impact, approximately 33% (60%) of the variations in stock returns are associated with these shocks in the long run for Norway (Korea). The explanatory power of the structural shocks is far higher than that for the US, as shown in the study of Kilian and Park (2009), and this is probably associated with the more oil-dependent technology and limited access to global financial markets in these countries relative to the US. Aggregate demand shock accounts for 17% of stock return variations in Norway, and has the largest explanatory power. Almost 50% of stock return variations in Korea are accounted for by both aggregate demand shock and oil-specific demand shock.

3.3. Responses of Stock Return Volatility: Norway vs. Korea

In this study, we address the responses of stock return volatility to oil price shocks in Norway and Korea. First, we show, in Figure 4, the plots of estimated realized stock return volatility for both markets. The Norwegian stock market evidences extremely high volatilities during October 1987 (when the US stock market experienced crash), and during the recent global financial crisis. The Korean stock market evidences a sizeable spike in volatility during the period of the Asian financial crisis. The volatility had declined gradually since that time, but evidenced another large spike during the recent global financial crisis.

Figures 5 and 6 show the responses of stock return volatility to oil price shocks for Norway and Korea, respectively. In a manner similar to the stock return response, the dynamics of the effect of oil price shocks differ substantially depending on the cause of the rise in the crude oil price. Additionally, whether an economy exports or imports oil is clearly relevant to understanding the responses of stock return volatility. Sudden oil production disruptions do not exert a significant impact on the volatility for either market, owing to the limited effects of oil supply shocks on the crude oil price. However, aggregate demand shock can induce a substantial reduction of the volatility in an oil-exporting country, because of its sustained positive impact on the Norwegian stock market. The effect of the global demand shock is significantly negative for an approximate one-year horizon. Aggregate demand shock can reduce volatility in the Korean stock market, but its effect is significant upon impact and after the one-month horizon. This short-lived effect might be due to the fact that the aggregate demand shock simultaneously generates booming global activity and high oil prices.

The oil-specific demand shock and exchange rate shock do not induce any sustained and significant impacts on stock market volatility in Norway over the two-year horizon. In other words, these shocks have largely insignificant effects on Norwegian stock market volatility, with the exception of the brief but positive effect from the exchange rate shock, which persists for two to three months. By way of contrast, these two types of shocks are capable of significantly and persistently raising the levels of volatility in the Korean stock market. These responses indicate that these two shocks tend to negatively affect demand and production costs, which causes the stock returns to fall and the uncertainty to rise in Korea. Interestingly, although it requires approximately 20 months for the exchange rate shock to stimulate the export from Korea and exerts a positive effect on stock returns, the response of the volatility in the Korean stock market continues to remain at a significantly positive level, even after 20 months.

The variance decomposition is provided in Tables 4 and 5 to compute the average contribution of each type of structural shock on the level of volatility. Whereas shocks in the world crude oil market together are responsible for less than 5% of variations in the volatility on impact, their contributions increase with the horizon, and in the long-run the three shocks collectively explain approximately 40% of variations in the volatility in the Norwegian market. The aggregate demand shock has the highest level of explanatory power (26%) and the exchange rate shock can explain 11% of movements in the volatility. In the Korean market, shocks in the world crude oil market together account for merely 3% of variations in the volatility on impact, but their contributions rise rapidly and three shocks together explain approximately 47% of variations in the volatility in the Korean market in the long-run. Unlike the case of Norway, however, the oil-specific demand shock has the largest contribution (25%). Interestingly, the exchange rate shock has a very large explanatory power in the short-run, but its explanatory power converges to a level of approximately 25% in the long-run.

3.4. Comovements between Stock Returns and Volatility

Many finance theories predict a positive relation between stock returns and volatility. As risk-averse investors tend to dislike high volatility, stock returns must necessarily increase with increases in volatility or uncertainty. Without this compensation (high returns with high volatility), there would be no demand for stocks in the market. However, financial economists have experienced great difficulties in finding this tradeoff between risk and return from time series data. The majority of GARCH models have provided weak evidence for this prediction from the theory (see Lundblad (2007) and references therein). In this sub-section, we attempt to determine whether the responses of stock returns and volatility to oil price shocks can be explained by the risk-return tradeoff. In service of this objective, we employ the following measure of the conditional covariance based on the estimated impulse responses in previous sub-sections.

$$C(h) = r_h^{imp} \cdot v_h^{imp} \qquad (3)$$

where r_h^{imp} denotes the impulse response coefficient of real stock returns at horizon h to a given shock, and v_h^{imp} denotes the corresponding response of the stock return volatility. This comovement measure was proposed by Den Haan (2000) and Den Haan and Summer (2004), and was also employed in the studies of Kilian (2009) and Kilian and Park (2009).

Figure 7 presents the conditional covariance measure for the Norwegian market. Unlike the implication from the risk-return theories, no pronounced positive comovements occur between stock returns and volatility. In fact, the conditional covariance measure is significantly negative at the one-month horizon for the aggregate demand shock. These plots would appear to suggest that it is difficult to explain the comovements of the impulse responses on the basis of the risk-return tradeoff relationship. This conjecture is more pronounced in Figure 8, which demonstrates the conditional covariance measure for the Korean market. In Figure 8, we can detect strong negative comovements between stock return responses and volatility responses in many cases. This implies that when the aggregate demand shock (the oil-specific demand shock or the exchange rate shock) has a positive (negative) impact on the demand and cost of products in the short run, the shock also tends to reduce (raise) the level of uncertainty in the Korean market. This strongly implies that the risk-return tradeoff is limited in terms of providing insight vis-à-vis the impact of oil price shocks on stock returns or volatility. Instead, the source of oil price increase and the oil export/import status are important in understanding the effect of oil price shocks on stock returns and volatility.

4. Conclusion

In this study, we have investigated the responses of aggregate stock returns and volatility to oil price shocks in both the Norwegian and Korean markets. Both Norway and Korea are small open economies, although the former is an oil exporter and the latter is an oil importer. We find that the responses of aggregate stock returns and volatility differ substantially, depending on the underlying cause of the rise in oil price and also on whether the given economy is an oil exporter or an oil importer. Additionally, a larger portion of stock return variations in small open economies can be explained by the world crude oil market than that in the US, which implies that the small open economies possess more oil-dependent technology and more limited access to the global financial market. Finally, the analysis of the conditional covariance measure indicates that the responses of stock returns and volatility are not predicated on the risk-return tradeoff relationship. These findings must bear some important implications for investors who wish to adjust their portfolio in response to oil price shocks.

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Table 1. Results of the Unit Root Test

Variable	Mean	Standard Deviation	ADF statistic
Growth rate of global oil production	0.0004	0.0136	-12.8248***
Global economic activity index	-0.0286	0.2318	-3.5221***
Real price of crude oil	-1.0700	0.4770	-2.5715*
Real exchange rate for Norway	1.7736	0.1352	-2.1817
Real exchange rate for Korea	6.9438	0.1525	-2.0600
Stock returns for Norway	0.0283	0.0738	-4.7358***
Stock returns for Korea	0.0184	0.0870	-4.6356***

NOTES: The ADF test statistic is computed form the regression of $y_t = c + \rho y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \cdots + \gamma_{p-1} \Delta y_{t-p} + \varepsilon_t$, where y_t is the growth rate of global oil production, global economic activity index, the real price of crude oil, the real exchange rate for Korea or Norway, and stock returns for Korea or Norway. The lag order is determined sequentially. '*', '**', and '***' denote the significance level at the 10%, 5%, and 1% level, respectively.

Table 2. Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of Norway Real Stock Returns

Horizon	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock	Exchange rate shock	Other Shocks
1	0.0042	0.0280	0.0292	0.0258	0.9128
2	0.0043	0.0641	0.0286	0.0351	0.8679
3	0.0152	0.0809	0.0296	0.0360	0.8383
12	0.0400	0.0966	0.0507	0.0548	0.7578
∞	0.0691	0.1731	0.0839	0.0907	0.5832

NOTES: Based on variance decomposition of the structural VAR model (1).

Table 3. Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of Korea Real Stock Returns

Horizon	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock	Exchange rate shock	Other Shocks
1	0.0315	0.0433	0.0082	0.0199	0.8971
2	0.0272	0.0784	0.0233	0.0966	0.7746
3	0.0246	0.0688	0.1125	0.1060	0.6881
12	0.0277	0.1318	0.1638	0.1384	0.5384
∞	0.1034	0.2385	0.2618	0.1367	0.2597

NOTES: Based on variance decomposition of the structural VAR model (1).

Table 4. Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of Norway Real Stock Return Volatility

Horizon	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock	Exchange rate shock	Other Shocks
1	0.0012	0.0431	0.0017	0.0012	0.9528
2	0.0118	0.0968	0.0041	0.0020	0.8853
3	0.0164	0.1221	0.0196	0.0153	0.8266
12	0.0374	0.1655	0.0491	0.0529	0.6952
∞	0.0425	0.2634	0.1002	0.1112	0.4827

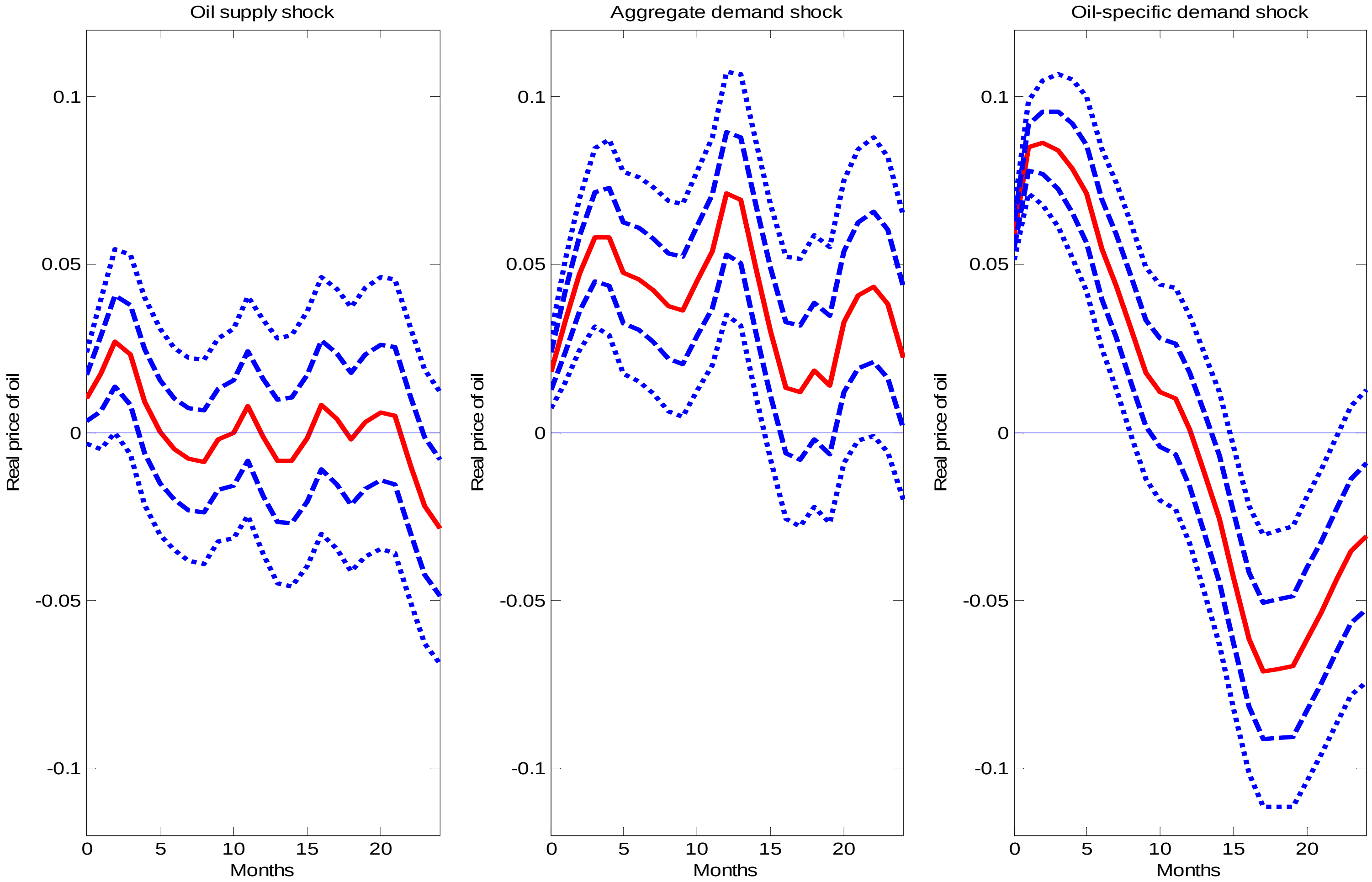
NOTES: Based on variance decomposition of the structural VAR model (1).

Table 5. Contribution of Demand and Supply Shocks in the Crude Oil Market to the Overall Variability of Korea Real Stock Return Volatility

Horizon	Oil Supply Shock	Aggregate Demand Shock	Oil-specific Demand Shock	Exchange rate shock	Other Shocks
1	0.0009	0.0263	0.0002	0.2497	0.7228
2	0.0113	0.0475	0.0116	0.4233	0.5064
3	0.0107	0.0412	0.0306	0.4325	0.4850
12	0.0305	0.0479	0.2177	0.3477	0.3562
∞	0.0655	0.1612	0.2505	0.2531	0.2697

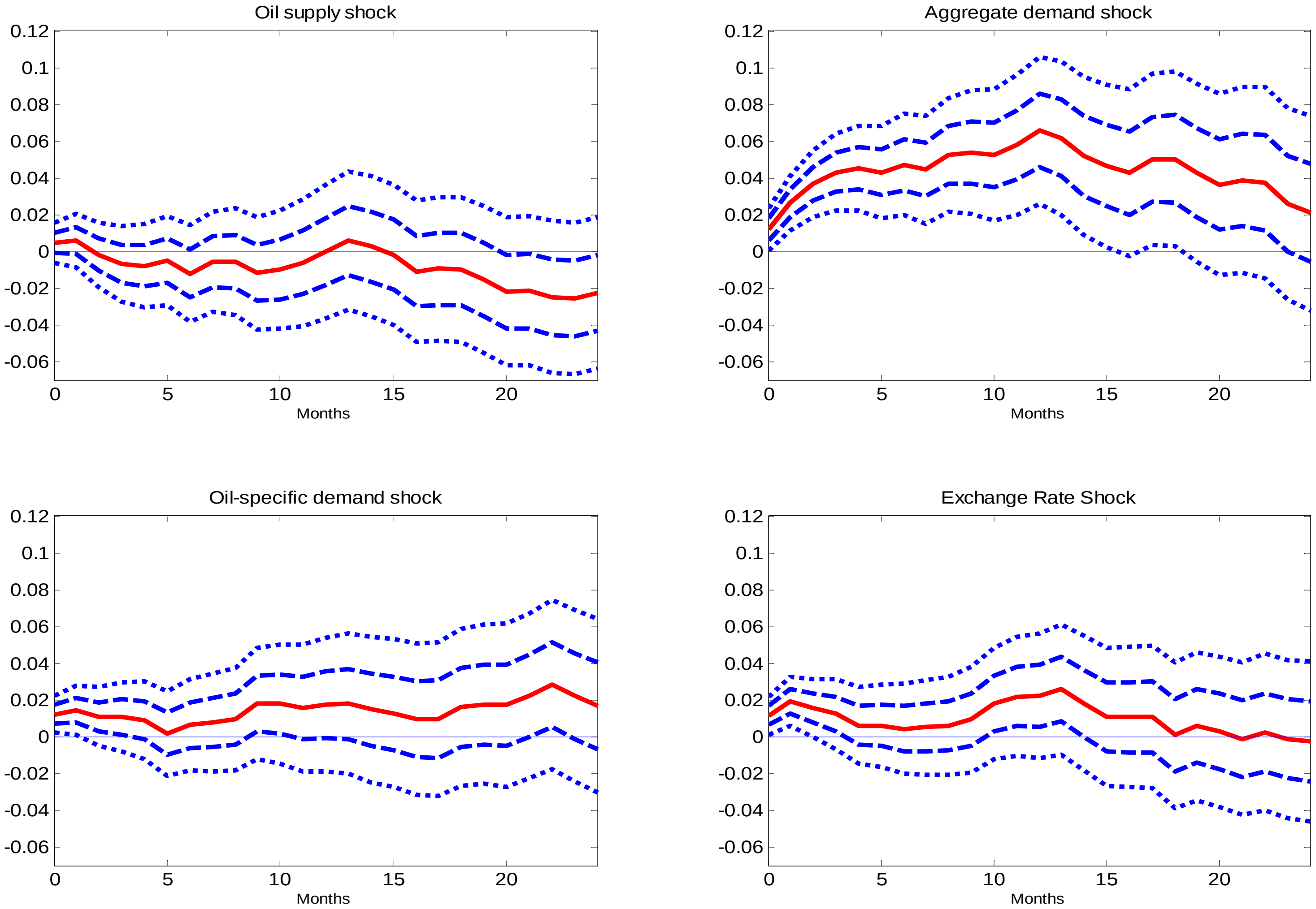
NOTES: Based on variance decomposition of the structural VAR model (1).

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



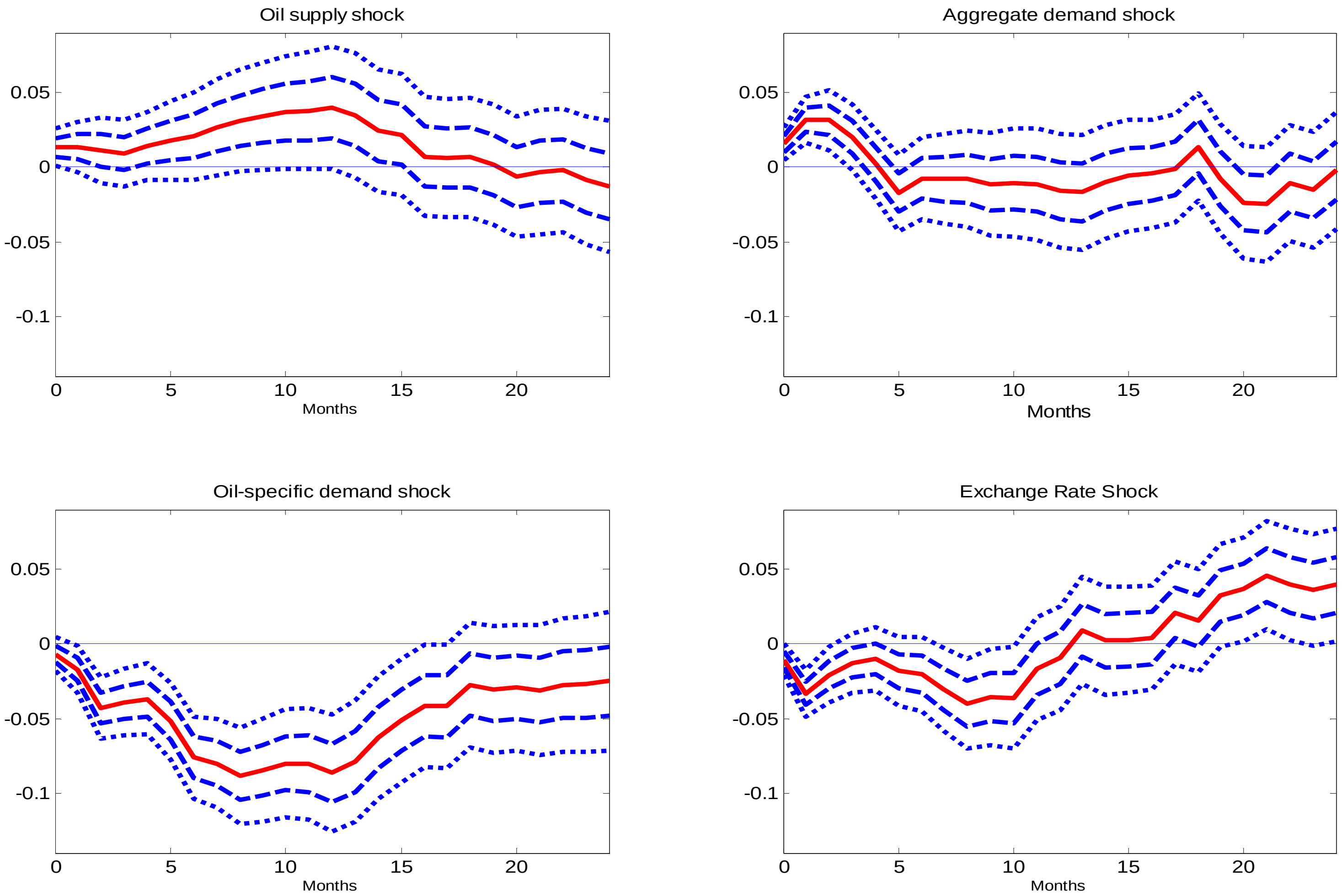
NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Kilian, 2004).

Figure 2. Cumulative Reponses of Norway Real Stock Returns Point Estimates with One- and Two-Standard Error Bands



NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Killian, 2004).

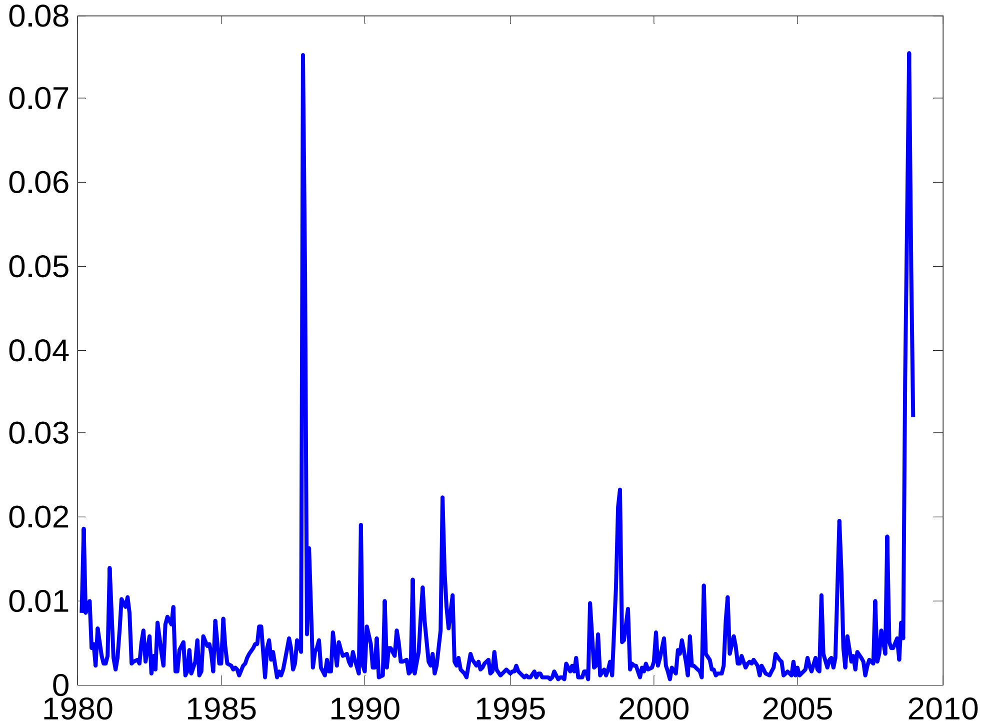
Figure 3. Cumulative Reponses of Korea Real Stock Returns Point Estimates with One- and Two-Standard Error Bands



NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Killian, 2004).

Figure 4. Stock Market Volatilities: Norway and Korea

Volatility in the Norwegian Stock Market



Volatility in the Korean Stock Market

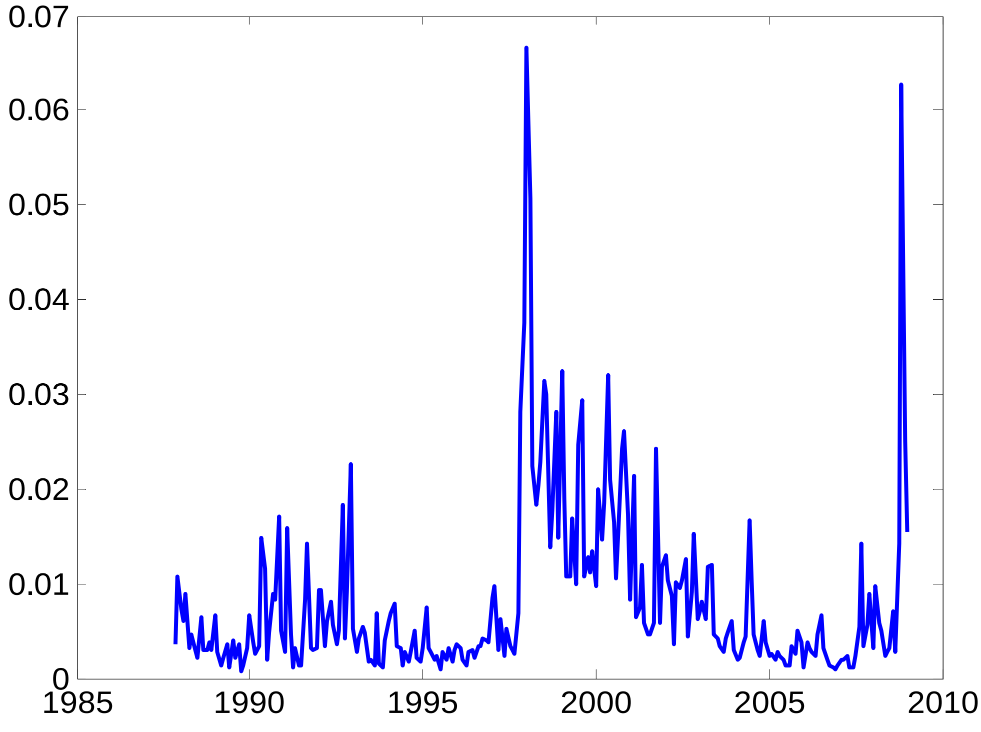
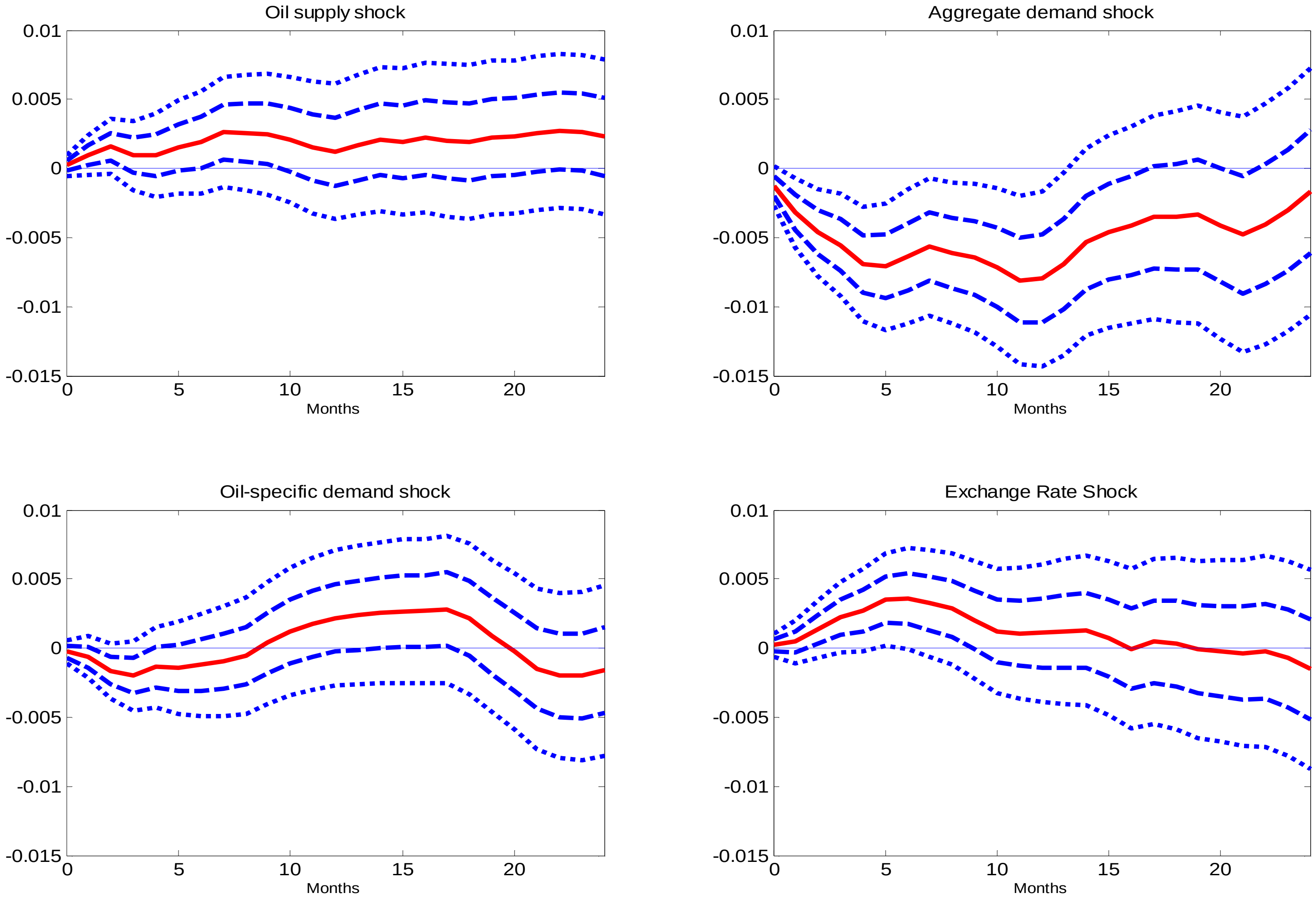
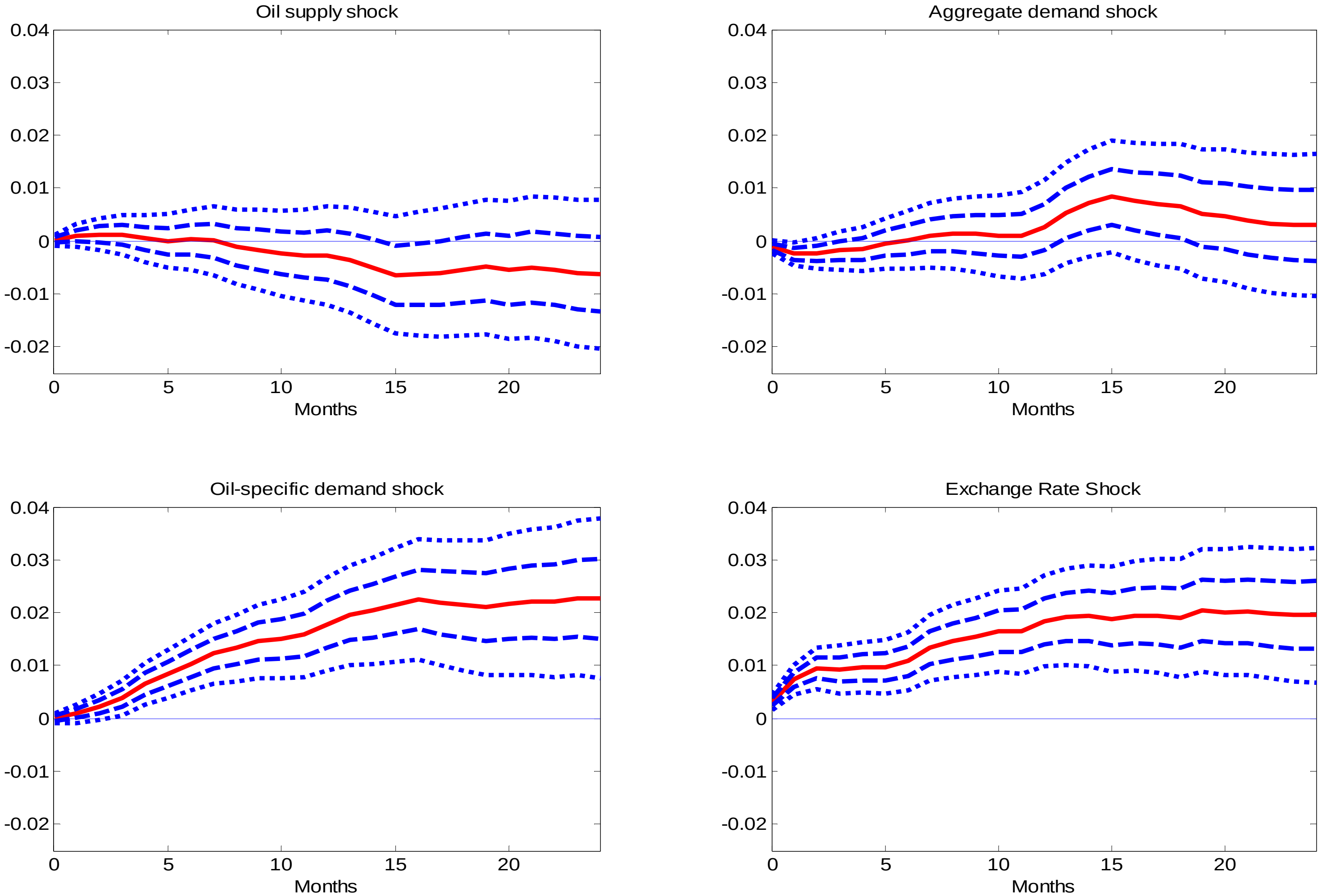


Figure 5. Cumulative Reponses of Norway Real Stock Return Volatility Point Estimates with One- and Two-Standard Error Bands



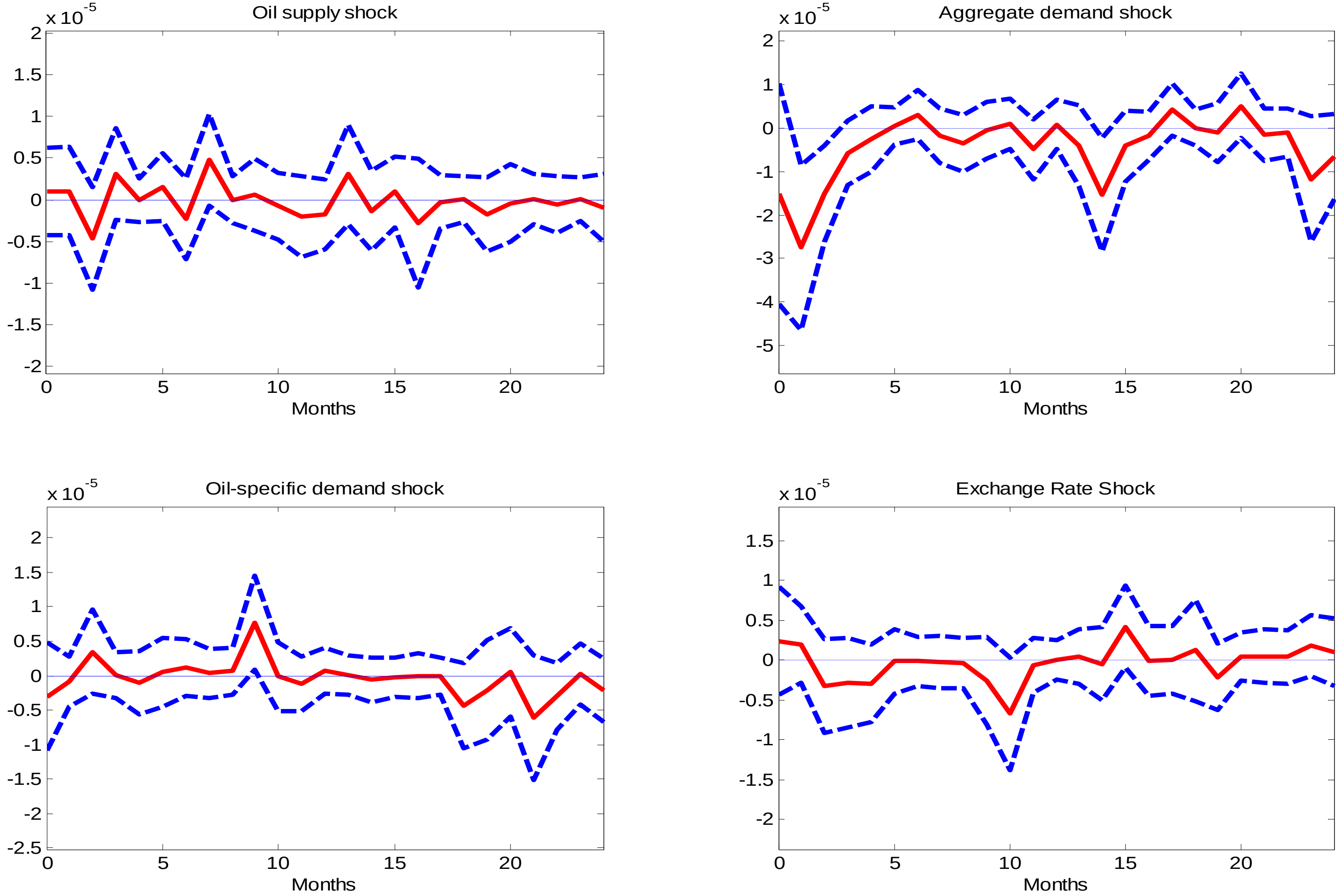
NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Killian, 2004).

Figure 6. Cumulative Reponses of Korea Real Stock Return Volatility Point Estimates with One- and Two-Standard Error Bands



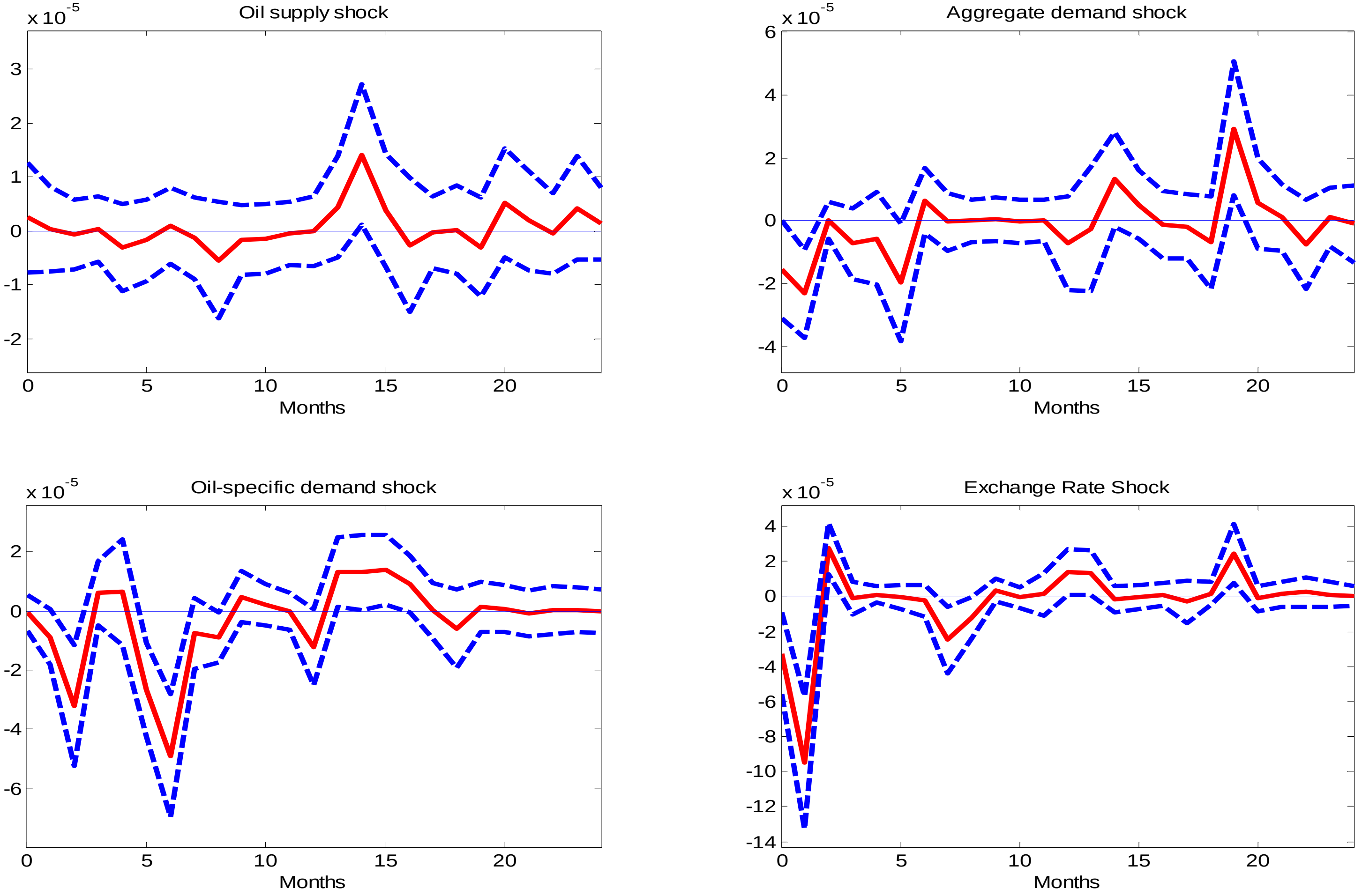
NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Killian, 2004).

Figure 7. Conditional Covariance between Responses of Norway Real Stock Returns and Volatility: Point Estimates with 90% Confidence Bands



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

Figure 8. Conditional Covariance between Responses of Korea Real Stock Returns and Volatility: Point Estimates with 90% Confidence Bands



NOTES: Estimates based on the VAR model described in text. The confidence intervals were constructed using a recursive-design wild bootstrap (see Gonçalves and Killian, 2004).