RIETI Discussion Paper Series 15-E-028

Oil Price, Exchange Rate Shock, and the Japanese Economy

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http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 15-E-028
March 2015

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Abstract

By using the framework of a structural vector autoregression (VAR) model, in this paper, we provide a quantitative assessment of the relative importance of exogenous shocks to Japanese output, as measured by aggregate sales, industry sales, and the sales of different firm-size groups. We analyze four structural shocks: (i) oil supply shock; (ii) oil price fluctuations not related to supply and demand; (iii) world economic activity (an aggregate demand shock); and (iv) exchange rate fluctuations not related to other structural shocks. We find that exogenous variation in oil production has little effect, whereas global economic conditions have a clear positive effect on output. The impact of the exchange rate depends on industry and firm size. Although appreciation of the yen has a negative impact on the Japanese economy as a whole, it has a clear positive effect on small and medium-sized enterprises in the nonmanufacturing sector. Our results suggest that recognizing the difference between fluctuations in the exchange rate and an exchange rate "shock" is important for macroeconomic policy management. In particular, much of the yen's appreciation following the Lehman Brothers collapse can be explained by the sudden slowdown in global real economic activity and the sharp decline in crude oil prices. Ignoring these factors greatly exaggerates the negative impact of the yen's appreciation on the Japanese economy.

Keywords: Japanese economy, Oil price, Exchange rates, Exports, Structural VAR
JEL classification: F31, F41, Q43

* This study is conducted as a part of the research project "Exports and the Japanese Economy: Experiences in the 2000s and the lessons for the future" at the Research Institute of Economy, Trade, and Industry (RIETI). We appreciate comments from Masahisa Fujita, Takatoshi Ito, Masayuki Morikawa, and seminar participants at RIETI. Iwaisako also acknowledges the financial support from Grant-in-Aid for Scientific Research (A) 25245037.
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1 Introduction

For many years, the most important exogenous shocks to the Japanese economy have been exchange rate fluctuations and energy price increases, particularly crude oil price increases. The impact of oil prices on macroeconomic activity has been an important research theme and policy concern in many developed countries as well as in Japan since the first oil shock of the early 1970s. Such analyses include those of Bruno and Sachs (1985), Hamilton (1983, 1996), Davis and Haltiwanger (2001), and Lee and Ni (2002). More recently, strong economic growth and the increased presence of emerging countries have strengthened energy demand and caused oil prices to surge. Whether such sharp increases in crude oil prices reflect global economic fundamentals or speculative concerns, which may generate asset bubbles, has been the subject of debate (Barsky and Kilian 2004; Blanchard and Gali 2007; Hamilton 2003, 2011). Because the Japanese economy relies heavily on importing energy from abroad, understanding the effects of oil price movements on the domestic economy is particularly important for Japan.

Economists and policy makers have been more interested in exchange rate fluctuations than in energy prices because of the Japanese economy's heavy dependence on exports. Although external demand and exchange rates have been considered important for the domestic business cycle, historically, so too have crude oil prices and their impact on the yen. In particular, because the postwar Japanese economy has relied heavily on imports of crude oil, rising crude oil prices have always been recognized as a contributor to a weaker yen. Hence, one would expect a "good" yen depreciation due to economic expansion overseas to affect the performance of Japan's economy and its industries differently to a "bad" yen depreciation due to higher crude oil prices. A historical example is the rapid appreciation of the yen following the Plaza Accord of September 1985, which caused the subsequent "strong-yen recession (Endaka Fukyo)" of 1986, which is generally considered to be the result of the international policy coordination used to correct the Reaganomics-induced overvaluation of the US dollar in the early 1980s. At the same time, the appreciation of the yen in this period occurred in parallel with the substantial drop in crude oil prices subsequent to the second oil shock in the early 1980s. In that sense, the yen appreciation in the mid-1980s could be characterized as a "good" one. Thus, identifying the key drivers of Japan's exchange rate movements is important for analyzing the impact of exchange rates on output, and this is expected to have important implications for macroeconomic policy management.

Hence, identifying the structural shocks behind oil price and exchange rate movements is important for fully understanding their effects on domestic business conditions. In this paper, we extend the empirical framework developed by Lutz Kilian (Kilian 2009; Kilian and Park 2009). This enables us to distinguish between the exchange rate fluctuations explained by other structural shocks, including oil price shocks and those unrelated to such shocks. Then, we investigate the effects of these structural shocks on Japan's macroeconomic and industry performance.

Fukunaga, Hirakata, and Sudo (2011) were the first to apply Kilian's framework to analyzing the effect of oil prices on Japan's macroeconomic performance. Our approach differs from theirs, and from Kilian's original studies of the US economy, by explicitly identifying the temporal exchange rate shocks that cannot be explained by economic fundamentals including oil prices. In addition, we analyze quarterly data on all Japanese industries, obtained from the Financial Statements Statistics of Corporations by Industry (in Japanese, Houjin Kigyo Toukei; hereafter FSSCI). By contrast, Fukunaga, Hirakata, and Sudo (2011) used monthly industrial production data to analyze only manufacturing industries. Hence, our coverage is broader and includes nonmanufacturing sectors of the Japanese economy.

2 Framework of Analysis and the Estimation of Structural Shocks

To examine the quantitative impact of exogenous changes in crude oil prices on the economy, it is important to make an identifying assumption that distinguishes the price movements due to supply shocks from those due to demand shocks. The observed crude oil price fluctuations reflect the influence of both supply and demand, as well as the temporary demand shocks based on precautionary and/or speculative motives induced by expected future price movements. Therefore, to appropriately evaluate the effect of pure exogenous oil price changes, we must make an assumption that identifies exogenous structural shocks as being distinct from actual oil price movements.

2.1 Kilian's structural VAR

In a series of papers (Kilian 2009; Kilian and Park 2009), Lutz Kilian addressed this issue by proposing a new measure of global real economic activity based on data on ocean freight transport fares, which is then used to identify the global demand for crude oil. To analyze the impact of exogenous shocks on the US economy, he assumed that crude oil supply does not respond to shocks to the demand for oil within the same month.

Specifically, Kilian (2009) assumed that the current month's oil price movements are driven by three types of structural shocks. The first is changes in global crude oil supply capacity, or exogenous shocks to oil supply, such as those induced by coordinated OPEC production cuts. He referred to these as oil "supply shocks". The second type of shock relates to global economic conditions, referred to as "aggregate demand shocks". Third, there are changes in current demand based on expected future oil price fluctuations. Such demand shocks are based on precautionary and/or speculative motives; in what follows, these are referred to as crude oil market "specific shocks." For example, increased geopolitical risk in the Middle East is expected to generate a precautionary demand for oil because of the increased possibility of future production cuts. Alternatively, when the global economy expanded strongly in the mid-2000s, some investors might have expected further expansion, which would have generated speculative demand for oil in anticipation of further economic expansion and crude oil price increases. These demand shocks are considered "oil market specific demand shocks." However, for our empirical work, we treat these market specific shocks as oil price fluctuations that are not explained by oil supply shocks or aggregate demand shocks. Because such "specific shocks" are represented by estimated residuals that cannot be explained by other structural shocks, their meaning is open to economic interpretation and requires careful discussion.

Kilian estimated the following three-variable VAR system for oil production, global economic activity (aggregate demand), and the oil price:

$$X_t = \alpha + \beta X_{t-1} + u_t. \tag{1}$$

$$X_t \equiv \begin{bmatrix} \mathrm{prod}_t \\ \mathrm{real}_t \\ \mathrm{poil}_t \end{bmatrix}, \quad u_t \equiv \begin{bmatrix} u_t^{\mathrm{prod}} \\ u_t^{\mathrm{real}} \\ u_t^{\mathrm{poil}} \end{bmatrix}, \quad \mathrm{E}\left[u_t u_t'\right] = V.$$

The variables in the VAR system are:

- prod_t: growth rate of world crude oil production;

- real_t: proxy for global real economic activity (Killian);
- poil_t: crude oil price.

Kilian imposed the following restrictions relating to the observed variables and structural shocks:

$$u_t = \begin{bmatrix} u_t^{\text{prod}} \\ u_t^{\text{real}} \\ u_t^{\text{poil}} \end{bmatrix} = A_0 \epsilon_t = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} \epsilon_t^{SY} \\ \epsilon_t^{DE} \\ \epsilon_t^{OIL} \end{bmatrix}, \tag{2}$$

$$\mathrm{E}\left[\epsilon_t \epsilon_t'\right] = I.$$

The structural shocks are defined as follows:

- ϵ_t^{SY}: oil supply shock;
- ϵ_t^{DE}: aggregate demand shock;
- ϵ_t^{OIL}: oil market specific demand shock.

This assumption has a number of implications for the relationship between the observed data series in the current month and the structural shocks. (i) The coefficients in the first row of A_0, which represent the effects of structural shocks on observed oil supply, are zero except that a_{11} implies that the change in crude oil supply in a particular month is not affected by any other shock. (ii) The coefficients a_{21} and a_{22} in the second line of A_0, which represent the relationship between observed real economic activity and the structural shocks, are nonzero. This implies that global real economic activity in the current month is affected by the oil supply and demand shocks, but is not affected by the crude oil price in the same month ($a_{23} = 0$). (iii) All coefficients in the third row of A_0 are nonzero, which implies that the oil price in the current month is affected by all structural shocks.

Having imposed such restrictions, Kilian (2009) estimated a monthly series for structural shocks, and then converted this to quarterly data. He regressed US GDP growth on the quarterly structural shocks to investigate the effects of three different sources of oil price fluctuations: oil supply shocks, oil price changes due to aggregate demand shocks, and oil price changes due to temporary market specific oil price shocks. Using monthly data on industrial production, Fukunaga, Hirakata, and Sudo (2011) applied Kilian's analytical framework to Japan.

2.2 Extension of the System to include Foreign Exchange Rates

We extend Kilian's framework and add exchange rates fx_t as a fourth variable to our VAR system. This implies that there is another structural shock ϵ_t^{FX}, which represents a foreign exchange market specific shock that is not contemporaneously correlated with any of the other three structural shocks. We assume that current movements in the exchange rate are affected by all structural shocks. Thus, we impose the following restrictions on the four-variable VAR system to identify the structural shocks, as we did for the three-variable system in equation (2):

$$u_t = \begin{bmatrix} u_t^{\mathrm{prod}} \\ u_t^{\mathrm{real}} \\ u_t^{\mathrm{poil}} \\ u_t^{\mathrm{fx}} \end{bmatrix} = A_0 \epsilon_t = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \epsilon_t^{SY} \\ \epsilon_t^{DE} \\ \epsilon_t^{OIL} \\ \epsilon_t^{EX} \end{bmatrix}. \tag{3}$$

The restriction imposed by (3) implies that oil market specific demand shocks affect the contemporaneous exchange rate, but foreign exchange market specific demand shocks do not affect the current oil price. Admittedly, this is difficult to rationalize theoretically, but preliminary analysis suggests that the shapes of the impulse response functions hardly change if the ordering of the temporary oil price shocks and exchange rate shock is switched. Thus, in what follows, our empirical results are based on estimating a VAR system that incorporates the exchange rate shock as a fourth structural shock.

To estimate our structural VAR, we used data on global real economic activity from Kilian (2009) and Kilian and Park (2009). These data come in the form of an index that Kilian constructed from data on shipping freight from Drewry Shipping Consultants, Inc., which we downloaded from his website. Data on crude oil prices were obtained from the IMF's Primary Commodity Price Statistics, and represent the average (dollar) price of North Sea Brent, West Texas Intermediate, and Dubai Fateh. Data on Japan's real effective exchange rate are from the Bank of Japan's website.

Using these data, we estimated a VAR system, from which we obtained impulse response functions and the corresponding structural shocks series. The results are shown in Figure 1. The impulse response functions and structural shocks shown in the graphs are cumulative rather than per-period responses. This means that the current response to a structural shock is the sum of all previous responses.

First, let us consider the cumulative impulse response function shown in Panel A. The first column shows the responses of oil production to the structural shocks. The oil supply shock has a large immediate effect on oil production. Although the effect of the initial shock gradually diminishes, it never dies out. After six months, it decreases to about one-third of the initial response and remains statistically significant. Although the global demand shock does not affect oil production immediately, by assumption, it gives oil production a slight boost for about six to 12 months after the initial shock. The effects on crude oil production of both the temporary oil price shock and exchange rate shock are negligible.

[Figure 1 here]

In the second column, global real economic activity is hardly affected by the crude oil supply shock. By contrast, the global aggregate demand shock has a clear and persistent impact on global economic activity, and the market specific oil price shock has a temporary positive effect that lasts for up to six months. In the third column, the aggregate demand shock and particularly the market specific oil price shock have large positive impacts on oil prices. Although oil prices are hardly affected by the crude oil supply shock, this may be because no large oil supply shocks occurred during our sample period.

The fourth column shows the responses of real effective exchange rates to the structural shocks. A positive global demand shock slightly lowers the long-run value of the yen, for at least six months after the initial shock. By contrast, the exchange rate falls following a market specific oil price shock for up to six months. Reasonably, a temporary exchange rate shock has a large and persistent effect on the real effective exchange rate.

There are notable features of the cumulative structural shock series shown in Panel B of Figure 1. First, clear positive demand shocks were continuously generated from 2001 to 2007. Second, from the late 1990s, fluctuations in market specific oil price shocks increased substantially from their levels in the mid-1990s. The first point suggests that, in our VAR system, much of the global economic boom and oil price rise of the mid-2000s can be explained by the autonomous expansion of the real economy itself. In relation to the second point, because we use 12-month averages of monthly shocks, the large swings in the oil price responses from the late 1990s do not necessarily imply that the average size of the temporary oil shocks has increased. Rather, the increased serial correlation in the specific shocks series based on monthly data has generated large observed fluctuations in the 12-month average monthly shocks.

Next, let us consider the exchange rate shocks. The graph of the cumulative shocks implies that there were large consecutive negative exchange rate shocks in the first half of the 1980s. Therefore, the sharp increase in the value of the yen following the Plaza Accord of September 1985 simply represents a recovery in its value following the excessive depreciation of the first half of the 1980s. The fact that the cumulative exchange rate shock peaks at around 1993 is consistent with Japan's real effective exchange rate recording its historical peak around 1993–1995. Another feature of the graph is the relatively long period of consecutive negative shocks, which suggest a weak trend in the yen in 2000–2004. These were followed by consecutive positive shocks in 2008 and 2009, after the collapse of Lehman Brothers. However, the cumulative exchange rate shocks were no more volatile after 2000, and were perhaps less volatile in the second half of the 2000s, than they were in the 1980s and 1990s. Therefore, in the 2000s, aggregate global demand shocks and oil market specific demand shocks had much more important quantitative impacts on the real effective exchange rate than did exchange rate shocks.

In his original analysis, Kilian did not use the variable that we have labeled "exchange rate specific shock". Hence, this variable warrants detailed discussion. The variable "exchange rate shock" represents real effective exchange rate fluctuations that cannot be explained by other structural shocks, i.e., oil supply shocks, global aggregate demand shocks, and oil market specific demand shocks. To illustrate the difference in the movements of real effective exchange rates and cumulative pure exchange rate shocks, we plot these two series on the same graph in Figure 2.

In Figure 2, cumulative exchange rate shocks dipped below real effective exchange rates in the first half of the 1980s, as partially discussed earlier. Crude oil prices reached their local peak around the time of the second oil shock in the late 1970s. Adjusted for inflation, the price of crude oil at the beginning of the 1980s was only slightly below its all-time historical peak in 2007 and 2008, immediately before the collapse of Lehman Brothers. The price of crude oil dropped sharply around 1985. Given that lower oil prices benefit the Japanese economy, the oil price decline in the mid-1980s explains much of the yen's appreciation in 1985–1986. Pure exchange rate shocks played a much more important role in the appreciation of the yen after the collapse of the bubble economy, from 1992 to the summer of 1995. Therefore, the estimated effect of the exchange rate on Japan's economy and industries differs significantly depending on whether one uses as an explanatory variable a raw exchange rate variable or exchange rate specific shocks that cannot be explained by other exogenous shocks.

[Figure 2 here]

3 The Japanese Economy's Response to Structural Shocks

Next, we use the following model to regress quarterly industry sales data y_t on our estimated structural shock series:

$$y_t = \delta + \sum_{i=0}^{24} \psi_i \widehat{\epsilon}_{t-i} + \nu_t, \tag{4}$$

where y_t represents the 12-month rate of change in industry sales denominated by the GDP deflator, and $\widehat{\epsilon}_{t-i} = \left[\begin{array}{cccc} \epsilon_{t-i}^{SY} & \epsilon_{t-i}^{DE} & \epsilon_{t-i}^{OIL} & \epsilon_{t-i}^{EX} \end{array} \right]'$ is the vector of structural shocks at time t estimated using restriction (3).

However, our regression relates quarterly output data to explanatory variables on the right-hand side that are structural shocks converted from monthly data to quarterly data. Hence, by construction, the response of industrial sales y_{t+1} to the structural shocks at time t is

$$\frac{dy_{t+1}}{d\widehat{\epsilon}_t^k}, \tag{5}$$

where the k subscript denotes the four individual structural shocks, SY (the crude oil supply shock), DE (the global demand shock), OIL (specific price shocks in the crude oil market), and EX (the shock unique to the exchange rate market). If each variable is stationary, for t,

$$\frac{dy_t}{d\widehat{\epsilon}_{t-1}^k} = \frac{dy_{t+1}}{d\widehat{\epsilon}_t^k} = \psi_{ik}, \tag{6}$$

which can be used to calculate (cumulative) impulse responses to structural shocks.

To measure output, we use quarterly industry sales data from FSSCI. In related research, Fukunaga, Hirakata, and Sudo (2011) applied Kilian's framework to the Japanese economy and used monthly data on industrial production. The FSSCI data cover the nonmanufacturing and service industries, which are not covered by the industrial production data. FSSCI also has subgroup data for each industry based on corporations' capital levels. Although the choice of break points is rather arbitrary, this subdivision enables us to examine whether responses of large and small corporations in the same industry differ. However, industrial production data have higher frequency and generate greater sample sizes than FSSCI data.

Figure 3 shows the impulse responses for total sales growth for all FSSCI corporations and for different subgroups in intervals of 100 million yen of capital stock. Subgroups are also divided into "manufacturing" and "nonmanufacturing and services". Table 1 summarizes the main results illustrated by Figure 3. Our ensuing discussion of the impulse responses for Japanese industries is based on Table 1.

[Insert Table 1 and Figure 3 here]

According to the results reported in Table 1, the oil supply shock had no statistically significant effect on sales growth, both overall and for the subgroups based on industry and capital size. The oil supply shock has no effect on output because our sample period starts in the early 1980s and does not include a period in which there were large production cuts, as occurred during the first oil shock. Although the aggregate demand shock (global economic activity) has a significant effect overall, its effects on small and medium-sized enterprises, particularly those in the nonmanufacturing and service industries, are rather limited. This is understandable given that large manufacturing firms are more internationalized and export dependent.

Our interpretation of the impulse responses to market specific oil price shocks is subtle. The results reported in Table 1 suggest that Japanese output responds positively to a temporary oil price increase, although the impulse responses are statistically significant only for large manufacturing corporations. This is consistent with the result obtained by Fukunaga, Hirakata, and Sudo (2011) using industrial production data. They argue that soaring oil prices give an advantage to Japanese companies that are good at developing energy-saving technology. However, the fact that we obtain similar results for the nonmanufacturing and service industries undermines this interpretation. In particular, as we explained when discussing the cumulative impulse responses to the structural shocks in Section 2.2, because the oil market specific price shocks are residuals, they represent fluctuations in oil prices that cannot be explained by either oil supply shocks or global aggregate demand shocks. Thus, including variables currently excluded from our VAR system that might explain the movements in these residuals could form the basis of future research.

The effects of exchange rate specific shocks differ in sign between subgroups, but are relatively straightforward to interpret economically. Although the output of large companies responds to an appreciation of the yen by falling, the output levels of small and medium-sized companies do not respond significantly. However, from the results for industry subgroups, irrespective of company size, an appreciation of the yen has a negative effect on manufacturing corporations, but a positive effect on small and medium-sized nonmanufacturing and service enterprises. Because the latter subgroup is less exposed to international competition, a yen appreciation primarily lowers their energy costs. A yen appreciation improves the profitability of retail and wholesale companies by lowering the price of imported products, provided that domestic prices are maintained.

Figure 4 and Table 2 report the results based on individual industry data. Because of space constraints, rather than report the results for all 33 industries, we select representative industries. For the same reason, we ignore subgroups based on capital stocks.

[Table 2 and Figure 4 here]

From the summary reported in Table 2, which is consistent with the results for the Japanese economy as a whole reported in Table 1, the oil supply shock does not have a significant effect on the quarterly sales of individual industries. The impact of global economic conditions, and thus overseas demand for Japanese exports, is particularly important for manufacturing industries and, unsurprisingly, less important for nonmanufacturing and service industries. Among nonmanufacturing and service industries, whereas foreign demand shocks clearly raise sales in the wholesale industry, they lower them in the retail industry, at least in the short term. A market specific oil price shock increases sales in several manufacturing industries. This is understandable in the case of the coal and petroleum industries, but less so for "electrical machines and appliances" and the chemicals industry. Hence, this warrants further research.

Exchange rate specific shocks strongly affect manufacturing industries and the aggregate economy. The effects in "automobiles and auto parts" are especially strong, particularly relative to "electrical machines and appliances" and the chemicals industry. Explaining this difference is beyond the scope of this paper but warrants further research. The effect of exchange rate shocks is unclear in wholesale but is clearly negative in retail, at least in the short run. Aggregate demand shocks also negatively affect short-run retail sales.

4 Conclusions

In this paper, we extended the analytical framework of Kilian and his coauthors to examine the effects of oil price shocks and exchange rate shocks that are not correlated with the Japanese economy's fundamentals. Specifically, we assumed four types of structural shocks: (i) oil supply shocks; (ii) oil price fluctuations that cannot be explained by contemporaneous demand and supply conditions; (iii) global demand shocks; and (iv) exchange rate fluctuations that are not explained by other factors. We regressed quarterly industry FSSCI sales data on these structural shocks to examine their effects on the Japanese economy as a whole, individual industries, and on subgroups of different-sized firms. Our empirical results suggest that exogenous variations in crude oil production have a negligible effect, but global demand shocks have a large effect on the Japanese economy. Whereas temporary fluctuations in exchange rates negatively affect the Japanese economy as a whole, they positively affect small and medium-sized firms in the nonmanufacturing and service industries. Temporary oil price fluctuations have a positive impact on Japanese output. Although these results are consistent with the findings of Fukunaga, Hirakata, and Sudo (2011), their economic interpretation warrants further research.

The time series plots of the cumulative structural shocks in Panel B of Figure 1 and the comparison of real effective exchange rates and the cumulative exchange rate shock in Figure 2 are particularly important for the policy implications of our empirical results. These two graphs suggest that the negative effects of the sharp appreciations in the Japanese yen, which occurred from late 1985 to 1986 following the Plaza Accord and in late 2008 to 2009 following the Lehman Brothers collapse, have been largely overstated. The yen's appreciation of the mid-1980s was a largely inevitable correction of the yen's excessive depreciation (relative to the US dollar) in the early 1980s. It also reflected the contemporaneous decline in crude oil prices, which to some extent made it a "good appreciation" of the yen.

In relation to the 2008–2009 appreciation, the cumulative structural shocks plotted in Panel B of Figure 1 clearly show that the sudden contraction of global economic activity (which substantially lowered foreign demand for Japanese exports) and the negative temporary shock in the price of crude oil played a large part in Japan's deteriorating domestic economic performance. To some extent, the appreciation of the yen that occurred in that period is attributable to exchange rate specific shocks included in our VAR system. However, the "exchange rate specific shocks" of the late 2000s were much less severe than those of the early 2000s. Hence, much of the yen's appreciation in this period resulted from the rapid contraction of global economic activity and the decline of crude oil prices.

Therefore, during the deep recession of 2009–2010, neither foreign exchange intervention in the form of aggressively selling the yen nor an accommodating monetary policy would have stopped the appreciation of the yen. Furthermore, even if Japanese policy makers had stopped the yen from appreciating, this would not have been sufficient to prevent a large reduction in Japanese exports because this was largely caused by rapidly declining foreign demand. Although this trend was reversed and the yen got weaker with the advent of "Abenomics" (the economic policies advocated by Japanese Prime Minister Shinzo Abe) and the implementation of an aggressive monetary policy by the new Bank of Japan governor Kuroda, Japanese exports have not recovered to the level they were at before the Lehman Brothers collapse because global aggregate demand has remained sluggish. Indeed, microeconomic factors, such as large manufacturers moving production overseas, are important explanations of why Japanese export growth remains weak despite the substantial depreciation of the yen. However, our results indicate that macroeconomic conditions have also played an important role. Hence, a quantitative assessment of the relative importance of different factors in explaining Japan's stagnating exports requires more careful examination in future research.

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Table 1
Domestic Industries' Responses to Structural Shocks

		Oil supply ϵ^{SY}_{t-i}	Demand ϵ^{DE}_{t-i}	Oil price ϵ^{OIL}_{t-i}	FX ϵ^{EX}_{t-i}
	all sizes	–	up	–	–
all industries	large	–	up*	–	down
	medium–small	–	up	–	–
	all sizes	–	up	–	down
manufacturing	large	–	up	up	down
	medium–small	–	up	–	–
nonmanufacturing	all sizes	–	up	–	–
and services	large	–	up*	–	down
	medium–small	–	–	–	–

Note: "up" denotes an impulse response to a particular shock that is significant at the 10% level for at least two consecutive quarters out of the 12 we examine. "up*" indicates that, in addition to the condition for "up", the increase of the variable in the last (12th) quarter is significantly positive. Similarly, "down" and "down*" indicate that the variable decreases.

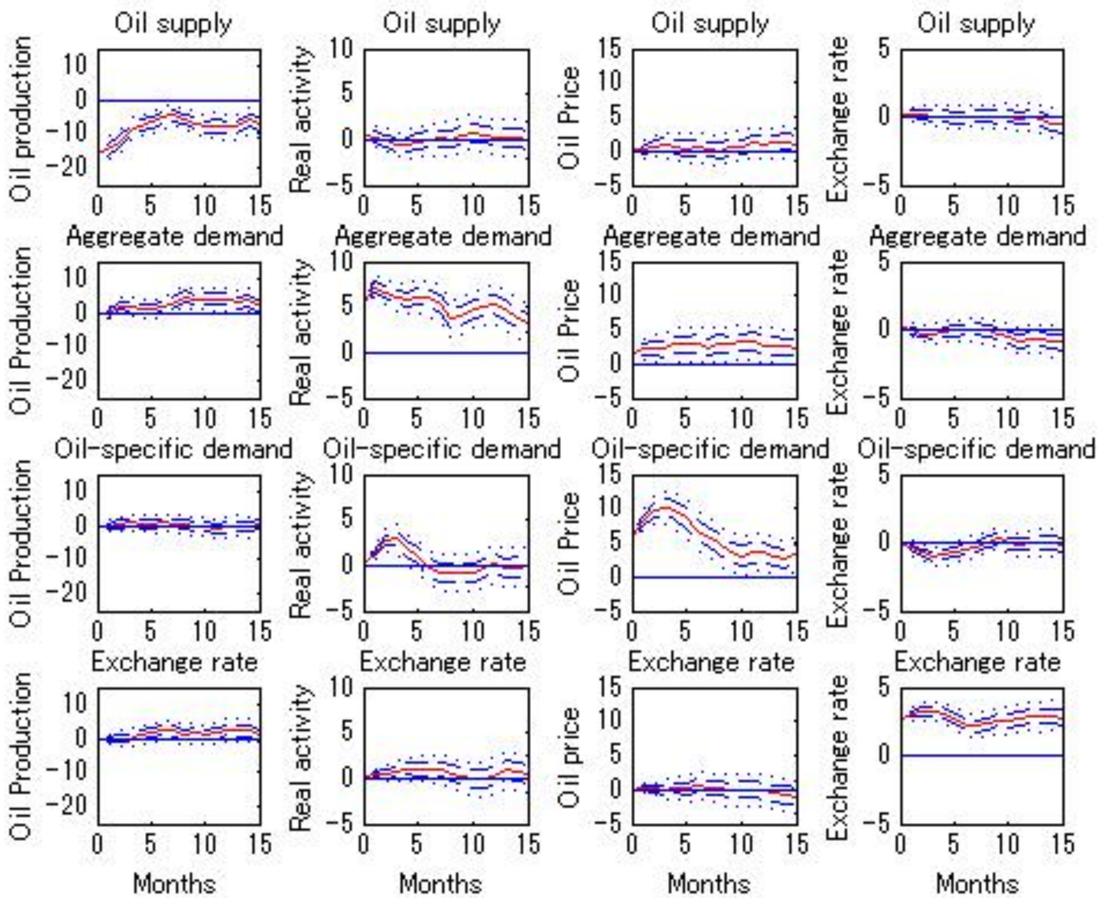
Table 2
Individual Industries' Responses to Structural Shocks

	Oil supply ϵ^{SY}_{t-i}	Demand ϵ^{DE}_{t-i}	Oil price ϵ^{OIL}_{t-i}	FX ϵ^{EX}_{t-i}
coal and petroleum	–	up*	up	–
automobiles and auto parts	–	up	–	down*
electrical machines and appliances	–	up	up	–
chemicals	–	up*	up	down
land transportation	–	–	–	down
wholesale	–	up*	–	–
retail	–	down?	–	down?
real estate	–	–	–	–
construction	–	–	–	–

Note: See note to Table 1.

Figure 1   Impulse Responses to Structural Shocks

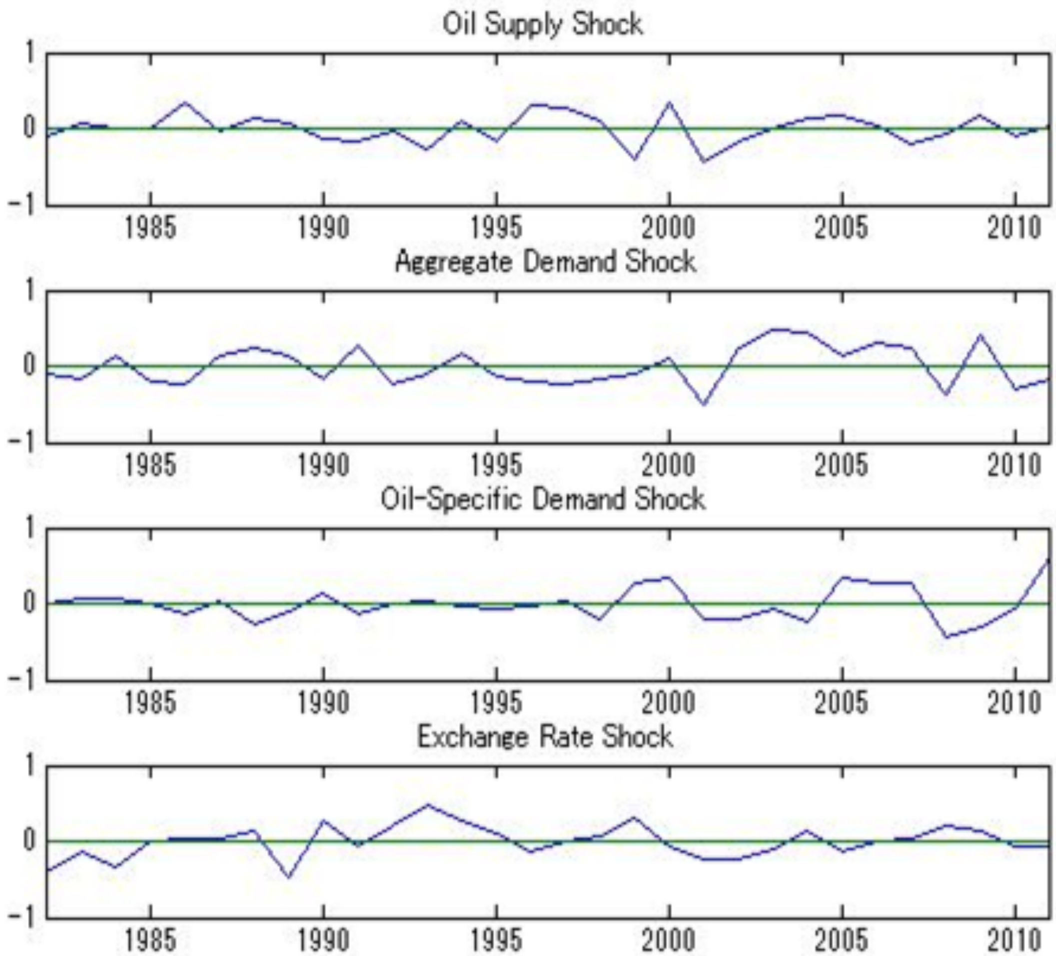
Panel A: Cumulative impulse response functions



Note: The upper and lower bands shown in the graphs represent ±1 standard errors (solid lines) and ±2 standard errors (dotted lines).

Figure 1 (continued)

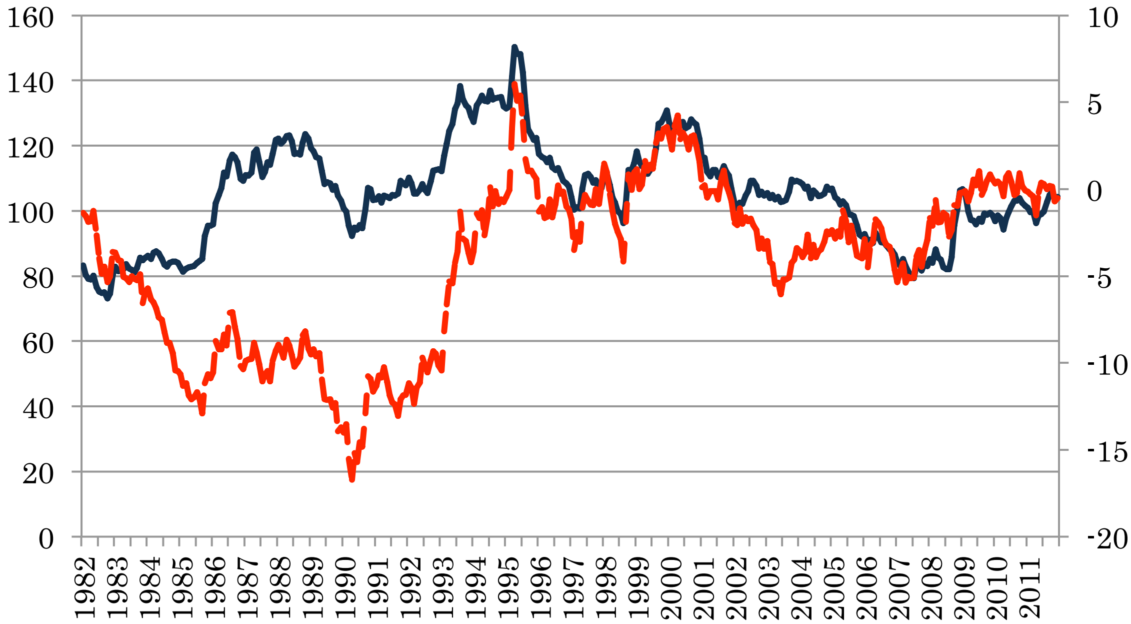
Panel B: Time series of structural shocks



Note: 12-month moving averages of structural shocks calculated using identifying restriction (3) are plotted.

Figure 2 Japan's Exchange Rate and Oil Price: 1982–2011

Panel A: Japan's real effective exchange rate (solid line) and cumulative exchange rate specific shock (dotted line)



Panel B: Real oil price

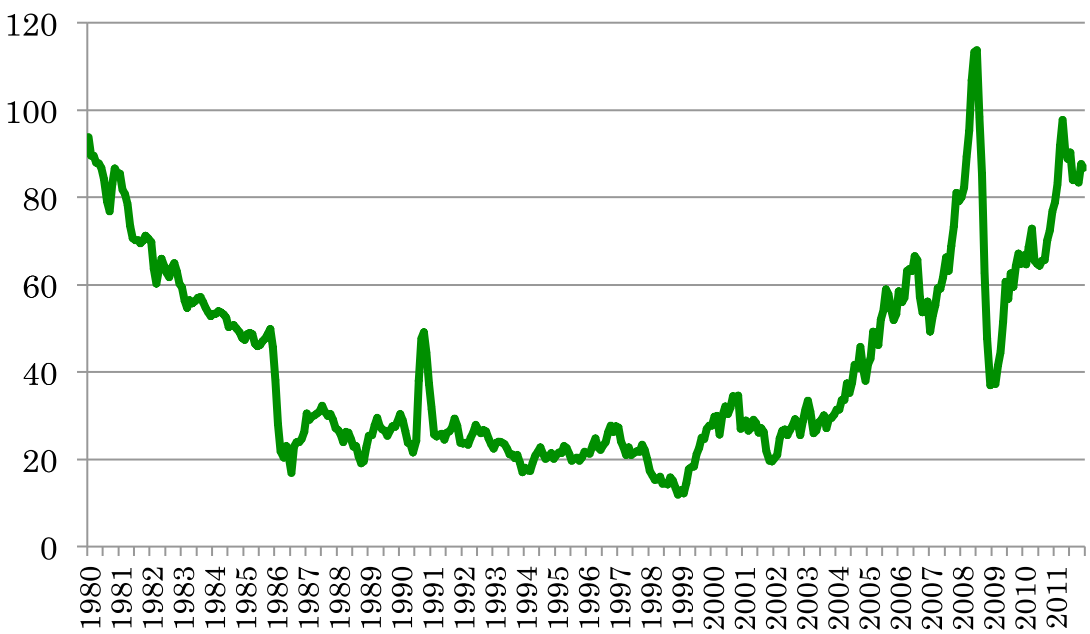
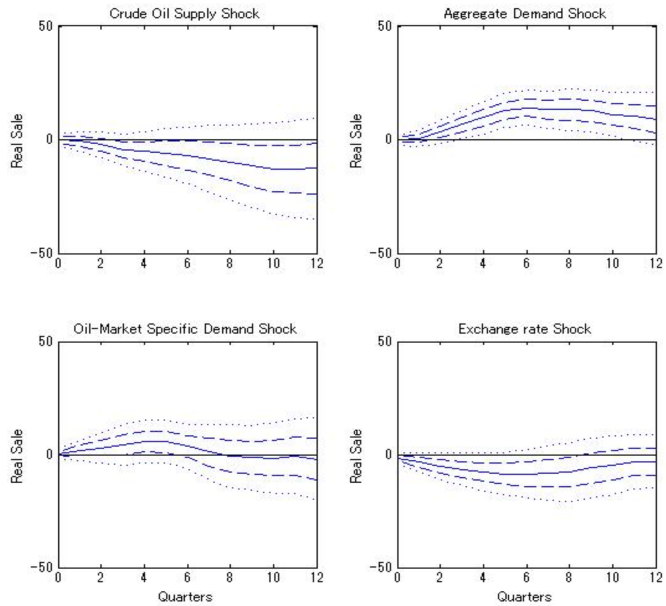


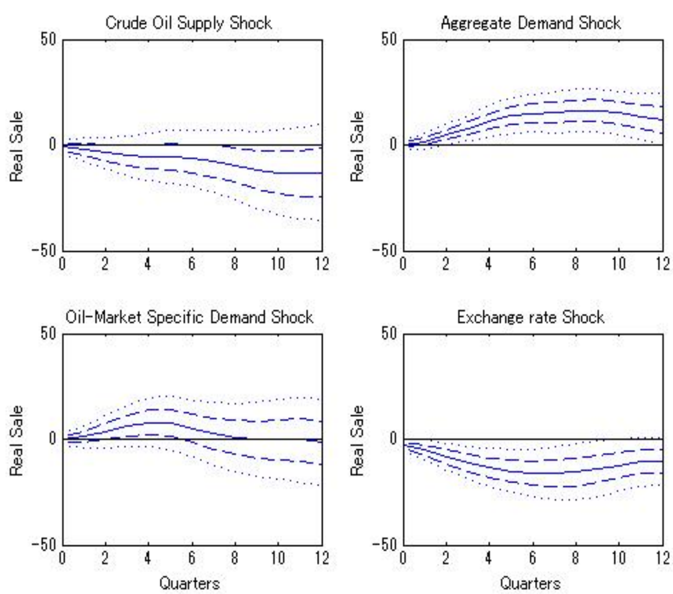
Figure 3 Effects of Structural Shocks on the Japanese Economy

Impulse responses calculated from a regression of sales data from Financial Statements Statistics of Corporations by Industry on structural shocks. See the note for Figure 1 about standard error bands.

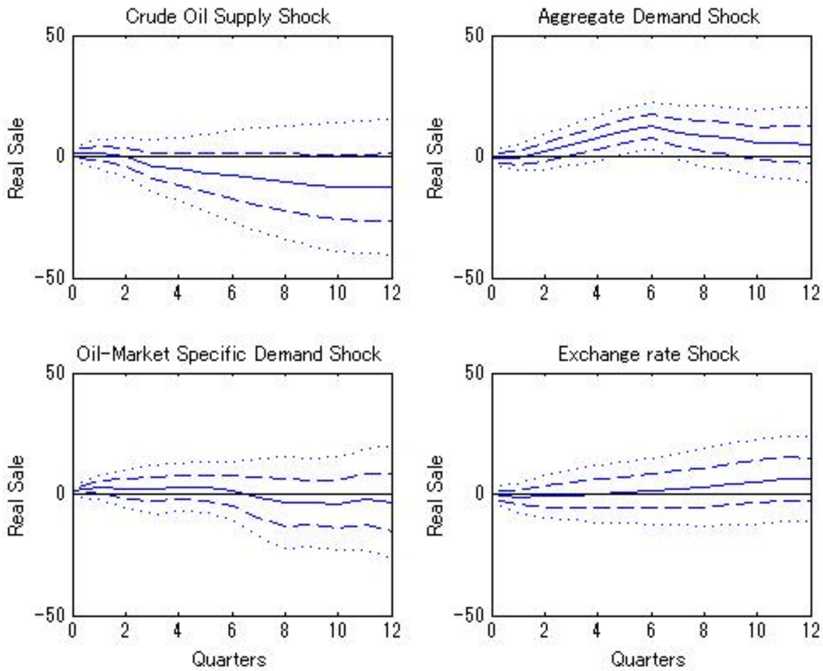
All industries – all firm sizes



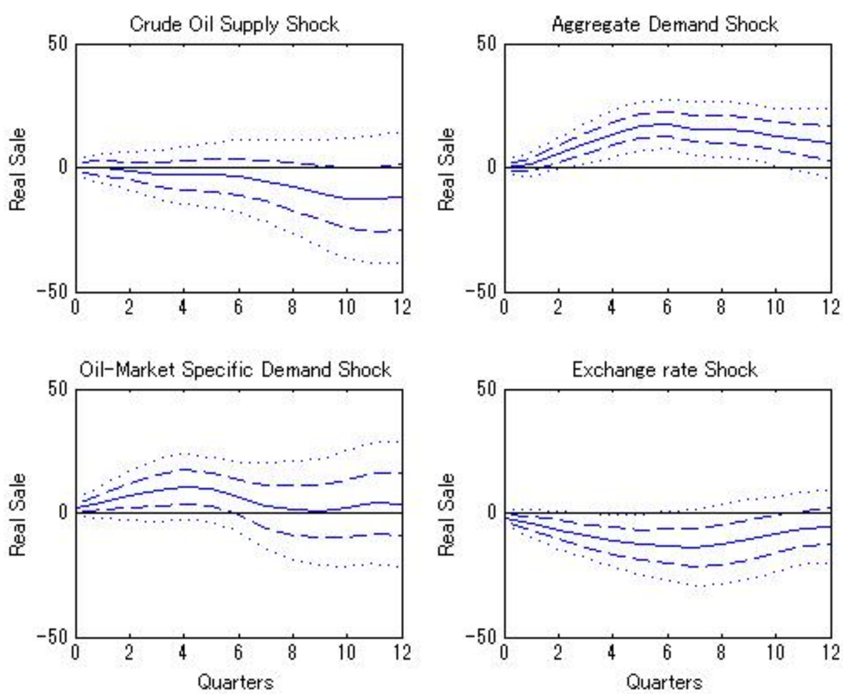
All industries – large firms



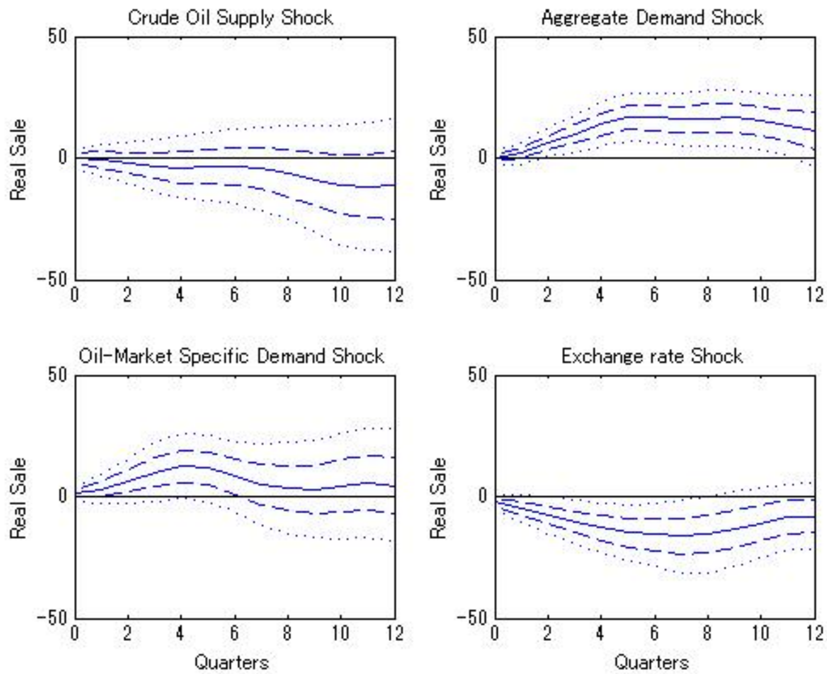
All industries – small and medium-sized firms



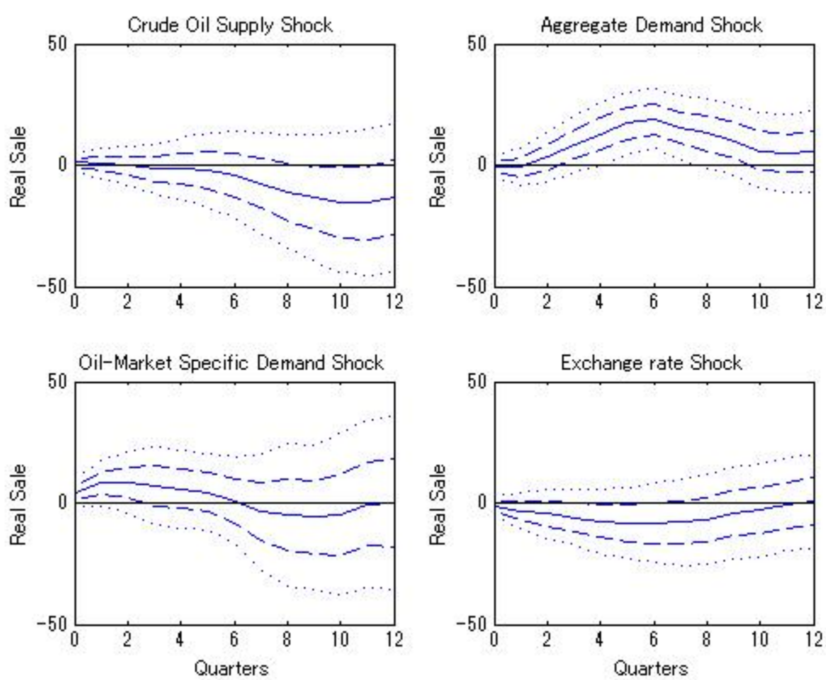
Manufacturing industry – all firm sizes



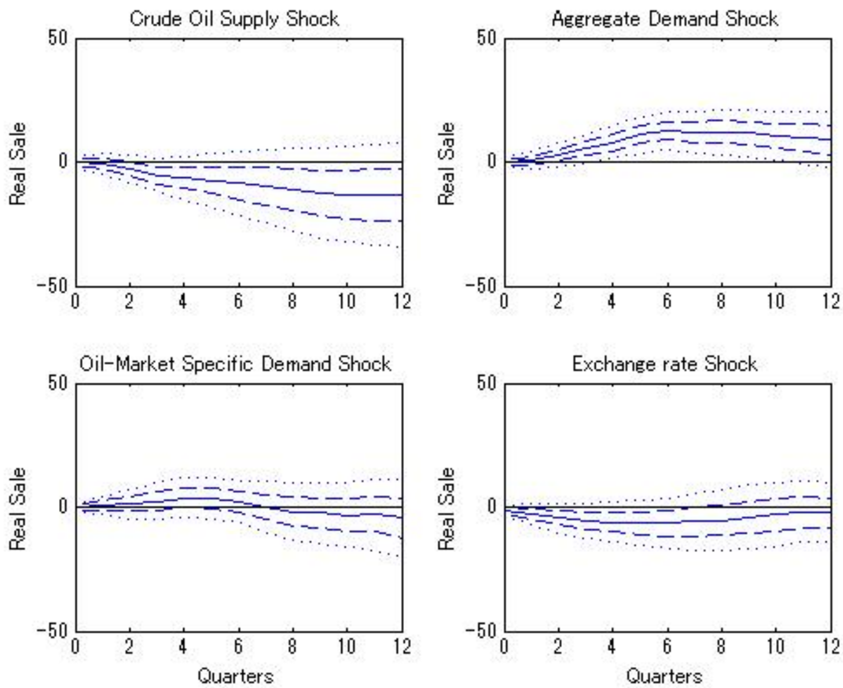
Manufacturing industry – large firms



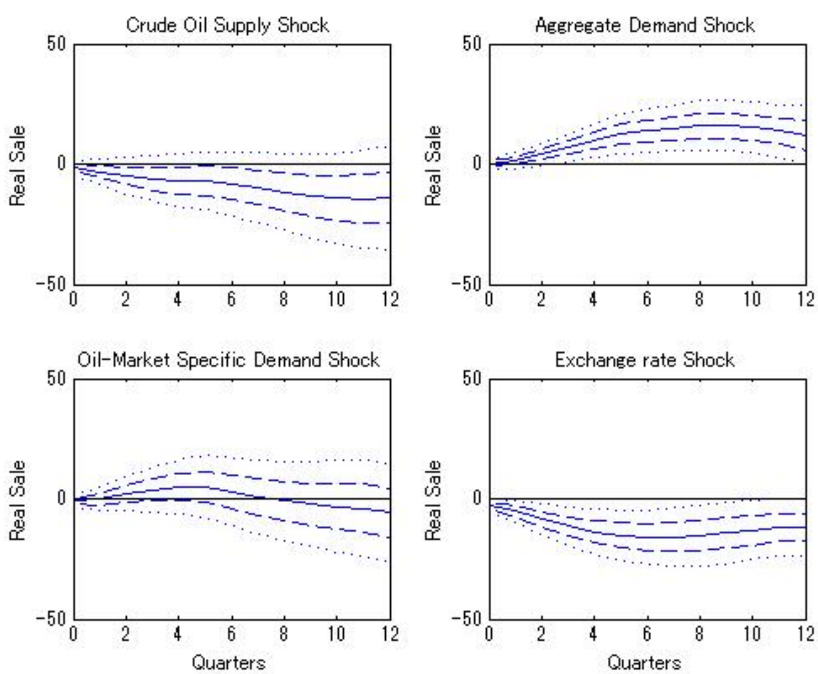
Manufacturing industry – small and medium-sized firms



Nonmanufacturing and service industries – all firm sizes



Nonmanufacturing and service industries – large firms



Nonmanufacturing and service industries – small and medium-sized firms

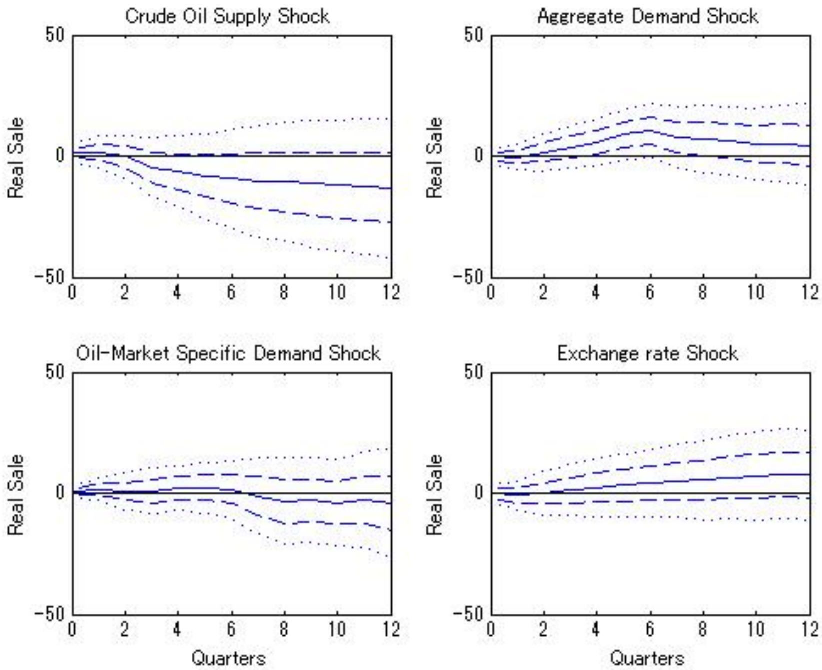
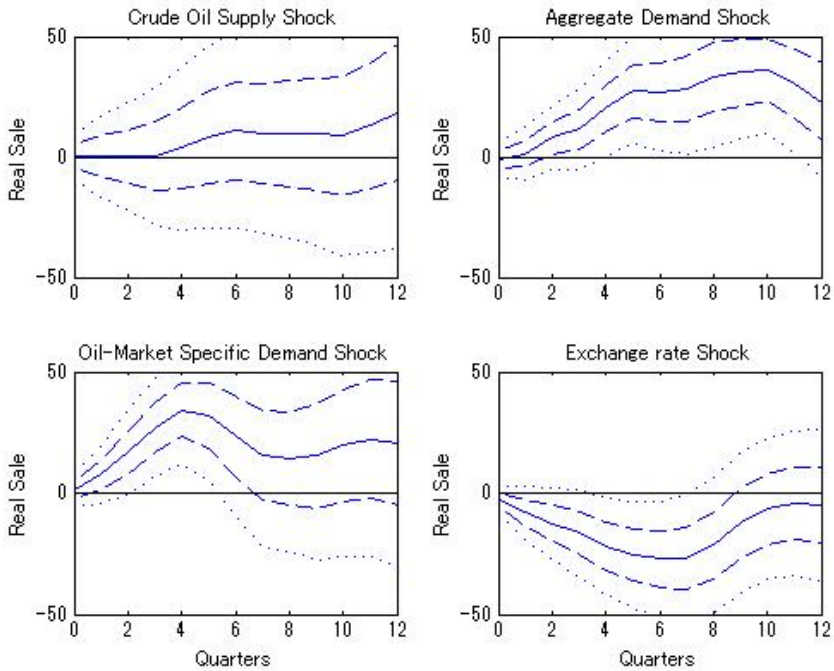


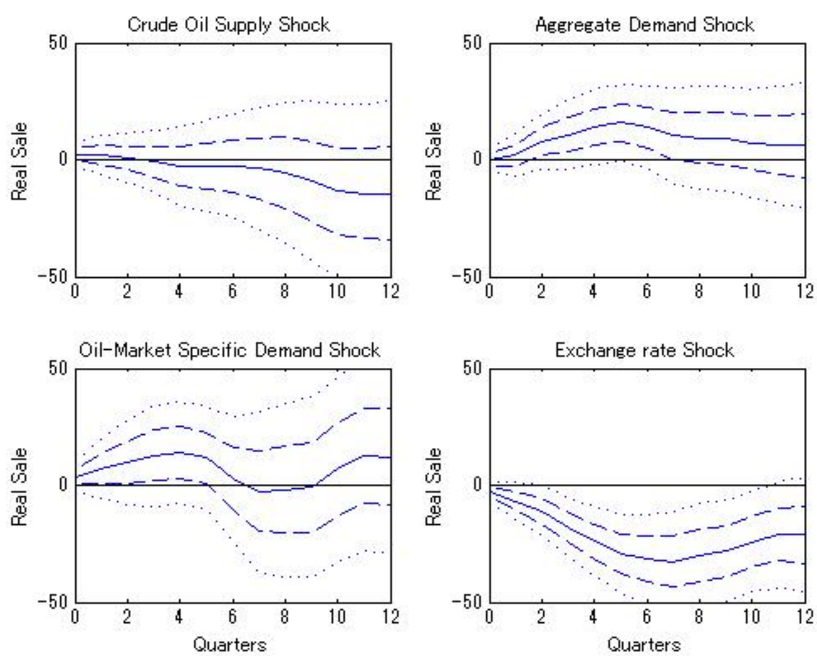
Figure 4 Effects of Structural Shocks for Individual Industries

See the note for Figure 3.

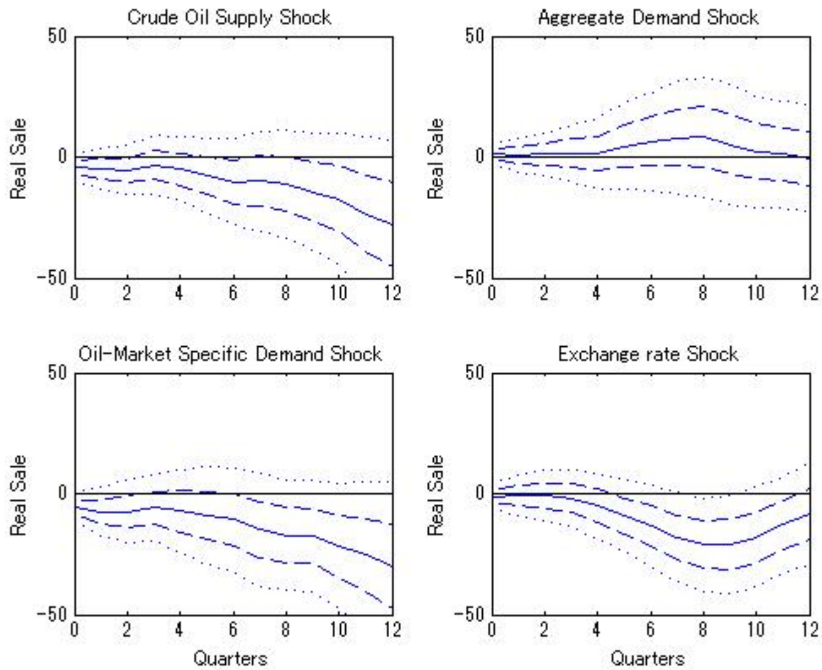
Coal and petroleum



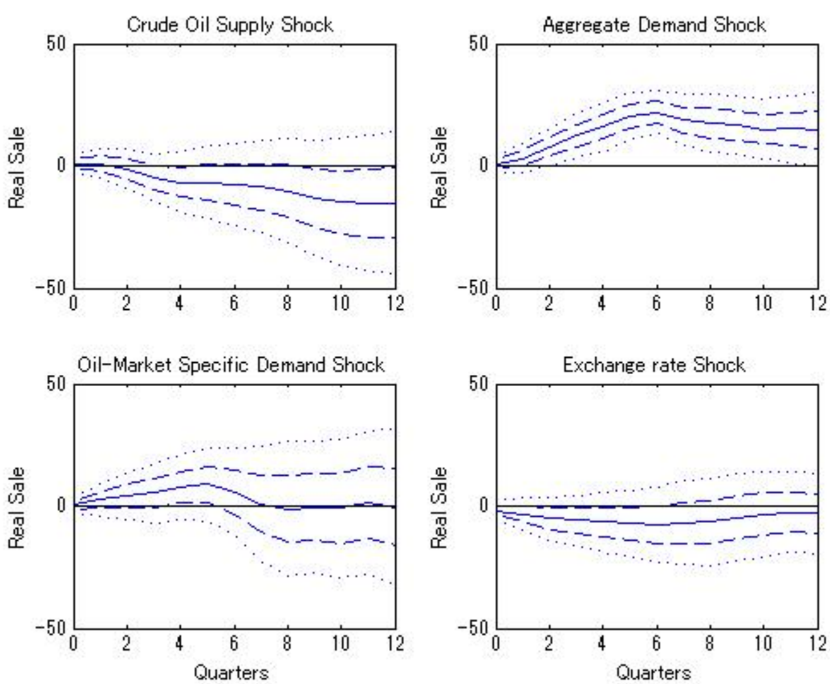
Automobiles and auto parts



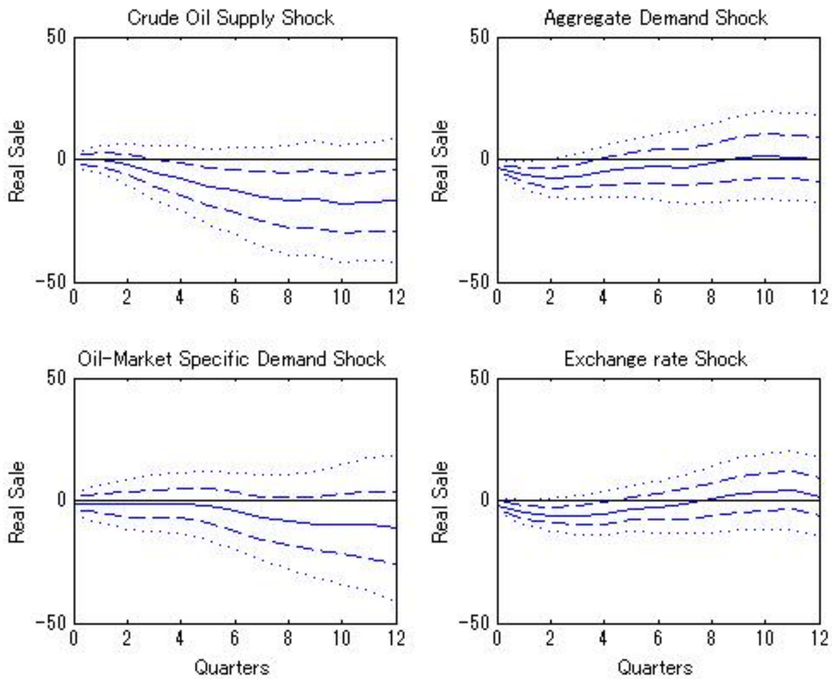
Land transportation



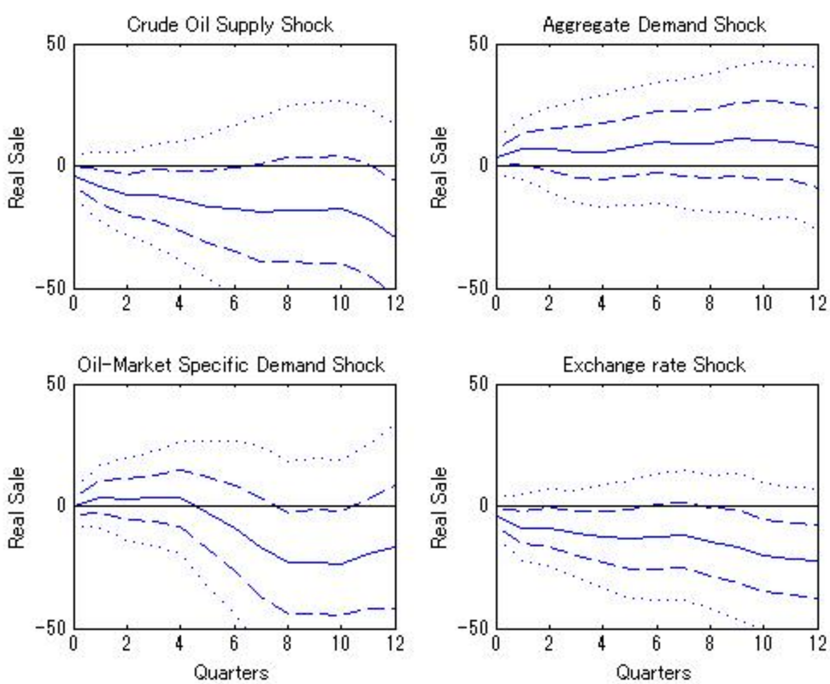
Wholesale



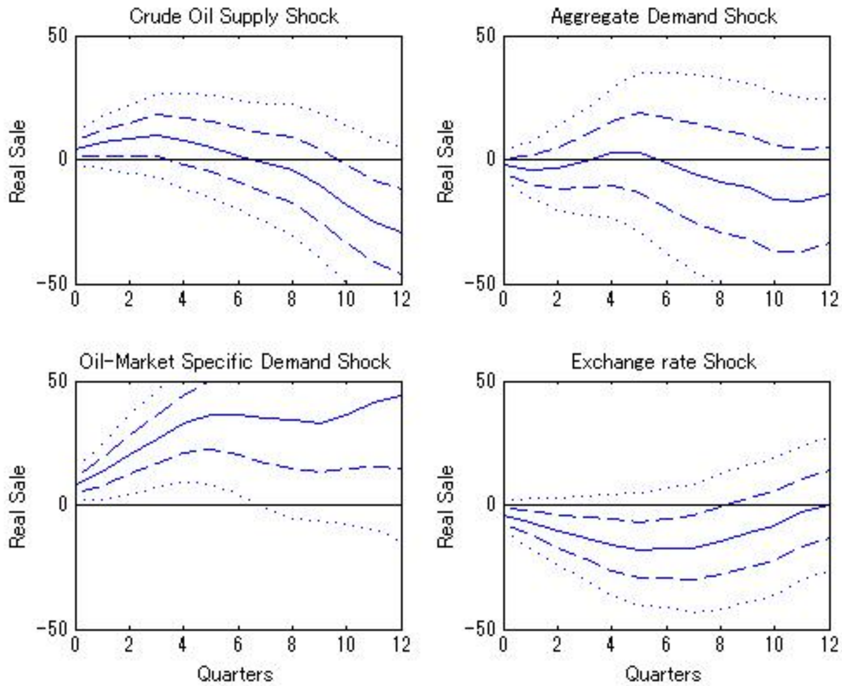
Retail



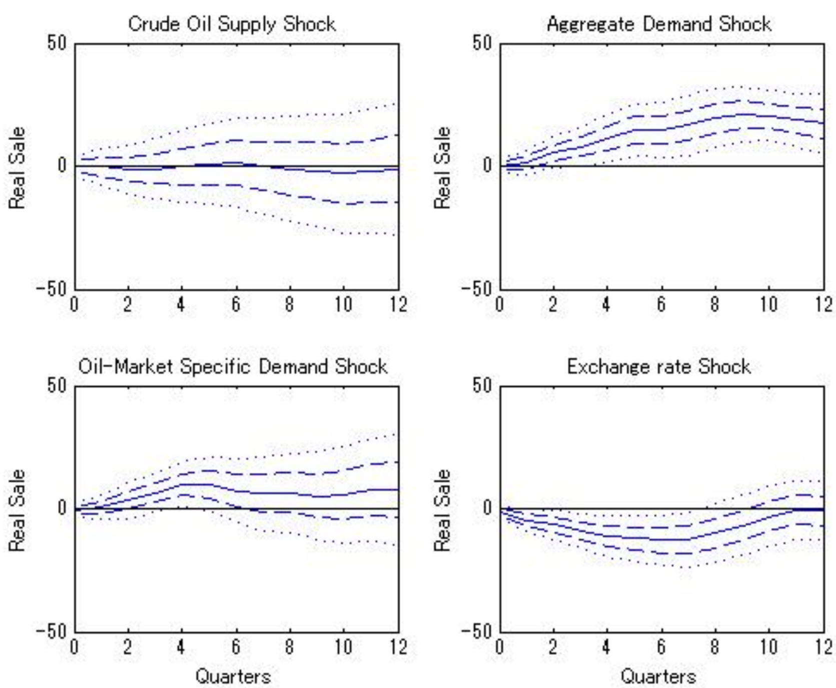
Real estate



Electrical machines and appliances


Crude Oil Supply Shock
Aggregate Demand Shock
Oil-Market Specific Demand Shock
Exchange rate Shock
Real Sale
Quarters
50
0
-50
0
2
4
6
8
10
12

Chemicals


Crude Oil Supply Shock
Aggregate Demand Shock
Oil-Market Specific Demand Shock
Exchange rate Shock
Real Sale
Quarters
50
0
-50
0
2
4
6
8
10
12

Construction