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Determinants and Prediction of the Stock Market during COVID-19: Evidence from Indonesia*

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Abstract

This research examines the stock market index determinants and the prediction using the FFT curve fitting of the Jakarta Stock Exchange (JKSE) Composite Index during the COVID-19 pandemic. This paper has used daily data of Jakarta Stock Exchange (JKSE) Composite Index, interest rate, and exchange rate from 15 October 2019 to 15 September 2020, and a total of 224 observations, retrieved from Indonesia Stock Exchange (IDX), Indonesia Statistics Central Bureau and Observation & Research of Taxation. The study covers descriptive statistics, multicollinearity test, hypothesis tests, determination test, and prediction using FFT curve fitting. The results unveil four fresh and robust evidence. Partially, the interest rate has affected positively and significantly the stock market index. Partially, the exchange rate has affected negatively and significantly the stock market index. The F-test result, interest rate, and exchange rate have significantly affected the stock market index (JKSE) simultaneously. Furthermore, the FFT curve fitting has predicted that the stock market fluctuates and increases over time. The results have shown a strong influence of the independent variables and the dependent variable. The value of Adjusted R-Square is 0.719, which means that the independent variables have simultaneously impacted the dependent variable for 71.9%; other factors have influenced the remaining 28.1%.

Keywords: Stock Market, Interest Rate, Exchange Rate, FFT Curve Fitting, Prediction

JEL Classification Code: E43, E44, F31, F37, G01

1. Introduction

Novel Coronavirus (2019-nCoV, hereinafter referred to as COVID-19) is a new type of virus that has never been identified before in humans. Coronavirus is a zoonosis (transmitted between animals and humans), where clinical manifestations usually appear within two to 14 days after exposure. Pandemic outbreaks of COVID-19 disease have had an enormous impact on various sectors in Indonesia. One of the affected sectors is the economic sector, including but not limited to the stock market index, interest rate, and exchange rate.

The COVID-19 pandemic has led to a tremendous slowdown in economies' growth (Ding, Levine, Lin, & Xie, 2020; Park et al., 2020). Hence, a firm and the financial sector need to understand the determinants of Indonesia's stock price during the pandemic. Before the epidemic, previous studies show that stock price positively impacts consumption expenditures and economic activities (Davis & Zhu, 2009; Davis & Zhu, 2011; Ludvigson, 2004).

The result from the study by Assefa, Esqueda, and Mollick (2017) shows interest rates have significant effects on stock prices. With the interest rate under the severest scenario, some banks may face a significant capital shortage if market rates start to increase dramatically from current low levels and decrease the firm value (Cifter & Ozun, 2008; Das, 2005; Dzmuranova & Teply, 2016). However, a low-interest rate is associated with decreased profitability for banks, particularly for small institutions, and simultaneously lower the firm value (Hamrita & Trifi, 2011; Reilly, Wright, & Johnson, 2007). The policymakers can mitigate the

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global financial crisis's effects by lowering the interest rate, providing fiscal stimulus, and protecting the poorest from economic deterioration (Purwono & Yasin, 2018).

The unpredictable exchange rate change can cause negativity on an economy, such as more significant uncertainty on future consumption (Devereux, 2004), increased change in business profitability (Aghion, Bacchetta, Rancière, & Rogoff, 2006; Braun & Larrain, 2005), and an elevated risk for domestic and foreign direct investment (Byrne & Davis, 2005; Serven, 2003). Zhao (2010) indicates bidirectional volatility spillover between stock prices and exchange rates.

To the best of our knowledge, no other studies have examined the influence of interest rate and exchange rate on the stock price during the COVID-19 pandemic, especially in Indonesia. This paper also predicts the trend of stock prices.

This paper aims to understand how the interest rate affects the stock market index; how the exchange rate affects the stock market index; how interest rate and exchange rate impact the stock market index during the COVID-19 pandemic; and predict stock market price during COVID-19.

The reason for choosing Indonesia as an object of analysis is because Indonesia is one of the emerging economies, which contains great economic potential that put the country in an excellent position for newly-advanced economic development. It is Southeast Asia's largest economy; therefore, the state-owned enterprises (SOEs) and large private business groups (conglomerates) play a significant role. In 2025, Indonesia will count 287 million population, making Indonesia occupy the world's 4th most populous country. This study's contribution provides fresh and robust evidence for the investors to take precautionary steps before trading in stocks during this pandemic and to the extant literature by focusing on the determinants of stock market indices. The paper consists of five parts: Part 1 introduces research issues; Part 2 presents the review of literature; Part 3 presents research data and methods; Part 4 shows the result of empirical research and discussion, and; the final section summarizes the findings.

2. Literature Review

2.1. Firm Value

The purpose of establishing a company is to create value and to increase the welfare of the shareholders (Block, Hirt, & Danielsen, 2011; Brigham & Houston, 2015; Sumarsan, 2020). Many firm value concepts include face value, market value, intrinsic value, book value, and liquidation value. A technique to value a company comprises of profitability approach, discounted cash flow method, dividend growth method, assets revaluation method, stock price method, and economic value-added method. Stock market indices reacted to the news (Alam, Alam, & Chavali, 2020; Khan et al., 2020).

2.2. Interest Rate

The interest rate can be an indicator in influencing the people's decision to spend or deposit the money and the business world's decisions to make loans for various purposes. When an interest rate is lower, more firms are willing to borrow money to expand their businesses, and the results are an increase in stock prices (Huang, Mollick, & Nguyen, 2016). Saymeh and Orabi (2013) used the Granger causality statistic to determine inflation causes interest rates, although each variable is an independent variable. The interest rates in monetary policy influenced the stock prices (Apergis & Eleftheriou, 2002; Assefa, Esqueda, & Mollick, 2017). The study of Tursoy (2019) shows a significant relationship between stock prices and domestic interest rates; interest rates have negatively affected the stock prices. However, Apergis and Eleftheriou (2002) show that interest rate correlates positively and insignificantly to stock prices.

2.3. Exchange Rate

According to Flota (2014), the concept of exchange risk comes from uncertain risk. The appreciation of the exchange rate decreased competitiveness (Rossi & Malavasi, 2016). Doukas, Hall, and Lang (2003) thought that the exchange rate fluctuations on the firms' market value depend on the firm's exchange rate exposure. Domestic firms will be affected indirectly, through a mechanism whereby the exchange rate exposure affects aggregate demand and industrial competitiveness and concentration (Mok, 1993). According to Hendry (1980), the exchange rate to prices generally defines through two channels, such as direct and indirect. Regression analysis is one of the most widely used techniques for analyzing multi-factor data. Successful use of regression requires an appreciation of both the theory and the practical problems that typically arise when the method employs real-world data (Novotny et al., 2019). In this study, the interest rates and exchange rates are the independent variables, and the stock market index is the dependent variable. The use of SPSS in this study varies from the other studies that use the Johansen cointegration test, generalized method of moments (GMM), and PLS-SEM.

There are various methods to do forecasting, such as time-series forecasting, class of artificial intelligence models, different neural network models, frequency-domain models (Mallikarjuna & Rao, 2019), and logistic regression models (Huet et al., 2004). The results showed no single forecasting technique provided uniformly optimal forecasting for all markets (Mallikarjuna & Rao, 2019). The forecasting of market fluctuation helps investors make the appropriate adjustment to the portfolios (Nguyen & Nguyen, 2019). Fourier transformations have been used in this study to forecast the financial time series.

Therefore, based on the literature review, the hypotheses for this study are as follows:

H1: *Interest rate has affected positively and significantly the stock market index.*

H2: *Exchange rate has affected negatively and significantly the stock market index.*

H3: *Interest rate and exchange rate have affected the stock market index significantly.*

3. Data and Methodology

3.1. Data Set

This paper focuses on whether, during the pandemic, interest rate and exchange rate affect stock prices or not. It has used daily data of Jakarta Stock Exchange (JKSE) Composite Index, interest rate, and exchange rate from 15 October 2019 to 15 September 2020, a total of 224 observations, retrieved from Indonesia Stock Exchange (IDX), Indonesia Statistics Central Bureau, and Observation & Research of Taxation. The data are collected and built-in Microsoft Excel, then SPSS is used to run the regression model.

3.2. Method

In this study, the relationship between the stock market index and the set of independent variables uses the coefficient determinants and an algorithm of Multiple Linear Regression. Other studies use the Johansen cointegration test. The independent variables are the exchange rate and interest rate, and the dependent variable is stock market prices – the general multiple linear least-square models.

$$Y = a_0 z_0 + a_1 z_1 + ... + a_m z_m + e \quad (1)$$

Meanwhile, to predict the stock market index uses an algorithm of Fourier Transformation, the other studies have used logistic regression models, auto-regressive conditional heteroscedasticity (ARCH), and Generalized ARCH (GARCH). Following the predictability literature and using Matlab tools, the available model Fourier usually can be written as:

$$f(t) = A_0 + A_1 cos(\omega_0 t) + B_1 sin(\omega_0 t) \quad (2)$$

Where Ao is the mean value, A1 = C1cos θ, B1 = -C1sinθ, C1 is the amplitude, ωo is the angular frequency, t is period of time, and θ is the phase angle or phase shift.

The fast Fourier transformation (FFT) is a speedy way of calculating the discrete Fourier transformation (DFT). FFT works by splitting several data sets to be transformed into smaller groups of data to be changed. The larger the number of terms included in this series, the better the periodic function approximates. It provides many sines and cosine waves and produces a higher spectral resolution.

Hence, in this study, the general model Fourier 8 terms are used, as follows:

$$\begin{aligned} f(t) = {} & A_0 + A_1 \cos(\omega_0 t) + B_1 \sin(\omega_0 t) + A_2 \cos(2\omega_0 t) \\ & + B_2 \sin(2\omega_0 t) + A_3 \cos(3\omega_0 t) + B_1 \sin(\omega_0 t) \\ & + A_4 \cos(4\omega_0 t) + B_4 \sin(4\omega_0 t) + A_5 \cos(5\omega_0 t) \\ & + B_5 \sin(5\omega_0 t) + A_6 \cos(6\omega_0 t) + B_6 \sin(6\omega_0 t) \\ & + A_7 \cos(7\omega_0 t) + B_7 \sin(7\omega_0 t) + A_8 \cos(8\omega_0 t) \\ & + B_8 \sin(8\omega_0 t) \end{aligned} \quad (3)$$

Simplify, the equation is:

$$f(t) = A_0 + \sum_{n=1}^{8} A_n cos(n\omega_0 t) + B_n sin(n\omega_0 t) \quad (4)$$

To predict the stock price, firstly, the data sets import to the Matlab. For the period time, the daily data are chosen from 15 October 2019 to 15 September 2020 and will predict the future short-term of the stock price.

Secondly, the data are fitted and took the best-fit curve of the actual price followed by interpolation for the number of days to predict the stock price, which is one year ahead. A general model, Fast Fourier Transformation 8 terms of the actual price, is taken and interpolated for many days. Finally, the two components are added and demonstrated the graph with the prediction for a year ahead.

4. Results and Discussion

The study has 224 sample data. The mean of the stock price is 5418,0758, and the standard deviation is 668,04300. The mean of interest rate is 4,5670, and the standard deviation is 0.37131. The mean of the exchange rate is 14310,2411, and the standard deviation is 1037,75344.

Table 1 shows that the dependent variable does not have multicollinearity to independent variables because the tolerance (0.998) is not 1, and the VIF (1.002) is smaller than 10. The interest rate has affected positively and significantly stock prices because the t-value (19.616) is greater than the t-table (1.65), and the significance of interest rate (0.000) < 0.05. In other words, if the interest rate is higher, then the stock price increases too, and on the other way. The result supports the study of Apergis and Eleftheriou (2002); however, the outcome adverse to the study of Tursoy (2019) and Lee and Brashmasrene (2020). During the pandemic, the investors decide to produce more products into the market and the cheap interest rate. However, the oversupply of products will slow down the firm's profit, and in the end, the firm value is decreasing. So, investors have to wait for the right time to make their investments.

Table 1: Multicollinearity, t-Test, F Test, and Determination

Model		Collinearity Statistics		t	Sig.
		Tolerance	VIF		
1	(Constant)			8,654	,000
	interest_rate	,998	1,002	19,616	,000
	exchange_rate	,998	1,002	-12,815	,000
F Statistics		286,571			
Sig (F-Statistics)		,000[b]			
R-Squared		,722			
Adjusted R Square		,719			
Dependent Variable: stock price					

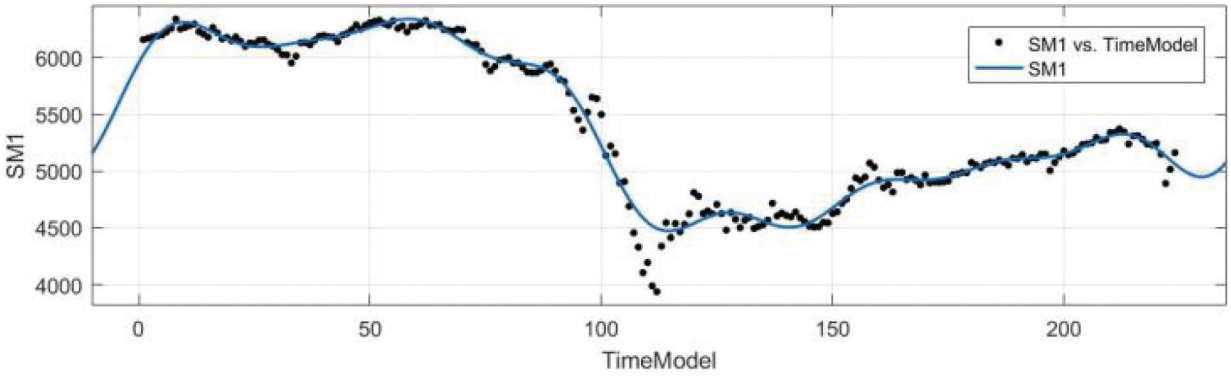

Figure 1: Plots of Stock Prices From Matlab

For the exchange rate, the t-value is -12.815, and the t-table is 1.65. So, the exchange rate has negatively and significantly affected the stock market index because of the t-value < t-table, and the significance of the exchange rate is < 0.05. The result shows that if the exchange rate increases, the stock price declines, and vice versa. The work differs from Lee and Brahmasrene (2018, 2020). The exchange rate increase in this study means that the IDR is weakening against the USD. If the IDR is depreciating against USD, the stock price is slowing down and trends to decrease.

The F-test uses multiple linear regression to know and analyze that interest rate and exchange rate have simultaneously affected the stock prices. The result of Table 1 indicates that independent variables have significantly impacted the stock market. The coefficient of determination (R2) shows at the Adjusted R-Square column. The value of Adjusted R-Square is 0.719 means that the independent variables simultaneously affect the dependent variable for 71.9%; the remaining 28.1% is influenced by other variables that are not described in this study. The result has shown a strong influence of the independent variables and the dependent variable.

The prediction result for the stock market price index is in the below graphs.

From the graph above, the coefficient of determination for stock prices in Indonesia is 0.9056. The diagram indicates that the stock market index is predicted to fluctuate and will increase over time.

4.1. Implication

The result of the prediction of the stock market price is as the following table.

Figure 1 and Figure 2 show the prediction of the JKSE index; the graphs show that the stock market index fluctuates and is increasing over time. The investors have to wait the right time to invest greedily into the market. In this study, the interest rate and exchange rate are to determine the stock price. During the pandemic, policymakers have a decreased interest rate to attract more consumers and make the business better. However, with a low-interest rate, most firms will offer more products to market, and due to oversupply, then the price of the products will decrease and slow down the profit of the firm; as a result, the firm value decreases. Based on the study result, the increase in the exchange rate or the weakening of IDR against USD will reduce the stock price. Investors will benefit from managing their portfolio risk, interest risk, and currency risk. The policymakers know the behavior of stock market price index, interest rates, and exchange rates.

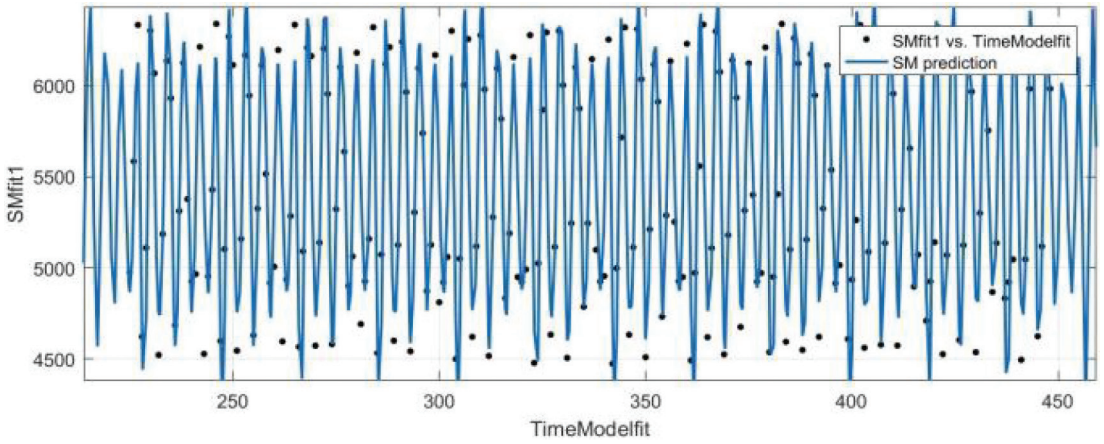

Figure 2: Plots of using FFT Method

Table 2: Prediction Accuracy of JKSE

Prediction	4976,34	5584,89	6334,28	6302,59	6068,52	4521,98	5185,33	6136,62
Actual	5058,48	5038,4	5059,22	4999,36	4934,09	4917,96	4842,76	4945,79
% Error	0,0165	0,097	0,201	0,206	0,186	0,087	0,066	0,194

5. Conclusions

The paper had successfully conducted stock price prediction. The prediction model has already been generated using Fast Fourier Transform (FFT), and its effects have also been analyzed using SPSS. The study's result is the interest rate and exchange rate have affected the stock market prices simultaneously. The coefficient of determination is 71.90%, which means that the independent variables simultaneously affect the dependent variable for 71.9%. The stock market index will increase over time, which means the economy is getting better; it will operate efficiently to survive during a pandemic. Investors should wait for the right time to invest in the stock market to make money during the pandemic. Policymakers have to make the right decision in determining the interest rate so that the exchange rate will benefit the businesses to generate profit and, in the end, to increase in the firm value, that is, the increase of stock price.

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