Causality Effect Among ASEAN-5 Stock Markets in COVID-19 Pandemic: VAR Model Approach

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ARTICLE INFO	ABSTRACT
	Financial globalization increase integration degree of capital flow. However, the global shock could impact many countries, either positive and negative. COVID-19 pandemic is one of the shock that affect world including ASEAN-5. This paper apply the Vector Autoregressive (VAR) model to identify the linkage among ASEAN-5 stock markets during the COVID-19 pandemic and it is used because of no spesific theory behind it. The data used in this paper is the weekly return of the composite index of ASEAN-5 stock markets from 11 March 2020 to 29 December 2021. This paper finds that there is a linkage among ASEAN-5 stock markets indicated by decreasing price index consecutive. Therefore, the implication of this paper is that the investors have to switch the investment instrument from stock to other instrument carefully. Once the negative impact begins to taper off, investors could do international stock investment.

1. Introduction

The stock market has an important role to the economy. One of them is a medium to fund company and investment medium for investors [1]. Stock market performance could reflect economic condition well. The benefit of investment is a yield that consist of return and dividend from the issuer. That is one reason for the community to invest. It also helps issuers to expand production from the fund they get.

Financial globalization supports economic growth from investment. Financial globalization is the integration process among financial systems in one country to international financial markets and institutions [2]. One characteristic of financial globalization is economic regional integration marked by cooperation among countries in a certain region. This cooperation opens investment opportunities from other countries, so that capital could inflow without any barriers. Financial globalization could increase market efficiency, reduce investment risk, also strengthen financial partnerships among countries [3].

The Association of Southeast Asia Nations (ASEAN) is one example of globalization in the southeast Asia region. The goal is to accelerate economic growth, social improvement, and cultural development in southeast Asia, and also promote peace and regional stability. Countries that first form ASEAN are Indonesia, Malaysia, Filipina, Singapore, and Thailand (ASEAN-5). Then other

countries join such as Brunei Darussalam, Vietnam, Laos, Myanmar, and Cambodia. The establishment of ASEAN benefits the member such as the development of trade areas, the liberation of capital flow, and reducing the cost of a trade. In 2015, ASEAN form Masyarakat Ekonomi ASEAN (MEA) to make ASEAN economy integrated and cohesive. Moreover, ASEAN forms investment cooperation to create a liberated and transparent investment area that increases investment flow to the ASEAN area. With that policy, indeed economic growth in the ASEAN region is more integrated. This makes all markets integrated and have a strong connection to others. The movement of market price could impact another market. Price movement could be transmitted to another market [4]. Market integration will ease foreign investors to fund other countries.

Besides the positive impact of integrated markets, there is also a negative impact from integrated markets. Integrated countries have more sensitive to changes in other countries. A crisis in one country could give an impact on others. COVID-19 pandemic is one global shock that hurts the world. COVID-19 pandemic comes from one to another country, which is known as the contagion effect. Countries with regional cooperation could have more impact from that situation. The investor would pull their fund to save their stocks asset to reduce the negative impact of the crisis. This would decrease the demand for stocks and later lower the stock market's performance in the effect of the economic crisis [5].
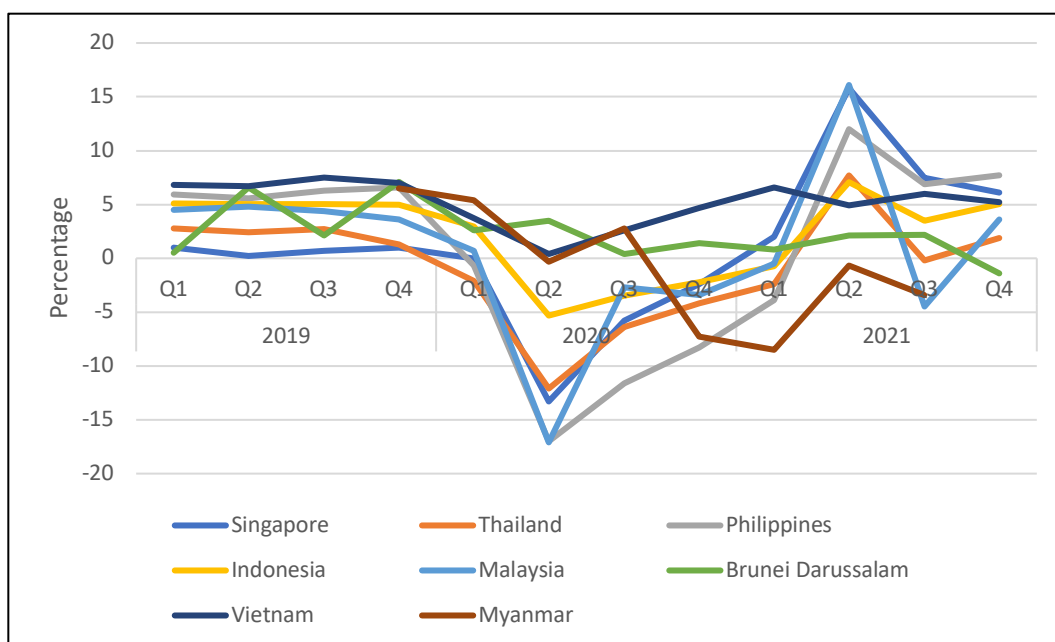

Fig. 1 Economic growth (Y-on-Y) ASEAN countries from 2019-2021.

Fig. 1 shows economic growth of ASEAN countries from 2019 to 2021. Growth from Laos and Cambodia is excluded because of the limitation of the data. ASEAN-5 countries experience economic contraction during COVID-19 pandemic and turn into a recession while the other countries have a positive growth in the early of COVID-19 pandemic. It shows that degree of integration of ASEAN-5 countries is higher than other countries in ASEAN, indicated by the similiarity of economic contraction in early 2020. Moreover, there is co-movement among ASEAN-5 countries during a pandemic and have recovery in quarter 1 2021. ASEAN-5 countries are also have the biggest economic contribution in ASEAN. That is the basis for determining ASEAN-5 as an integrated region and exposed to each other by COVID-19 pandemic. Investment is one component that plays important role in an economy marked by GDP. Thus, the economic performance of ASEAN-5 could be reflected by the performance of its stock market. The investment could cross the domestic border so which may cause similar conditions in other countries. This effect of global shock needs to be concerned because the stock market is one of the supporters of international investment, which

contributes to the economy of a country. Lack of investment would slow economic development and have a bad effect such as economic slowdown.

Some previous studies that examined the relationship between stock markets during crisis conditions such as Rahim and Nor [6] in 1997 Asian crisis explained that there was an increase in linkages between stock markets in crisis conditions only. The method used in that paper was VAR model. After the crisis, the relationship condition would return to normal so investment between countries was still an option to diversify the international portfolio. Adisetiawan and Rahmadi [7] examined the causality relationship between stock markets in ASEAN-5 countries. The model used to analyze those relationship was granger causality test. From 2001 to 2018, not all stock markets had two-way causality but there was a one-way relationship where the Indonesian exchange influenced the Singapore, Malaysia, and Philippine exchanges. Rachmawati, Saputra, Prihatin, and Yunita [8] with wilcoxon signed rank test and t-test also stated that there were significant differences in the stock indices of countries in ASEAN before and after the lockdown was implemented during the COVID-19 pandemic.

Based on previous studies, it is proven that there is a significant difference in stock market perfomance during crisis. Study related to the impact of COVID-19 pandemic towards ASEAN-5 stock markets become a challenge to be conducted because this event change the behavior of stock markets performance and might change the behavior in the future. ASEAN-5 as locus of research is chosen because integrated region where countries are cooperated is likely to be more impacted toward global shock. This study is conducted to identify the linkage among ASEAN-5 stock markets as a reflection of investment flow and its effect during the COVID-19 pandemic.

2. Method

2.1. Data and Data Sources

This data used in this study is the weekly closing composite index from ASEAN-5 countries that consist Indonesia (Index Harga Saham Gabungan, IHSG), Malaysia (Kuala Lumpur Composite Index, KLCI), The Philippines (Philippines Stock Exchange Index, PSEI), Singapore (Strait Times Index, STI), and Thailand (Stock Exchange of Thailand Index, SETI). This study uses secondary data from the yahoo finance site from 11 March 2020 to 29 December 2021. After that, the data are transformed to composite index return with the formula that follows [9]:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \tag{1}$$

Where $R_{i,t}$ define the return of composite index with i country and t periode. P stands for the value of weekly closing composite index. Descriptive analysis is conducted to see interrelationship among varibles during COVID-19 Pandemic. Graphs and tables are used to depict the condition that occured in the stock markets during COVID-19 Pandemic

2.2. VAR Model

This paper apply VAR model to find out the linkage among ASEAN-5 stock markets. The VAR system formula can be written as follows [10]:

$$x_t = A_0 + A_1 x_{i,t-1} + A_2 x_{i,t-2} + \cdots + A_p x_{i,t-p} + e_t \tag{2}$$

where x_t is a $(n \, x \, 1)$ vector that consist n endogenous variables in VAR system. A_0 is an interceps vector with size $(n \, x \, 1)$. A_1 is an $(n \, x \, n)$ coefficient matrix. e_t is an $(n \, x \, 1)$ vector of error terms. Augmented Dickey Fuller (ADF) test is used to examine whether the data is stationary [11]. The granger causality test [12] is also used to test causality among ASEAN-5 stock markets in term of return of composite index. The Impulse Function Response (IRF) and Variance Decomposition (VD) is employed to find out spillover effects and contagion effects among ASEAN-5 stock markets. IRF could trace the effect of shock from one stock market to other stock markets. VD explain the proportion of the movements in a series due to its own shock against shocks from the other markets.

In summary, the procedures of VAR model analysis are: (1) stationary test to check whether there is a unit root based on the data. (2) Determine optimum lag length of VAR model. In this paper use eight lag as maximum and select optimum lag based on LR, FPE, and AIC. (3) Stability test is used due to validity of IRF and VD analysis. (4) Granger causality test is carried out to see interrelationship among variables. (5) VAR model is estimated based on optimum length and consider all variables as endogen variable. (6) IRF and VD is utilized as a further analysis based on VAR model estimation.

3. Results and Discussion
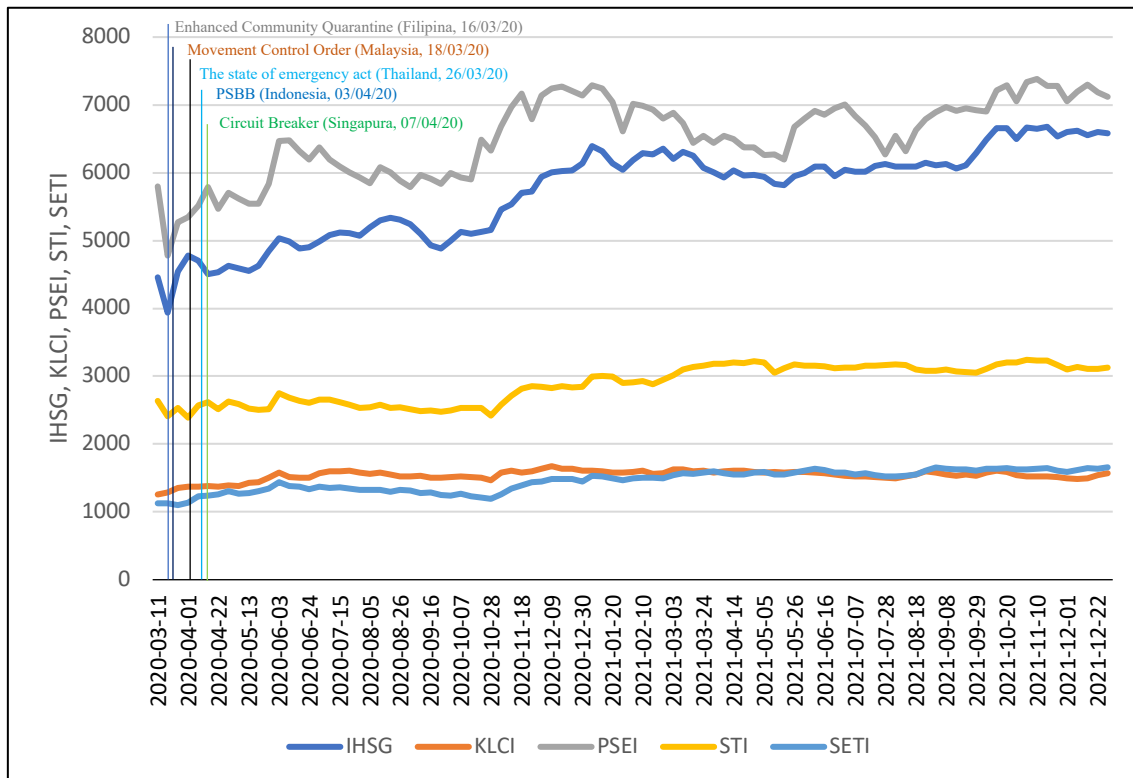
3.1. Descriptive Analysis

Fig. 2 Movement of composite index in ASEAN-5 countries.

Based on Fig. 2, it is shown that at the beginning of the COVID-19 pandemic on 11 March 2020. the entire value of the stock price index in ASEAN-5 countries decreased. Various mobility restriction policies are carried out. Thailand went into lockdown on 26 March 2020. However, previously, there was a closure of entertainment venues and densely populated areas by the local government on 18 March 2020. This left eight million Thais out of work on 13 April 2020 [13]. Indonesian government employ Pembatasan Sosial Berskala Besar (PSBB) on 3 April 2020. COVID-19 is expected to have a greater impact on the economy in the second quarter due to the policy [14]. Economic growth fell to 3% from 5% in the first quarter of 2020. Investment fell deeper with a growth of just under 2%. The IHSG value also fell to one-third of the previous value. In January, it was around 6,400 points to 4,000 points in mid-March.

The composite index of stocks in Singapore (STI) also experienced a decline during the COVID-19 pandemic. From 7 April 2020 to 1 June 2020, a Circuit Breaker (CB) policy was made as a form of lockdown policy in Singapore that closed entertainment areas, schools, and crowded places [15]. The lowest decline was at 2389.29 points on 1 April 2020. In addition to the lockdown policy, the Government has spent $60 billion to help businesses stay alive and protect workers from losing their jobs [16]. On 16 March 2020, the Malaysian government carried out mobility restrictions under the

name Movement Control Order (MCO) which started from 18 March to 31 March 2020 [17]. Malaysia's composite index of stocks has declined since the beginning of the COVID-19 pandemic to a low of 1256.58 points. The Philippine stock market also experienced a decline in performance during the COVID-19 pandemic. The Philippine government implemented enhanced community quarantine (ECQ) on 16 March 2020 to restrict people's movements. It should be noted that PSEI experienced a decline in performance in line with the increase in COVID-19 cases [18]. The lowest decline occurred on 18 March at 3937.63 points. COVID-19 cases began to decline, the issuance of COVID-19 vaccines and the easing of public mobility made the economy recover, which was marked by the strengthening of stock indices in each country.

In the previous explanation, an overview of price movements and stock index returns in each ASEAN-5 country has been presented during the COVID-19 pandemic. The description of the data will be displayed with the size of centering, dispersion, and correlation between stock index returns in ASEAN-5 countries. It is useful to know the value that represents the whole of the observation and how dispersed the data is from its center. In addition, correlation is useful to know the relationship between two variables in the short term.

Table 1. Descriptive Statistics Table

Statistics	IHSG	KLCI	PSEI	STI	SETI
Mean	0.0029	0.0012	0.0014	0.0009	0.0025
Median	0.0022	-0.0006	-0.0040	0.0012	0.0019
Maximum	0.1527	0.0777	0.1073	0.0959	0.0782
Minimum	-0.1464	-0.1216	-0.1752	-0.1104	-0.1727
Standard deviation	0.0315	0.0231	0.0402	0.0273	0.0292
Skewness	-0.4576	-0.9097	-0.7648	-0.2420	-.1769
Kurtosis	13.5871	11.0552	7.7771	7.4715	15.6145

Table 1 shows that the average return on stock indices in ASEAN-5 countries is in the range of 0%. Returns have a fairly heterogeneous variation with the highest value being in the JCI with a return rate of up to 15%. The lowest return value during the COVID-19 pandemic is PSEI with a return rate of up to negative 17%. This indicates an asymmetry at the rate of return. Asymmetry can lead to extreme profit or loss events. The high standard deviation indicates that the state of the market during the COVID-19 pandemic is unstable. The skewness row shows that all stock indices in ASEAN-5 countries experienced negative skewness during the COVID-19 pandemic. Negative skewness indicates frequent gains that are worth a little and rarely get losses that are of great value. This also happened during the financial crisis of 2008 and the crisis of 1988 which made all ASEAN-5 countries experience negative turmoil. When viewed from the degree of collapse (kurtosis row), the distribution curve shape of each return is classified as fat tail, heavy tail, or leptokurtic because of the large fourth-moment value (more than three). This heavy tail phenomenon has a distribution form whose tail is thicker than the normal distribution. This causes a greater chance of extreme events than the normal distribution can model. Therefore, the size of cramps and collapses is the cause of stock data in ASEAN-5 countries not distributed normally.

Table 2. Correlation on Stock Index Return among ASEAN-5 Countries

Correlation	INA, MY	INA, PH	INA, SG	INA, TH	MY, PH	MY, SG	MY, TH	PH, SG	PH, TH	SG, TH
Value	0.526	0.650	0.577	0.456	0.444	0.454	0.644	0.648	0.475	0.665

Table 2 shows the short-term correlation between stock market index returns in ASEAN-5. Supranto [19] says that correlation relationships are strong when the correlation coefficient is close to one (or negative). These results show that there is a fairly close relationship between stock market index returns in ASEAN-5. Empirical research also proves that the correlation between stock markets is high during periods of crisis. The positive correlation value implies that there is a reduction in

profits from diversification internationally because if one of the stocks falls the other stock will also fall. Therefore, in the short term, diversifying in a country that is strongly correlated positively (integrated) will be inefficient.

3.2. Inference Analysis

Table 3 shows the result of the ADF tests on the return variables of the stock index at the level. Based on the result, there is no root unit in the time series of stock market index returns in ASEAN-5 countries during the COVID-19 pandemic. This suggests that the time series is already stationary which means that the average value and variation of the data are constant over time and the distance between the covariant is determined by the number of lags in the distance. Since the data is already stationary at the level, the modeling to be built is VAR in level.

Table 3. ADF Test for Stationarity of Index Return among ASEAN-5 Countries

Variable	ADF Statistic	Critical value 5%	Prob.	Conclusion
R_{IHSG}	-8.252665	-3.457808	0.0000	Stationary
R_{KLCI}	-8.721218	-3.457808	0.0000	Stationary
R_{PSEI}	-9.576374	-3.457808	0.0000	Stationary
R_{STI}	-9.335166	-3.457808	0.0000	Stationary
R_{SETI}	-5.170686	-3.457808	0.0000	Stationary

Table 4 shows the optimal lag test results with each criterion. It can be known that the upper limit given to conducting the modeling experiment is the length of the lag along with two. LR, FPE, and AIC values suggest a lag of two. The number of lags selected in the analysis is as large as two to ensure that all dynamic relationships in the data are captured [20]. This means that the variables in the model are related not only to the present period but also to the previous two weeks.

Table 4. Determination of the Optimal VAR Lag

Lag	LR	FPE	AIC	SC	HQ
0	NA	4976.905	22.7019	22.8364*	22.2756
1	97.1876	2829.121	22.1363	22.9428	22.4622*
2	62.8694*	2275.526*	21.9141*	23.3927	22.5116
3	12.8302	3310.515	22.2780	24.4287	23.1471
4	22.1131	4243.937	22.5055	25.3282	23.6461
5	22.3173	5303.432	22.6939	26.1887	24.1061
6	23.3173	5567.696	22.6903	26.8571	24.3740
7	33.9166	5738.820	22.6456	27.4845	24.6009
8	33.6909	6791.944	22.7103	28.2213	24.9372

The next process is a stability test to ensure that the VAR process is stable so that the resulting IRF and VD analysis is valid. Based on the stability test in Fig. 3, it can be shown that the modulus value is inside the circle unit or the value of the entire modulus is below one so that the VAR model meets the stability conditions. A stable VAR process will fluctuate around a constant average and its variability does not change (constantly) during the process.

Table 5. Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
RMY does not Granger Cause RINA	95	165.461	0.0001
RINA does not Granger Cause RMY		0.02813	0.8672
RPH does not Granger Cause RINA	95	612.958	0.0151
RINA does not Granger Cause RPH		172.894	7.E-05
RSG does not Granger Cause RINA	95	358.330	0.0615
RINA does not Granger Cause RSG		763.593	0.0069
RTH does not Granger Cause RINA	95	0.70467	0.4034

RINA does not Granger Cause RTH		164.539	0.0001
RPH does not Granger Cause RMY	95	758.687	0.0071
RMY does not Granger Cause RPH		323.579	2.E-07
RSG does not Granger Cause RMY	95	706.226	0.0093
RMY does not Granger Cause RSG		146.203	0.0002
RTH does not Granger Cause RMY	95	569.937	0.0190
RMY does not Granger Cause RTH		920.025	0.0031
RSG does not Granger Cause RPH	95	249.772	0.1174
RPH does not Granger Cause RSG		0.43317	0.5121
RTH does not Granger Cause RPH	95	153.477	0.0002
RPH does not Granger Cause RTH		135.898	0.2467
RTH does not Granger Cause RSG	95	170.756	8.E-05
RSG does not Granger Cause RTH		0.04339	0.8355

Furthermore, a granger causality test will be carried out. Based on the pairwise granger causality test in Table 5, there is a two-way causality relationship between the returns of Indonesia's stock index and the Philippines during the COVID-19 pandemic. In addition, there is also a two-way relationship between Malaysia and Thailand, Malaysia with the Philippines, and Malaysia with Singapore. Indonesia itself is influenced by Singapore and Thailand. The movement of the returns of Thailand's previous stock index has successfully affected the stock markets of Singapore and the Philippines. This result concludes that not all stock markets in ASEAN-5 countries have a two-way causality relationship during the COVID-19 pandemic. The other ASEAN-5 countries have one-way relations while the capital markets of the Philippines and Malaysia do not have significant relations.
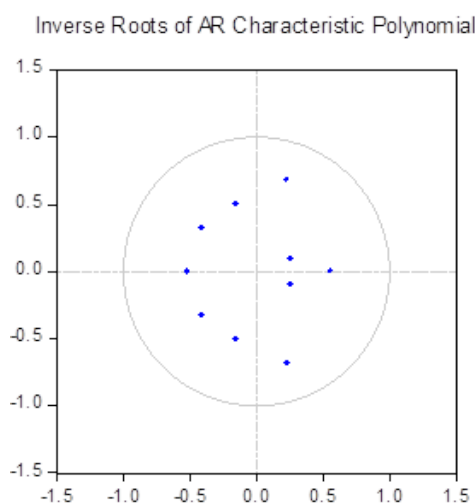

Fig. 3 Stability test.

After conducting the granger causality test, an IRF analysis was performed to see the effect of a change of one standard deviation from another variable on the current and future endogenous variables in the model. The analysis is based on markets that have strong residual correlations with other markets. From Table 6, it is obtained that the Thai stock market is strongly correlated with Singapore and Malaysia and the Indonesian stock market is strongly correlated with Singapore and the Philippines (the residual correlation value is more than 0.5). Based on Fig. 4, The shock influence of the Thai stock market has a strong influence on Singapore. But the shock from the Singapore stock market did not significantly affect the Thai stock market.

Table 6. Residual Correlation Matrix

Correlation	INA, MY	INA, PH	INA, SG	INA, TH	MY, PH	MY, SG	MY, TH	PH, SG	PH, TH	SG, TH
Value	0.433	0.566	0.567	0.463	0.376	0.466	0.651	0.525	0.410	0.689

When there is a negative shock to the Thai market of one standard deviation, it will be responded negatively by the Singapore stock market, which is characterized by a decrease in STI returns of up to 1.61% in the first period. The impact decreases (tapers off) in the later period and begins to disappear by the sixth week. These results imply that the negative impact of the Thai stock market is temporary. The Thai stock market has a stronger influence than the Malaysian stock market influence in influencing each other. The shock from the Thai stock market will be responded to by a decrease in SETI returns by up to 1.36% in the first period. The Malaysian stock market only affected the Thai stock market in the second period where the effect was less than the influence of the stock market on Thailand. The effectbegan to disappear in week 2 which indicates that the relationship between the two stock markets is also temporary.
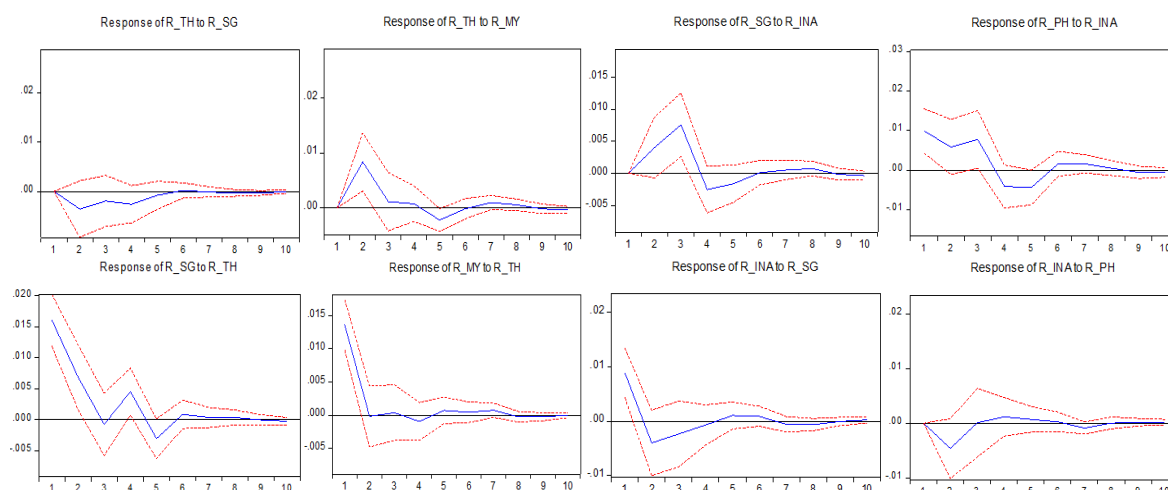

Fig. 4 Impulse response functions.

In the relationship between the Indonesian and Singapore stock markets, the shock that occurred in the Singapore stock market responded negatively with a decrease in IHSG returns by 0.9% in the first period. The effect decreases in the next period. The Indonesian stock market had no influence on the Singapore stock market during the first period, but thereafter had an impact on the Singapore stock market of up to 0.76% in the third week. The effect begins to subside and converge by the sixth week. The last stock market relationship to be analyzed is the Indonesian stock market with the Philippine stock market. The shock that occurred in the Indonesian stock market had a positive effect on the Philippines. This indicates that when there is a negative shock to the Indonesian stock market, it will also hurt the Philippine stock market. The magnitude of the effect was 1% in the first period, decreasing to 0.6% in the second week and finally subsiding in the sixth week. In contrast, the shock from the Philippine stock market did not significantly affect the Indonesian stock market in each period. This is indicated by the value of the confidence interval which contains the zero value in each period. VD analysis to see the contribution of variables in the system to other variables. Since VD is sensitive to sequencing, sequencing is carried out based on residual correlations. Based on the highest to lowest residual correlation, it can be concluded that the sorting variables to be formed are Thailand, Singapore, Malaysia, Indonesia, and the Philippines. This is also related to the first case of COVID-19 which was first found in the ASEAN-5 region in Thailand. Therefore, Thailand is considered the origin of the transmission of stock index returns in the ASEAN-5 region. Due to load limitations, VD will be displayed in the next one, two, five, and ten weeks of forecast errors.

Table 7. Variance Decomposition of Return Index Among ASEAN-5 Countries in COVID-19 Pandemic

Market	Period	SETI	STI	KLCI	IHSG	PSEI
	1	**100.00**	0.00	0.00	0.00	0.00
SETI	2	81.04	1.63	8.96	7.81	0.56
	5	77.60	2.67	8.62	9.47	1.64

Market	Period	SETI	STI	KLCI	IHSG	PSEI
	10	77.34	2.68	8.74	9.60	1.64
STI	1	47.54	**52.46**	0.00	0.00	0.00
	2	44.34	43.53	4.74	2.34	5.05
	5	41.77	37.59	4.37	10.26	6.01
	10	41.48	37.25	4.82	10.27	6.18
KLCI	1	42.45	0.06	**57.49**	0.00	0.00
	2	36.34	4.04	52.71	3.45	3.46
	5	33.25	5.61	51.82	5.31	4.01
	10	32.98	5.58	51.46	6.00	3.97
IHSG	1	21.43	11.72	4.92	**61.92**	0.00
	2	25.33	9.91	15.39	47.13	2.24
	5	24.49	9.60	17.57	46.13	2.20
	10	24.41	9.50	17.94	45.92	2.22
PSEI	1	16.85	11.14	1.75	8.69	**61.55**
	2	23.04	9.41	8.55	8.50	50.50
	5	21.38	11.60	8.09	13.15	45.78
	10	21.36	11.52	8.31	15.36	45.44

Based on the Table 7, it can be seen that the Thai stock market is the leading market where it has a major impact on other countries while being least affected by other markets during the COVID-19 pandemic. From the first to the tenth period, the stock market in ASEAN-5 tended to be integrated during the COVID-19 pandemic because the value of the forecast error variance described from other stock markets was quite large (about 50%). In week 10, the percentage of forecast error variance for the Thai stock market that can be explained by its innovations was 77.34%. After that, it was followed by Malaysia with a percentage of forecast errors that can be explained by its innovations of 51.46%. For Indonesia, the Philippines, and Singapore, it is 45%, 45%, and 37% respectively. The smallest contribution of innovation to itself, Singapore (37.25%), indicates that Singapore is becoming a sensitive market to other markets during the COVID-19 pandemic. In terms of influencing other markets, Thailand became the leading market, explaining 41.48% of the forecast error variance of the Singapore market, 32% in the Malaysian market, 24% in the Indonesian market, and 21% in the Philippine stock market. There was a contagion effect on the COVID-19 pandemic as the percentage of the unexplained variance of one's own country's innovations decreased in each period while innovations from other stock markets increased.

4. Conclusion

Based on the result above, it could be concluded that the entire stock market in ASEAN-5 decreased and highly fluctuated at the beginning of COVID-19 Pandemic. Nevertheless, the fluctuation gradually decreased and stock markets get stronger. This imply that shocks during COVID-19 pandemic is temporary. Some markets in ASEAN-5 influenced each other (IHSG-PSEI, SETI-KLCI, PSEI-KLCI, STI-KLCI).

Thailand became leading market during COVID-19 pandemic due to high residual correlation and large forecast error variance contribution to other markets. The impact of the shock on ASEAN-5 stock markets increased during the beginning of COVID-19 pandemic. However, it declined (dies out) quickly and markets experienced a recovery. The higher linkage among ASEAN-5 stock markets due to COVID-19 pandemic would decrease the benefit of international diversification. So it suggest that investors to find alternative instuments carefully. For the further research are to be able to accomodate from the volatility aspect because there is an interrelationship between risk and return.

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