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Oil Price Fluctuations and Oil Consuming Sectors: An Empirical Analysis of Japan

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Abstract

Since the oil price shocks of the 1970s, several studies have found significant impacts of oil prices on macro variables. However, it is particularly crucial to know how each micro sector in an economy, such as the residential, transport, industrial and non-energy sectors, respond to oil price impulses. In this research, we try to shed light on the impact of crude oil price volatility on each sector in Japan, the world's third-largest crude oil consumer. In order to do so, we apply a vector auto regression model and perform impulse response analysis by using quarterly data from Q1 1990 to Q1 2014. The findings indicate that some economic sectors, such as the residential sector, did not have significant sensitivity to the sharp oil price fluctuations. In contrast, some other sectors, like the commercial, industrial, and transport sectors, were strongly sensitive to the drastic oil price fluctuations. Moreover, our findings show that after the Fukushima disaster in 2011, which led to the shutdown of nuclear power plants in Japan, because of greater reliance on oil imports, the sensitivity of most sectors to oil price volatility declined.

JEL Classification: C32, O49, Q43

Contents

1. INTRODUCTION

Global demand for oil has risen drastically since the 1970s oil price shocks, while at the same time, new, energy-related technologies, new energy resources, and government-mandated energy efficiency targets have made global consumers more resistant to oil shocks.

Several studies have found that oil price shocks have played a significant role in economic downturns. In recent years, both the sharp increase in oil prices that began in 2001 and the sharp decline that followed in 2008 following the subprime mortgage crisis have renewed interest in the effects of oil prices on the macroeconomy. Recently, the price of oil more than halved in a period of less than 5 months from September 2014. After nearly 5 years of stability, the price of a barrel of Brent crude oil in Europe fell from more than $100 per barrel on September 2014 to less than $46 per barrel on January 2015. Several studies have evaluated these impacts (see, inter alia, Taghizadeh-Hesary et al. [2013]; Taghizadeh-Hesary and Yoshino [2013]; Taghizadeh-Hesary and Yoshino [2014]; Yoshino and Taghizadeh-Hesary [2014]; Taghizadeh-Hesary et al. (2015), Yoshino and Taghizadeh-Hesary [2015a].

However, the response of all economic sectors in a country to oil price fluctuations might not be the same. In this research we will determine which economic sectors are more sensitive to oil price volatility. The policy implications of this paper will be beneficial in helping energy policy makers to protect those sectors with higher sensitivity. Then, if another sharp oil price increase occurs, the identified sectors and the whole economy can be shielded from the negative impacts of the shock.

In this survey, we consider Japan as our case study. Japan is a country that is almost fully dependent on energy imports. In March 2011, a devastating earthquake and Tsunami hit eastern Japan and damaged the nuclear power plant in Fukushima. This disaster led to the shutdown of all nuclear power plants due to the lack of government safety approvals. Japan replaced this significant loss of nuclear power with energy generated from imported natural gas, low-sulfur crude oil, fuel oil, and coal. Based on the importance of oil for Japan, we chose to focus on it in this survey. In this paper, we investigate the effects of oil price fluctuations on the oil consuming economic sectors of Japan using quarterly data from Q1 1990 to Q1 2014 through an autoregression approach. Our research questions are the following: i) Considering the new energy-related technologies and energy resources, and government-mandated energy efficiency targets, do economic micro sectors still react to oil price movements? ii) If the answer is yes, are the responses of all economic sectors to oil price impulses of the same scale? Which sectors show higher sensitivities?

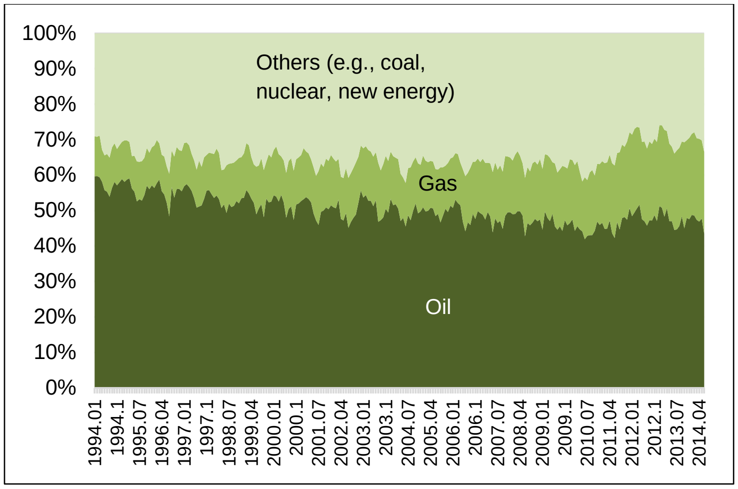
This paper is structured as follows. The next section will provide an overview of energy consumption in Japan. Section 3 provides the data analysis. Section 4 presents the empirical analysis, and the final Section 5 presents the concluding remarks.

2. OVERVIEW OF ENERGY CONSUMPTION IN JAPAN

Japan is one of the world largest energy consumers. It is the world’s largest liquefied natural gas (LNG) importer, the second-largest coal importer, and the third-largest net oil importer. Domestic energy sources in Japan meet less than 15% of its own total primary energy use.

Figure 1 shows the shares of different energy sources in the Japanese energy basket during January 1994–June 2014.

Figure 1: Shares of Different Energy Sources in the Japanese Energy Basket, January 1994–June 2014



Notes: Shares are calculated by the calorific value of the energy sources. Oil is imported crude oil plus imported petroleum products. Gas is imported liquefied natural gas. Other energy sources include coal, nuclear power, hydropower, and new energy.

Source: Yoshino and Taghizadeh-Hesary (2015b).

In March 2011, a 9.0 magnitude earthquake struck off the coast of Sendai, Japan, triggering a large tsunami. The damage to Japan resulted in an immediate shutdown of about 10 gigawatts of nuclear electric generating capacity. Between the 2011 Fukushima disaster and May 2012, Japan lost all of its nuclear capacity as a result of scheduled maintenance and the lack of government approvals to return to operation. Japan replaced the significant loss of nuclear power with generation from imported natural gas, low-sulfur crude oil, fuel oil, and coal. This caused the price of electricity to rise for the government, utilities, and consumers. Japan spent $250 billion on total fuel imports in 2012, a third of the country's total import charges. Despite strength in export markets, the yen's depreciation and soaring natural gas and oil import costs due to a greater reliance on fossil fuels continued to deepen Japan's trade deficit throughout 2013. In the wake of the Fukushima nuclear incident, oil is still the main energy carrier in Japan, although the share of oil consumption in total energy consumption has reduced from about 80% in the 1970s to 43% in 2011. Japan consumed over 4.7 million barrels per day of oil in 2012 (Taghizadeh-Hesary et. al 2015).

According to the International Energy Agency[1], strategic crude oil stocks in Japan totaled 590 million barrels at the end of December 2012, 55% of which were government stocks and 45% commercial stocks.

Historical analysis of crude oil consumption trends in Japan is interesting, as shown in Figure 2. Crude oil consumption had a peak in 1996 of nearly 5.7 million barrels per day[2] and a lowest point of 4.3 million barrels per day in 2009 after the global financial crisis, which reduced the economic output and energy demand in the country. During late 1980 until 2006, crude oil consumption was almost 5 million barrels per day, but consumption dropped below 5 million barrels per day from 2008, following the global financial crisis.

[1] http://www.eia.gov/beta/international/analysis_includes/countries_long/Japan/japan.pdf

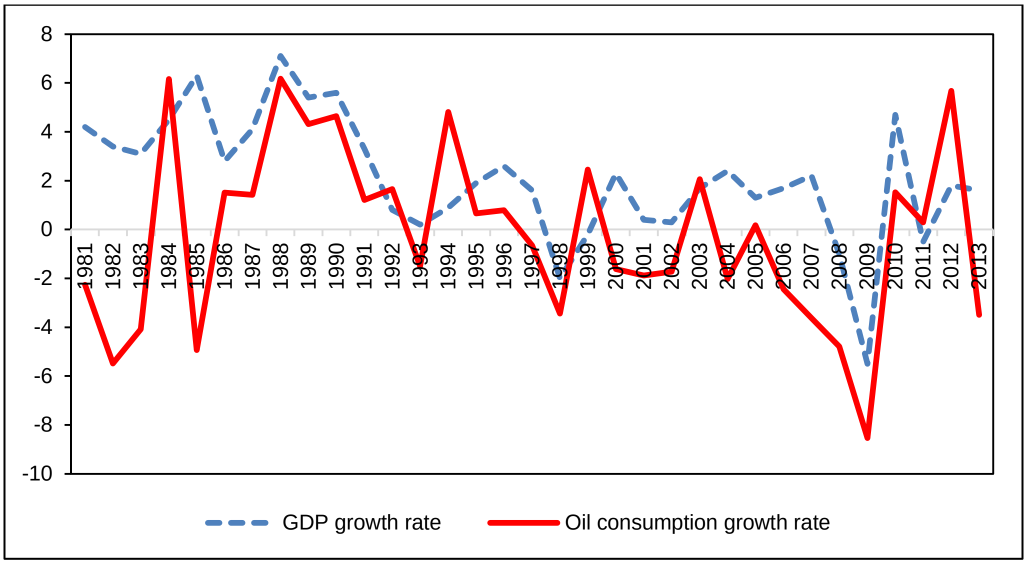
[2] Average total consumption of petroleum products in February 1996 was 6.8 million barrels per day.

In 2015, due to the relative improvement in Japanese economic growth, demand for energy (including oil) rose and total consumption of petroleum products has reached above 5 million barrels per day.

Besides the aforementioned trends, crude oil consumption in Japan is a pro-cyclical variable. This means that increases in the gross domestic product (GDP) growth rate are correlated and have boosted the consumption of crude oil, while economic downturns have reduced oil consumption. Figure 2 illustrates the GDP growth rate and crude oil consumption growth rate trends during 1981–2013.

Figure 2: GDP Growth Rate and Crude Oil Consumption Growth of Japan, 1981–2013

(%)



GDP = gross domestic product.

Note: GDP is annual change in constant prices.

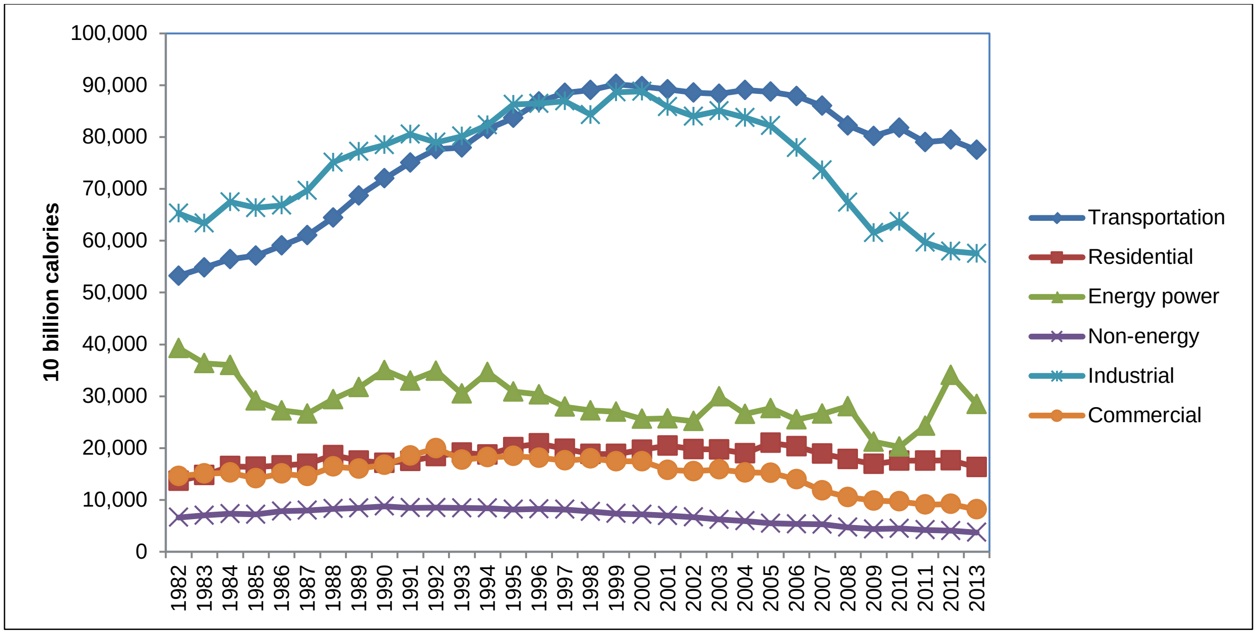
Source: International Energy Agency (IEA) database and World Economic Outlook (WEO) database of the International Monetary Fund (IMF) (April 2015).

2.1 Oil Consumption in Japan by Sector

Generally, there are six oil consuming sectors in an economy: the commercial, energy power generation, industrial, non-energy, residential, and transportation sectors.

Figure 3 shows the oil consumption in each of these six sectors in Japan during 1982–2013. Clearly, the transportation and industrial sectors have had the highest consumption during this period and importantly, until early 1990, the industrial sector had used more crude oil than the transportation sector. However, after the burst of the Japanese asset price bubble in the 1990s, the Japanese economy started suffering from sluggish economic growth and recessions (Japan's so-called "lost decade") and the industrial sector's oil demand started to shrink (Yoshino and Taghizadeh-Hesary 2016). Another reason for the reduced demand for oil in the industrial sector was the huge foreign direct investment (FDI) from Japan to other Asian countries, including the People's Republic of China, Thailand, and Malaysia, which moved a significant part of industrial production to other countries. Since that period, the transportation sector has remained the major consumer of oil in the country, and consumption in the sector has been almost constant. However in recent years mainly because of the increased share of hybrid cars and higher energy efficiency in Japanese automobiles, demand for oil in the sector has started to decrease. Industrial sector demand has a negative slope and demand for oil for energy power generation has also been decreasing because of substitution for LNG.

Figure 3: Crude Oil Consumption by Sector in Japan, 1982–2013



Source: Energy Data and Modelling Center (EDMC) database of the Institute of Energy Economics, Japan (IEEJ).

In 1982, shares of the transportation, residential, energy power, non-energy, industrial, and commercial sectors in total oil consumption were 28%, 7%, 20%, 3%, 33%, and 9%, respectively. However, it is interesting to mention that by 2013, these ratios had changed and the shares of the transportation, residential, energy power, non-energy, industrial, and commercial sectors were measured at 40%, 8%, 15%, 2%, 30%, and 5%, respectively.

3. DATA ANALYSIS

3.1 Variables

The seven variables used in this analysis are comprised of the six energy consuming sectors and the oil price, all in logarithmic terms. Table 1 describes the symbols and definitions of these variables.

Table 1: Variables and Definitions

Variable	Definition
LOILP	Logarithm of CIF price of imported crude oil to Japan (yen)
LCOMMER	Logarithm of crude oil demand by the commercial sector in Japan
LINDUS	Logarithm of crude oil demand by the industrial sector in Japan
LNONEN	Logarithm of crude oil demand by the non-energy sector in Japan
LTRANSPO	Logarithm of crude oil demand by the transportation sector in Japan
LPOGEN	Logarithm of crude oil demand by the power energy sector in Japan
LRESIDEN	Logarithm of crude oil demand by the residential sector in Japan

Note: CIF = cost, insurance, and freight.

Source: Authors' compilation.

Data on these seven variables are for Q1 1990–Q1 2014.The source of the data is the Energy Data and Modelling Center Database (EDMC) of the Institute of Energy Economics, Japan (IEEJ).

3.2 Unit Root Test

In order to evaluate the stationarity of all series, we performed two unit root tests on all variables at levels and first differences. The tests used are the augmented Dickey-Fuller (ADF) test, Phillips-Perron test the results are summarized in Table 2 and Table 3.

3.2.1 Augmented Dickey-Fuller Test

Our results in Table 2 imply that almost all variables are non-stationary in levels. These variables include the crude oil prices and the oil consumption in all six sectors, in logarithmic form. However, the first differences of almost all the variables using ADF test show stationary results. These results suggest that all variables contain a unit root.[3] Once the unit root test was performed and it was discovered that the variables are non-stationary in levels and stationary in the first differences, they were integrated of order 1, or I(1). Because of the non-stationary series, the next step was to apply a cointegration analysis to examine whether the series are cointegrated and whether long-run relationships exist among these variables.

Table 2: Unit root Test Using the Augmented Dickey-Fuller Test

	Variable	ADF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	H0	Stationary
In Levels	Lcommer	0.46	-3.48	-2.88	-2.57	Accept	No
	Lindus	-2.19	-3.48	-2.88	-2.57	Accept	No
	Lnonen	1.31	-3.48	-2.88	-2.57	Accept	No
	Lpogen	-2.93	-3.48	-2.88	-2.57	Accept	No at 1%
	Lresiden	-2.31	-3.48	-2.88	-2.57	Accept	No
	Ltranspo	-2.19	-3.48	-2.88	-2.57	Accept	No
	Loilp	-0.20	-3.48	-2.88	-2.57	Accept	No
First Difference Form	D(Lcommer)	-5.69	-3.48	-2.88	-2.57	Reject	Yes
	D(Lindus)	-4.97	-3.48	-2.88	-2.57	Reject	Yes
	D(Lnonen)	-5.88	-3.48	-2.88	-2.57	Reject	Yes
	D(Lpogen)	-4.97	-3.48	-2.88	-2.57	Reject	Yes
	D(Lresiden)	-7.94	-3.48	-2.88	-2.57	Reject	Yes
	D(Ltranspo)	-1.46	-3.48	-2.88	-2.57	Accept	No
	D(Loilp)	-9.26	-3.48	-2.88	-2.57	Reject	Yes
Second Difference Form	DD(Ltranspo)	-9.57	-3.48	-2.88	-2.57	Reject	Yes

ADF test = augmented Dickey-Fuller test.
Note: D refers to first differences, DD refers to second differences.
Source: Authors' compilation.

[3] With the exception of the transportation sector crude oil demand, which was stationary in the second differences form.

3.2.2 Phillips-Perron Test

If the time period of analysis includes any structural changes, we should use more than one stationary test in order to confirm the results obtained from the first test. Since the period of our analysis contains several crucial points that affected the energy market—including the 1990–1991 Persian Gulf War, the bursting of the Japanese asset price bubble in 1990–1991, the 1997 Asian financial crisis, the 2008–2009 global financial crisis, and the Fukushima disaster in 2011—hence we used Phillips-Perron test for the robustness check.[4] The results of the Phillips-Perron test are shown in Table 3. The results confirm the ADF test output for almost all series. The Phillips-Perron test results show that all variables each contain a unit root and all series became stationary in first differences.

Table 3: Unit Root Test Using the Phillips-Perron Test

	Variable	**Philips-Perron Test Statistic**	**1% Critical Value**	**5% Critical Value**	**10% Critical Value**	**H0**	**Stationary**
First difference form	D(Lcommer)	-23.9	-3.48	-2.88	-2.57	Reject	Yes
	D(Lindus)	-16.49	-3.48	-2.88	-2.57	Reject	Yes
	D(Lnonen)	-19.33	-3.48	-2.88	-2.57	Reject	Yes
	D(Lpogen)	-25.57	-3.48	-2.88	-2.57	Reject	Yes
	D(Lresiden)	-22.26	-3.48	-2.88	-2.57	Reject	Yes
	D(Ltranspo)	-14.48	-3.48	-2.88	-2.57	Reject	Yes
	D(Loilp)	-8.54	-3.48	-2.88	-2.57	Reject	Yes

Note: D refers to first differences.
Source: Authors' compilation.

3.3 Cointegration Test

We conducted a cointegration analysis using Johansen's technique by assuming a linear deterministic trend. This approach proposes two likelihood ratio test statistics: the trace and the maximum eigenvalue statistics. Here, we select the maximum eigenvalue statistic and the results are presented in Table 4. Based on the results, the series are not cointegrated and there are not any long-run relationships between variables, so we can use the vector autoregressive (VAR) model.

Table 4: Johansen Cointegration Test

Maximum Eigenvalue Statistic			
Null hypothesis	Alternative hypothesis	t-statistic	**Critical Value, 5%**
r=0	r>0	37.26	**46.23**
r<=1	r>1	31.88	**40.07**
r<=2	r>2	23	**33.87**
r<=3	r>3	15.29	**27.58**
r<=4	r>4	12.20	**21.13**

Source: Authors' compilation.

[4] For more information about the causes of energy price elevation following the sub-prime mortgage crisis and global financial crisis, see Yoshino and Taghizadeh-Hesary (2014).

3.4 Lag Length Selection

One main issue in VAR models is lag order selection. Normally, six main criteria are available for lag order selection: the Schwarz Information Criterion (SIC), the Hannan-Quinn Criterion (HQC), the Akaike Information Criterion (AIC), the general-to-specific sequential likelihood ratio (LR) test, a small-sample correction to that test (SLR), and the Lagrange multiplier (LM) test. In this present research, we selected optimal lag numbers using the Hannan-Quinn Criterion (HQC) standard, which suggests four lags. Table 5 shows the results.

Table 5: Lag Length Selection

Lag	LogL	AIC	SIC	HQC
0	299.26	-6.56	-6.37	**-6.49**
1	717.16	-14.8	-13.29	**-14.22**
2	941.35	-18.7	-15.85*	**-17.6**
3	1027.72	-19.6	-15.32	**-17.89**
4	1128.24	-20.79	-15.11	**-18.50***
5	1174.04	-20.72	-13.67	**-17.87**

AIC = Akaike Information Criterion, HQC = Hannan-Quinn Criterion, LogL = log likelihood, SIC = Schwarz Information Criterion.

Note: * shows the optimized lag by the criteria.

Source: Authors' compilation.

4. EMPIRICAL ANALYSIS

In order to answer to the questions raised in the Introduction, we developed a vector autoregressive model (VAR).

4.1 Vector Autoregressive Model

According to Sims (1980) this approach has the favorable character of endogeneity of the variables. So in this kind of econometric model we cannot divide the variables into two endogenous and exogenous groups. Mathematically, the VAR model can be written as:

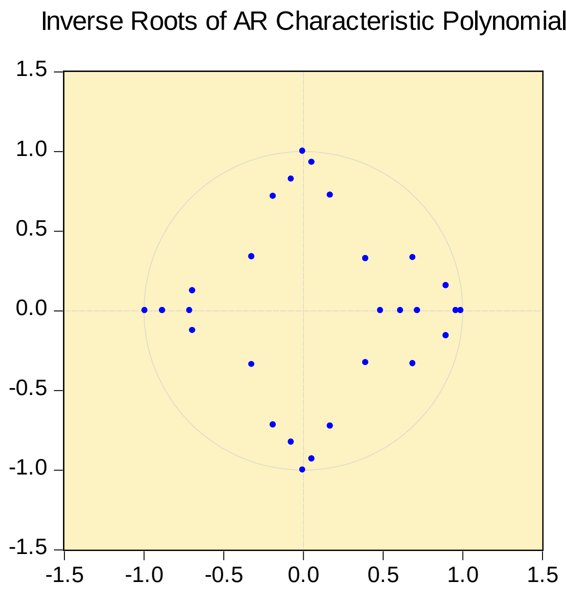
$$y_t = c + \sum_{i=1}^{p} A_i \cdot y_{t-1} + \varepsilon_t \qquad (6)$$

In the above equation, y_t is a k*1 vector, c is a vector of intercepts, and y_{t-1} is the lag of the variable y. Furthermore, A_i indicates a time-invariant matrix. In order to estimate the VAR model, there are further required steps in addition to the stationarity test and lag selection already discussed. We need to consider the stability of the VAR to ensure reliable results, and also need to do an autocorrelation test of the Lagrange multiplier (LM), then finally the Chow test for capturing any structural breaks.

4.2 Stability Test of VAR

Agung (2009) shows that for the stability test of the VAR model we can use the inverse roots of the characteristic polynomial. If all model roots are placed inside the circle, our model will be reliable and stable. Figure 4 illustrates the result of this test and demonstrates the stability of our model.

Figure 4: Stability Test of the VAR Model



AR = autoregressive.

Source: Authors' compilation.

4.3 Lagrange Multiplier Autocorrelation Test

Before applying the impulse response (IR) analysis, we have to perform the autocorrelation test of residuals. This test investigates the problem of autocorrelation between the residuals of the model. The results of the LM test are shown in Table 6.

Table 6: Lagrange Multiplier Autocorrelation test

Lag	LM t-statistic	P-value
1	59.82	**0.138**
2	60.58	**0.124**
3	62.89	**0.088**
4	82.07	**0.210**
5	61.76	**0.104**

LM = Lagrange multiplier.

Source: Authors' compilation.

According to Table 6, the null hypothesis, which shows no autocorrelation in the residuals, is not rejected at the 5% critical value, so our model's residuals do not have an autocorrelation problem.

4.4 Chow Test for Structural Breaks

In order to find the presence of structural changes throughout the period of our survey, we tested two significant points. The first was Q3 2008, when oil demand dropped worldwide, including in Japan, due to the recession following the financial crisis. The second point was after the March 2011 Great East Japan earthquake and tsunami, which shut down all nuclear power generation capacity in Japan due to a lack of technical approval, requiring substitution by oil and other fossil fuels. We used the Chow test in order to check the availability of structural breaks at these points. The results confirm a structural break at Q3 2008 and as a result we can determine two subperiods for our analysis: i) Q1 1991–Q3 2008, and ii) Q4 2008–Q1 2014. From the results, we could not find evidence of a structural break in the data following the Fukushima disaster.

Table 6: Chow Test for Structural Break in Q3 2008

F-statistic	3.16	**Prob. F(7,83)**	0.005
Log likelihood ratio	22.92	**Prob. Chi-square(7)**	0.002
Wald statistic	22.13	**Prob. Chi-square(7)**	0.002

Prob. = probability.
Source: Authors' compilation.

As shown in Table 6, since the p-value is lower than 5%, the null hypothesis can be rejected and hence we can confirm the structural break in Q3 2008.

4.5 Causality Tests between Crude Oil Price and Each Sector's Consumption

In this section, we perform the Granger causality test to investigate the short-run relationship between crude oil prices and oil consumption in each economic sector in Japan. Since according to microeconomic theory, price is one of the influencing factors on consumption, we can assume that the causality direction is from oil prices to oil consumption. In other words, in this research, the imported oil price in Japan is an active variable whose fluctuations influence oil consumption in the economic sectors. The results of the Granger test represent the causality direction from oil prices to oil consumption for the specified sectors. As can be seen from Table 7, the statistic χ^2 is significant in all sectors at the 5% level, with the exception of the non-energy sector. Hence, our null hypothesis is rejected.

Table 7: Granger Causality Test

Variables	χ^2 Statistic	P-value	Null Hypothesis
Lcommer	3.71	0.44	**Reject**
Lindus	4.13	0.38	**Reject**
Lnonen	10.18	0.03	**Accept**
Lresiden	6.54	0.16	**Reject**
Ltranspo	5.82	0.21	**Reject**
Lpogen	1.45	0.83	**Reject**

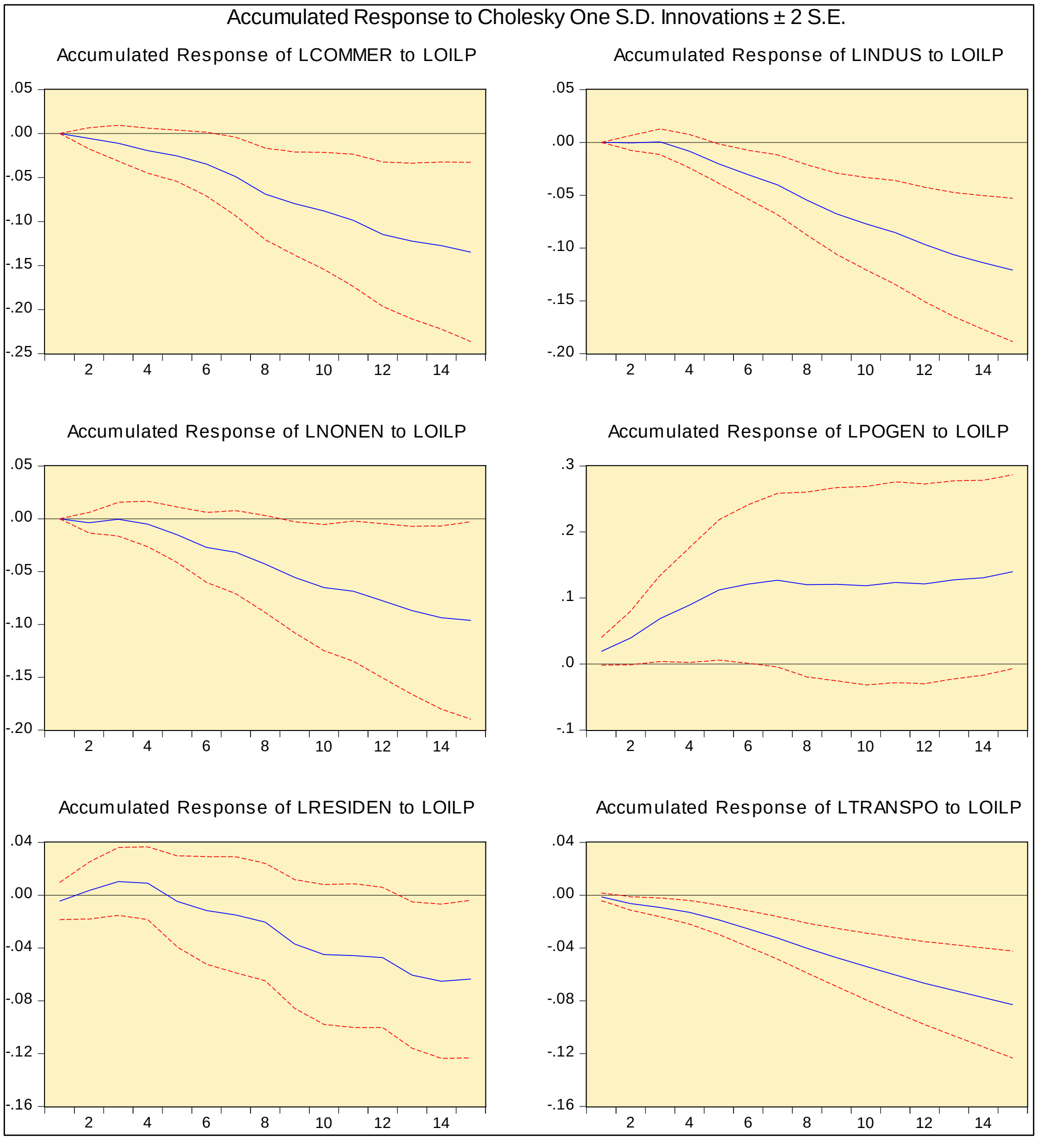
Source: Authors' compilation.

4.6 Impulse Response Functions

In addition to the causality result obtained in the previous section, we ran an impulse response function. We estimated the responses of each sector to an oil price impulse. According to Lutkepohl and Reimers (1992), impulse response functions (IRFs) are the best way to explore the response of economic variables to the impulse of an indicator. Based on the results of the Chow test for a structural break, we divided our data into two subperiods and estimated the IRF for each subperiod and also for the whole period:

i) Total time period (Q1 1991–Q1 2014)

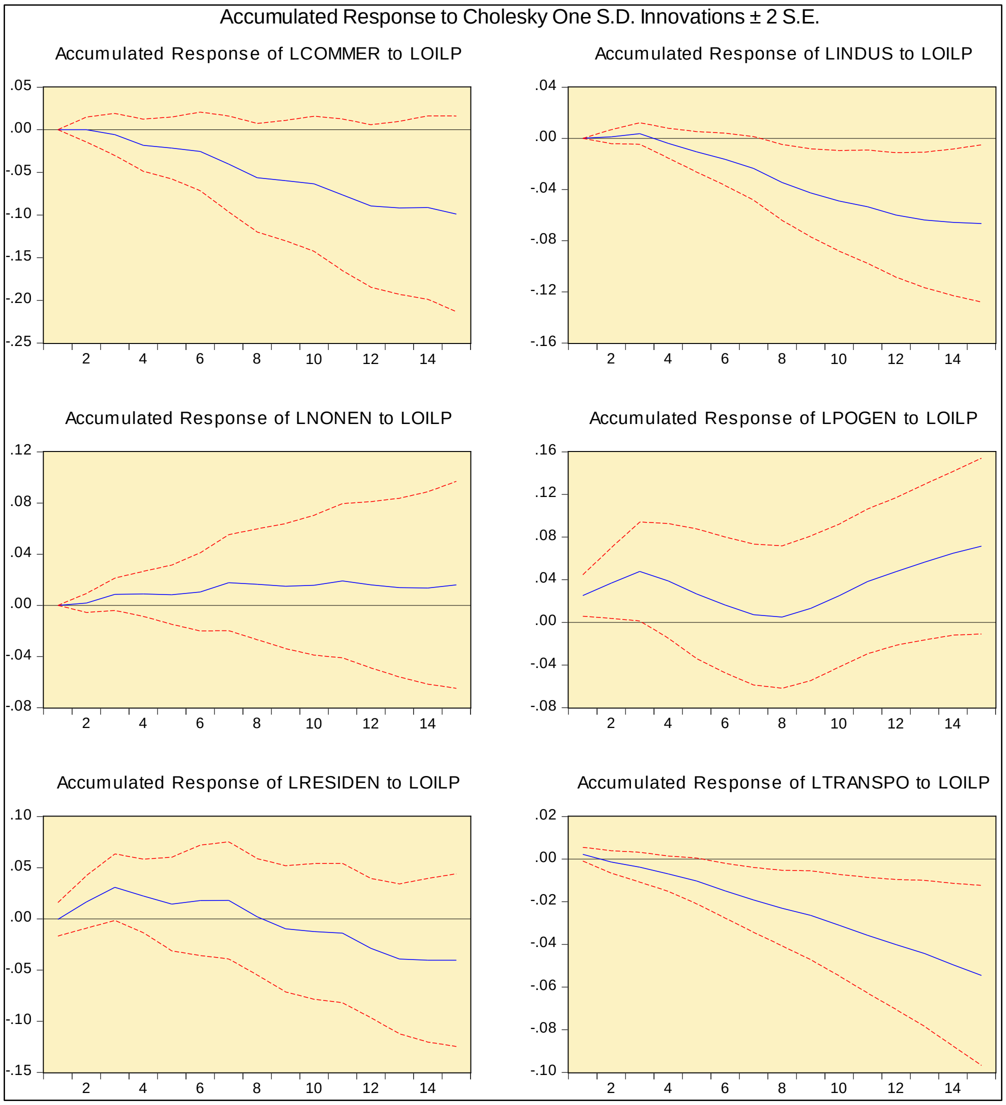
Figure 5: Response of Japan's Economic Sectors to an Oil Price Fluctuation, Q1 1990–Q1 2014



Source: Authors' compilation.

ii) Time period (Q1 1991–Q3 2008)

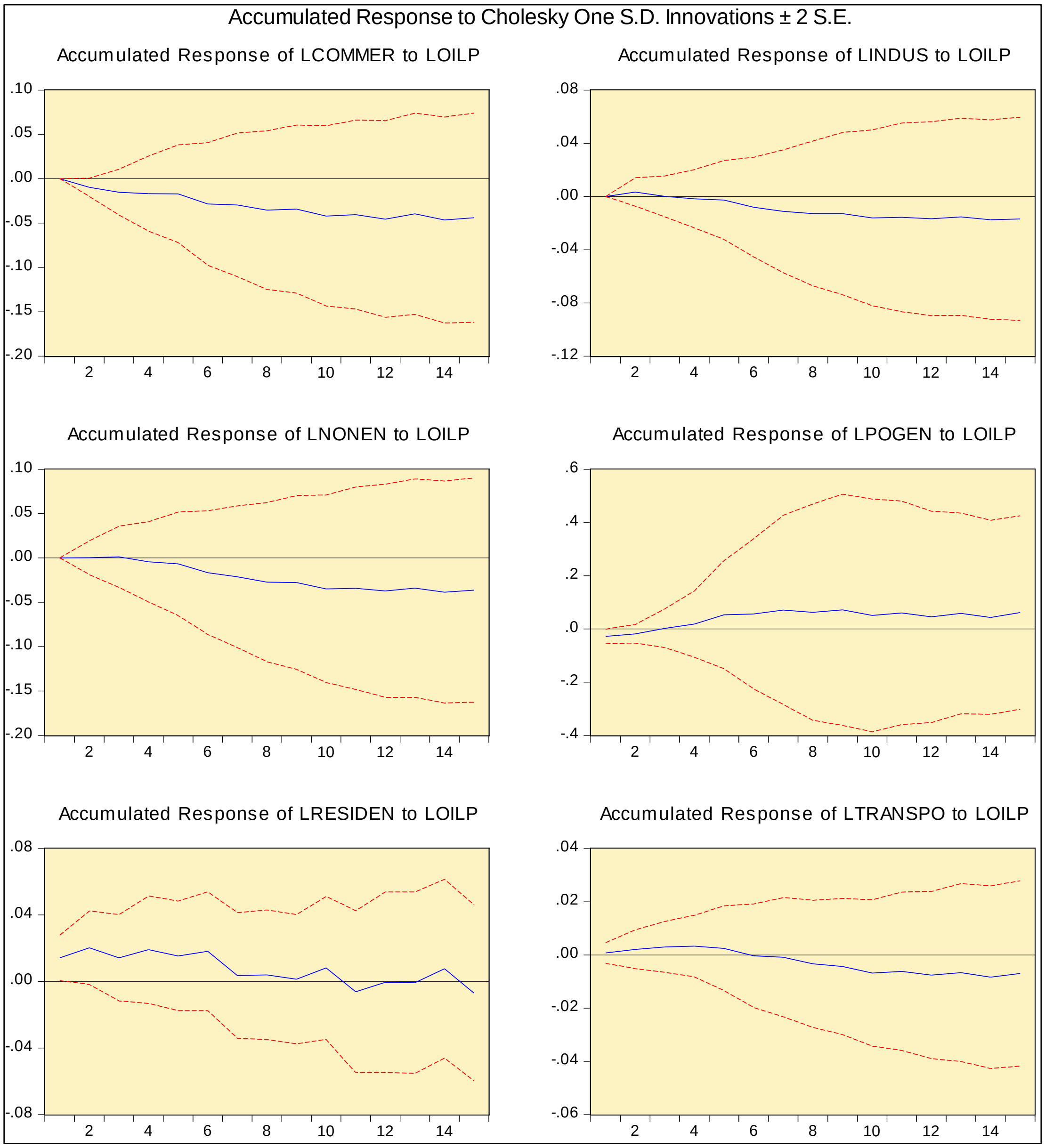
Figure 6: Response of Japan's Economic Sectors to an Oil Price Fluctuation, Q1 1990–Q3 2008



Source: Authors' compilation.

iii) Time period (Q4 2008–Q1 2014)

Figure 7: Response of Japan's Economic Sectors to an Oil Price Fluctuation Q4 2008–Q1 2014



Source: Authors' compilation.

Figures 5, 6, and 7 represent the accumulated responses of each oil consuming sector in Japan to oil price impulses.

Figure 5 depicts the IRF for the whole period, Q1 1990–Q1 2014. As this figure portrays, the power energy sector responds positively to the positive oil price impulse because the majority of Japanese energy is coming from oil, so even if the price of oil rises, demand in the energy sector will still exist and may even increase. Furthermore, a sharp oil price increase leads to an increase in oil consumption by the residential sector until period 4, which can be considered as a short-run period, and after that significantly declines. Oil consumption in the other sectors negatively responds to a positive oil price impulse.

Figure 6 illustrates the IRF for the period Q1 1990–Q3 2008. It is obvious that in this period, the commercial, industrial, and transportation sectors have a high negative sensitivity to oil price positive impulses. The residential sector shows a negative response from period 8, which can be considered as a medium-run period. In this period, the non-energy and power energy sectors showed positive responses for higher oil prices. The reason for the positive response of the non-energy sector is that after several years of recession, during the 2000s, the growth rate of Japanese GDP in real terms was positive. Because of higher economic growth from higher consumption and higher exports, demand for oil as a raw material in petrochemical and industrial production sectors was boosted.

Figure 7 depicts the IRF for the years after the global financial crisis of 2008, which includes the Fukushima incident in 2011. It can be seen from the figure that for the period Q4 2008–Q1 2014, the sensitivity of oil consumption by economic sector to oil price fluctuations is low because of the nuclear power shutdown—the economy had higher demand for oil, hence the lower sensitivity to oil price fluctuations. Some sectors, such as the industrial, commercial, and non-energy sectors, respond negatively, while the power energy sector positively responds to an oil price fluctuation. In this period, while the price of oil increased, oil was being used more in the power generation sector than before because of the lack of nuclear power in Japan. This is the reason for the positive impulses of the oil price, and consumption of oil in the power generation sector also increased. Additionally, the transportation and residential sectors have a positive–negative response. The non-energy sector in the second subperiod shows negative responses to an increase in oil price, which is contrary to the findings for the first subperiod. This is because in the second subperiod, the economy was in recession, so demand for oil as a raw material in petrochemical sectors and other non-energy sectors shrank because of lower aggregate demand. All in all, we can see that the transportation, industrial, and commercial sectors in Japan have a high negative sensitivity to oil price fluctuations.

5. CONCLUDING REMARKS

Based on the importance of crude oil, typically for industrialized nations that are generally oil importers, in this paper we tried to investigate the effects of imported crude oil price fluctuations on oil consumption in various economic sectors in Japan. We used vector autoregressive analysis of quarterly data collected from the EDMC of the IEEJ. Following evidence of a structural break in the data, the fluctuation analysis in our model was performed for two different periods, Q1 1990–Q3 2008 and Q4 2008–Q1 2014, and the whole period, Q1 1990–Q1 2014.

The data trend shows that oil is still the main energy carrier in Japan, although the share of oil consumption in total energy consumption in Japan declined from about 80% in the 1970s to 43% in 2011. Furthermore, crude oil consumption in Japan is a pro-cyclical variable. This means increases in the GDP growth rate have boosted the consumption of crude oil, and economic downturns have had the effect of reducing oil consumption. The data trend of oil consumption by various economic sectors in Japan indicates that the transportation and industrial sectors recorded the highest consumption during the period. Importantly, until early 1990, the industrial sector was consuming more crude oil than the transportation sector. But after the bursting of the Japanese asset price bubble in the 1990s, the Japanese economy suffered from sluggish economic growth and recession—Japan’s so-called “lost decade”—and industrial sector oil demand started to shrink.

Apart from the data trend, the IRF findings indicate the accumulated response of oil price fluctuations in oil consumption of six economic sectors in Japan for three time periods. To sum up the IRF results, we can conclude that the transportation, industrial, and commercial sectors in Japan have a high negative sensitivity to oil price positive impulses. For the industrial sector, higher oil prices led to increased energy efficiency and reduced energy intensity, and hence demand for oil shrank. Moreover, higher oil prices affected total costs and final prices in the sector and affected sales, hence demand for oil diminished. The same reasons are applicable to the commercial sector. As for the transportation sector, with higher oil prices, Japanese households used their private automobiles less and demand for public transportation increased. On the other hand, however, Japanese automotive manufacturers have increased the energy efficiency of their products in recent years and the share of hybrid cars has risen.

The power generation sector shows a positive response to an oil price increase in both subperiods and for the whole period. The reason for this is the lack of energy resources in Japan and the almost full dependency of the economy on energy imports, especially oil imports. Oil is the main mover of the Japanese economy, hence even at higher prices, the country still needs oil for generating energy.

The responses of the residential and non-energy sectors vary in different subperiods. The second period of our analysis includes the Fukushima nuclear disaster. The results of this paper show that in the second subperiod, in the wake of the Fukushima nuclear incident, because the country’s dependency on oil increased, almost all economic sectors had lower sensitivity to oil price fluctuations.

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* The Asian Development Bank refers to China by the name People's Republic of China.