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Comparison of Vector Autoregressive (VAR) and Vector Error Correction Models (VECM) for Index of ASEAN Stock Price

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Abstract. Capital markets can be an indicator of the development of a country's economy. The presence of capital markets also encourages investors to trade; therefore investors need information and knowledge of which shares are better. One way of making decisions for short-term investments is the need for modeling to forecast stock prices in the period to come. Issue of stock market-stock integration ASEAN is very important. The problem is that ASEAN does not have much time to implement one market in the economy, so it would be very interesting if there is evidence whether the capital market in the ASEAN region, especially the countries of Indonesia, Malaysia, Philippines, Singapore and Thailand deserve to be integrated or still segmented. Furthermore, it should also be known and proven What kind of integration is happening: what A capital market affects only the market Other capital, or a capital market only Influenced by other capital markets, or a Capital market as well as affecting as well Influenced by other capital markets in one ASEAN region. In this study, it will compare forecasting of Indonesian share price (IHSG) with neighboring countries (ASEAN) including developed and developing countries such as Malaysia (KLSE), Singapore (SGE), Thailand (SETI), Philippines (PSE) to find out which stock country the most superior and influential. These countries are the founders of ASEAN and share price index owners who have close relations with Indonesia in terms of trade, especially exports and imports. Stock price modeling in this research is using multivariate time series analysis that is VAR (Vector Autoregressive) and VECM (Vector Error Correction Modeling). VAR and VECM models not only predict more than one variable but also can see the interrelations between variables with each other. If the assumption of white noise is not met in the VAR modeling, then the cause can be assumed that there is an outlier. With this modeling will be able to know the pattern of relationship or linkage of share prices of each country in ASEAN. The best modeling comparison result of the ASEAN stock price index is VAR.

INTRODUCTION

Stock price index modeling with time series data is more appropriate using time series approach. If the analyzed variables are only one type of stock, in general ARIMA model (Autoregressive Integrated Moving Average) is more appropriate to use in the analysis. This is indicated by the research on cash inflows and outflow cash flow at Indonesia Central Bank or Bank Indonesia (BI) of Sulawesi in general, the results show that ARIMA is the best model for forecasting the currency outflow and inflow at South Sulawesi [1].

The multivariate time series approach is more appropriately used if the observed variable as well as the predicted one is more than one. This is possible because of the dependencies between one variable with another variable. Both VAR and VECM models are very well used if the observed data of the pattern tends to have no high fluctuations or

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no outliers. The weakness of this model if the data fluctuate is very high, then the result of the model prediction will not be stationary, not white noise, bias and certainly residual not normally distributed.

In Suharsono's research on VAR (Vector Autoregressive) modeling, it was found that there is a significant relationship between the volume of stock trading in Indonesia in terms of inflation, interest rates and foreign exchange rates [2]. Here it can be concluded that the VAR model will provide a good solution if in case of time series data there is a very strong relationship between variables. The modeling of stock price forecasting in Indonesia in relation to world stocks, America, Japan, UK, Singapore, Hongkong. Using univariate time series ARIMA and multivariate time series VAR analyzes, Indonesia with the world share price [3]. Subsequent research states that the VAR model is very well used to analyze stock market behavior in Indonesia [4]. VARX method, that is VAR model with exogenous variable that is effect of calendar variation stated that there is correlation of index of share price in ASEAN, this is because at the moment there is tendency of person or company tends to passive in investing in stock [5]. Research by Suhartono, Lee and Hamzah on inflation in Indonesia states that VARX modeling that is VAR with exogenous variables is very suitable to describe the inflation condition in Indonesia, because there may be an outlier in its data, there is an increase in oil price or other government policy [6].

LITERATURE REVIEW

ASEAN Stock Price

The stock price index is an indicator showing the current stock price movement. And Index serves as an indicator of market trends, meaning that the index movement describes market conditions at a time, whether the market is active or lethargic. Securities markets serve to help allocate capital among households, corporations and governments as well as provide a variety of options for investors who want to exchange or sell securities easily, quickly and efficiently. This market provides liquidity in two ways. First, they can get companies to increase their funding by selling securities and helping investors to buy and sell securities with relative ease and speed.

Indicators of stock price indexes such as JSX (Jakarta Stock Exchange), KLSE (Kuala Lumpur Stock Exchange), PSE (Philippine Stock Exchange), SGX (Singapore Exchange), SETI (Stock Exchange of Thailand), reflect the performance of the stock market. The index can be used to evaluate how well a stock or stock market performs in relation to stocks included in the index calculation. The price of a stock determines the index of the stock as a whole. But the stock price index is more influenced by stocks that have large capitalization and liquid. So the index calculation is not determined by the number or number of transactions, but by the price. The composite stock price index includes all shares in the calculation process. While the other indexes include some shares with predefined criteria first.

While the stock price itself is affected by the risk of ownership of shares. Components of risk have been traditionally categorized into several groups; Business risk, interest rate risk, market risk, liquidity risk, and financial risk. All components of the risk are systematic risks determined exogenously or by market forces as well as unsystematic risks that are unpredictable or by non-market forces.

Bursa Malaysia formerly known as Kuala Lumpur Stock Exchange (KLSE), is a stock exchange company that provides different services related to derivative and securities trading and others.

The Singapore Stock Exchange is a stock exchange located in Singapore, formerly known as the Stock Exchange of Singapore (SES) until it merges with the Singapore International Monetary Exchange (SIMEX) on November 30, 1999. Exchange it also trades other securities such as government bonds and derivatives such as stock options. SGX's main stock market index is the Straits Times Index (Strait Times Index, STI).

Singapore Exchange Limited is an investment holding company that provides different services related to derivative and securities trading and others. SGX is a member of the World Federation of Exchanges and the Asian and Oceanian Stock Exchanges Federation. Trading period on the SGX exchange is 08:00 to 17:30 every day except Saturday, Sunday, and holidays specified by the previous bourse managers.

The Stock Exchange of Thailand (SETI) is the national stock exchange of Thailand. As of 31 January 2015, the Stock Exchange of Thailand had 584 listed companies with a combined market capitalization of 15,030 billion baht or 460 billion USD. The indices of the stock exchange are the SET Index, SET50 Index and SET100 Index.

The Indonesian capital market the composite stock price index (IHSG) and the Malaysian stock exchange were the most positive during the day compared to other countries in ASEAN. Based on Bloomberg data, JCI closed up slightly 0.22% or 9.2 points to 4,237.73 level continued strengthening the previous day. Meanwhile, Malaysia's

FTSE KLCI rose 1.05% or 16.4 points to 1,580.37. On the contrary, Thai stocks fell 0.29% or 3.8 points to 1320.08. Similarly, Singapore's FTSE Strait Times stock exchange also fell 0.46% or 13.2 points to 2,873.00.

Vector Autoregressive Model

Vector Autoregressive is a statistical method used to analyze the relationship between several influencing variables. Vector autoregressive (VAR) processes are popular in economics and other sciences because they are flexible and simple models for multivariate time series data. In econometrics they became standard tools when questioned the way classical simultaneous equations models were specified and identified and advocated VAR models as alternatives.

VAR model is actually a combination of several models of autoregressive (AR), where these models form a vector between the variables affect each other. VAR model is a quantitative forecasting approach usually applied to multivariate time series data. This model describes the relationship between observations on a particular variable at a time with his own observations on the variables at earlier times and also its association with observations on other variables at previous times [7].

VAR is a simple regression of the equation

$$Y_t = \Gamma_1 X_{t-1} + \varepsilon_t \tag{1}$$

There are two important assumptions that must be considered from the time series data in order to set up a VAR model, (1) stationary, (2) the error normality and independence. Unit Root Test is one way to test for stationarity. While testing the independence of errors made in a way to make a residual plot. If $\boldsymbol{\varepsilon_t}$ point in the plot there is a clear pattern, it can be said that the $\boldsymbol{\varepsilon_t}$ is independent

According to [8], the VAR model is used if there is simultaneity between several variables, and cannot differentiate between the dependent variable and which the independent variables.

The general form of the model VAR [9]

$$y_t = c + \phi(B) y_t + \varepsilon_t \tag{2}$$

$$y_t = c + (\phi_1 B + \phi_2 B^2 + \phi_3 B^3 + ... + \phi_p B^p) y_t + \varepsilon_t \tag{3}$$

$$\varepsilon_t \sim N(0, \Sigma) \tag{4}$$

Identification of the VAR Model

In principle, the identification of multivariate time series models is almost the same as the univariate time series model identification. Identification of the VAR model is based on a pattern or structure of the Matrices autocorrelation function (MACF) and Matrices partial autocorrelation function (MPACF) having previously performed the appropriate transformation to stabilize the variance, and or differencing to stabilize the average, i.e. if the data is not stationary in the variance and the average [8].

Parameter estimation of VAR Model

In estimating the VAR model parameters (p), there are two methods that can be performed, the method of Maximum Likelihood (MLE) and the method of Least Squares (LS) [9]. Maximum Likelihood Estimator (MLE) is used to parameters estimation of a model known density function, by maximizing the likelihood function.

Density function for the observation is

$$f(\mathbf{y}_t) = (2\pi)^{-m/2} \left|\boldsymbol{\Sigma}^{-1}\right|^{1/2} \exp\left[(-1/2)(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})^T \boldsymbol{\Sigma}^{-1} (\mathbf{y} - \mathbf{X}\boldsymbol{\beta})\right] \tag{5}$$

Random sample of n observations $\mathbf{y}_1, \mathbf{y}_2, ..., \mathbf{y}_n$ obtained likelihood function is

$$L(\boldsymbol{\beta}, \boldsymbol{\Sigma}) = \prod_{t=1}^{n} (2\pi)^{-m/2} \left|\boldsymbol{\Sigma}^{-1}\right|^{1/2} \exp\left[(-1/2)(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})^T \boldsymbol{\Sigma}^{-1} (\mathbf{y} - \mathbf{X}\boldsymbol{\beta})\right] \tag{6}$$

and the log likelihood function

$$\log L(\boldsymbol{\beta}, \boldsymbol{\Sigma}) = -(n\,m/2)\log(2\pi) + (n/2)\log\left|\boldsymbol{\Sigma}^{-1}\right| - (1/2)\sum_{t=1}^{n}\left[(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})^T \boldsymbol{\Sigma}^{-1} (\mathbf{y} - \mathbf{X}\boldsymbol{\beta})\right] \tag{7}$$

Estimates for $\boldsymbol{\beta}$

By using MLE to estimate the parameters $\boldsymbol{\beta}$ of the log likelihood

$$\log L(\boldsymbol{\beta},\boldsymbol{\Sigma}) = -(nm/2)\log(2\pi) + (n/2)\log\left|\boldsymbol{\Sigma}^{-1}\right| - (1/2)\sum_{t=1}^{n}\left[(\mathbf{y}-\mathbf{X}\boldsymbol{\beta})^T\boldsymbol{\Sigma}^{-1}(\mathbf{y}-\mathbf{X}\boldsymbol{\beta})\right]$$

The estimates obtained results

$$\hat{\boldsymbol{\beta}} = \left[\sum_{i=1}^{n}\mathbf{x}_t^T\mathbf{x}_t\right]^{-1}\left[\sum_{i=1}^{n}\mathbf{x}_t^T\mathbf{y}_t\right] \tag{8}$$

The *j*th Row *j* of $\hat{\boldsymbol{\beta}}$ is

$$\hat{\boldsymbol{\beta}}_j = \left[\sum_{i=1}^{n}\mathbf{x}_t^T\mathbf{x}_t\right]^{-1}\left[\sum_{i=1}^{n}\mathbf{x}_t^T\mathbf{y}_{jt}\right] \tag{9}$$

Estimates for $\boldsymbol{\Sigma}$

Log likelihood function is

$$\log L(\boldsymbol{\beta},\boldsymbol{\Sigma}) = -(nm/2)\log(2\pi) + (n/2)\log\left|\boldsymbol{\Sigma}^{-1}\right| - (1/2)\sum_{t=1}^{n}\left[(\mathbf{y}-\mathbf{X}\boldsymbol{\beta})^T\boldsymbol{\Sigma}^{-1}(\mathbf{y}-\mathbf{X}\boldsymbol{\beta})\right]$$

parameter estimation $\boldsymbol{\Sigma}$ using the MLE is

$$\hat{\boldsymbol{\Sigma}}^T = \frac{1}{n}\sum_{t=1}^{n}\left[\hat{\boldsymbol{\beta}}_t^T\hat{\boldsymbol{\beta}}_t\right] \tag{10}$$

Vector Error Correction Model

VECM (Vector Error Correction Modeling) is one of the modeling in the Multivariate Time Series. The simplest univariate modeling is ECM (Error Correction Modeling), a long term relationship between some non-stationary variables in the original data. The emergence of this cointegration is like giving new hope to achieve the creation of a stationary condition in the long run through a combination of linear variables. So, the point is said cointegrated if in the long run will reach the equilibrium point. If cointegration analysis is possible ECM can be used. If testing gets to the ECM analysis (short-term relationship), it will meet with the term Error Correction Term (ECT). This is used as an adjustment of the state of the equilibrium (speed of adjustment) is expected to be negative (convergent). One more thing, in a cointegration analysis the possibility of ECM is tantamount to the usual regression of known terms of independent and bound variables.

To test the roots of each series, a Dickey-Fuller (ADF) augmented methodology was performed [10]. The regression equation form for VECM is as follows,

$$\begin{aligned}\Delta y_t &= \alpha_1 + p_1 e_1 + \sum_{i=0}^{n}\beta_i\Delta y_{t-i} + \sum_{i=0}^{n}\delta_i\Delta x_{t-i} + \sum_{i=0}^{n}\gamma_i z_{t-i}\\ \Delta x_t &= \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n}\beta_i y_{t-i} + \sum_{i=0}^{n}\delta_i\Delta x_{t-i} + \sum_{i=0}^{n}\gamma_i z_{t-i}\end{aligned} \tag{11}$$

Where α_1 and α_2 is a constant.

Time series for economic data is generally stochastic or has a trend that is not stationary, meaning that the data has a root unit. To be able to estimate a model using the data,

a. first step to do is testing the stationarity of data or known as the unit root test. If the data used contains the root element of the unit, it will be difficult to estimate a model because the data trend tends to fluctuate not around its average value. It can be concluded that stationary data will have a tendency to approach its average value and fluctuate around its mean value. More specifically, this study will use Augmented Dickey-Fuller (ADF) test Relationship Between International Trade and Phillips-Perron (PP) to test the stationarity of each variable. The results of the ADF and PP test will be compared with McKinnon Critical Value.

b. Optimum Lag Selection The determination of the number of lags (orders) to be used in the VAR model can be determined based on the criteria of Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) or Hannan Quinn (HQ). The lag to be chosen in this research model is the model with the smallest HQ value. In this stage also tested the stability of the VAR model. Determination of optimum lag and VAR stability test is done before going through cointegration test stage.

c. Cointegration Test If the stationarity phenomenon is at the first difference level, it is necessary to test to see the possibility of cointegration. The concept of cointegration is basically to see the long-term balance among the observed variables. Sometimes a data that is individually is not stationary, but when linearly connected the data becomes stationary. It is then called that the data is cointegrated. In addition, the cointegration test will also be performed by following Johansen's procedure. In the Johansen test, the determination of cointegration is seen from the value of trace statistic and max eigen statistic after preceded by finding the length of the lag to be known. Trace statistic and max eigen statistic values that exceed their critical values indicate that there is cointegration in the model used.

d. Vector Error Correction Model is a form of Vector Autoregressive, which is restriction. This additional restriction must be given due to the existence of non-stationary but cointegrated data forms. VECM then utilizes the cointegration restriction information into its specifications. That's why VECM is often called the VAR design for nonstationary series, which has cointegration relationships. After the cointegration is known then the next test process is done by using error correction method. If there are different degrees of integration between the test variables, the test is done jointly between the long-term equations with the error correction equation, after it is known that in the cointegration variable occurs. The degree of integration for cointegrated variables is called Lee and Granger as multi cointegration. However, if not encountered cointegration phenomenon, then test is continued by using variable of first difference. VAR has a specific instrument that has a specific function in explaining the interaction between variables in the model. The instruments include Impulse Response Function (IRF) and Forecast Error Variance Decompositions (FEVD), or so-called Variance Decompositions (VD) [11].

METHODOLOGY

This research used secondary data of the Indonesia stock exchange. Data are monthly observations from July 2012 till June 2017. The data used for modeling is 60 observations and is. There are five responses, i.e. the Indonesia stock price index (IHSG) as ($Y_{1,t}$), Malaysia's stock price index (KLSE) as ($Y_{2,t}$), Singapore share price index (SGE) as ($Y_{3,t}$),The Philippine stock price index (PSE) as ($Y_{4,t)}$, and Thailand stock price index (SETI) as ($Y_{5,t}$).

Steps performs an VAR,

1. Test stationarity of data and degree of integration
2. Determination of lag length
3. Test the granger causality
4. Estimation of VAR
5. Variance decomposition
6. Forecasting

Steps performs an VECM,

1. Determination of lag length
2. Test the granger causality
3. Cointegration degree test
4. Estimation of VECM
5. Variance decomposition

ANALYSIS AND DISCUSSION

Descriptive analysis is needed to give an overview of the stock price index to be studied. The characteristic of the Stock price index since July 20012 to June 2017 is shown as Table 1.

TABLE 1. Descriptive Statistics of the Stock price index

Variable	Mean	SE Mean	StDev	Minimum	Maximum
SGE	6900,7	91,4	708,0	5196,2	7963,1
IHSG	4876,1	57,3	444,2	4060,3	5742,4
KLSE	1733,3	10,9	84,2	1610,8	1882,7
PSE	3116,2	27,3	211,6	2629,1	3487,4
SETI	1450,0	13,9	107,3	1199,3	1597,9

From the table above shows that the index of stock price singapore (SGE) has a higher average of 6900.7 compared to the four other stock price index. This shows that SGE has a high level of sales. However, judging from the standard deviation of 708 indicates that the fluctuation of SGE stock price is also quite high. The next highest order ranking is owned by Indonesia, Philippines, Malaysia and Thailand.

While from the time series plot obtained the results as shown below,

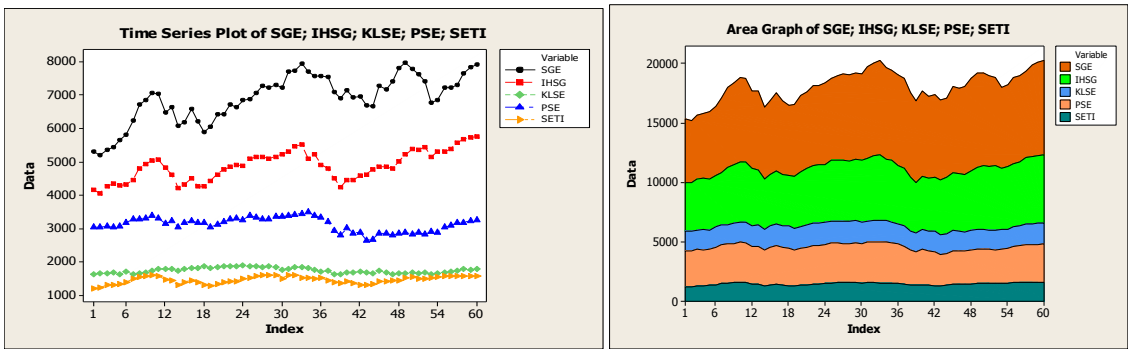

FIGURE 1. Time Series Plot of Stock price index since July 20012 to June 2017

In general, the time series plots indicate two main the pattern, i.e. The same pattern between IHSG and SGE on the one side and the same pattern between KLSE, SETI and PSE.

From the picture looks the pattern of data that is not stationary for the stock price index that exists. Time series requires the data pattern to be stationary. For that it is necessary differencing to make the data pattern become stationer.

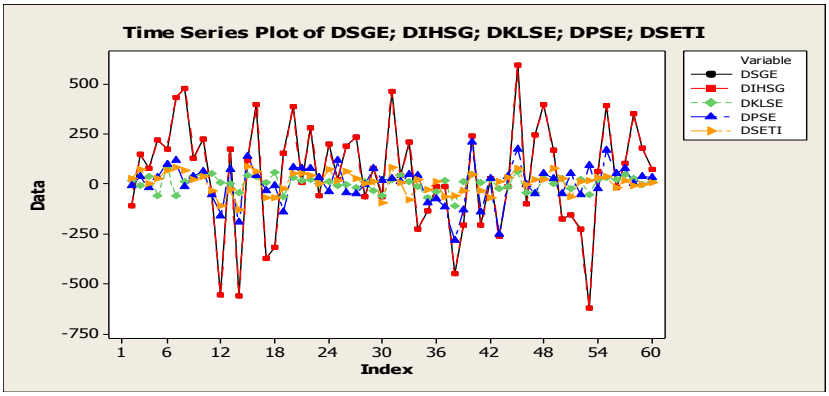

FIGURE 2. StationarityTime Series Plot of Stock price index since July 20012 to June 2017

From the figure 2 looks the pattern of data that has been stationary after done differencing.

The stationarity test of the data was performed using Augmented Dickey Fuller (ADF) at the same degree so that it was obtained a stationary data, ie the data whose variance was not too large and had a tendency to approach the

average value. One of the problems that occur in stationary test is optimal lag determination. If the lag is used too little, then the residual of the regression will not show the white noise process, so the model cannot accurately estimate actual error

TABLE 2. VAR Lag Order Selection Criteria

Endogenous variables: Philippines Indonesia Malaysia Singapore Thailand

Lag	LR	FPE	AIC	SC	HQ
0	NA	6.31e+21	64.38604	64.56852	64.45661
1	343.9764*	1.41e+19*	58.27520*	59.37011*	58.69861*
2	21.63369	2.18e+19	58.69262	60.69995	59.46887
3	35.33161	2.33e+19	58.69577	61.61553	59.82487
4	32.23399	2.51e+19	58.65680	62.48899	60.13874
5	20.47579	3.78e+19	58.85983	63.60444	60.69461

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

From the Table 2 above, note that all the stars are in lag 1. This indicates that the recommended optimal lag is lag 1. Furthermore from the VAR estimation results obtained results as in the following table,

TABLE 3. Vector Autoregression Estimates

	PSE	IHSG	KLSE	SGE	SETI
PSE(-1)	0.777100	-0.097876	-0.002648	-0.041305	-0.026632
	[3.80843]	[-0.76738]	[-0.08715]	[-0.58082]	[-0.71757]
IHSG(-1)	0.485707	0.963569	0.015824	0.038716	0.110610
	[1.97426]	[5.31366]	[2.36624]	[2.38292]	[2.09622]
KLSE(-1)	-2.010081	-0.356851	0.684117	0.179160	-0.441491
	[-1.89227]	[-2.53743]	[4.32420]	[2.48392]	[-2.28501]
SGE(-1)	0.036680	0.038567	-0.020472	0.538678	0.059831
	[2.07074]	[2.11899]	[-2.26508]	[2.98070]	[2.63437]
SETI(-1)	0.725819	1.441546	0.111831	0.578452	0.867930
	[0.71071]	[2.25816]	[0.73524]	[1.62516]	[4.67245]
C	867.8129	609.8648	157.6210	171.7094	386.2591
	[1.03682]	[1.16566]	[1.26443]	[0.58862]	[2.53718]
Akaike AIC	14.10920	13.06945	10.00069	12.00110	10.10046
Schwarz SC	14.49997	13.16022	10.29147	12.29187	10.09124

From the above table can be written in the form of equation as follows:

PSE = 0.777100 PSE(-1) + 0.485707 IHSG(-1) – -2.010081 KLSE(-1) + 0.036680 SGE(-1)

IHSG = 0.963569 IHSG(-1) - -0.356851 KLSE(-1) + 0.038567 SGE(-1) + 1.441546 SETI (-1)

KLSE = 0.015824 IHSG(-1) + 0.684117 KLSE(-1) -0,020472 SGE(-1)

SGE = 0.038716 IHSG(-1) + 0.538678 SGE (-1)

SETI = 0.110610 IHSG(-1) - 0.441491 KLSE(-1) + 0.059831 SGE(-1) + 0.867930 SETI(-1) +386.2591

Furthermore from the VECM estimation results obtained results as in the following table,

TABLE 4. VECM Estimates

Cointegrating Eq:	**CointEq1**				
PHILIPPINES (-1)	1.000000				
INDONESIA (-1)	-7.382568				
	[-2.55218]				
MALAYSIA (-1)	13.30375				
	[1.43551]				
SINGAPORE (-1)	-7.011680				
	[-1.56784]				
THAILAND (-1)	42.29652				
	[3.21428]				
C	-33586.28				
Error Correction:	**D(PHILIPPINES)**	**D(INDONESIA)**	**D(MALAYSIA)**	**D(SINGAPORE)**	**D(THAILAND)**
CointEq1	-0.023218	-0.006427	0.000166	-0.003835	-0.010373
	[-1.41877]	[-0.63318]	[0.06771]	[-0.61930]	[-3.58478]
D(PHILIPPINES (-1))	-0.138448	-0.128267	-0.001538	-0.040070	-0.019574
	[-0.69960]	[-1.04491]	[-0.05173]	[-0.53507]	[-0.55939]
D(INDONESIA(-1))	0.338927	0.027180	0.029347	0.028067	0.044361
	[1.22920]	[0.15892]	[0.70857]	[0.26900]	[0.90989]
D(MALAYSIA(-1))	-1.604728	-0.275650	-0.253719	0.161007	-0.315218
	[-1.54146]	[-0.42686]	[-1.62249]	[0.40870]	[-1.71242]
D(SINGAPORE (-1))	0.153173	0.151321	0.015169	-0.205673	0.043566
	[0.33139]	[0.52779]	[0.21848]	[-1.17590]	[0.53307]
D(THAILAND(-1))	1.421360	1.597091	0.080428	0.663997	0.287827
	[1.55432]	[2.81555]	[0.58552]	[1.98881]	[1.78007]
C	37.83639	24.05326	1.554727	0.771797	4.297727
	[1.08676]	[1.11377]	[0.29729]	[0.05858]	[0.69812]
Akaike AIC	14.27044	13.11533	10.27901	12.12692	10.60519
Schwarz SC	14.31911	13.36400	10.52768	12.37559	10.85386

From Table 3 and Table 4 it can be explained that the VAR model is better than the VECM model. This can be seen from the value of Akaike AIC and Schwarz SC value of the VAR model is smaller than the VECM model.

CONCLUSIONS

In general, the results indicate that VAR is the best model to forecast the ASEAN share price index. Of the five VAR models of the ASEAN share price index, the Malaysia stock price index model is the best model, because it has Akaike AIC and Schwarz SC with the smallest value. The second best model is the SETI stock price index. Furthermore, SGE, IHSG and PSE.

In addition, further research is needed to improve the approximate accuracy by developing new models involving more independent variables.

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