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How Oil Prices Impact the Japanese Economy: Evidence from the stock market※

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Abstract

Oil prices increased 120% between 2020 and 2024. How do oil prices affect Japanese firms? Since Japan is an oil importer, oil price increases may act as a tax on Japanese firms. This would decrease their cash flows and stock prices. This paper examines how oil prices affect stock prices. 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 increases raise Japanese aggregate stock returns. Aggregate demand-driven oil price increases benefit sectors that compete in global markets and harm sectors that depend on oil and sell to the domestic market. Supply-driven oil price increases benefit Japanese industrial firms that service the oil industry. These findings imply that, if the Japanese government wants to alleviate the burden of high oil prices, it should not provide blanket subsidies but target subsidies to sectors harmed by oil price increases.

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

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1. Introduction

Oil is Japan's largest energy source, with 39% of its total energy supply coming from oil in 2022. Dubai crude oil spot prices increased logarithmically by 120% between April 2020 and June 2024.[1] How has this surge in petroleum costs affected Japanese firms?

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.[2] 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 to oil exporters.

The Japanese government tried to offset the burden of high energy prices. 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). Kishida acknowledged that these subsidies encourage fossil fuel consumption and work against decarbonization. The fiscal costs are also burdensome given Japan's large public debt.

Blanket subsidies do not take account of the fact that some sectors gain from oil price increases. 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

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[1] These data come from the International Energy Agency and the Refinitiv Datastream database. The websites for these sources are, respectively, www.iea.org and https://www.lseg.com/en/data-analytics/products/datastream-macroeconomic-analysis .

[2] According to Bank of Japan data, prices for oil imported into Japan increased logarithmically by more than 100% between May 2020 and March 2024. The website for these data is https://www.boj.or.jp/en/ .

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.

Thorbecke (2019) used Kilian's (2009) decomposition and structural VARs estimated over the January 1990-November 2017 period to investigate how oil price shocks affect Asian stock returns. He found almost no evidence that shocks to global economic activity or oil production affect Japanese stock prices. Residual oil price changes, on the other hand, affect several sectors.

Hamilton (2021), Demirer et al. (2020), and others have criticized Kilian's (2009) decomposition. Hamilton noted that Kilian used the questionable approach of taking the log of a log when calculating bulk dry cargo freight rates. This implies that the initial value used influences subsequent values of the series. Hamilton showed that initializing the series at different dates produces strikingly different values for the index. Hamilton also showed that Kilian's proxy for global economic activity had strange properties, such as implying that the global economy in 2015 suffered a more severe downturn than during the 1974-1975 recession or the 2008-2009 Global Financial Crisis. Examining industrial production over these periods indicates that the global downturns were far more severe in 1974-1975 and 2008-2009 than in 2015. Demirer et al. argued that the Kilian decomposition assigns too much weight to oil price shocks not explained by global economic activity or oil production. This could explain why Thorbecke (2019) found that these residual oil price shocks rather than global activity or oil production affect Japanese stock returns.

Hamilton's (2014) presented an alternative method to decompose oil price changes into the portion driven by aggregate demand and the portion driven by oil supply and other factors. To capture the effect of aggregate demand on oil prices, he 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.

Shocks to global aggregate demand should be related to returns on the world stock market. As shown in the next section, the correlation coefficient between Hamilton's (2014) measure of the portion of oil price changes driven by aggregate demand factors and the return on the world stock market equals 0.70 and the covariance t-statistic equals 14.49. Hamilton's measure is thus closely related with global aggregate demand.

Using Hamilton's (2014) measure of global aggregate demand, results reported below indicate that 41 out of 57 Japanese sectors exhibit statistically significant responses to oil price increases driven by aggregate demand. Thorbecke (2019) found that only one out of 40 sectors exhibit a statistically significant response using Kilian's (2009) measure of global aggregate demand. Understanding whether aggregate demand or oil supply factors drive changes is important for understanding how sectors are affected by oil price changes. Sectors that gain because of 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.

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 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 construction and tires that depend on oil and energy suffer from higher oil prices driven by supply factors.

The next section presents the data and methodology. Before discussing how to investigate the exposure of Japanese sectoral stock returns to oil price shocks, it considers how to estimate the price elasticity of demand for imported oil. Section 3 presents the results. Section 4 concludes.

2. Data and Methodology

The first step is to estimate import elasticities for crude oil. Hamilton (2009) reported several findings indicating that the short run price elasticity of demand for oil is low. More recently Taghizadeh-Hesary et al. (2017) employed cointegration analysis and a vector error correction model to investigate whether the elasticity of oil consumption in Japan to oil prices decreased after the Fukushima disaster in 2011. They reported that the absolute value of the price elasticity of oil consumption fell in sectors such as industry and transportation after 2010.

Sasaki et al. (2021) used industry-specific nominal effective exchange rates and industry-specific import price indices to examine exchange rate pass-through. Employing time-varying parameter vector autoregression (VAR) analysis and monthly data over the January 1988 to December 2017 period, they reported high pass-through of exchange rate changes to petroleum import prices. These pass-through coefficients also increased over time.

The findings of Taghizadeh-Hesary et al. (2017) suggest that price elasticities for imported oil should be low. On the other hand, the finding of Sasaki et al. (2021) that exchange rate changes lead to large changes in oil import prices suggests that exchange rate changes may impact the volume of oil imports. If the results indicate that yen depreciations do not impact oil imports, then factors such as depreciations that increase the yen costs of oil imports should decrease the cash flows of Japanese firms.

To estimate import elasticities for crude oil, the imperfect substitutes model is used. This model posits that the volume of imports depends on the real exchange rate and on economic activity in the importing country. Data on the volume of oil imports are obtained from the Petroleum Association of Japan via the CEIC database. Data on the Japanese CPI-deflated broad real effective exchange rate are obtained from the Bank for International Settlements (BIS). Data on Japanese industrial production are obtained from the OECD.[3]

The sample period extends from March 1997 to December 2019. The sample period ends before COVID-19 arrived to avoid any distortions caused by the pandemic. Augmented Dickey-Fuller tests do not permit rejection of the null hypothesis of a unit root for the log of crude oil imports and the real effective exchange rate but do for the log of industrial production. ARDL estimation, which is preferable when including variables that are integrated of different orders, is thus employed.

Following Pesaran and Shin (1999), ARDL involves regressing the first difference of the dependent variable on lagged levels and lagged first differences of the dependent and independent variables. The estimated equation takes the form:

$$\Delta OilIm_t = \beta_0 + \beta_1 \, OilIm_{t-1} + \beta_2 \, IP_{t-1} + \beta_3 \, REER_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \, \Delta OilIm_{t-i} + \sum_{i=0}^{m} \gamma_{2i} \Delta IP_{t-i} + \sum_{i=0}^{n} \Delta REER_{t-i} + u_{i,t} \quad (1)$$

where $OilIm_t$ represents Japanese real oil imports, IP_{t-1} represents Japanese industrial production, REER represents the Japanese real effective exchange rate, and all variables are measured in

[3] The websites for the CEIC, BIS, and OECD databases are, respectively, https://www.ceicdata.com/ja , https://www.bis.org/statistics/eer.htm , and www.oecd.org .

natural logs. The long run exchange rate elasticity is given by β_3/β_1. The Schwartz information criterion is used to determine the number of lags. Monthly dummy variables and a trend term are also included in the estimation. Bounds F- and t-tests are used to test the null hypotheses of no cointegration.

To examine how oil price shocks affect profitability, 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 price increases impact stock prices, we can infer how they impact firms' profitability.

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 rate (see, e.g., Dominguez and Tesar, 2006). In this paper stock returns on 57 Japanese 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 Japanese stock market and changes in the log of the nominal yen/dollar exchange rate.

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.

To decompose oil prices into the portion driven by aggregate demand and by oil supply, 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 the change in oil prices driven by aggregate demand. The residuals from this regression represent the change in oil prices driven by oil supply and other factors. As Kilian and Park (2009), Hamilton (2014), Bernanke (2016), and many others have noted, changes in oil prices driven by global aggregate demand have very different implications for stock prices than changes 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. The equation including the spot price of Dubai oil as a regressor takes the form:

$$\Delta R_{i,t} = \alpha_0 + \alpha_1 \Delta R_{m,Japan,t} + \alpha_2 \Delta(\frac{yen}{dollar})_t + \alpha_3 \Delta Dubai_t, \qquad (2)$$

where $\Delta R_{i,t}$ is the monthly stock return for Japanese sector i, $\Delta R_{m,Japan,t}$ is the monthly stock return for Japan's aggregate market, $\Delta(yen/dollar)_t$ is the change in the log of the nominal yen per dollar exchange rate, and $\Delta Dubai_t$ is the change in the log of the spot price for Dubai crude oil.[4]

The equation including Dubai oil price changes decomposed into the portions due to global aggregate demand (Oildd) and to supply factors (Oilss) as regressors takes the form:

$$\Delta R_{i,t} = \alpha_0 + \alpha_1 \Delta R_{m,Japan,t} + \alpha_2 \Delta(\frac{yen}{dollar})_t + \alpha_4 Oildd_t + \alpha_4 Oilss_t \ . \qquad (3)$$

[4] Since the equation controls for exchange rates, it should capture the impact of oil price changes on stock returns.

We follow Chen et al. (1986) in assuming that causality flows from the macroeconomic variables on the right-hand side of equations (2) and (3) to the sectoral variables on the left-hand side and that any causality flowing in the other direction is of second order.

Data on Japanese sectoral and aggregate stock returns, the nominal yen/U.S. dollar exchange rate, and the spot price of Dubai crude oil come from the Refinitiv Datastream database. Data on copper futures come from investing.com. Data on the other variables come from the Federal Reserve Bank of St. Louis FRED database.[5] The model is estimated over the February 2001 to December 2019 period. It ends before the COVID-19 pandemic began to avoid distortions that could be caused by the very unusual period that began in early 2020.

Changes in global aggregate demand should be related to changes in returns for the world stock market. The correlation coefficient between changes in Dubai crude oil prices driven by Hamilton's (2014) measure of aggregate demand and world stock returns over the February 2001 to December 2019 period equals 0.70.[6] The covariance t-statistic between these two variables equals 14.49. These results indicate that Hamilton's measure of oil prices changes driven by global aggregate demand is closely and positively related to changes in world stock returns. This lends confidence that Hamilton's approach is capturing world demand factors.

3. Results

For equation (1), bounds F- and t-tests permit rejection of the null hypothesis of no cointegration at the 1% level. The long run elasticity of oil imports with respect to industrial production equals 0.480 with an associated heteroskedasticity and autocorrelation consistent

[5] The websites for 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/ .

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

(HAC) standard error of 0.094. The long run elasticity of oil imports with respect to the real effective exchange rate equals 0.001 with an associated HAC standard error of 0.052. These results indicate that Japanese oil imports depend on economic activity as measured by industrial production but not on the real effective exchange rate.

The results of regressing the return on the aggregate Japanese stock market on the yen/dollar exchange rate and crude oil prices, with HAC standard errors in parentheses, are:

$$\Delta R_{m,Japan} = \underset{(0.16)}{0.83^{***}}(\Delta yen/dollar) + \underset{(0.04)}{0.16^{***}}\Delta Dubai$$

Adjusted R-squared = 0.292, Standard error of regression = 0.042, Sample period = February 2001 – December 2019. *** indicates significance at 1% level.

The results indicate that an increase in oil prices is associated with an increase in Japanese stock returns. To shed light on these findings, oil price changes can be decomposed into the portion due to global aggregate demand and due to oil supply. The results, with HAC standard errors in parentheses, are:

$$\Delta R_{m,Japan} = \underset{(0.14)}{0.88^{***}}\Delta(yen/dollar) + \underset{(0.06)}{0.38^{***}}Oildd + \underset{(0.03)}{0.06^{*}}Oilss$$

Adjusted R-squared = 0.361, Standard error of regression = 0.039, Sample period = February 2001 – December 2019. *** (*) indicates significance at 1% (10%) levels.

These findings indicate that oil price changes driven by global aggregate demand increase Japanese stock returns. The coefficient on oil price changes driven by oil supply factors is also positive. The probability value on Oilss equals 0.058. The finding that price increases driven by supply changes are associated with rising stock returns seems puzzling as Japan is an oil importer. Oil price increases should thus act as a tax on Japanese firms. To investigate these findings further, Table 1 presents the responses of 57 Japanese sectors to Oildd and Oilss.

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.

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 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.

Column (8) presents the coefficients on the yen/dollar exchange rate and column (9) presents the associated HAC standard errors. Those exhibiting positive exposures 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 the yen/dollar exchange rate in column (8) on the coefficients on Dubai oil price changes driven by aggregate demand in column (2) yields a coefficient of 0.31 with a t-statistic of 3.10.

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 machinery: industrial, industrial engineering, industrial suppliers, and industrial materials, 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 both the aggregate Japanese stock market and 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.

4. Conclusion

Japan depends on imported oil. Evidence presented by Hamilton (2009), Taghizadeh-Hesary et al. (2017), and evidence presented here indicate that the price elasticity of demand for oil is low. An increase in oil prices should thus transfer wealth from Japanese firms to foreign oil producers.

Stocks are a key component of a country's net wealth. Oil price increases might thus decrease Japanese stock prices. Evidence presented here indicates on the contrary that oil price increases are associated with rising Japanese aggregate stock prices. When Hamilton's (2014) method is used to decompose oil price changes into portions driven by global aggregate demand and by oil supply, the results indicate that oil price increases driven by both demand and supply factors raise aggregate stock prices.

To shed light on these findings this paper investigates the impact of oil price shocks across sectors. The sectors that benefit from aggregate demand-driven oil price increases are those that compete in global markets such as machinery, consumer electronics, industrial engineering, automobiles, and auto parts. The sectors harmed by aggregate demand-driven oil price increases are those that focus on the domestic market such as home furnishings, railroads, transport services, delivery services, electricity, and restaurants and bars. These sectors do not gain from increases in global aggregate demand but suffer from higher costs arising from oil price increases.

Firms in the industrial and oil sectors benefit from oil price increases driven by supply factors. Firms dependent on oil for production such as tires and construction lose from supply-driven oil price increases. Among the industrial firms that benefit from supply-driven oil price increases are those that provide goods or services to the energy sector.

These findings indicate that many Japanese sectors and firms benefit from oil price increases. One policy implication that follows from this is that, if the Japanese government wants to alleviate the burden of higher oil prices, it should avoid universal subsidies. To promote decarbonization and preserve fiscal space, it should target subsidies only towards those sectors and individuals that suffer from oil price hikes.

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
Pharmaceuti-cals	-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
Semiconduc-tors	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.

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