RIETI Discussion Paper Series 24-E-065

How Oil Prices Impact the Japanese and South Korean Economies: Evidence from the stock market and implications for renewable energy
(Revised)

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

RIETI Discussion Paper Series 24-E-065
First draft: July 2024
Revised: March 2025

How Oil Prices Impact the Japanese and South Korean Economies: Evidence from the Stock Market and Implications for Renewable Energy※

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Abstract

Oil prices are volatile. How does this affect Japanese and South Korean firms? To investigate this question, this paper examines how oil prices affect sectoral stock returns. Using Hamilton's (2014) method to decompose oil prices into portions driven by aggregate demand and by oil supply, the results indicate that both demand- and supply-driven oil price changes impact many sectors in both countries. Large oil price swings will persist due to wars, tariffs, geopolitical events and climate change. These will whipsaw sectors in both countries. To shield their economies from oil price changes, Japan and Korea should expedite the switch from fossil fuels to sustainable energy sources. This paper considers steps to promote this transition.

Keywords: Crude oil prices, Stock returns, Japan, South Korea
JEL classification: Q43, G14

※This paper was previously circulated under the title "How Oil Prices Impact the Japanese Economy: Evidence from the stock markets", and revised by including an analysis of RIETI DP 24-E-070 and adding considerations regarding renewable energy. This study is conducted as a part of the project "Economic Shocks, the Japanese and World Economies, and Possible Policy Responses" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). The first draft of this paper was presented at the DP seminar of the Research Institute of Economy, Trade and Industry (RIETI).

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1. Introduction

Fossil fuels dominate Japan and South Korea's energy supplies. In Japan 85% of energy came from fossil fuels in 2023 and in Korea 79% came from fossil fuels.[1] Oil was the largest source, with 38% of energy supply in Japan and 37% in Korea coming from oil. Both Japan and Korea have pledged to cut greenhouse gas emissions and reach carbon neutrality by 2050.

Both countries also wrestle with energy security. In Japan 99.6% of crude oil supply came from imports in 2023 and in Korea 98.9% came from imports. As Figure 1 shows, oil prices are volatile. Fernald and Trehan (2005) noted that, unlike for domestically produced oil, an increase in prices for imported oil shifts income from domestic users to foreign oil producers. They thus argued that price increases for imported oil act like a tax on domestic users. Golub (1983) similarly observed that oil price increases transfer wealth from oil importing countries such as Japan and Korea to oil exporters. High oil prices impose costs on these economies.

To investigate these effects, this paper examines how oil prices impact sectoral stock returns. Black (1987) reported that sectoral changes in stock prices presage sectoral changes in output, profits, or investment. Examining how oil prices impact sectoral stock returns can thus shed light on how they will impact sectoral sales, earnings, and investment.

Previous research has found a link between stock prices and subsequent economic activity. Liu et al. (2007) found that industry valuations obtained from earnings data track stock prices well in several industries across several countries. Chatelais et al. (2023) reported that sectoral equity variables in the context of a factor model forecast industrial production better than other predictors. McMillan (2021) found that stock prices help predict GDP growth across several countries. Croux and Reusens (2013) reported that the slowly fluctuating components of

[1] The data in this and the next paragraph come from the International Energy Agency. Their website is www.iea.org .

stock prices obtained from the frequency domain predict economic activity well. Barro (1990), Schwert (1990), Velinov and Chen (2015), and others also found that stock prices help predict economic activity.

This paper thus examines the response of stock returns to oil price changes to shed light on how oil prices impact economic activity across sectors in Japan and Korea. The results indicate that many sectors in both countries are exposed to oil price changes.

Fukunaga et al. (2010) reported that oil price increases raise production for several Japanese sectors. They used Kilian's (2009) decomposition to investigate how shocks to oil production, global aggregate demand, and oil market-specific price shocks affect stock returns. They followed Kilian in using bulk dry cargo freight rates to measure global demand for industrial commodities and thus global economic activity. They estimated structural vector autoregressions (VARs) over the January 1973-December 2008 period to investigate how oil price shocks affect American and Japanese industries. They found that positive oil market-specific price shocks not explained by global economic activity or oil production decrease aggregate and sectoral production across several industries in the U.S. and increase aggregate and sectoral production across several industries in Japan. They interpreted their findings by noting that Japanese products in sectors such as automobiles tend to be more energy-efficient than American products in the same sectors. An increase in oil prices would thus switch demand from American to Japanese products. This would stimulate production in other industries such as steel and precision instruments that provide inputs to Japanese final goods.

Abhyankar et al. (2013) found that oil price shocks primarily affect the cash flows of Japanese companies. Using Kilian's (2009) decomposition and structural VARs, they reported that positive innovations in their measure of global economic activity produced a positive and statistically significant response of Japanese aggregate stock returns. They also found that oil market-specific price shocks not explained by global economic activity or oil production were associated with declines in Japanese aggregate stock returns. The response of stock returns to oil market specific-shocks was not different from zero, however, using two standard error bands. Finally, using the methodology of Campbell (1991), they reported that oil price shocks primarily affected Japanese stock returns by affecting expected cash flows.

Batten et al. (2019) examined whether stock markets in China, Hong Kong, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand are integrated with an energy portfolio. They uncovered two regimes, one where stock markets are not integrated with energy stocks and a second where they are. They reported positive energy-related risk premia during high integration regimes. These results indicate that oil and other energy sources impact Asian stock markets.

Kotsompolis et al. (2024) employed daily data and an autoregressive distributed lag framework to examine how oil price shocks impacted stock prices in China, Japan, Indonesia, Malaysia, the Philippines, and South Korea. Using impulse-response techniques, they found that positive shocks to West Texas Intermediate oil prices raised stock returns in all six countries over the January to June 2020 period and in all countries except China in the June 2020 to May 2023 period. They reported larger responses during the first period.

Hamilton (2014), Bernanke (2016), and others have noted that the positive relationship between oil prices and stock prices could occur because oil price increases are associated with increases in global aggregate demand and the aggregate demand increases raise stock prices. To measure the effect of aggregate demand on oil prices, Hamilton regressed the change in the log of oil prices on the change in the log of copper prices, the change in the ten-year Treasury constant maturity interest rate, and the change in the log of the trade-weighted dollar exchange rate. He then measured the change in oil prices driven by oil supply and other factors as the residuals from this regression. Bernanke (2016) used Hamilton's approach to examine how aggregate demand and oil supply shocks affect stock returns.

This paper uses Hamilton's (2014) approach to investigate how shocks to aggregate demand and oil supply affect Japanese and Korean stock returns. The results indicate that Japanese sectors that compete in world markets such as machinery, electronic components, and consumer electronics benefit from oil price increases driven by global aggregate demand. Sectors oriented towards the domestic market such as food producers, railroads, hotels, restaurants, and delivery services suffer from oil price increases driven by global demand. Japanese industrial and engineering sectors gain from oil price increases driven by supply factors. This may reflect Fukunaga et al.'s (2010) findings that Japanese firms provide crucial products that agents demand when oil prices increase. Japanese sectors such as airlines, construction and tires that depend on oil and energy suffer from higher oil prices driven by supply factors.

Similarly, for Korea sectors benefiting from global demand such as iron and steel and shipbuilding gain from oil price increases due to aggregate demand increases. The commercial vehicle sector also benefits from higher oil prices due to demand increases as this increases the usage of public transportation relative to private vehicles. As with Japan, sectors relying on oil such as airlines and food producers are hurt by oil price increases.

The finding that oil prices affect many sectors provide Japan and Korea an additional reason to hasten the transition from fossil fuels to renewable energy sources. Not only will this help to achieve carbon neutrality but it will also reduce the dislocation arising from frequent oil price shocks. This is especially true as wars, tariffs, geopolitical events, climate change, and other factors will multiply oil price fluctuations going forward.

The next section presents the data and methodology. Section 3 contains the results. Section 4 considers how Japan and Korea can transition from fossil fuels to sustainable energy sources. Section 5 concludes.

2. Data and Methodology

To examine how oil price shocks affect individual sectors, their impact on stock prices is examined. Finance theory indicates that stock prices equal the expected present value of future cash flows. Abhyankar et al. (2013), using the variance decomposition methodology of Campbell (1991), reported that oil price shocks primarily affect the cash flows of Japanese firms. By examining how oil prices impact stock prices, we can infer how they impact firms' profitability.

To understand why oil price changes driven by global aggregate demand might impact profits differently than oil price increases driven by oil supply consider a profit-maximizing firm. Profits are the difference between total revenues and total costs. An increase in oil prices raises total costs and thus reduces profits. However, for firms active in global markets, an increase in aggregate demand can increase total revenues. If the increase in total revenues arising from the increase in demand exceeds the increase in total costs arising from the oil price increase, then profits will increase. An increase in oil prices driven by oil supply will only increase revenues for the subset of firms that are well positioned to benefit from oil price increases (e.g., oil producers) but will raise costs for many firms. Thus more firms should lose profits when confronted by an oil price increase driven by oil supply restrictions.

Hamilton's (2014) method is used to decompose oil price changes into the portion driven by global aggregate demand and the portion driven by oil supply. Following Hamilton, the monthly change in the log of Dubai oil prices is regressed on the change in the log of copper futures prices, the change in the log of the U.S. nominal effective exchange rate, and the change in the ten-year constant maturity U.S. Treasury interest rate. The values predicted by this regression represent oil price changes driven by aggregate demand. The residuals from this regression represent oil price changes driven by oil supply and other factors.

If Hamilton's method provides a good measure of oil price changes driven by global aggregate demand, this variable should be related to returns on the global stock market. The correlation coefficient between these two variables over the February 2001 to December 2019 period equals 0.70 and the covariance t-statistic equals 14.49.[2] This lends confidence that Hamilton's approach provides a useful measure of oil price changes driven by aggregate demand.

As Kilian and Park (2009), Hamilton (2014), Bernanke (2016), and others have noted, oil price changes driven by global aggregate demand have very different implications for stock prices than oil price changes driven by oil supply. Sectors that gain from aggregate demand increases that happen to raise oil prices do not necessarily benefit from higher oil prices. Sectors that gain because supply factors raise oil prices are benefitting from the oil price increases themselves. On the other hand, sectors that are harmed by demand- or supply-driven oil price increases are suffering from the price increases themselves.

Many have examined stock returns' exposure to exchange rates. This involves regressing a firm or sector's stock return on the return on the country's stock market and on the exchange

[2] Data on world stock returns come from the Refinitiv Datastream database.

rate (see, e.g., Ito et al., 2016, or Dominguez and Tesar, 2006). In this paper stock returns on 57 Japanese sectors and 64 Korean sectors are included as left hand-side variables and changes in the log of oil prices are included as an additional right-hand side variable along with the return on the country's aggregate stock market and changes in the log of the country's exchange rate relative to the U.S. dollar.

In one specification the change in the log of the spot price of Dubai crude oil is included as a regressor. In the other specification the log of the spot price of Dubai crude oil is decomposed using the method of Hamilton (2014) into the portion driven by global aggregate demand and the portion driven by oil supply.

In every case augmented Dickey-Fuller tests permit rejection of the null hypothesis that the series have unit roots. The equations are thus estimated using least squares. When the spot price of Dubai oil is used as a regressor, the equations take the form:

$$\Delta R_{i,c,t} = \alpha_0 + \alpha_1 \Delta R_{m,c,t} + \alpha_2 \Delta(\frac{currency}{dollar})_{c,t} + \alpha_3 \Delta Dubai_t, \qquad (1)$$

where $\Delta R_{i,c,t}$ is the monthly stock return for sector *i* in country c (either Japan or Korea), $\Delta R_{m,c,t}$ is the monthly stock return for country c's aggregate market, $\Delta(\text{currency/dollar})_{c,t}$ is the change in the log of the nominal exchange rate in country c relative to the U.S. dollar, and $\Delta Dubai_t$ is the change in the log of the spot price for Dubai crude oil.

When Dubai oil price changes are divided into the parts driven by global aggregate demand (Oildd) and by oil supply (Oilss), the equations take the form:

$$\Delta R_{i,c,t} = \alpha_0 + \alpha_1 \Delta R_{m,c,t} + \alpha_2 \Delta(\frac{currency}{dollar})_{c,t} + \alpha_4 Oildd_t + \alpha_4 Oilss_t \text{ . (2)}$$

This paper follows Chen et al. (1986) in assuming that causality flows from the macroeconomic variables on the right-hand side of equations (1) and (2) to the sectoral variables on the left-hand side and that any causality flowing in the other direction is of second order.

The sample period extends from February 2001 to December 2019.[3] It ends before the COVID-19 pandemic began because volatile movements in the variables during this period might cloud inference. Data on sectoral and aggregate stock returns, Dubai crude oil spot prices, and nominal exchange rates come from the Refinitiv Datastream database. Data on copper futures come from investing.com. The other data come from the FRED database provided by the Federal Reserve Bank of St. Louis.[4]

3. Results

Tables 1 and 3 present results for sectoral returns for Japan and Korea. The models perform well, with adjusted R-squareds averaging 0.51 for Japan and 0.33 for Korea. In these tables column (2) presents the coefficients on oil price changes driven by aggregate demand shocks (from equation (2)), column (4) presents the coefficients on oil price changes driven by supply factors (from equation (2)), column (6) presents the coefficients on total oil price changes (from equation (1)), and column (8) presents the coefficients on the exchange rate relative to the U.S. dollar (from equation (2)). The columns to the right of columns (2), (4), (6), and (8) present the associated heteroskedasticity and autocorrelation consistent (HAC) standard errors.

[3] In cases where data are not available in February 2001, the sample begins with the first month when data become available.

[4] The websites for Refinitiv Datastream, investing.com, and FRED are, respectively, https://www.lseg.com/en/data-analytics/products/datastream-macroeconomic-analysis , https://www.investing.com/commodities/copper-historical-data , and https://fred.stlouisfed.org/ .

3.1 Results for Japan

Table 1 presents the results for 57 Japanese sectors. Column (2) presents the coefficients on oil price changes driven by global aggregate demand shocks (Oildd) and column (3) presents the associated HAC standard errors. Of the 57 sectors, 24 exhibit positive and statistically significant exposures to Oildd and 17 exhibit negative and statistically significant exposures. Those exhibiting positive exposures are largely those Japanese sectors that compete in global markets. These sectors include four different types of machinery industries (construction, industrial, specialized, and tools), consumer electronics, industrial engineering, industrial suppliers like Japanese trading companies (*sogo shosha*), electronic and electrical equipment, luxury items (primarily watches), electronic components, automobiles, and auto parts. In addition, sectors related to the oil industry gain from increases in Oildd. For all of these sectors, the benefits of increased global demand offset the costs arising from higher oil prices.

The sectors harmed by increases in Oildd are those that focus on the domestic market. These include home furnishings, railroads, transport services, delivery services, electricity, restaurants and bars, and food producers. These sectors do not gain from increases in global aggregate demand but suffer from higher costs as oil prices increase. For instance, higher oil prices increase the cost of running tractors and thus the cost of producing food.[5] In addition, as Ready (2018) noted, higher oil prices reduce consumers' discretionary income and thus their ability to spend on domestic goods. Higher oil prices also harm the cosmetics industry by increasing input costs and decreasing consumers' capacity to purchase non-essential items.

Column (4) presents the coefficients on oil price changes driven by supply factors (Oilss) and column (5) presents the associated HAC standard errors. Of the 57 sectors, seven exhibit

[5] Taghizadeh-Hesary et al. (2019) noted that oil and other fossil fuels are essential inputs to agricultural production.

positive and statistically significant exposures to Oilss and three exhibit negative and statistically significant exposures. Four of those exhibiting positive exposures are related to the oil industry. In addition, the industrial engineering, industrial suppliers, and industrial materials sectors benefit from oil price increases driven by supply factors. Japanese industrial firms excel at providing goods and services that are needed when energy prices increase, and the beneficial effect of increases in Oilss reflects the increased demand for Japanese products that arises when oil prices increase.

The sectors harmed by increases in Oilss are tires, construction, and home construction. Oil is one of the largest costs for tire manufacturers, and they lose when supply factors drive up oil prices. Costs of moving items to construction sites and paying for electricity rise as oil prices increase. Thus the construction industry suffers from higher oil prices. The coefficients on electricity and airlines are also large and statistically significant at the 10% level. The electricity industry uses various energy sources including oil, and suffers when oil prices increase. Airlines also depend on oil and are harmed by oil price increases.

Column (6) presents the coefficients on total oil price changes and column (7) presents the associated HAC standard errors. Fourteen sectors gain from oil price increases and fifteen sectors lose. Many of these sectors exhibit the same responses to Oildd and Oilss and to overall oil price changes. Three industrial sectors (industrial engineering, industrial suppliers, and machinery: industrial) have positive exposures to Oildd and Oilss and also to overall oil prices. In addition, several oil-related sectors (crude oil production, oil equipment and services, and international oil and gas) benefit from increases in Oildd and Oilss and from increases in overall oil prices. Electricity, home construction, and airlines have negative coefficients on Oildd and Oilss and on overall oil price changes. The betas to total oil price changes in column (6) are closely related to the betas to Oildd and Oilss in columns (2) and (4). Regressing the total oil price betas on the Oildd betas yields a coefficient of 0.40 with a t-statistic of 11.44 and regressing the total oil price betas on the Oilss betas yields a coefficient of 1.10 and a t-statistic of 16.71.

Column (8) presents the coefficients on the yen/dollar exchange rate and column (9) presents the associated HAC standard errors. Those exhibiting positive exposures (implying that a yen depreciation raises returns) are largely those Japanese sectors that compete in global markets. These include automobiles, auto parts, construction machinery, and consumer electronics. The sectors that benefit from a weaker yen exchange rate overlap with the sectors that benefit from an increase in oil prices driven by global aggregate demand. Regressing the coefficients on Dubai oil price changes driven by aggregate demand in column (2) on the coefficients on the yen/dollar exchange rate in column (8) yields a coefficient of 0.31 with a t-statistic of 3.67.

To shed further light on why increases in oil prices due to supply factors as reported in column (4) of Table 1 benefit Japanese industrial sectors, Table 2 reports elasticities for individual Japanese industrial companies with statistically significant exposures to Oilss. Out of 81 firms in the categories industrial engineering, industrial suppliers, industrial materials, and machinery: industrial, nine benefit from increases in oil prices driven by supply factors and none are harmed.

Japan Steel Works (JSW) benefits from higher oil prices. JSW makes tank walls for oil tankers, and oil tankers become more profitable as oil prices increase. JSW also produces components for alternative energy sources such as hydro, wind, thermal, nuclear, and geothermal power. Demand for alternative power generation sources increases as oil prices increase.

Komatsu benefits from higher oil prices. Komatsu provides support to oil companies such as the Komatsu Argus Payload Management system. Oil companies' demand for Komatsu's services rises as oil prices increase.

Mitsui, Marubeni, and Nikkiso have positive coefficients for Oilss and for total oil price changes. Mitsui and Marubeni are Japanese trading companies that provide petroleum products. Both of these benefit from higher oil prices. Nikkiso makes cryogenic pumps. These are used at oil refineries and in liquified natural gas plants. Demand for their products increases as oil prices rise.

The important implication of the results reported here is that oil price increases, even when driven by supply factors rather than global aggregate demand factors, benefit many Japanese industrial sectors. This reflects the fact that Japanese companies supply many specialized goods and services that agents demand as oil prices increase. These results resonate with Fukunaga et al.'s (2010) finding that oil price hikes can raise demand for Japanese products.

3.2 Results for South Korea

Table 3 presents the results for 64 Korean sectors. Column (2) presents the coefficients on oil price changes driven by global aggregate demand shocks (Oildd) and column (3) presents the associated HAC standard errors. Of the 64 sectors, 10 exhibit positive and statistically significant exposures to Oildd and 11 exhibit negative and statistically significant exposures. In column (2) of Table 3, sectors benefiting from global demand such as iron and steel and marine transport (i.e., shipbuilding) gain. The commercial vehicle sector gains as higher oil prices increase the demand for public transportation as opposed to using private vehicles. As with Japan, sectors related to the food industry such as food producers and drug and grocery stores are hurt by higher oil prices. As discussed above, higher oil prices increase the cost of producing food and also decrease the discretionary income of consumers. As with Japan, higher oil prices also harm the cosmetics industry by increasing the costs of inputs and reducing the ability of consumers to purchase non-essentials.

In column (4) of Table 2 for Korea, the sectors harmed from oil price increases driven by supply factors are airlines, industrial transportation, and electricity. Fuel costs are paramount for airlines and industrial transportation, and higher oil prices raise their costs. Oil is also one input to electricity generation. No sectors benefit from oil price increases driven by supply side factors.

Columns (6) and (8) of Table 2 for Korea present the betas to total oil price changes and the won/dollar exchange rate. Again the betas to total oil price changes in column (6) are closely related to the betas to Oildd and Oilss in columns (2) and (4). Regressing the total oil price betas on the Oildd betas yields a coefficient of 0.26 with a t-statistic of 7.31 and regressing the total oil price betas on the Oilss betas yields a coefficient of 0.89 and a t-statistic of 14.13. Also there is again a positive relationship between sectors that gain from increases in global demand in column (2) and sectors that gain from a weaker currency in column (8). Regressing the Oildd betas on the won/dollar betas yields a coefficient of 0.22 with a t-statistic of 2.68.

One important implication of these results is that several sectors in Korea gain during times of high oil prices if price increases are driven by increases in global demand. These include iron and steel, shipbuilding, and commercial vehicles. Another implication is that several sectors are harmed by oil price increases, whether driven by aggregate demand or by supply side factors. These include airlines, drug and grocery stores, consumer staples, food producers, industrial transportation, and cosmetics. No sectors benefit from supply-driven oil price increases.

4. Discussion

The results indicate that many sectors in Japan and Korea are exposed to oil price changes. Figure 1 shows that oil prices can fluctuate violently. Hari (2025) noted that tariffs, trade wars, and geopolitical shocks will continue disrupting oil markets. The findings in Tables 1 through 3 indicate that the resulting oil price changes will whipsaw the economy. As Hari argued, governments should respond by expediting the shift to renewable energy sources.

Japan in 2025 approved a plan to reduce greenhouse gas emissions by 63% by 2035 and by 73% by 2040 relative to 2013 levels. The plan involves raising solar energy sources from 9.8% in 2023 to between 22% and 29% in 2040, raising nuclear power sources from 8.5% to 20%, and reducing fossil fuel sources from over 80% to between 30% and 40%. Korea plans to decrease greenhouse gas emissions by 40% by 2030 compared to 2018 levels. Because so many firms are exposed to oil price changes, Japan and Korea should be more ambitious in switching from fossil fuels to renewables. Investing in technologies to improve wind, hydro, and solar power would not only help them to reach their climate goals but also reduce firms' exposures to oil price changes.

One problem is that renewable energy sources can be more expensive and unpredictable than fossil fuels. Clean energy relies on sunshine, wind, and other intermittent sources. If Japan and Korea and other Northeast Asian neighbors could partner together, they could develop more affordable and reliable sources of renewable energy (Korea Energy Foundation, 2018). If they could strengthen infrastructure for receiving, storing, and distributing power produced by their neighbors, they could reduce the volatility associated with clean energy (Xiangchengzhen and Yilmaz, 2020). Hama (2024) reported that the Korean government rejected an offshore wind farm because there was insufficient grid capacity. Europe and Southeast Asia share energy across countries. Northeast Asia should learn from them.

Another problem is that Japan and Korea are mountainous. As Dempsey (2025) discussed, this means that there is less room for solar farms. One solution would be to use perovskite cells. These are 20 times thinner than regular solar panels and can be used in smaller spaces. Governments should continue sponsoring research into this technology.

Individual sectors and firms should also reduce their exposure to oil prices.[6] Tables 1 and 3 indicate that airlines in both Japan and Korea are harmed by higher oil prices. As Russell (2025) reported, airlines aim to achieve carbon neutrality by 2050. A major step would be to replace fossil fuels with sustainable aviation fuel (SAF). While SAF could cut carbon dioxide output by 80%, it is four times more expensive than fossil jet fuels. For this reason, Japan Airline's SAF use in 2023 was 0.012%, All Nippon Airways' SNF use was less than 0.1%, and Korean Airlines use was also miniscule. In addition to using SAF, airlines could reduce emissions by reorganizing flight plans, adjusting flap angles during takeoff, releasing the landing gear later, and adjusting other procedures. They could also employ newer fuel efficient planes. These steps are costly. However, tourists visiting Japan have increased from 25 million in 2023 to 36.8 million in 2024, to projections of more than 40 million in 2025.[7] Tourists visiting Korea increased from 11 million in 2023 to 16.4 million in 2024 to projections of 19 million in 2025.[8]

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[6] This paragraph draws on Russell (2025).
[7] Japanese tourist statistics are available at https://statistics.jnto.go.jp/en/ . Forecasts for 2025 come from Naoya Haraikawa, Commissioner of the Japan Tourism Agency (see Terada, 2025).
[8]These data come from *Straits Times* (2025) and from Yanolja Research (2025).

If governments levied a small surcharge on tourists, they could help fund airlines' decarbonization efforts.

The results indicate that cosmetics sectors in both Japan and Korea are exposed to oil price increases. Many cosmetic products rely on petrochemicals. These could be replaced by environmentally friendly products. For instance, petrochemicals could be replaced by oleochemicals derived from vegetable oils and other renewable materials. Because oleochemicals contain fewer carcinogens than petrochemicals, they are not only more sustainable but also healthier for consumers in the long run (see Nogueria et al., 2024).

Food producers are exposed to oil price increases. Both countries should provide incentives for the adoption of smart farms. These use information and communication technology (ICT) and data to grow food more sustainably. Mi et al. (2023) found that people who graduated from specialized schools and vocational colleges were more likely to adopt smart farming and ICT methods. Subsidizing education at these institutes could help promote sustainable farming practices.

The travel and leisure sectors in both Japan and Korea are harmed by oil price increases. Hotels could switch to renewable energy sources. For instance, Japan's Super Hotels have achieved carbon neutrality across their 173 hotels in Japan (Tanimoto, 2025). This not only reduces their exposure to fossil fuel prices but also helps attract customers, as 73% of people surveyed said that they wanted to travel in a sustainable manner in 2025 (Tanimoto, 2025). A small surcharge on tourists could help to fund this transition.

Promoting the use of electric vehicles (EVs) instead of internal combustion engine vehicles could also reduce countries' dependence on oil. Research has indicated that increasing the number of charging facilities and ensuring their full functioning is more cost-effective than providing consumers with subsidies (Kim, 2024). It is also important to raise the quantity and quality of charging infrastructure at travel hubs such as highway rest stops. Governments in Japan and Korea are working in these areas, and to promote decarbonization and protect their economies from shocks arising from oil price changes they should redouble their efforts.

Semiconductor manufacturing requires massive amounts of energy. Within the electronics supply chain, Gupta et al. (2021) found that the majority of the carbon output of electronic goods such as smartphones and computers comes from manufacturing the semiconductors inside the electronic devices. To be more environmentally friendly, semiconductor producers in Japan and Korea should decrease the share of high global-warming potential gases used in manufacturing, reduce the energy requirements of their furnaces, clean rooms and other machines, and transport their final products to customers in fuel-efficient ways (McKinsey, 2020). In addition, by consciously designing chips that employ less energy, such as by layering integrated circuits on top of each other in a 3D manner, they could slash their carbon footprints (Salata Institute, 2024).

Unlike Japan, Korea has no sectors in Table 3 that gain from oil price increases driven by supply side factors. Several Japanese industrial firms excel at providing goods and services that are needed when energy prices increase, and supply-driven increases in oil prices raise demand for Japanese products. Korean firms could become more resilient by following Japanese firms up the technology ladder and producing products that are needed as oil prices increase.

Japan has often resorted to blanket subsidies to offset the burden of high energy prices. For instance, starting in 2022 it provided subsidies to oil wholesalers in order to lower gasoline and fuel prices to final users. It also provided subsidies to reduce electricity and gas bills. By August 2023 it had spent 6.3 trillion yen on fuel subsidies (Kishida, 2023). Starting in 2025 it provides subsidies when gasoline prices exceed 185 yen per liter. Subsidies encourage fossil fuel consumption, work against decarbonization, and impose large fiscal costs. The findings that many Japanese sectors gain from higher oil prices indicate that the Japanese government should not provide universal subsidies but rather target subsidies only towards those sectors and individuals that suffer from oil price hikes.

5. Conclusion

Nearly 40% of Japan and Korea's energy supply in 2023 came from imported oil. Oil prices fluctuate wildly. This paper investigates how oil prices impact both economies by examining how they impact sectoral stock returns. The results indicate that many sectors are exposed to oil price changes.

Oil prices will remain volatile and whipsaw their economies. To stay resilient, both Japan and Korea should expedite their transitions from fossil fuels to sustainable energy sources. They are targeting carbon neutrality by 2050. However, because of the need to import oil and the damage to large swaths of their economy from oil price swings, they should achieve neutrality sooner.

Figure 1. Price of Dubai Crude Oil.
Source: Federal Reserve Bank of St. Louis Fred Database.

Table 1. The Exposure of Japanese Sectors to Oil Price Changes and the Yen/dollar Exchange Rate.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sector	Coefficient on Dubai Oil Price Changes Driven by Aggregate Demand	Standard Error	Coefficient on Dubai Oil Price Changes Driven by Oil Supply	Standard Error	Coefficient on Total Dubai Oil Price Changes	Standard Error	Coefficient On Yen/dollar Exchange Rate	Standard Error
Airlines	-0.235***	0.082	-0.087*	0.049	-0.124***	0.044	-0.206	0.159
Aluminum	0.041	0.108	0.008	0.064	0.017	0.051	-0.521**	0.209
Automobiles	0.123**	0.055	0.009	0.033	0.038	0.028	0.870***	0.106
Auto Parts	0.155***	0.053	0.003	0.031	0.041	0.034	0.674***	0.102
Banks	-0.114*	0.063	0.059*	0.038	0.015	0.030	-0.301**	0.123
Biotech-nology	0.079	0.200	-0.030	0.123	-0.002	0.099	0.147	0.411
Cement	-0.077	0.112	0.062	0.066	0.027	0.081	-0.085	0.217
Chemicals	0.092**	0.037	-0.005	0.022	0.020	0.023	0.089	0.072
Construction	-0.079	0.077	-0.119***	0.046	-0.109***	0.040	-0.420***	0.150
Consumer Electronics	0.315***	0.087	0.004	0.052	0.082*	0.044	0.529***	0.169
Consumer Staples	0.045	0.031	0.011	0.018	0.019	0.016	0.483***	0.060
Cosmetics	-0.134*	0.076	0.029	0.046	-0.013	0.040	-0.301**	0.148
Delivery Services	-0.211***	0.077	-0.041	0.046	-0.084**	0.037	-0.113	0.150
Electronic & Electrical Equipment	0.191***	0.043	-0.001	0.025	0.048**	0.023	0.394***	0.083
Electronic Equipment: Controls	0.051	0.096	0.025	0.057	0.032	0.526	-0.133	0.186
Electronic Equipment: Gauges	0.146***	0.047	-0.012	0.028	0.028	0.025	0.345***	0.092
Electronic Equipment: Pollution	0.107	0.097	0.016	0.058	0.039	0.049	-0.197	0.189
Electronic Office Equipment	0.179***	0.060	-0.061*	0.036	-0.000	0.033	0.685***	0.117
Electricity	-0.253***	0.095	-0.104*	0.056	-0.141***	0.044	-0.088	0.184
Electronic Component	0.213***	0.050	0.011	0.030	0.062**	0.026	0.324***	0.096
Fishing & Farming	-0.065	0.069	0.013	0.040	-0.007	0.041	0.094	0.130
Fertilizers	-0.216*	0.129	-0.035	0.077	-0.081	0.075	0.507**	0.250
Food Producers	-0.154***	0.046	-0.022	0.027	-0.056**	0.027	-0.119	0.089
Food Retail & Wholesale	-0.273***	0.066	-0.054	0.039	-0.109***	0.036	-0.249*	0.128
Gas Distribution	-0.233***	0.057	-0.040	0.034	-0.089**	0.035	-0.121	0.111

General Industrials	0.184***	0.061	0.026	0.036	0.066**	0.033	-0.086	0.118
Health Care	-0.133***	0.043	0.013	0.026	-0.023	0.020	-0.140*	0.084
Home Furnishings	-0.271***	0.066	-0.021	0.039	-0.083**	0.033	-0.189	0.127
Home Construction	-0.141**	0.060	-0.082**	0.036	-0.097***	0.032	-0.224*	0.116
Hotels	-0.285***	0.083	-0.035	0.050	-0.098**	0.045	-0.223	0.162
Industrial Engineering	0.215***	0.043	0.060**	0.026	0.099***	0.023	0.151*	0.084
Industrial Suppliers	0.426***	0.065	0.148***	0.038	0.219***	0.031	-0.021	0.127
Industrial Materials	-0.181**	0.085	0.123**	0.050	0.046	0.060	-0.414**	0.164
International Oil and Gas	0.310***	0.085	0.186***	0.051	0.217***	0.049	0.031	0.166
Iron & Steel	0.227***	0.071	0.062	0.042	0.103***	0.030	0.133	0.137
Leisure Goods	0.150***	0.054	0.024	0.032	0.056*	0.032	0.287***	0.105
Luxury Items	0.303***	0.094	-0.028	0.056	0.055	0.074	0.684***	0.183
Machinery: Agriculture	-0.068	0.094	0.033	0.056	0.007	0.055	0.221	0.183
Machinery: Construction	0.622***	0.083	0.090*	0.049	0.225***	0.043	0.589***	0.160
Machinery: Industrial	0.183***	0.049	0.053*	0.029	0.086***	0.027	0.046	0.096
Machinery: Specialized	0.167**	0.068	0.006	0.040	0.047	0.039	0.109	0.131
Machinery: Tools	0.224***	0.078	0.009	0.047	0.063	0.043	0.224	0.152
Marine Transport	0.172*	0.097	0.101*	0.058	0.119**	0.050	0.055	0.188
Medical Equipment	0.022	0.069	0.075*	0.041	0.061*	0.037	0.102	0.134
Nonferrous Metals	0.455***	0.084	0.031	0.050	0.138***	0.044	-0.043	0.163
Oil Equipment & Services	0.283**	0.139	0.299***	0.088	0.295***	0.063	-0.600	0.282
Oil Refining & Marketing	0.220**	0.096	0.199***	0.057	0.204***	0.055	-0.022	0.187
Oil: Crude Production	0.298***	0.083	0.289***	0.049	0.291***	0.047	0.194	0.161
Pharmaceuticals	-0.163***	0.050	0.007	0.030	-0.036	0.023	-0.162*	0.097
Railroads	-0.229***	0.047	-0.018	0.028	-0.071***	0.021	-0.267***	0.091
Restaurants & Bars	-0.251***	0.049	-0.048*	0.029	-0.100***	0.025	-0.373***	0.094
Semiconductors	0.166*	0.086	-0.027	0.051	0.022	0.043	0.343**	0.168
Technology Hardware	0.167***	0.055	-0.012	0.033	0.034	0.026	0.192*	0.108
Tires	-0.025	0.080	-0.119**	0.048	-0.096**	0.042	0.855***	0.156
Transport	-0.191***	0.061	-0.015	0.037	-0.059*	0.034	-0.307***	0.119

Services								
Travel & Leisure	-0.264***	0.046	-0.031	0.027	-0.090***	0.020	-0.285***	0.089
Trucking	-0.202***	0.055	-0.032	0.033	-0.075**	0.031	-0.202*	0.107

Notes: The coefficients in columns (2), (4), and (8) represent the regression parameters from a regression of stock returns for the sectors listed in column (1) on 1) the change in the log of Dubai spot crude oil prices driven by global aggregate demand (column (2)), 2) the change in the log of Dubai spot crude oil prices driven by supply (column (4)), 3) the yen/dollar nominal exchange rate (column (8)), and 4) the return on the Japanese stock market (not reported). The coefficients in columns (6) represent the regression parameters from a regression of stock returns for the sectors listed in column (1) on 1) the change in the log of Dubai spot crude oil prices (column (6)), 2) the return on the Japanese stock market (not reported) and 3) the yen/dollar nominal exchange rate (not reported). Following Hamilton (2014), the change in crude oil prices driven by aggregate demand factors is captured by regressing the change in the log of oil prices on the change in the log of copper futures prices, the change in the ten-year Treasury constant maturity interest rate, and the change in the log of the trade-weighted dollar exchange rate. The change in oil prices driven by oil supply and other factors is measured as the residuals from this regression. The regressions are all run over the February 2001 to December 2019 period. Columns (3), (5), (7), and (9) report heteroskedasticity and autocorrelation consistent standard errors.

*** (**) [*] denote significance at the 1% (5%) [10%] levels.

Table 2. The Exposure of Japanese Industrial Firms to Oil Price Changes and the Yen/dollar Exchange Rate.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Company	Coefficient on Dubai Oil Price Changes Driven by Aggregate Demand	Standard Error	Coefficient on Dubai Oil Price Changes Driven by Oil Supply	Standard Error	Coefficient on Total Dubai Oil Price Changes	Standard Error	Coefficient On Yen/dollar Exchange Rate	Standard Error
Daio Paper	-0.352**	0.145	0.155**	0.075	0.027	0.081	-0.303	0.264
Japan Steel Works	0.218	0.168	0.201**	0.084	0.206**	0.084	-0.700*	0.383
Komatsu	0.696***	0.133	0.107**	0.045	0.256***	0.041	0.626***	0.187
Marubeni	0.345***	0.107	0.185***	0.065	0.224***	0.050	-0.497*	0.257
Mitsui	0.496***	0.061	0.169***	0.037	0.252***	0.036	-0.039	0.115
Nikkiso	0.029	0.148	0.190***	0.069	0.149**	0.072	0.036	0.237
Nitto Boseki	0.041	0.149	0.184**	0.084	0.147*	0.078	-0.145	0.231
Oji Holdings	-0.112	0.108	0.153**	0.070	0.086	0.067	-0.260	0.219
Tadano	-0.044	0.114	0.186**	0.077	0.128**	0.058	0.229	0.212

Notes: The coefficients in columns (2), (4), and (8) represent the regression parameters from a regression of stock returns for the firms listed in column (1) on 1) the change in the log of Dubai spot crude oil prices driven by global aggregate demand (column (2)), 2) the change in the log of Dubai spot crude oil prices driven by supply (column (4)), 3) the yen/dollar nominal exchange rate (column (8)), and 4) the return on the Japanese stock market (not reported). The coefficients in columns (6) represent the regression parameters from a regression of stock returns for the firms listed in column (1) on 1) the change in the log of Dubai spot crude oil prices (column (6)), 2) the return on the Japanese stock market (not reported) and 3) the yen/dollar nominal exchange rate (not reported). Following Hamilton (2014), the change in crude oil prices driven by aggregate demand factors is captured by regressing the change in the log of oil prices on the change in the log of copper futures prices, change in the ten-year Treasury constant maturity interest rate, and the change in the log of the trade-weighted dollar exchange rate. The change in oil prices driven by oil supply and other factors is measured as the residuals from this regression. The regressions are all run over the February 2001 to December 2019 period. Columns (3), (5), (7), and (9) report heteroskedasticity and autocorrelation consistent standard errors.

*** (**) [*] denote significance at the 1% (5%) [10%] levels.

Table 3. The Exposure of Korean Sectors to Oil Price Changes and the Won/dollar Exchange Rate.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sector	Coefficient on Dubai Oil Price Changes Driven by Aggregate Demand	Standard Error	Coefficient on Dubai Oil Price Changes Driven by Oil Supply	Standard Error	Coefficient on Total Dubai Oil Price Changes	Standard Error	Coefficient On Won/dollar Exchange Rate	Standard Error
Airlines	-0.163	0.171	-0.30***	0.106	-0.278***	0.085	-0.427	0.311
Asset Managers	-0.081	0.075	0.056	0.042	0.021	0.038	-0.092	0.069
Auto Parts	-0.200	0.140	0.038	0.057	-0.012	0.053	0.206	0.190
Automobiles	-0.031	0.127	0.013	0.055	0.004	0.050	0.295	0.187
Banks	0.230***	0.074	0.010	0.061	0.060	0.057	-0.142	0.139
Basic Materials	0.282***	0.075	0.003	0.035	0.061**	0.031	-0.262***	0.083
Basic Resources	0.377***	0.093	0.036	0.045	0.107***	0.038	-0.321***	0.116
Biotechnology	0.128	0.354	0.308	0.293	0.262	0.274	-0.105	0.498
Casinos/Gambling	-0.151	0.108	0.038	0.078	-0.001	0.064	-0.577**	0.236
Cement	-0.437**	0.208	-0.063	0.111	-0.141	0.111	-0.838**	0.385
Chemicals	0.236*	0.142	-0.048	0.062	0.011	0.052	-0.029	0.142
Commercial Vehicles & Parts	0.364**	0.154	0.052	0.073	0.117*	0.067	0.298	0.173
Computer Hardware	-0.061	0.128	0.009	0.079	-0.008	0.064	0.247	0.238
Computer Services	-0.235	0.187	0.015	0.071	-0.027	0.065	0.040	0.426
Consumer Digital Services	0.009	0.167	-0.013	0.095	-0.009	0.077	0.090	0.173
Construction & Materials	0.052	0.102	0.007	0.054	0.016	0.045	-0.178	0.173
Construction	0.073	0.135	-0.000	0.067	0.015	0.056	-0.120	0.211
Consumer Discretionary	-0.176**	0.058	0.023	0.026	-0.019	0.023	0.011	0.080
Consumer Electronics	-0.027	0.118	-0.031	0.063	-0.030	0.056	0.246	0.204
Consumer Products & Services	-0.189***	0.064	0.014	0.034	-0.028	0.029	-0.023	0.087
Consumer Staples	-0.222***	0.072	-0.006	0.033	-0.051*	0.028	0.139	0.102
Cosmetics	-0.380**	0.153	0.035	0.080	-0.051	0.070	-0.220	0.205
Diversified Industrials	0.086	0.112	0.033	0.060	0.044	0.054	-0.047	0.150
Diversified Retail	0.031	0.113	0.058	0.045	0.052	0.040	-0.078	0.198
Drug/Grocery Stores	-0.407***	0.131	0.021	0.072	-0.068	0.058	-0.252	0.161
Electronic Entertainment	0.104	0.237	-0.156	0.109	-0.102	0.095	0.118	0.281
Electricity	-0.057	0.095	-0.130**	0.052	-0.115**	0.047	-0.427***	0.153
Electronic Components	-0.076	0.116	-0.086	0.073	-0.084	0.059	0.173	0.132
Energy	0.283**	0.141	0.075	0.069	0.118*	0.062	-0.135	0.147
Financial Data Providers	0.008	0.187	-0.001	0.063	0.001	0.059	-0.248	0.299
Food Producers	-0.196**	0.090	-0.000	0.049	-0.041	0.041	-0.454***	0.171
Health Care	-0.196	0.198	0.139	0.085	0.069	0.091	0.109	0.211
Household Equip. Production	-0.530***	0.145	0.147*	0.084	0.004	0.063	-0.192	0.211
+ Industrial	0.250**	0.121	0.034	0.065	0.079	0.056	0.039	0.158

Engineering								
Industrial Goods & Services	0.039	0.069	0.015	0.034	0.020	0.027	0.049	0.096
Industrial Metals & Mines	0.376***	0.093	0.036	0.045	0.107***	0.038	-0.319***	0.116
Industrial Support Svstems	0.156	0.113	0.108*	0.064	0.118**	0.058	-0.183	0.168
Industrial Transport	-0.057	0.141	-0.158**	0.070	-0.137**	0.055	-0.046	0.164
Insurance	0.056	0.087	-0.009	0.055	0.004	0.042	0.146	0.165
Investment Banks & Brokers	-0.161	0.123	-0.054	0.065	-0.077	0.050	-0.219	0.174
Iron & Steel	0.375***	0.101	0.054	0.049	0.121***	0.041	-0.304**	0.132
Leisure Goods	-0.079	0.110	-0.015	0.051	-0.028	0.050	0.127	0.169
Life Insurance	0.197*	0.119	-0.009	0.062	0.026	0.056	0.307	0.272
Machinery: Industrial	-0.021	0.191	0.120	0.099	0.091	0.091	-0.143	0.235
Marine Transport	0.334**	0.145	-0.008	0.071	0.063	0.060	0.022	0.227
Nonlife Insurance	0.089	0.092	-0.026	0.055	-0.002	0.043	0.112	0.168
Oil Refining & Marketing	0.212	0.161	0.092	0.072	0.117*	0.067	-0.147	0.186
Personal Goods	-0.422***	0.129	0.055	0.061	-0.045	0.051	-0.267*	0.153
Personal Product	-0.423***	0.134	0.020	0.073	-0.072	0.058	-0.262	0.160
Pharmaceutical & Biotech	-0.194	0.198	0.138	0.085	0.069	0.091	0.110	0.211
Pharmaceuticals	-0.532*	0.319	-0.150	0.122	-0.216*	0.110	-1.473***	0.553
Precious Metals & Mines	0.528***	0.160	-0.077	0.076	0.049	0.077	-0.121	0.278
Retailers	-0.017	0.109	0.069	0.047	0.051	0.042	-0.117	0.188
Software & Computer Services	0.073	0.140	0.018	0.085	0.030	0.076	0.085	0.155
Security Systems	-0.017	0.127	0.041	0.060	0.029	0.058	0.073	0.212
Semiconductors	-0.459	0.309	-0.054	0.148	-0.139	0.108	0.426	0.269
Technology Hardware	-0.218	0.138	-0.005	0.064	-0.050	0.057	0.402**	0.171
Telecommun-ication Equipment	-0.485	0.344	-0.218	0.153	-0.274*	0.141	-1.253***	0.419
Telecommun-ication Service Providers	-0.101	0.099	-0.054	0.053	-0.064	0.049	-0.094	0.118
Tires	-0.101	0.150	-0.043	0.060	-0.055	0.052	0.213	0.204
Tobacco	-0.107	0.088	0.079	0.065	0.040	0.052	0.178	0.129
Transport Services	-0.239	0.227	-0.080	0.073	-0.120*	0.064	-0.118	0.185
Travel & Leisure	-0.215**	0.101	0.034	0.058	-0.018	0.054	-0.424***	0.163
Trucking	-0.117	0.294	-0.039	0.105	-0.059	0.098	0.050	0.276

Notes: The coefficients in columns (2), (4), and (8) represent the regression parameters from a regression of stock returns for the sectors listed in column (1) on 1) the change in the log of Dubai spot crude oil prices driven by global aggregate demand (column (2)), 2) the change in the log of Dubai spot crude oil prices driven by supply (column (4)), 3) the won/dollar nominal exchange rate (column (8)), and 4) the return on the Korean stock market (not reported). The coefficients in column (6) represent the regression parameters from a regression of stock returns for the sectors listed in column (1) on 1) the change in the log of Dubai spot crude oil prices (column (6)), 2) the return on the Korean stock market (not reported) and 3) the won/dollar nominal exchange rate (not reported). Following Hamilton (2014), the change in crude oil prices driven by aggregate demand factors is captured by regressing the change in the log of oil prices on the change in the log of copper futures prices, the change in the ten-year Treasury constant maturity interest rate, and the change in the log of the trade-weighted dollar exchange rate. The change in oil prices driven by oil supply and other factors is measured as the residuals from this regression. The regressions are all run over the February 2001 to December 2019 period. Columns (3), (5), (7), and (9) report heteroskedasticity and autocorrelation consistent standard errors.

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