

Dynamic Ensemble Time Series for Prediction Major Indices in ASEAN

Evita Purnaningrum¹, Rina Fariana²

¹Management Department, Universitas PGRI Adi Buana Surabaya, Indonesia

²Accounting Department, Universitas PGRI Adi Buana Surabaya, Indonesia

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Corresponding Author:

Evita Purnaningrum

purnaningrum@unipasby.ac.id



ABSTRACT

World financial markets have been affected and depressed during the COVID-19 pandemic; all-digital capital market transactions experienced a sharp decline. No exception is the dynamics of capital markets in ASEAN countries. The uncertainty of the impact of the ASEAN Pandemic encourages stock price forecasting to reduce investment risk. It is also a topic that is consistently enthusiastically discussed in economic forums. This article applied stock price changes in five major ASEAN countries one year after the Coronavirus. Dynamic ensemble method that combines various predictive models to improve the accuracy of forecasts. The results showed that the model has a high level of accuracy with a small error value, which is below 1.5% for MAPE (Mean Absolute Percentage Error), and an average RMSE (Root Mean Square Error) of 5%. This suggests that investors could reduce their long-term investment risk by stealing the pandemic by using this model. In addition, these results are committed to being used as a basis for policy and decision-making for investors.

1. INTRODUCTION

Financial markets have been affected and under pressure during the COVID-19 pandemic. The unprecedented event slowed and shut down business activity and financial markets (Narayan, Purnaningrum, & Khawari, 2021). In addition, the entire capital market recently experienced aftershocks, with all capital market transactions experiencing a sharp

decline. Many previous studies have addressed the effects of pandemics on financial markets. Purnaningrum and Ariyanti (2020) have analyzed the influence of a pandemic on stock movements in Indonesia, affected the stock market and the exchange rate, and the retail price in the Philippines (CAMBA & CAMBA, 2020). Anh and Gan (2020) have confirmed that Covid 19 harms stock returns on the Vietnamese stock market. The positive cases and deaths in Malaysia hurt stock returns in the country's capital market, although they are insignificant (Chia, Liew, & Rowland, 2020). Thus, the coronavirus outbreak has proven to impact stock markets, especially in ASEAN countries.

However, stock market recovery, which has experienced a sharp decline, will continue to be made, albeit slower. One method that can measure stock recovery is by predicting stock prices based on the dynamic stock data. One year later, the financial world is still recovering from the aftershocks of the Covid pandemic. Previous researchers have used various methods to obtain a high degree of accuracy in predicting post-pandemic stock changes. Generally, stock price forecasting is always challenging due to the non-stationary, non-linear and dynamic nature of stock markets (Huang, Nakamori, & Wang, 2005), more so during this pandemic. Integrating Wavelet Transform and Bidirectional methods to predict stock prices during the Covid-19 pandemic can result in an average yield of RMSE (4.5%) and MAPE (3%) (Štifanić et al., 2020). Purnaningrum (2020) has predicted the paramount stock price in Indonesia after the pandemic effect using the Kalman filter with the results of forecasting a MAPE of 2.4% and 1.9% by considering seasonal periods and cycles of a time series data. Gormsen and Koijen (2020) have projected that future dividends will decrease in July 2020. Sadorsky (2021) has predicted the direction of stock prices using a decision tree bagging and random forest with an accuracy of between 85% and 90%.

Various forecasting methods have been developed, ranging from modifying conventional models to using machine learning and large data, such as the ensemble method. In addition, ensemble learning is applied to improve prediction accuracy by combining models. Previously, the ensemble method has been practiced to predict and forecast data; for example, Das and Gosh (2017) have combined deep learning and forecasting ensemble, which has effectively improved predicting missing data. Ensemble models have a significance level of 85% for the prediction of gold stocks and 79% for silver stocks (Mahato & Attar, 2014). Akyuz *et al.* (2017) also utilized ensemble learning to predict replenishment demand by combining time series models such as regression, exponential smoothing, holt winters, and ARIMA models.

Similarly, Kim and Hur (2020) predicted wind power output using an ensemble forecasting model based on a statistical approach. Furthermore, deep ensemble learning has successfully predicted time-series data from electricity load demand (Qiu, Zhang, Ren, Suganthan, & Amaratunga, 2014). Finally, Galicia *et al.* (2019) have also utilized ensemble models to predict big data time series with an MRE value of 2%, yielding good accuracy. Based on the above background, this study applied an ensemble to predict the stock price index in ASEAN countries during the covid-19 pandemic. Further, this study also aimed to add new literature to forecasting stock prices using the ensemble method.

2. METHODS

2.1. Dataset

The dataset is secondary data extracted from Investing.com (<https://www.investing.com>), referring to significant stocks in the Southeast Asia Region. Five ASEAN countries fall into this category during the daily observation period from the pandemic, namely December 31, 2020, to February 17, 2021. The dataset is divided into two parts: exact data for training and testing cohorts with a ratio of 3: 1. The main stocks from the ASEAN

region include IDX Composite from Indonesia, FSTE Malaysia KLCI from Malaysia, PSEi Composite from the Philippines, SET Index from Thailand, and VN from Vietnam. We only chose one of the three leading stocks for Vietnam, namely VN.

2.2. Dynamic Ensemble for Time Series

Time series forecasting has received the attention of researchers in engineering, science, economics, and finance, with the ensemble dynamic model gaining more popularity. Ensemble techniques are fast-evolving and help predict time series, especially for data modeling (Allende & Valle, 2017; De Gooijer & Hyndman, 2006). This method was first introduced in 2017 with two types of approaches, namely arbitrated dynamic ensemble (ADE) (Vitor Cerqueira, Torgo, Pinto, & Soares, 2017) and dynamic ensemble for time series (DETS) (Vitor Cerqueira, Torgo, Oliveira, & Pfahringer, 2017). ADE combines various forecasting models with arbitrage, while DETS uses basic models from ensembles to forecast time series. Moreover, in principle, the steps of the two methods are the same as the different DETS and use a more traditional approach in combining their estimation. In addition, these two methods use the same student base, namely the Gaussian process, the Projection Regression Model, the General Linear Model, the Random Forest Model, the M5 Tree Model, the Multivariate Adaptive Splines Regression Model, the Support Vector Regression Model, the Feedforward Neural Network Model, and Partial. At least. Regression Model and Main Component Regression Model. This study combines all of these models to obtain high accuracy in predicting stock prices (Evita Purnaningrum, 2021).

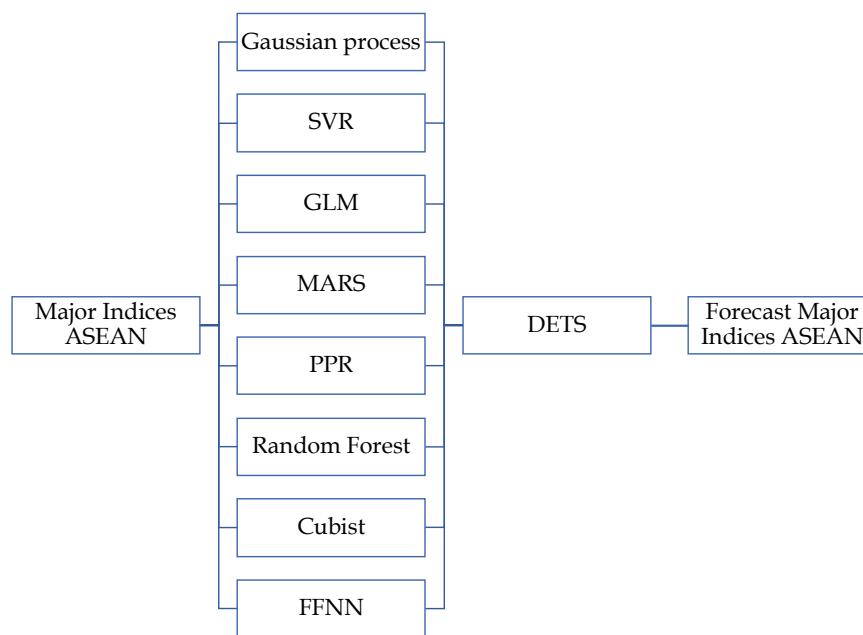


Figure 1 Model DETS for forecasting Major Indices

3. RESULTS AND DISCUSSION

3.1 Data Description

The dynamic stock price of the main 5 ASEAN countries a discernable decline at the end of March 2020 on various days. Firstly, The IDX Composites had a 38% decline on March 24, 2020, from the first declaration of the Coronavirus case in Wuhan, China. Despite that, the IDX Composites have surpassed its pre-pandemic initial price and reached a record high in mid-January 2021. In addition, from January to February 2021, the IDX composite stock prices

have been 5862.35 - 6435.21 (IDR). On the other hand, The FSTE Malaysia KLCI fell sharply by 395.95 (MYR) to its lowest point on March 19, 2020. However, the Malaysian stock markets had been gradually recovering to the same level as pre-pandemic in December 2020.

Table 1 Statistic Descriptive

Countries	Mean	Min	Max	1 st Qu	3 rd Qu
Indonesia	5369	3938	6435	4924	5953
Malaysia	1523	1220	1685	1491	1590
Philippines	6428	4623	7841	5894	7103
Thailand	1362	1024	1600	1274	1482
Vietnam	914.3	659.2	1194.2	848.7	966.2

Similarly, the major indices of the Philippines have sunk to the lowest point. In fact, until February 2021, the PSEi composites have not exceeded the share price at the outbreak's start, with a difference of only 776.1 (PHP). However, by 2021, stock prices have returned to above average. Thailand and Vietnam's main share prices fell on March 23 and 24, 2020. Vietnam experienced a significant increase in share prices compared to Thailand after Vietnam succeeded in suppressing the number of Covid positive cases.

Interestingly, from the beginning of 2021, the main share price (VN) has been higher than in the pre-pandemic era. A brief explanation of the descriptive statistics of the five major ASEAN stocks is shown in Table 1. Overall, major stocks in the ASEAN countries have recovered following a positive trend after a brief curve dip at the end of March 2020. Even though prices have declined occasionally, they consistently remained above their respective averages (Table 1). After the data were analyzed descriptively, the next step was to predict stock changes using a dynamic ensemble with various models.

3.2 Prediction Result and Analysis

In principle, learner models in ensembles are modifications of linear models. In this study, the iterations were limited to 100 with fixed lambda and omega of 50 and 0.2, respectively. Furthermore, from 100 iterations, a model approach with the smallest RMSE and MAPE has been selected. RMSE and MAPE were used to measure the accuracy of time series forecasting (Cho, 2003). The learner parameters have been applied to this research from the default system of packages (<https://cran.r-project.org/web/packages/tsensembler/tsensembler.pdf>). The iteration results show that three stocks have the same iteration points between the smallest error values from the RMSE and MAPE calculations, namely Indonesia, the Philippines, and Vietnam. On the other hand, the other two countries had different iterations.

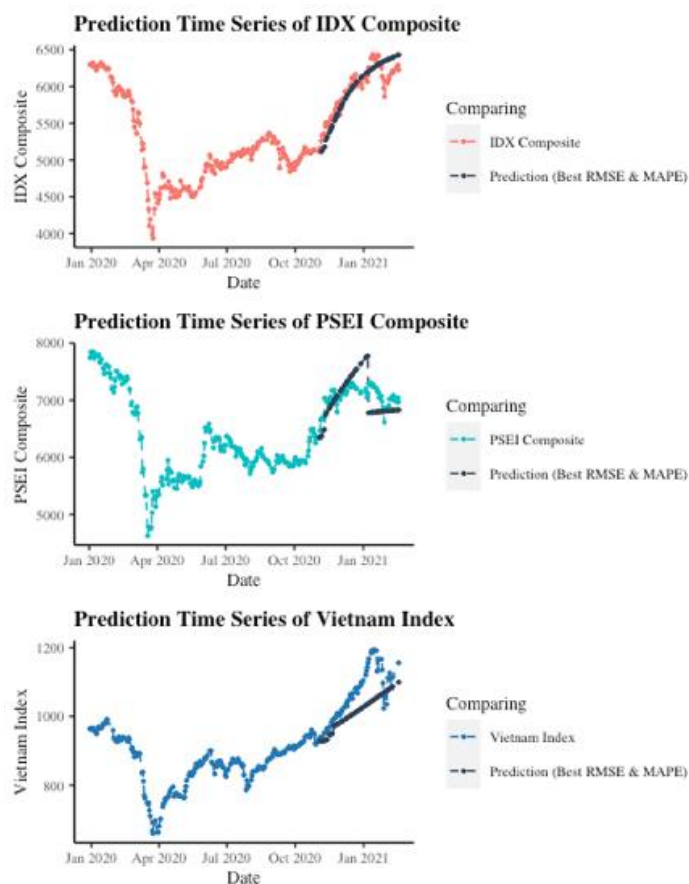


Figure 2 Three predictions of major indices

The prediction graph for the three countries with the same iteration for the smallest error (see Fig. 2) depicts stock price changes based on predictive models from the training data. Overall, it can be seen that even though the stock price movement at the time of the outbreak was inconsistent, the dynamic ensemble was able to capture the inconsistency, as evidenced by a small error value (below 5% for MAPE and a maximum of 10% for RMSE). The stock price follows a pattern similar to the previous data, even though the learner model predicts an upward linear trend for the two countries, namely Indonesia (IDX Composite) and the Vietnam Index. Meanwhile, the main shares of the Philippines (PSEi Composite) had an initial rise followed by a subsequent decline with a steady return to baseline from the end of 2020 to February 2021. The main stocks of the two countries (Indonesia and Vietnam) are expected to increase in the following days even though the Philippine stocks remained stable. This shows that investors have accepted the pandemic and are starting a new normal era.

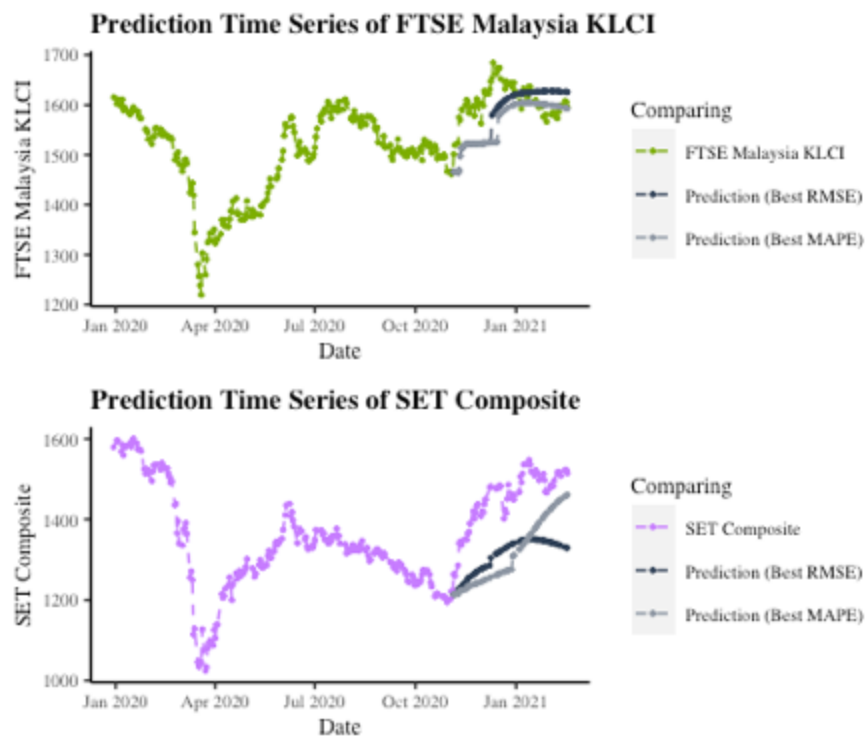


Figure 3 Two predictions of major indices

The stock price has increased significantly, although the models have different iterations to obtain the smallest RMSE and MAPE values in the two countries (Malaysia and Thailand) (see Fig. 3). According to the chart, similar to the previous three countries, the stock markets of both countries have bounced back after a very steep fall in March. Still, Thailand's stocks declined again at the end of October 2020, with the second wave of coronavirus underway. In addition to that, this incident affects forecasting accuracy, causing the accuracy of forecasting for Thailand to be lower than that of other countries. However, a dynamic ensemble has an excellent predictive value of stock changes, especially during the pandemic.

Table 2 Error of prediction

Countries	Indicator (iteration)	Error of Prediction	
		<i>RMSE</i>	<i>MAPE</i>
Indonesia	RMSE (54)	0.02771591	0.002728908
	MAPE (54)		
Malaysia	RMSE (20)	0.03763724	0.004388615
	MAPE (75)	0.04120859	0.004379509
Philippines	RMSE (20)	0.04208091	0.003908715
	MAPE (20)		
Thailand	RMSE (64)	0.1062558	0.01423130
	MAPE (45)	0.1074676	0.01367561
Vietnam	RMSE (59)	0.062449	0.0074215
	MAPE (59)		

The table (see Table II) compares the RMSE and MAPE error values from the dynamic model for the five ASEAN countries. Overall, Indonesia had the lowest error in the prediction model at 2% and 0.2% for RMSE and MAPE, respectively. Meanwhile, Thailand had the most significant error when compared to other countries. This shows that the pattern of Thai stock movements is classified as uncertain and unpredictable and could be attributed to the ripple effects of the Coronavirus. However, this table shows that the dynamic ensemble for time series data is proven significant and highly accurate for predicting stock prices. Even so, this model needs to be further developed and validated and can be combined with other methods such as the Kalman filter (Fauziyah & Purnaningrum, 2021; E. Purnaningrum, Cahyaningtias, & Kusumawardhani, 2021; E. Purnaningrum, 2018; Evita Purnaningrum, 2020; Evita Purnaningrum & Apriliani, 2016) or adding other data such as google trends (Kusumawardhani & Purnaningrum, 2021; Nafah & Purnaningrum, 2021; E. Purnaningrum & Nafah, 2021; Evita Purnaningrum & Ariqoh, 2019).

4. CONCLUSION

The timelines of the beginning and the end of the Coronavirus pandemic remain uncertain, even as new vaccines are made available. In a new normal era, all fields have resorted to coping mechanisms, and the financial sector and the stock markets are no exceptions. This study has predicted an increase in stock price changes in line with the availability of vaccines and good news related to this outbreak. Most stock markets in five ASEAN countries have experienced a significant appreciation. Furthermore, this research also provides a new alternative to stock price forecasting. However, it needs to be developed and validated by combining and comparing it with conventional predictive methods. Future research is needed to address issues such as market sentiment by using large data as an additional variable in increasing the accuracy of stock market forecasting. Big data be an additional variable to increase the accuracy of the forecast.

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