RIETI Discussion Paper Series 24-E-070

How Oil Prices Impact the Indonesian and South Korean Economies: Evidence from the stock market

THORBECKE, Willem
RIETI

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 24-E-070
September 2024

How Oil Prices Impact the Indonesian and South Korean Economies: Evidence from the stock market※

Willem Thorbecke
Research Institute of Economy, Trade and Industry, Tokyo, Japan

Abstract

Oil prices have been high and volatile. This paper investigates how oil prices affect Indonesian and South Korean stocks. Using Hamilton's (2014) method to decompose oil prices into portions driven by shocks to aggregate demand and to oil supply, the results indicate that demand-driven oil price increases benefit sectors such as coal, iron and steel, and shipbuilding that compete in global markets. They harm sectors such as food and consumer goods that use oil for production and depend on consumer purchasing power. Supply-driven oil price increases benefit the resource sector in Indonesia and harm the airlines, electricity, and industrial transport sectors in Korea. The finding that several sectors benefit from oil price increases indicates that blanket fuel subsidies are suboptimal. The finding that many sectors suffer from oil price increases indicates that Indonesia and Korea should reduce their exposure to oil by switching to sustainable energy sources.

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

※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 draft of this paper was presented at the DP seminar of the Research Institute of Economy, Trade and Industry (RIETI). I thank Kyoji Fukao, Keiichiro Kobayashi, and Eiichi Tomiura for excellent comments. Any errors are my responsibility.

1. Introduction

Dubai crude oil prices rose from $26 per barrel in April 2020 to $112 in June 2022. In July 2024 its price was $85.[1] How do rising and volatile oil prices affect the economies of Indonesia and South Korea?

Oil plays a vital role in the energy mixes of both Indonesia and Korea. According to the International Energy Agency, 43% of Indonesia's total energy consumption and 54% of Korea's total energy consumption are oil or oil products. Domestic oil production equaled about half of Indonesia's oil consumption and almost none of Korea's oil consumption.[2]

Oil price increases transfer wealth from net oil importers such as Indonesia and Korea to oil exporters (Golub, 1983). They thus act as a tax on agents in these two countries (Fernald and Trehan, 2005). Since stocks are one of the primary stores of net wealth for a country, oil price increases might decrease their aggregate stock prices. The IMF (2014) predicted that oil price increases would cause large decreases in aggregate equity prices for oil-importing countries.[3]

A lot can be learned by examining the response, not only of aggregate stock prices but also of sectoral stock prices to oil price changes. Finance theory teaches that stock prices equal the expected present value of future cash flows. Black (1987) noted that sectoral changes in stock prices presage sectoral changes in output, profits, or investment. Examining how oil price changes impact sectoral stock returns can thus shed light on how they will impact sectoral sales, earnings, and investment.

---

[1] These data come from the Federal Reserve Bank of St. Louis FRED database. The website for this source is: https://fred.stlouisfed.org/ .

[2] These data are for 2022 for Korea's total energy consumption. For the other variables they are for 2021. They come from the International Energy Agency and from the CEIC database. The websites for these sources are: www.iea.org and ceicdata.com.

[3] For instance, for advanced economy oil importers, the IMF posited that a 20% increase in oil prices would decrease overall stock prices by 3% to 8%.

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

Ready (2018) divided oil price shocks into those driven by demand shocks and by supply shocks. He defined demand shocks as returns to an index of large publicly traded oil companies that are orthogonal to unexpected changes in the Chicago Board Options Exchange volatility index (VIX). He defined supply shocks as changes in oil prices that are orthogonal to demand shocks and changes in the VIX. He reported that positive oil supply shocks reduce consumer stocks in Indonesia, Korea, and other Asian countries. He interpreted his findings as indicating that oil price increases driven by supply shocks reduce consumer spending.

Batten et al. (2019) examined whether Asian stock markets including Indonesia's and Korea's are integrated with an energy portfolio. They uncovered two regimes, one where stock markets were not integrated with energy stocks and a second where they were integrated. They reported positive energy-related risk premia during high integration regimes. These results indicate that oil and other energy sources can exert important effects on Asian stock markets.

Thorbecke (2019) used Kilian and Park's (2009) decomposition and structural VARs to investigate how oil price shocks affect Asian stock returns. Kilian and Park employed global crude oil production and dry cargo bulk freight rates to decompose oil price changes into those portions driven by supply, demand, and residual factors. He found little evidence that oil supply and demand shocks mattered for Indonesian and Korean stock returns.

Demirer et al. (2020) and Hamilton (2021) have criticized Kilian and Park's (2009) decomposition. Demirer et al. observed that Kilian and Park's approach overweighs the portion of oil price changes not explained by oil production or global economic activity. Hamilton reported that Kilian and Park's measure of economic activity behaves strangely. It implies that the world economy in 2015 experienced a more severe recession than the 2008-09 Global Financial Crisis (GFC) or the 1974-75 recession. World industrial production actually fell much more during the GFC or the 1974-75 recession than it did in 2015. Hamilton also observed that Kilian and Park took the log of a log when calculating bulk dry cargo freight rates. This questionable approach causes the initial value of the series to influence subsequent values. Hamilton found that choosing different initial dates markedly changes the index.

Hamilton's (2014) recommended another approach to divide oil price changes into portions due to aggregate demand and due to oil supply. To measure how aggregate demand impacts oil prices, he regressed the first difference of the log of crude oil prices on the first difference of the log of copper prices, the first difference of the ten-year Treasury constant maturity interest rate, and the first difference of the log of the trade-weighted dollar exchange rate. To measure how oil supply and other factors impact oil prices, he used the residuals from this regression. Bernanke (2016) employed Hamilton's method to investigate how demand and supply shocks affect stock returns.

Using Hamilton's (2014) decomposition, the results indicate that 18 sectors in Indonesia and 26 sectors in Korea are affected by aggregate demand or oil supply shocks. Thorbecke (2019) found that only one sector in Indonesia and one sector in Korea are affected by demand and supply shocks using Killian and Park's (2009) measures. Hamilton's approach thus seems useful for uncovering how demand and supply driven shocks impact oil prices.

The next section presents the data and methodology. Section 3 presents the results. Section 4 concludes.

2. Data and Methodology

To examine how oil price shocks affect stock prices, this paper builds on the papers examining stocks' exposure to exchange rates. In this literature, the return on a firm or sector's stock is regressed on the exchange rate and the return on the country's aggregate stock market (see, e.g., Ito et al., 2016, or Dominguez and Tesar, 2006). This paper includes returns on 46 Indonesian sectors and 67 Korean sectors as left-hand side variables and the change in the log of crude oil spot prices along with the return on the country's aggregate stock market and the change in the log of the exchange rate as right-hand side variables.

Two specifications are employed. In one the first difference of the log of the Dubai crude oil spot price is included as a regressor. In the other the log of the Dubai crude oil spot price is decomposed using Hamilton's (2014) approach into the part driven by global aggregate demand and the part driven by oil supply and other factors.

To calculate the change in oil prices driven by global aggregate demand, the first difference in the log of Dubai oil prices is regressed on the first difference in the ten-year constant maturity U.S. Treasury interest rate, the first difference in the log of the U.S. nominal effective exchange rate, and the first difference in the log of copper futures prices. The predicted values from this regression measure oil price changes driven by changes in aggregate demand. The R-squared from this regression equals 0.30. The residuals then measure oil price changes driven by changes in oil prices and other shocks. These residuals account for 70% of the variance of oil prices

Augmented Dickey-Fuller tests permit rejection of the maintained hypothesis that the series employed have unit roots. The equations can thus be estimated using least squares. When using the spot price of Dubai oil as a regressor, the equation takes the form:

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

(1)

where $\Delta R_{i,c,t}$ is the monthly stock return for sector *i* in country c (either Indonesia 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) factors, the equation takes the form:

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

(2)

Chen et al. (1986) argued that, in equations such as (1) and (2), causality should flow from the economy-wide regressors on the right-hand side to the individual portfolio returns on the left-hand side. They posited that causality flowing from the portfolio returns on the left-hand side to the macroeconomic variables on the right-hand side should be small.

The sample period extends from February 2001 to December 2019. 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]

There is a close relationship between changes in Dubai oil prices driven by global aggregate demand and the returns on the world 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.[5] The close relationship between these two variables is what one would expect if Hamilton's measure captures changes in oil prices driven by global aggregate demand.

3. Results

Regressing the return on the overall Indonesian stock market on the change in the log of the rupiah/dollar exchange rate and the change in the log of Dubai crude oil prices yields, with heteroskedasticity- and autocorrelation-consistent (HAC) standard errors in parentheses:

---

[4] 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/ .

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

$$\Delta R_{m,Indonesia} = \underset{(0.21)}{-1.05^{***}}(\Delta rupiah/dollar) + \underset{(0.06)}{0.11^{*}}\Delta Dubai$$

Adjusted R-squared = 0.354, Standard error of regression = 0.050, Sample period = February 2001 – December 2019. *** (*) indicates significance at 1% (10%) level.

These findings show a positive relationship between the returns on the aggregate Indonesian stock market and the change in Dubai crude oil prices. To understand these results, the return on the Indonesian stock market is regressed on oil price changes divided into the parts due to aggregate demand and to oil supply. The results are:

$$\Delta R_{m,Indonesia} = \underset{(0.14)}{-0.98^{***}}\Delta(rupiah/dollar) + \underset{(0.10)}{0.28^{***}}Oildd + \underset{(0.05)}{0.05}Oilss$$

Adjusted R-squared = 0.372, Standard error of regression = 0.049, Sample period = February 2001 – December 2019. *** indicates significance at 1% levels.

These results indicate that oil price increases driven by increases in global aggregate demand increase Indonesian stock returns. A one standard deviation increase in Oildd would raise the return on the Indonesian market by 1.4%. Oil price increases driven by supply factors do not affect Indonesian aggregate stock returns.

Regressing the return on the overall Korean stock market on the change in the log of the won/dollar exchange rate and the change in the log of Dubai crude oil prices yields, with HAC standard errors in parentheses:

$$\Delta R_{m,Korea} = \underset{(0.12)}{-0.63^{***}}(\Delta won/dollar) + \underset{(0.05)}{0.15^{***}}\Delta Dubai$$

Adjusted R-squared = 0.202, Standard error of regression = 0.052, Sample period = February 2001 – December 2019. *** indicates significance at 1% level.

These findings show a positive relationship between the returns on the aggregate Korean stock market and the change in Dubai crude oil prices. To understand these results, the return on the

Korean stock market is regressed on oil price changes divided into the parts due to aggregate demand and to oil supply. The results are:

$$\Delta R_{m,Korea} = \underset{(0.12)}{-0.35^{***}}\Delta(won/dollar) + \underset{(0.08)}{0.47^{***}}Oildd + \underset{(0.04)}{0.05}Oilss$$

Adjusted R-squared = 0.265, Standard error of regression = 0.050, Sample period = February 2001 – December 2019. *** indicates significance at 1% levels.

These results indicate that oil price increases driven by increases in global aggregate demand increase Korean stock returns. A one standard deviation increase in Oildd would raise the return on the Korean market by 2.3%. Oil price increases driven by supply factors do not affect Korean aggregate stock returns.

Golub (1983) showed that an oil price increase transfers wealth from net oil importers such as Indonesia and Korea to oil exporters. Since stocks are one of the primary stores of a country's net wealth, the IMF (2014) predicted that oil price increases would cause large decreases in aggregate equity prices for oil-importing countries. Contrary to this prediction, oil price increases driven by supply factors do not affect stock prices in Indonesia and Korea and oil price increases driven by increases in aggregate demand raise stock prices.

To shed further light on these findings, Tables 1 and 2 present results for sectoral returns for Indonesia and 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 on the nominal 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 HAC standard errors.

In column (2) of Table 1 for Indonesia, sectors benefitting from global demand such as coal, iron and steel, and paper gain from oil price increases driven by aggregate demand. Sectors such as drug and grocery stores, consumer staples, tobacco, and telecommunication service providers are harmed by higher oil prices. Drug and grocery stores and consumer staples are closely related to the food industry. Higher oil prices increase the cost of running tractors and growing food. Higher oil prices also increase the costs of raising tobacco. Also, as Ready (2018) noted, higher oil prices reduce the ability of consumers to spend. This also helps explain why telecommunications service providers are harmed by higher oil prices.

In column (4) of Table 1 for Indonesia, the sectors benefitting from oil price increases driven by supply factors are basic materials and basic resources. As an exporter of resources, higher prices for oil and other commodities benefit the resource sector. No sectors in Indonesia are harmed by oil price increases driven by supply side factors.

Columns (6) and (8) of Table 1 for Indonesia present the betas to total oil price changes and to the rupiah/dollar exchange rate. Unsurprisingly, the betas to total oil price changes 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 0.28 with a t-statistic of 7.45 and regressing the total oil price betas on the Oilss betas yields a coefficient of 1.11 and a t-statistic of 4.76. Also there is a strong positive relationship between sectors that gain from increases in global demand in column (2) and sectors that gain from a weaker rupiah in column (8). Regressing the Oildd betas on the rupiah/dollar betas yields a coefficient of 0.23 with a t-statistic of 7.39. Those sectors that compete in global markets benefit from increases in global demand and from a weaker currency.

The findings for Indonesia in Table 1 are similar to findings for other countries. Thorbecke (2019) found that sectors such as coal, iron and steel, and industrial metals and mines in several Asian countries gained from higher oil prices. He also reported that sectors related to food and consumer good lost due to higher oil prices in several Asian countries.

In column (2) of Table 2 for Korea, 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 Indonesia, sectors such as drug and grocery stores, consumer staples, and those related to the food industry such as food producers 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. 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.

In Japan several sectors benefit from oil price increases driven by supply side factors. Fukunaga et al. (2010) reported that oil price increases raise production for several Japanese sectors. They interpreted their findings by noting that Japanese products in several sectors are energy-efficient, and an increase in oil prices switches demand to Japanese products. Thorbecke

(2024) found that oil price hikes increase stock returns for several Japanese industrial sectors. He interpreted this finding by noting that 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. The finding that supply-driven oil price increases do not benefit any sectors in Korea indicates that oil price hikes, as opposed to increases in global demand, do not benefit Korean companies.

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 0.28 with a t-statistic of 7.04 and regressing the total oil price betas on the Oilss betas yields a coefficient of 0.98 and a t-statistic of 9.07. 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 2.59.

Comparing the results in Tables 1 and 2 with the results in Thorbecke (2019), some of the same sectors that are affected by oil prices in Tables 1 and 2 are affected by oil prices in the results reported by Thorbecke. For instance, basic material stocks in Indonesia in Table 1 and in the results reported by Thorbecke both benefit from oil price increases. Iron and steel and industrial metals and mines stocks in Korea in Table 2 and in the results reported by Thorbecke benefit from oil price increases. The striking difference between the results reported here and those reported in Thorbecke is that the results here ascribe the oil price exposures to global aggregate demand or to oil supply factors. The results reported in Thorbecke almost never ascribe the oil exposure in Indonesia and Korea to global demand or oil supply factors. The results here indicate that many sectors that should benefit from global demand have positive betas to Oildd and many sectors that should be exposed to oil price shocks have negative betas to Oildd and Oilss. This occurs because Hamilton's (2019) decomposition offers a better way to divide oil price changes into demand and supply influences than Kilian and Park's (2019) method does.

One important implication of these results is that several sectors in Indonesia and Korea gain during times of high oil prices if price increases are driven by increases in global demand. In Indonesia these include coal, iron and steel, and paper and in Korea 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. In Indonesia these include drug and grocery stores, consumer staples, tobacco, and telecommunication service providers and in Korea these include airlines, drug and grocery stores, consumer staples, food producers, industrial transportation, and cosmetics. In Indonesia the basic materials and basic resources sectors gain from supply-driven oil price increases and in Korea no sectors benefit from supply-driven oil price increases.

4. Conclusion

This paper investigates how oil price changes impact stock prices in Indonesia and Korea. It uses Hamilton's (2014) methodology to divide oil price changes into those portions driven by global aggregate demand and those driven by supply-side factors. Since oil price increases act as a tax on net oil importers and transfer wealth to oil exporters, one might expect oil price increases to lower aggregate stock returns in Indonesia and Korea. Contrary to these predictions, demand-driven oil price increases raise aggregate stock returns in both countries and supply-driven oil price increases have no effect. As supply-driven oil price increases explain 70% of the variance of oil price changes, it is puzzling that supply-driven oil price changes do not affect aggregate stock returns.

The results also indicate that many sectors in both countries gain when oil prices rise due to increases in global aggregate demand. The sectors that gain are largely those that compete in global markets. Other sectors such as those that produce and sell food and cater to consumers do badly when aggregate demand increases raise oil prices.

The finding that some sectors gain and some lose from oil price increases has policy implications. In Indonesia the government subsidizes gasoline prices. In 2023, the government paid 132.44 trillion rupiah (8.4 billion USD) to subsidize the popular 90 octane gasoline Pertalite.[6] The results reported here indicate that several sectors in Indonesia gain from higher oil prices. Providing blanket subsidies to all users of gasoline ignores that fact that some parts of the economy gain when oil and gasoline prices increase. It also ignores the fact that wealthier households tend to use more energy and thus benefit more from fuel subsidies than poorer households (Wong and Dewayanti, 2024). As the World Bank (2024) discussed, these subsidies crowd out government spending on social programs and other priorities. Although it would be politically painful, the government should reform fuel subsidies to target poor consumers and others who suffer from high fuel prices.

The results indicate that many sectors in Indonesia and especially in Korea suffer from oil price increases. This highlights the priority of reducing oil consumption. Transitioning away from fossil fuels is also essential for combatting climate change. Meng et al. (2023) investigated the emissions of economies along global value chains. Using input-output tables and data on

---

[6] These data are available at: https://www.pertamina.com/en/news-room/news-release/pertamina-appreciates-the-government.s-compensation-payment-for-fuel-subsidies .

value-added in trade, they alternatively ascribed emissions to the countries where goods are produced and the countries where goods are consumed. They reported using either calculation that Indonesia was responsible for 1.7% of the world's carbon dioxide emissions. Although Meng et al. do not report results for Korea, data from the International Energy Agency indicate that Korea's emissions are close to Indonesia's emissions.[7] Thus Indonesia and Korea together account for about 3.5% of the world's emissions of CO_2. If they could reduce their use of fossil fuels, this would contribute to reducing total emissions in the world.

One problem is that renewable energy sources can be more expensive and unpredictable than fossil fuels. Clean energy relies on sunshine, wind, and other factors that are often intermittent. If Korea could partner with its Northeast Asian neighbors, they could together develop more affordable and reliable sources of renewable energy (Korea Energy Foundation, 2018). Korea has a good domestic electricity grid. If it could strengthen infrastructure for receiving, storing, and distributing power produced by its neighbors, it could reduce the volatility associated with clean energy sources (Xiangchengzhen and Yilmaz, 2020). Indonesia could incentivize the use of solar panels by allowing users to sell excess energy back to the grid at market prices (Wong and Dewayanti, 2024).

Promoting the use of electric vehicles (EVs) instead of internal combustion engine vehicles could also reduce their dependence on oil. Both Indonesia and Korea provide subsidies to promote the sale of EVs. 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.

[7] The website for the International Energy Agency is www.iea.org .

Indonesia and Korea should also continue with their clean energy partnerships. In 2024, Hyundai and LG Energy Solution opened a plant to manufacture EV batteries in Indonesia. This "mine-to-manufacturing" venture is designed to help Indonesia and Korea reach their zero emissions goals (Bowen, 2022). Such initiatives are supported by agreements between the two countries. Firms in both countries should explore other commercially viable ways to collaborate on renewable energy projects.

One of Korea's leading products is semiconductors. 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. Making semiconductors requires massive amounts of energy. To be more environmentally friendly, SK Hynix and Samsung could decrease the share of high global-warming potential gases used in manufacturing, reduce the energy requirements of their furnaces 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 vastly reduce the carbon footprint involved in making and using semiconductors (Salata Institute, 2024).

Oil prices have been high and volatile. High oil prices harm several sectors in Indonesia and Korea. Volatile prices whipsaw many sectors. To protect vulnerable sectors and to reach net zero emissions goals, both countries should prioritize transitioning from oil and other fossil fuels to sustainable energy sources.

Table 1. The Exposure of Indonesian Sectors to Oil Price Changes and the Rupiah/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 Rupiah/dollar Exchange Rate	Standard Error
Automobiles	-0.082	0.105	-0.106*	0.060	-0.100*	0.054	-0.155	0.234
Banks	-0.109	0.068	-0.041	0.055	-0.058	0.049	-0.340***	0.111
Basic Materials	0.547***	0.105	0.151***	0.063	0.251***	0.065	-0.044	0.155
Basic Resources	0.783***	0.10	0.137**	0.070	0.299***	0.068	0.113	0.18
Building Materials	-0.146	0.110	-0.029	0.057	-0.058	0.053	-0.413**	0.166
Cement	-0.210*	0.114	-0.091	0.06	-0.120**	0.059	-0.461***	0.155
Chemicals	0.370	0.226	0.025	0.137	0.126	0.110	0.062	0.642
Chemicals: Diversified	0.370	0.226	0.025	0.137	0.126	0.110	0.062	0.642
Coal	0.858***	0.190	0.087	0.122	0.280***	0.112	1.022	0.634
Consumer Digital Services.	-0.276	0.309	-0.153	0.155	-0.184	0.147	-0.295	0.716
Construction. & Materials	-0.136	0.099	-0.033	0.051	-0.059	0.048	-0.376**	0.150
Consumer Discretionary	-0.082	0.091	-0.083	0.052	-0.083*	0.048	-0.180	0.214
Consumer Staples	-0.129***	0.049	0.001	0.041	-0.032	0.034	0.150	0.107
Diversified Financial Services	0.255	0.254	0.056	0.167	0.106	0.117	0.007	0.421
Drug/Grocery Stores	-0.256**	0.084	-0.028	0.050	-0.085**	0.043	0.082	0.122
Energy	0.858***	0.190	0.086	0.122	0.280**	0.112	1.025	0.635
Entertainment	-0.600	1.840	0.145	0.324	-0.010	0.195	-4.282**	1.910
Farming, Fishing	0.097	0.181	-0.005	0.090	0.021	0.094	-0.522	0.342
Financial Services	0.298	0.235	-0.001	0.160	0.074	0.112	0.013	0.411
Financials	-0.115*	0.066	-0.034	0.052	-0.054	0.047	-0.310***	0.101
Food Producers	0.092	0.116	0.028	0.065	0.044	0.068	-0.007	0.129
Food Products	0.104	0.136	0.018	0.062	0.039	0.068	-0.135	0.153
Food Retail, Wholesale	0.044	0.268	0.109	0.100	0.090	0.107	0.437	0.485
Food, Beverage, Tobacco	0.113	0.114	0.036	0.065	0.055	0.067	0.004	0.128
General Mining	-0.396	0.255	0.047	0.081	-0.019	0.076	-0.554	0.463
Health Care	-0.037	0.100	-0.002	0.068	-0.011	0.062	0.078	0.212
Health Care Facilities	0.121	0.462	0.083	0.148	0.089	0.135	-0.953	0.849
Industrial Goods & Services	0.419***	0.110	0.101	0.081	0.181**	0.080	0.150	0.153
Industrial Materials	0.362**	0.176	0.103	0.170	0.168	0.146	-0.007	0.390
Industrial Metals & Mines	1.065***	0.212	-0.079	0.104	0.208**	0.094	0.154	0.331
Industrials	0.106	0.083	0.038	0.050	0.055	0.044	-0.054	0.175
Investment Banks & Brokers	0.298	0.235	-0.001	0.160	0.074	0.112	0.012	0.411
Iron & Steel	1.082***	0.212	-0.076	0.104	0.215**	0.094	0.159	0.332
Media	-0.600	1.840	0.146	0.324	-0.010	0.195	-4.281**	1.910
Oil, Gas, Coal	0.857***	0.190	0.088	0.122	0.281**	0.112	1.024	0.635
Paper	0.363**	0.176	0.103	0.170	0.168	0.146	-0.007	0.390
Personal Product	-0.264***	0.085	-0.030	0.052	-0.089	0.045	0.078	0.124
Pharmaceutical & Biotech	-0.043	0.111	-0.052	0.070	-0.050	0.060	-0.121	0.245

Pharmaceuticals	-0.043	0.111	-0.052	0.070	-0.050	0.060	-0.121	0.245
Software & Computer Services	-0.276	0.309	-0.152	0.155	-0.183	0.147	-0.295	0.716
Technology	-0.021	0.311	0.021	0.085	0.009	0.114	-0.177	0.448
Telecommunications	-0.159**	0.073	-0.031	0.049	-0.063	0.042	0.219	0.129
Telecommunications, Media, IT	-0.138*	0.070	-0.022	0.046	-0.051	0.040	0.178	0.124
Telecommunications Equipment	0.242*	0.144	0.167*	0.095	0.187**	0.078	0.874*	0.457
Telecommunications Service Providers	-0.230***	0.082	-0.032	0.053	-0.082*	0.046	0.234*	0.139
Tobacco	-0.217***	0.095	-0.017	0.058	-0.067	0.052	0.289	0.200

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 rupiah/dollar nominal exchange rate (column (8)), and 4) the return on the Indonesian 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 Indonesian stock market (not reported) and 3) the rupiah/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 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 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
Consumer Discretionary	-0.166**	0.07	0.021	0.031	-0.018	0.027	0.011	0.099
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 & Electrical Equipment	1.157	2.053	0.261	0.551	0.474	0.630	-0.028	1.507
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 Engineering	0.250**	0.121	0.034	0.065	0.079	0.056	0.039	0.158
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 Systems	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
Platinum and Precious Metals	0.528***	0.160	-0.077	0.076	0.049	0.077	-0.121	0.278
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.
*** (**) [*] denote significance at the 1% (5%) [10%] levels..

References

Batten, J. A., H., Kinateder, P. Szilagyi, and N. Wagner. 2017. Can Stock Market Investors Hedge Energy Risk? Evidence from Asia. *Energy Economics* 66, 559-570.

Barro, R., 1990. The Stock Market and Investment. *Review of Financial. Studies* 3, 115–131.

Bernanke, B. 2016. The Relationship between Stocks and Oil Prices. Web blog post. Ben Bernanke's Blog on Brookings, 19 February.

Black, F., 1987. *Business Cycles and Equilibrium*. New York: Basil Blackwell.

Bowen, J. 2022. Enhancing Clean Energy Cooperation in the Indo-Pacific. Web blog post. The National Bureau of Asian Research, 23 June.

Chatelais, N., A. Stalla-Bourdillon, and M. Chinn. 2023. Forecasting Real Activity using Cross-Sectoral Stock Market Information. *Journal of International Money and Finance* 131, Article Number 102800.

Chen, N., R. Roll, S. Ross. 1986. Economic Forces and the Stock Market. *The Journal of Business*, 1986, 59, 383-403.

Croux, C., and P. Reusens. 2013. Do Stock Prices Contain Predictive Power for the Future Economic Activity? A Granger Causality Analysis in the Frequency Domain. *Journal of Macroeconomics* 35, 93–103.

Demirer, R., R. Ferrer, and S.J. H. Shahzad. 2020. Oil Price Shocks, Global Financial Markets and Their Connectedness. *Energy Economics* 88, Article Number 104771.

Dominguez , M., and L. Tesar. Exchange Rate Exposure. *Journal of International Economics* 68, 188-218.

Fernald, J., and B. Trehan. 2005. Why Hasn't the Jump in Oil Prices Led to a Recession? *FRBSF Economic Letter* 2005-31, November 18.

Fukunaga, I., N. Hirakata, and N. Sudo. 2010. The Effects of Oil Price Changes on the Industry-Level Production and Prices in the U.S. and Japan. NBER Working Paper 15791. Cambridge, MA: National Bureau of Economic Research.

Golub, S. 1983. Oil Prices and Exchange Rates. *The Economic Journal* 93, 576–93.

Gupta, U., Y. Kim, S. Lee, J. Tse, H. Lee, G. Wei, D. Brooks, and C. Wu. 2021. Chasing Carbon: The Elusive Environmental Footprint of Computing. 2021 IEEE International Symposium on High-Performance Computer Architecture (HPCA). Available at: https://ieeexplore.ieee.org/document/9407142 .

Hamilton, J. 2021. Measuring Global Economic Activity. *Journal of Applied Econometrics* 36, 293-303.

Hamilton, J., 2014. Oil Prices as an Indicator of Global Economic Conditions. Web blog post. Econbrowser.com, 14 December.

IMF. 2014. World Economic Outlook. Legacies, Clouds, Uncertainties. Washington: International Monetary Fund.

Ito, T., S. Koibuchi, K. Sato, and J. Shimizu, J. 2016. Exchange rate exposure and risk management: The case of Japanese exporting firms. *Journal of the Japanese and International Economies* 41, 17-29.

Kilian, L., and C. Park. 2009. The Impact of Oil Price Shocks on the U.S. Stock Market. *International Economic Review* 50, 1267–1287.

Kim, H. 2024. Impact of Policy Incentives on Adoption of Electric Vehicles in South Korea. KDI FOCUS. Sejong City, South Korea: Korea Development Institute.

Korea Energy Foundation. 2018. Switching to Sustainable Energy in the Republic of Korea. *Nature Portfolio*, 12 December.

Liu, J., D. Nissim, and J. Thomas. 2007. Is Cash Flow King in Valuations? *Financial. Analysts Journal* 63, 1–13.

McKinsey. 2020. Sustainability in semiconductor operations: Toward net-zero production. Available at: https://www.mckinsey.com/industries/semiconductors/our-insights/sustainability-in-semiconductor-operations-toward-net-zero-production .

McMillan, D. 2021. Predicting GDP Growth with Stock and Bond Markets: Do They Contain Different Information? *International Journal of Finance and Economics* 26, 3651–75.

Meng, B., R. Wang, and M. Li. 2023. Tracing Carbon Dioxide Emissions along Global Value Chains. In Yuqing Xing, Ran Wang, and David Dollar, editors, Resilient and Sustainable GVCs in Turbulent Tines. Tokyo: IDE-JETRO.

Ready, R.C., 2017. Oil Prices and the Stock Market. *Review of Finance* 22, 155–176.

Salata Institute. 2024. Cutting the Carbon Footprint of Future Computer Chips. Web blog post. The Salata Institute for Climate and Sustainability at Harvard University, 19 March.

Schwert, G., 1990. Stock Returns and Real Activity: A Century of Evidence. *Journal of Finance* 45, 1237–1257.

Thorbecke, W. 2024. How Oil Prices Impact the Japanese Economy: Evidence from the Stock

Market. RIETI Discussion Paper 24-E-065. Tokyo: Research Institute of Economy, Trade and Industry.

Thorbecke, W. 2019. How Oil Prices Affect East and Southeast Asian Economies: Evidence from Financial Markets and Implications for Energy Security. *Energy Policy* 128, 628-638.

Velinov, A., and W. Chen. 2015. Do Stock Prices Reflect their Fundamentals? New Evidence in the Aftermath of the Financial Crisis. *Journal of Economics and Business* 80, 1–20.

Wong, R., and A. Dewayanti. 2024. Indonesia's Energy Transition: Dependency, Subsidies and Renewables. *Asia & the Pacific Policy Studies* 11, 1-22.

World Bank. 2024. Unleashing Indonesia's Business Potential. Indonesia Economic Prospects. Washington: World Bank.

Xiangchengzhen, X., and S. Yilmaz. 2020. Renewable Energy Cooperation in Northeast Asia: Incentives, Mechanisms, and Challenges. *Energy Strategy Reviews* 29, Article Number 100468.