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The Effects of Global Commodity Prices on ASEAN-5 Stock Markets

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Abstract

The increasing participation of investors and financial institutions in the commodity markets to diversify their portfolios led to spillovers from the real to the financial sector. This paper examined the return and volatility spillovers from the world commodity markets to the returns of the ASEAN-5 stock market. The return spillovers from the commodity markets were closely linked to the production economy. Palm oil prices affected the stock market returns of Indonesia and Malaysia. The returns of the rice commodity market were found to affect the stock market of Thailand. However, no spillover effects from rubber were found. On non-agricultural commodities, fuel had the widest return spillover effects. The stock market of Thailand is particularly susceptible to price movements in the gold market. The volatility spillovers were less compared to the return spillovers. The rice market volatility had a negative impact on the stock exchange of Thailand. Gold market volatility was positively related to the stock market returns of Singapore, suggesting gold to be a commodity for hedging against stock market turmoil. However, the stock markets of Malaysia and the Philippines were insulated from these spillovers. Given the connectedness between the commodity and stock markets, any policy designed to advance the financial sector must take cognizance of the development in the world commodity markets. The dynamics between these markets should be considered by the investors for portfolio planning and diversification.

Keywords: *Association of Southeast Asian Nations (ASEAN), Commodity market, Stock market, Spillover, Volatility*

1. Introduction

Volatility in stock markets increased following the Asian financial crisis in 1997 and the subprime mortgage crisis in 2007-2008. The increase in volatility was also due to highly integrated financial markets across the globe, as well as international economic integration (Rodrik, 2000). This integration led to not only cross-country volatility spillovers in the financial markets, but also between the real and financial sectors. The spillover from the real to financial sector is in part due to portfolio diversification by investors to cover a variety of assets, most notably stocks and commodities. Ordu-Akkaya, and Soytas (2020) showed that the connectedness between the stock and commodity markets was strengthened by foreign portfolio investment. The integration of the commodity and stock markets led to the proliferation of many studies on their relationship for different countries. Among others are Ahmed (2017), Antonakakis, Chatziantoniou, and Filis (2017); Arouri, Jouini, and Nguyen (2011); Kilian, and Park (2009); Martín-Barragán, Ramos, and Veiga (2015). Many researchers also investigated the shocks caused by commodities and the impact of these shocks on the stock markets (Cashin, & McDermott, 2002; Chkili, Hammoudeh, & Nguyen, 2014; Dwyer, Gardner, & Williams, 2011; Kang, McIver, & Yoon, 2016; Wright, 2011).

In quest of assets for portfolio diversification, financial institutions participated more actively in the commodity markets, leading to the financialization of these markets. Baldi, Peri, and Vandone (2016) and Ordu-Akkaya, and Soytas (2020) attributed the link between the stock and commodity markets to the financialization of the commodity markets. The size of connectedness between the stock and commodity market returns was quantified by Yoon, Al Mamun, Uddin, and Kang (2019). Generally, researchers used either the commodity indices or future prices of three categories of commodities, namely the energy, agricultural and precious metal sectors in their analysis (Ahmed, 2017; Berger, & Uddin, 2016; Dolatabadi, Nielsen, & Xu, 2016; Hammoudeh, Nguyen, Reboredo, & Wen 2014; Hegerty, 2016). On the energy and precious metal sectors, many studies opined that the mainshocks on stock markets originated from certain commodities like oil and gold (Antonakakis, et al., 2017; Do, McAleer, & Sriboonchitta, 2009; Kilian, 2008; Martín-Barragán et al., 2015; Nguyen, Bhatti, Komorníková, & Komorník, 2016; Zhang, 2017). Kilian (2008) showed that higher oil prices led to lower stock market returns when the oil market experienced demand shocks but the supply side shocks had a lesser impact. Their findings were supported by He, Wang, and Lai (2010) who also found that the demand for crude oil affected the stock markets. The wavelet analysis by Martín-Barragán et al. (2015) found little or no correlation between oil prices and stock market price movements in a stable market environment, but their correlation strengthened during stock market crashes. The findings of Fatima, and Bashir (2014) suggested that the relationship between oil price volatility and the stock market was weaker for emerging economies compared to the relationship reported for the developed countries by other researchers. The analysis of Baur, and McDermott (2010) on a sample of developed and developing countries suggested that gold served as a safe haven against stock market shocks, but its safe haven role is only significant in the developed countries. On the other hand, gold was reported to be useful for hedging against stock market risks by Afsal, and Haque (2016) for Saudi Arabia and Chkili (2016) for BRICS where the relationship between the two assets was weak particularly during crisis periods. Do et al, (2009) conducted a study on the effects of gold price on the stock market volatility of five ASEAN countries but found gold price volatility spillover to occur only in some of the markets. The analysis of the impact of agricultural commodities by Öztek, and Öcal (2017) indicated evidence against rising trends in correlation with stock market movements and they attributed the correlations to heightened volatility during financial crises. Kang et al, (2016) found a positive relationship between agricultural commodities such as corn, wheat, and rice and stock markets after a financial crisis which indicated the lack of diversification benefits by including these commodities in a portfolio during economic instability.

In recent years, more advanced models were applied to find the link between the commodity and stock markets. One of the popular methods is the generalized autoregressive conditional heteroscedasticity (GARCH) model with the BEKK specification named after Engle, and Kroner (1995) and developed further by Engle, and Kroner (1995). BEKK GARCH models were applied widely to study the dynamics between the two markets (Afsal, & Haque, 2016; Bouri, Awartani, & Maghyereh, 2016; Khalfaoui, Boutahar, & Boubaker, 2015; Olsson, 2007; Olson, Vivian, & Wohar, 2014). The BEKK specification in conditional variance offers flexibility and is particularly informative for cross-market dynamics. They, however, lack parameter parsimony and typically involve the estimation of a large number of parameters which may not be tenable when an analysis covers many markets (Bauwens, Laurent, & Rombouts, 2006). Another competing method is the DCC (dynamic conditional correlation) GARCH proposed by Engle (2002). The method was used by Akkoc, and Civcir (2019) to examine the dynamic linkages between selected commodity markets and the Turkish stock exchange. DCC is easy to apply using a two-step estimator and is particularly useful if a large number of markets are involved. However, the two-step estimators are not consistent, and this is one of the ten issues cautioned by Caporin, and McAleer (2013) about the DCC representations. In comparison, Chang, McAleer, and Tansuchat (2013) examined the volatility spillovers between the crude oil and financial markets by applying the VARMA (vector autoregressive moving average) GARCH model of Ling, and McAleer (2003). This model offers insights when the first moment of all endogenous variables follows an autoregressive moving average process. The model suffers a restrictive assumption of a constant conditional correlation unless its application is combined with the CCC approach (Salisu, Isah, & Assandri, 2019).

Even though the relationship between global commodity prices and the stock market volatility was established by other researchers, many studies tend to use oil or gold as the main commodity of study. As more investors start to include other commodities in their portfolio for diversification, commodities such as agricultural commodities, food commodities, and non-metal commodities are also expected to affect stock market performance. Despite the inclusion of some of these commodities in past studies, they may not have a significant representation in the economic output of the countries analyzed. This paper took into consideration a range of different commodities, including palm oil, rubber, fuel, rice, and gold to investigate the relationship between the global prices of these commodities and the price movements in the stock markets of ASEAN-5. Although volatility spillover among the ASEAN-5 stock markets was examined by

Lee, and Goh (2016); Kang, Uddin, Troster, and Yoon (2019); Vo, and Tran (2020), they did not examine the influence of commodity markets in their analysis. While fuel and gold are commodities widely recognized to influence the world economy, palm oil, rubber, and rice are produced and exported by some of the ASEAN-5 countries. Crude oil is also exported by Malaysia.

2. Objectives

The objectives of this study are as follows:

1. To examine the relationship between the returns of world commodity markets and stock markets of the ASEAN-5 countries;

2. To assess the impact of movements in the commodity market returns on the returns of ASEAN-5 stock markets; and

3. To determine the impact of commodity market volatility on the returns of ASEAN-5 stock markets.

3. Methods and Data

We considered two types of impacts commodity markets may have on stock markets. These are the return and volatility spillovers. To model these impacts, the model is:

$$r_{it}=\mu_i+\sum_{c=1}^{k}\tau_{i1}r_{ct}+\sum_{c=1}^{k}\tau_{i2}r_{c,t-1}+\sum_{c=1}^{k}\tau_{i3}v_{ct}+e_{it},\ \ i=1,2,\ldots,n \tag{1}$$

where r_{it} is the returns for stock market i, r_{ct} represents the returns for commodity market c, and v_{ct} represents the volatility of returns for commodity market c. The parameters are as follows: μ is a constant, and τ_{ij} is the slope coefficient for sensitivity of stock market returns to contemporaneous commodity market returns for j = 1, lagged commodity market returns for j = 2, and volatility of commodity market returns for j = 3. Given that five stock exchanges were included in the study, n = 5. The number of commodities under consideration is represented by k. The returns are $r_{jt} = \ln P_{jt} - \ln P_{j,t-1}$, where P_j refers to the price index of the stock market for j = i and the price index of the commodity market for j = c. Let $\varepsilon_t = (e_{1t}, e_{2t}, \ldots, e_{5t})'$ represent the stock market shocks where e_{it} is the error term.

The stock market price movements of ASEAN-5 are not independent of one another. Volatility spillovers were reported by Lee, and Goh (2016); Kang et al. (2019), and Vo, and Tran (2020), among others. Therefore, the error terms in ε_t do not follow an i.i.d. process. The dynamic volatility spillovers among the ASEAN-5 stock markets were modeled by applying a multivariate GARCH with the BEKK specification proposed by Engle, and Kroner (1995). Broadstock, Cao, and Zhang (2012) and Chang, McAleer, and Tansuchat (2011) showed evidence from the literature that the BEKK model is a robust model for analyzing volatility. The error terms follow a multivariate distribution $\varepsilon_t|I_{t-1}(0, H_t)$, where H_t is the variance-covariance matrix and I_{t-1} is the information set at time t-1. The conditional variance-covariance matrix H_t can be stated below:

$$H_t=\begin{bmatrix} h_{11t} & \cdots & h_{15t} \\ \vdots & \ddots & \vdots \\ h_{51t} & \cdots & h_{55t} \end{bmatrix} \tag{2}$$

where h_{iit} is the conditional variance of own stock market and h_{ijt} is the covariance between stock market i and j, for $i \neq j$. The volatility of stock market returns represented by the variance process of the BEKK specification is as follows:

$$H_t=C'C+A'H_{t-1}A+B'\varepsilon_{t-1}\varepsilon'_{t-1}B \tag{3}$$

where C is a 5×5 constant matrix, and A and B are the parameter matrices of 5×5. Equation (3) demonstrates that the BEKK model produces a positive definite variance-covariance matrix.

There is a huge number of parameters that need to be estimated and the issue of convergence is a concern in a full BEKK model. In the simplest form of GARCH (1,1) specification for the five stock markets, equation (3) contains 65 parameters to be estimated. Chang and McAleer (2017) demonstrated that a full BEKK model has no underlying stochastic process, regularity conditions, or asymptotic properties. The diagonal version which is not subject to these issues was utilized in this paper. In the diagonal BEKK, all coefficient matrices in equation (4) are diagonal. The diagonal reduced form is shown below:

$$h_{iit}=c_{ii}+a_{ii}^2h_{ii,t-1}+b_{ii}^2e_{i,t-1}^2 \quad (4)$$

$$h_{ijt}=c_{ij}+a_{ii}a_{jj}h_{ij,t-1}+b_{ii}b_{jj}e_{i,t-1}e_{j,t-1} \quad (5)$$

where c_{ii} and c_{ij} are constants, a_{ii}^2 is the coefficient for lagged own stock market volatility, and b_{ii}^2 is the coefficient for the lagged volatility of own stock market shocks. The number of parameters in equations (4) and (5) was reduced to 25. The co-volatility of two stock markets given by h_{ijt} is affected by the past co-volatility of both markets as well as the cross-product of their past shocks. The corresponding impacts are given by $a_{ii}a_{jj}$ and $b_{ii}b_{jj}$ which will be denoted as α_{ij} and β_{ij} respectively.

The models were estimated using the maximum log-likelihood method. This log-likelihood function is as follow:

$$l(\theta) = -\frac{5T}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left(\ln|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t\right) \quad (6)$$

where θ denotes the vector for all unknown parameters.

This paper used monthly data from January 1999 to December 2020. The stock market prices of ASEAN-5 were represented by the MSCI stock market indices which were sourced from Datastream (Thomson Reuters, n. d.). The advantage of using the MSCI series is that these market capitalization-weighted indices can be converted to US Dollar (USD) to remove any exchange rate influences which may affect the analysis. Another advantage is that the MSCI series dated back to 1992 are consistently available for all five stock markets.

Five commodities were chosen based on their relevance to the ASEAN economies from the perspective of exports and contribution to Gross Domestic Product, as well as their role as investment assets. The five commodities include fuel, gold, palm oil, rice, and rubber. The ASEAN countries are highly dependent on these commodities (except gold) for their export revenues as well as other manufacturing industries (ASEAN, 2016). Although gold is not the main trade item, it is widely accepted for portfolio investment and gold price was shown to impact the stock market price movements (Afsal, & Haque, 2016; Chkili, 2016; Reboredo, & Ugolini, 2017). Monthly data on the commodity market indices were taken from the IMF website except for gold. Gold prices were extracted from the same source as the stock market indices. Since some of the commodity prices retrieved from the IMF website are spot prices that involve different units, all these variables were converted into indices. The base year for all series is 2005.

Table 1 lists the variables and describes the abbreviations used in reporting the analysis.

Table 1 Variable abbreviation and description

Variable	Description
R_IND	Returns of the stock market of Indonesia computed from the MSCI Index, 2005=100
R_MAL	Returns of the stock market of Malaysia computed from the MSCI Index, 2005=100
R_PHI	Returns of the stock market of the Philippines computed from the MSCI Index, 2005=100
R_SIN	Returns of the stock market of Singapore computed from the MSCI Index, 2005=100
R_THA	Returns of the stock market of Thailand computed from the MSCI Index, 2005=100

Variable	Description
R_FUEL	Returns of the fuel market computed from the Fuel (Energy) Index, 2005 = 100 that includes crude oil (petroleum), natural gas, and coal price indices
R_GOLD	Returns of the gold market, computed from the gold price index, 2005 = 100
R_PALM	Returns of the palm oil market computed from the Palm Oil Index, 2005=100, Malaysia Palm Oil Futures (first contract forward) 4-5 percent FFA, US$ per metric ton
R_RICE	Returns of the rice market computed from the Rice Index, 2005=100, 5 percent broken milled white rice, Thailand nominal price quote, US$ per metric ton
R_RUBBER	Returns of the rubber market computed from the Rubber Index, 2005=100, Singapore Commodity Exchange, No. 3 Rubber Smoked Sheets, 1st contract, US cents per pound
V_FUEL	The volatility of the fuel market represented by the standard deviation in R_FUEL for the past 12 months
V_GOLD	The volatility of the gold market represented by the standard deviation in R_GOLD for the past 12 months
V_PALM	The volatility of the palm oil market represented by the standard deviation in R_PALM for the past 12 months
V_RICE	The volatility of the rice market represented by the standard deviation in R_RICE for the past 12 months
V_RUBBER	The volatility of the rubber market represented by the standard deviation in R_RUBBER for the past 12 months

4. Results and Discussion

Table 2 shows some financial information on the ASEAN-5 stock markets. The stock exchange of Singapore was the largest in terms of market capitalization while the stock market of the Philippines was the smallest.

Figure 1 plots the price indices of the stock markets. The two shaded areas indicate the global financial crisis that occurred after the first quarter of 2008 until the third quarter of 2009 and the Covid-19 pandemic that hit the ASEAN region since March 2020. There was a huge drop in the stock market prices during the sub-prime mortgage crisis that spurred the global financial crisis in the year 2008 to 2009, which affected all five stock markets. After the crisis, all stock exchanges were growing steadily. Except for the Singapore market, the other four markets surpassed the pre-crisis peak. These markets suffered another drop when the pandemic started. Although they rebounded, the indices were still lower than the pre-pandemic levels by the end of 2020.

Table 2 Financial information on the stock exchanges of ASEAN-5 as of 31 July 2017

Stock market	Market capitalisation (USD million)	Annualized 3-year price return (%)
Malaysia	112,199.97	-8.80
Indonesia	115,071.12	-0.16
Philippines	56,453.92	0.43
Thailand	104,321.15	0.33
Singapore	188,117.91	-0.28

Source: www.msci.com

The commodity prices shown in Figure 2 did not follow similar patterns. The commodity prices were growing steadily throughout the years before they dropped due to the global financial crisis. The crisis did not affect gold prices as much as it affected the other commodities. Gold price gained momentum during this crisis subsequently, before the downturn in 2014 due to the economic slowdown that also affected the other commodity markets. Palm oil prices peaked after the global financial crisis. The recovery after the crisis pushed its price up but the momentum was not sustained beyond 2011 due to oversupply. Rubber prices also shot up after the crisis, which indicated the increase in its consumption for goods that required rubber as an input during the upswing. However, like palm oil, its price began to fall after 2011. The rice price hiked beyond the crisis and stabilized after 2009 at a level higher than pre-crisis, reflecting the world's concern for food security. The fuel price dropped in 2016 to a level lower than that during the global financial crisis due to over-supply and was affected worse by a drastic reduction in its demand during the Covid-19 pandemic.

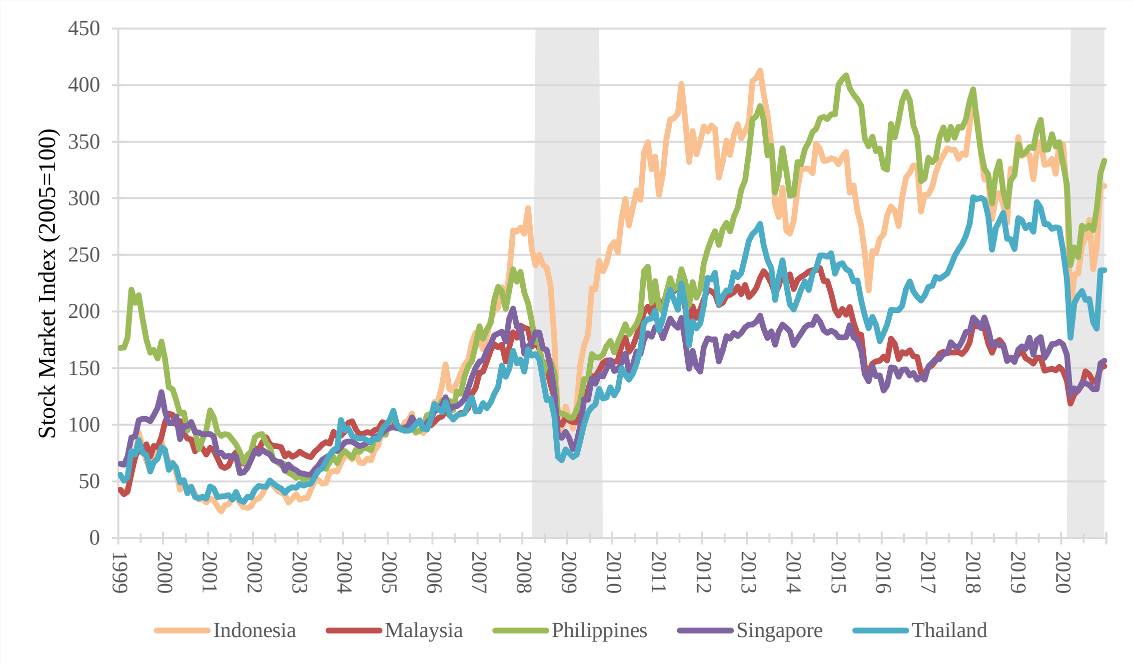

Figure 1 Stock market indices

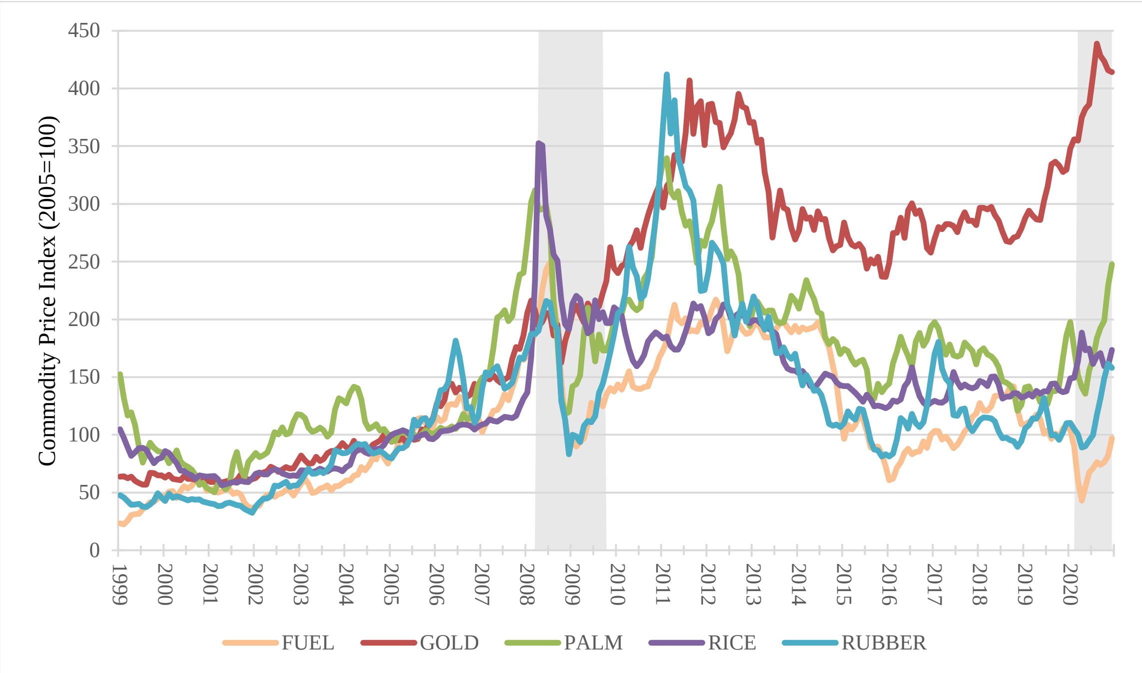

Figure 2 Commodity price indices

The descriptive statistics for the commodity and stock daily returns are summarised in Table 3. Gold recorded the highest return with a mean of 0.007 with relatively low risk. Its standard deviation is the lowest compared to the other commodities. On the other hand, the rice market recorded the lowest return. Fuel, palm oil, and rubber had the three highest variabilities in their returns. The stock markets yielded daily returns of between 0.3% to 0.7%. The stock markets of Indonesia and Thailand experienced higher uncertainty than the other stock markets as reflected in the higher variability of their returns. Most of the commodity and stock market returns were negatively skewed except for the rice market and stock exchange of Malaysia. All of the returns displayed excess kurtosis, indicating fat-tailed distributions. The Jarque-Bera test confirmed that all return series did not follow a normal distribution.

Table 3 Descriptive statistics of commodity and stock market daily returns

Variable	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis	Jarque-Bera Test
R_FUEL	0.0056	0.237	-0.404	0.082	-1.171	6.503	195.33***
R_GOLD	0.0071	0.165	-0.186	0.046	-0.147	4.175	16.14***
R_PALM	0.0017	0.290	-0.316	0.078	-0.177	4.606	29.77***
R_RICE	0.0022	0.412	-0.190	0.056	2.229	18.000	2693.59***
R_RUBBER	0.0048	0.188	-0.394	0.081	-0.586	5.269	71.76***
R_IND	0.0074	0.334	-0.507	0.104	-0.616	6.393	143.38***
R_MAL	0.0049	0.328	-0.194	0.059	0.429	6.867	172.61***
R_PHI	0.0026	0.215	-0.279	0.071	-0.398	4.297	25.49***
R_SIN	0.0033	0.214	-0.345	0.067	-0.899	6.947	206.89***
R_THA	0.0055	0.359	-0.402	0.088	-0.349	6.148	114.37***

Note: ***Significant level at 1%.

The plots in Figures 1 and 2 suggested the occurrence of structural breaks in all commodity and stock market indices. The stationarity properties of the series were established through the modified ADF breakpoint unit root tests. The test identified the global financial crisis to be the most common cause of breakpoints. It caused a structural break in the stock market and the rice and rubber markets. The breakpoint for fuel returns occurred during the Covid-19 pandemic. In Table 4, all commodity and stock indices were I(1) after their structural breaks were accounted for. All first differences were clearly stationary. The results supported the use of the first differences or returns for further analysis.

Table 4 Augmented Dickey-Fuller breakpoint unit root test of commodity and stock market indices

Variable	Breakpoint unit root test (t-statistic)		
	Level	First difference	Order of integration
(a) Commodity Market Index			
Fuel	-4.706	-12.537***	I(1)
Gold	-3.930	-18.741***	I(1)
Palm	-4.694	-12.419***	I(1)
Rice	-3.794	-12.802***	I(1)
Rubber	-3.591	-12.790***	I(1)
(b) Stock Market Index			
Indonesia	-3.319	-15.575***	I(1)
Malaysia	-3.926	-14.804***	I(1)
Philippines	-3.321	-15.947***	I(1)
Singapore	-3.350	-16.499***	I(1)
Thailand	-3.545	-18.100***	I(1)

Notes: ***Significant level at 1%. The test regression has an intercept and trend. The critical values at 1% and 5% significance levels are -5.348 and -4.860 respectively. The test used innovation outliers and lag length selected by Schwarz information criterion.

Table 5 shows the correlation between the returns of the commodity and stock markets. The correlation coefficients were less than 0.3 and positive. The correlation between rice and the stock markets was the weakest while fairly strong correlations were found between palm oil and the stock markets.

Table 5 Correlation between the commodity and stock market returns

Stock Market	Commodity Market				
	Fuel	Gold	Palm	Rice	Rubber
Indonesia	0.196	0.187	0.266	0.049	0.139
Malaysia	0.268	0.086	0.258	0.024	0.152
Philippines	0.147	0.164	0.152	0.003	0.098
Singapore	0.274	0.163	0.283	0.054	0.185
Thailand	0.190	0.208	0.244	0.090	0.117

The GARCH-BEKK model was estimated. Note that the news impact on the stock markets may be asymmetric (Botoc, 2014). Initially, the researchers tried to fit a threshold GARCH(1,1) model with diagonal BEKK specification. However, the estimation could not converge. A reduced threshold model with leverage order of 1 and GARCH(1,0) was then applied. Convergence was achieved but the market asymmetry coefficients were not significant. Subsequently, the GARCH(1,1) model was selected and the results are reported in Table 6.

These results are discussed to firstly examine the return spillovers from the commodity markets to the stock markets. Fuel price returns affected the stock markets of Indonesia, Singapore, and Thailand significantly. Every 1% increase in fuel returns led to an increase in the range of 0.16% to 0.18% in the returns of these stock markets. Indonesia, Singapore, and Thailand were the three largest consumers of oil in ASEAN, while Indonesia and Thailand were among the top three producers of oil in ASEAN (Economic Research Institute for ASEAN and East Asia, n. d.). Singapore is a financial hub in the region where financial institutions are highly responsive to fuel price movements and the impact on their investment portfolio.

The returns on gold impacted the stock markets of Indonesia and Thailand at the 5% significance level. Indonesia produced about 4% of world gold production and this ranked the country the sixth-largest world producer in 2019 (Baru Gold Corp, n. d.). Physical gold plays an important role in Thai culture and is generally accepted as an asset for the store of value (BullionStar, n. d.).

The palm oil returns exerted a significant impact on the stock markets of Indonesia, Singapore, and Thailand. The returns in these stock markets moved in the same direction as palm oil market returns. A 1% increase in palm oil returns was estimated to cause a 0.25% rise in the stock market returns of Indonesia, 0.17% rise in the stock market of Singapore, and 0.20% rise in the stock market of Thailand. Indonesia and Thailand are producers of palm oil. In 2018, they produced 40.57 and 2.78 million tonnes of oil palm crops respectively (Ritchie, & Roser, 2021). As palm oil exporters, their stock markets were buoyant when the palm oil market was doing well.

The return of the rice commodity market only affected the stock market of Thailand, whereby a 1% increase in the former led to a 0.23% increase in the latter. Given that Thailand is one of the largest world producers and exporters of rice, rice prices affect its economic performance closely.

The rubber commodity market was not found to have any significant effect on all stock markets. Rubber, although produced for export in the past by Indonesia and Malaysia, had been gradually replaced by oil palm crops and lost its dominant role in the GDP of these countries. Given the lack of correlation, rubber is a good candidate for portfolio diversification purposes.

The commodities that affected the stock markets significantly had positive coefficients at the 5% significance level. This finding suggested that they were not safe haven assets against turmoil in the stock market. However, at the 10% significance level, gold and rice exhibited safe-haven properties for Singapore, given their negative coefficients.

The spillovers from the volatility of the commodity markets to stock market returns were far less compared to their return spillovers. An increase in volatility of the gold market caused the stock market returns of Singapore to increase, suggesting possible shifts from the gold to the stock market when uncertainty in the gold market heightened. This again showed the safe-haven role of gold for the stock market of Singapore. The volatility of the rice market impacted the stock market of Thailand negatively. Higher rice market uncertainty for this rice exporting country conveyed bad market news that did not augur well for its stock exchange. It also had a negative impact on the stock market of Singapore at the 10% level.

The results showed that none of the commodity markets had return or volatility spillover effects on the stock markets of Malaysia and the Philippines. There is a strong relationship between the stock markets of Malaysia and Singapore. The stock market of the Philippines had the smallest market capitalization. One possible reason for this finding is that the commodity effects could be transmitted through and subsumed in the volatility spillovers between the stock markets of these two countries and the other stock markets.

The conditional variance equation reported in Table 6 conveyed information on the volatility spillovers among the five stock markets. The results showed how the volatility of one stock market affected the volatility of another stock market. All coefficients of the lagged own- and cross-volatility spillovers (α_{ii} and α_{ij}) were significant at a 1% level of significance. Most of the coefficients of lagged own- and cross-market shocks (b_{ii} and b_{jj}) were also significant. In comparison to the past volatility, the past shocks of the ASEAN stock market had lesser effects on the markets' conditional variance regardless of whether they were the own- or co-market innovations. The significant coefficients of lagged co-volatility between different stock markets suggested that the movements in returns of one market were dependent on the movements of other markets. It is noteworthy that the cross-market spillover effect from shocks in the stock market of Singapore had the highest impact on all markets. The stock markets of Malaysia and the Philippines were the most exposed as the spillovers from their own-market shocks were not significant compared to cross-market shocks.

5. Conclusion

This study analyzed the return and volatility spillover effects of global commodity markets on the returns of ASEAN-5 stock markets. The impact of fuel was significant on the stock markets of Indonesia and Thailand, both of which are producers of oil. Likewise, the spillovers from palm oil returns on the stock markets of Indonesia and Thailand which are palm oil exporters were also significant. Thailand, an exporter of rice, experienced rice market return spillovers on its stock market. Rubber, a crop that had been widely replaced by oil palm in the region, did not show any significant impact on any of the stock markets. Besides, the study found gold return spillovers on the stock market of Thailand, given the important role this commodity plays in the Thai tradition. The stock exchange of Singapore, the financial hub of ASEAN with the largest market capitalization, experienced return spillovers from all commodity markets except rubber.

The volatility spillovers were less compared to the return spillovers. While the rice market volatility had impacted the stock exchange of Thailand negatively, the gold market volatility was positively related to the stock market returns of Singapore.

This research provided empirical insights that are of practical significance. First, global commodity price movements influenced the returns of ASEAN-5 stock markets, in terms of commodity returns and to a smaller extent, volatility. The returns of fuel, palm oil, and rice markets had strong effects especially on the economies that produced and exported them. The relationship between the commodity and stock market returns is therefore largely related to the production economy.

Second, the return spillovers from the commodity to stock markets were generally positive. An exception is gold return spillovers on the stock market of Singapore. Coupled with its positive volatility spillover effects, gold could be considered a safe haven for the stock market of Singapore. The lack of significant association between rubber and the stock markets renders this commodity a choice for portfolio diversification.

Third, the Philippines stock exchange was not affected by the movements in the commodity market, which may be due to it being the smallest stock market in the region. It was relatively insulated from external shocks and is therefore an investment destination for portfolio diversification.

The findings of this study showed that the commodity markets had a role to play in the development of the financial sector. The financialization of commodities had led commodity markets to be increasingly integrated with the financial sector. The policymakers must take cognizance that the development of the financial sector will not be complete without taking the growth and expansion of the commodity markets into consideration. The investors must recognize the connectedness between the two sectors in their portfolio planning and for diversification purposes. Future research could measure the extent of this connectedness and shed further light on how portfolio diversification can be achieved based on the dynamics of the commodity and stock markets.

Table 6 Estimation of the diagonal BEKK GARCH model

	Indonesia (i = 1)		**Malaysia (i = 2)**		**Philippines (i = 3)**		**Singapore (i = 4)**		**Thailand (i = 5)**	
Variable/ Coefficient	**Coef**	**Std error**	**Coef**	**Std error**	**Coef**	**Std error**	**Coef**	**Std error**	**Coef**	**Std error**
Constant	-0.025	0.023	0.026	0.205	-0.036	0.207	-0.028	0.018	-0.018	0.015
R_FUEL_t	0.165^{**}	0.073	0.258	0.355	0.104	0.295	0.163^{***}	0.053	0.179^{***}	0.060
R_FUEL_{t-1}	0.095	0.097	0.056	0.258	-0.017	0.245	0.065	0.062	-0.071	0.065
R_GOLD_t	0.279^{**}	0.134	-0.027	0.646	0.157	0.562	0.081	0.079	0.261^{***}	0.085
R_GOLD_{t-1}	0.096	0.120	-0.092	0.466	-0.092	0.400	-0.166^{*}	0.088	-0.116	0.088
R_PALM_t	0.247^{***}	0.085	0.133	0.335	0.096	0.280	0.173^{***}	0.057	0.195^{***}	0.067
R_PALM_{t-1}	-0.063	0.103	-0.096	0.303	-0.018	0.253	-0.107^{*}	0.063	-0.116	0.073
R_RICE_t	0.093	0.132	0.053	0.552	0.055	0.511	0.139	0.087	0.230^{**}	0.091
R_RICE_{t-1}	-0.098	0.140	-0.148	0.672	-0.149	0.649	-0.146^{*}	0.086	-0.191^{*}	0.107
R_RUBBER_t	-0.042	0.071	-0.039	0.486	-0.004	0.465	0.021	0.050	-0.024	0.055
R_RUBBER_{t-1}	-0.027	0.086	-0.109	0.394	-0.013	0.361	-0.018	0.050	0.063	0.061
V_FUEL_t	0.324	0.253	0.110	1.881	0.256	1.804	0.157	0.165	0.116	0.156
V_GOLD_t	0.432	0.433	0.309	2.527	0.742	2.389	0.622^{**}	0.291	0.437	0.312
V_PALM_t	-0.046	0.268	0.087	1.160	-0.309	1.041	-0.060	0.178	0.046	0.227
V_RICE_t	-0.284	0.239	-0.228	1.640	-0.320	1.660	-0.305^{*}	0.168	-0.349^{**}	0.173
V_RUBBER_t	0.062	0.262	0.097	1.577	0.157	1.435	0.149	0.178	0.174	0.178
α_{i1}	0.868^{***}	0.038								
α_{i2}	0.954^{***}	0.021	1.048^{***}	0.007						
α_{i3}	0.955^{***}	0.022	1.049^{***}	0.004	1.051^{***}	0.006				
α_{i4}	0.875^{***}	0.020	0.961^{***}	0.015	0.962^{***}	0.014	0.881^{***}	0.026		
α_{i5}	0.887^{***}	0.024	0.974^{***}	0.011	0.976^{***}	0.012	0.893^{***}	0.017	0.906^{***}	0.021
β_{i1}	0.093^{**}	0.043								
β_{i2}	0.060^{**}	0.024	0.039	0.025						
β_{i3}	0.041^{**}	0.019	0.027^{*}	0.014	0.018	0.013				
β_{i4}	0.089^{***}	0.031	0.058^{**}	0.024	0.039^{***}	0.015	0.086^{**}	0.036		
β_{i5}	0.086^{***}	0.029	0.055^{**}	0.022	0.038^{**}	0.016	0.082^{***}	0.026	0.078^{***}	0.026

Note: ***, **, and * denote significance level at 1%, 5%, and 10% respectively. The dependent variables are stock market returns R_IND, R_MAL, R_PHI, R_SIN, and R_THA for the five countries, respectively. Coef refers to coefficient and std error refers to standard error. The constant values for the variance equations are not reported. The coefficients are $\alpha_{ij} = a_{ii}a_{jj}$ and $\beta_{ij} = b_{ii}b_{jj}$ in equations (4) and (5).

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