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THE NON-SEASONAL HOLT-WINTERS METHOD FOR FORECASTING STOCK PRICE RETURNS OF COMPANIES AFFECTED BY BDS ACTION

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Abstract

The non-seasonal Holt-Winters method is one of the methods of smoothing theory. This method can be implemented on time series data that does not have a seasonal component. In this study, this method is used to forecast the stock price returns of companies affected by the Boycott, Divestment, and Sanctions (BDS) action. Forecasting gets very good results that can be seen from the MAPE value of modeling the six stocks affiliated with Israel that continue to carry out Zionism against Palestine is not more than 10%. This method can also accommodate the limitations of existing data while still obtaining good forecasting results. In addition, the use of several transformations of stock price returns in this case is very useful in modeling to obtain appropriate error assumptions. The forecasting results of the model formed as a whole follow the trend in the stock price of each company. To produce good forecasting results using this method, it is recommended to do forecasting in the short term. The forecasting results show that of the six company stocks, almost all of them experienced a decrease in stock price returns. Only one stock of PT Map Boga Adiperkasa Tbk has increased. This also illustrates that the BDS action influences on these companies.

Keywords: Non-seasonal Holt-Winter Method, Stock Price Return, Exponential Smoothing, Forecasting, BDS

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INTRODUCTION

The Exponential smoothing (ES) is one of the most widely used forecasting methods due to its simplicity, adaptability, and accuracy. However, there are two important difficulties in choosing the smoothing constant and the initial value in the theory of exponential smoothing. In time series smoothing theory, there are many methods, one of which is the Holt-Winter method. This method is a system of recursive equations that defines a model for the dynamic structure of non-stationary time series, and provides a way to decompose the time series into hidden or unobserved components, namely trends (or levels) and seasonality, and to forecast them. Based on the composition of the time series, the Holt-Winter method is divided into 3 namely trended, non-seasonal Holt-Winter (THW), seasonal Holt-Winter (SHW), and Seasonal damped Holt-Winters (Fattore, 2019). The trended, non-seasonal Holt-Winter (THW) method is also called the Holt Method.

Research on the Holt-Winter method was conducted by Mawaddah, (2023) by comparing the Holt-Winters Exponential Smoothing and Holt Weight Exponential Moving Average methods in forecasting the price of cayenne pepper in Purbalingga Regency (Mawaddah, 2023). In its research, it was found that the Holt-Winter Exponential Smoothing method is the right method for forecasting the price of cayenne pepper in Purbalingga Regency, indicated by a smaller MAPE value compared to the Holt Weight Exponential Moving Average MAPE value. In the same year, Abdillah (2023) applied the Holt-Winters Exponential Smoothing algorithm to predict oil palm production (Case Study: PT Perkebunan Sumatera Utara Perseroda) (Abdillah, 2023). The results of his research provide palm oil production forecasting with a MAPE value of 8.41%. In addition, Djakaria & Saleh (2021) also conducted Covid-19 forecasting in the Gorontalo region using Holt-Winters Exponential Smoothing by getting a MAPE value of 6.14% (Djakaria & Saleh, 2021).

As we know, the Palestinian (Hamas) - Israeli conflict has heated up again since 7 October 2023 which is still in the media and has been reported as one of the biggest conflicts between Palestine and Israel in recent decades. The Israeli occupation, expansion of Jewish settlements, control of the Al-Aqsa compound, and the ongoing blockade (siege) of Gaza are some examples of Israeli Zionism's actions that triggered and strengthened the Palestinians (especially Hamas) to fight Israel (Muhamad, 2023). The war between Israel and the Palestinian Hamas Group in the Gaza Strip has entered its 100th day as of 13

January 2024. The latest report from Aljazeera, that as many as 23,843 people in Gaza have been killed to date, quoted Sunday (14/1/2024) (CNBC Indonesia, 2024). From this conflict, many countries have taken the form of boycotts against anything related to Israel including products affiliated with it. In Indonesia, Boycott, Divestment, and Sanctions (BDS) on products affiliated or 'smelling' with Israel are increasingly encouraged, after the Indonesian Ulema Council (MUI) issued Fatwa Number 83 of 2023 concerning the Law of Support for Palestine (IMC News.id, 2023). As a result, many companies collapsed as a result of this action. The stock prices of many companies have decreased and there has been no increase in 100 days.

Based on the opinion of most time series experts who suggest that the use of time series analysis requires at least 50 observations in the time series (Hecht & Zitzmann, 2021) and from this exposure, researchers want to implement the Non-seasonal Holt-Winters Method for forecasting the stock price returns of companies affected by BDS action.

METHODS

The non-seasonal Holt-Winters method

Financial time series data are often non-stationary. Therefore, it is difficult to perform statistical analyses on prices (or index values, exchange rates, interest rates) and it is more interesting to study the relative change (return) in prices which can be written in the following equation.

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \quad (2.1)$$

where R_t is the simple return of the asset in the price series P_t. However, in the statistical analysis of financial data, it is more common to consider log returns r_t defined as (Dettling, 2021)

$$r_t = log\left(\frac{P_t}{P_{t-1}}\right) = \log(P_t) - \log(P_{t-1}) = \log(1 + R_t) \quad (2.2)$$

Forecasting is closely related to statistical model building. Before we can forecast a variable, we usually build a model for that variable and estimate the model parameters using observed past data (Diebold, 2017). One of the necessary conditions in building models on time series data is the stationarity of the data. (Rao, 2022) said stationary means that the

statistical characteristics of time series data do not change over time. If the series is not stationary and the first differencing of the series is stationary, then the series contains unit roots. A commonly used method to test for the presence of unit roots is the Augmented Dickey-Fuller (ADF) test (Dickey & A. Fuller, 1979; Dickey & Fuller, 1981; Glynn et al., 2007). Using the null hypothesis test of $\alpha = 0$ (data is not stationary) and the alternative hypothesis $\alpha < 0$ (data is stationary), the ADF test is based on estimating the following regression equation.

$$\Delta r_t = u + \beta t + \alpha r_{t-1} + \sum_{i=1}^{k} c_i \Delta r_{t-1} + \varepsilon_t \quad (2.3)$$

where Δ denotes the first differencing, r_t denotes the log return of the time series under test, , t denotes times, and k denotes the number of lags added to the model to ensure that the residuals, ε_t are white noise. Given the ADF t-statistic as follows (Richards, 2005).

$$ADF_t = t_{\alpha=1} = \frac{\hat{\alpha}-1}{se(\alpha)} \quad (2.4)$$

if the value of $p < 0{,}05$, then the decision is to reject the null hypothesis. This decision states that the data is stationary.

Data transformation is one of the handling techniques when the error assumptions of the modeling results in statistics are not met. There are many types of data transformation, and in this study several transformations are used to support modeling so that the assumptions of model errors are met. The first transformation is the exponential series transformation (Boyadzhiev, 2005) defined in the following equation:

$$g(r_t^*|r_t) = \sum_{k=0}^{\infty} \frac{{r_t}^k}{k!} = e^{r_t} \quad (2.5)$$

The second transformation is a negative exponential transformation that converges to the standard exponential distribution (Norman L. et al., 1994), namely

$$g(r_t^*|r_t) = e^{-r_t} \quad (2.6)$$

The third transformation used in this study is the Double Exponential transformation first introduced by (Takahasi & Mori, 1973) which can be written in the following equation

$$|g(r_t^*|r_t)| \simeq \begin{cases} e^{-e^{|r_t|}} = \exp(-\exp|x|), \text{jika x} \to +\infty \\ e^{-|r_t|} = \exp(-|x|), \text{jika x} \to -\infty \end{cases} \quad (2.7)$$

where $x = e^{r_t}$ and r_t^* is the transformed data.

Given a log return series $\{r_t\}$.. For each time t, the time series can implicitly be assumed to be a decomposition of the level component l_t, the seasonal component S_t, and the error component e_t (Fattore, 2019):

$$r_t = l_t + S_t + e_t \tag{2.8}$$

In the trended, non-seasonal Holt-Winters (THW), the equation for each component can be described in the following equation.

$$l_t = \alpha r_t + (1-\alpha)(l_{t-1} + b_{t-1}) \tag{2.9}$$

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \tag{2.10}$$

$$\hat{r}_{T+h|\leq T} = l_T + hb_T \tag{2.11}$$

Where α is the smoothing parameter for level, β is the smoothing parameter for trend, $0 < \alpha, \beta < 1$, $h \in \mathbb{N}$, S_t are zero, and $\hat{r}_{T+h|\leq T}$ are the prediction of return at time $T+h$ is known at time T. For the exponential smoothing procedure, the smoothing parameters can be calculated by minimizing the squared error $e^2(\alpha, \beta)$ on the observed time series using Ordinary Least Square (OLS), i.e. by minimizing the following sum (Fattore, 2019).

$$e^2(\alpha, \beta) = \sum_{t=1}^{T} \left(r_t - \hat{r}_{t|\leq t-1}\right)^2 \tag{2.12}$$

Measuring the suitability and accuracy of estimates in time series is also an important criterion. Error measurement can be done using Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and Root Mean Square Error (RMSE). MAPE is the percentage value of the forecasting error. MAE is the average sum of the differences between actual and predicted values. RMSE is the root of the mean square of the difference between the actual and predicted values. The three measures can be written in the following equation.

$$\text{MAPE} = \frac{1}{\text{T}}\sum_{\text{t=1}}^{\text{T}}\frac{|\text{r}_\text{t} - \hat{\text{r}}_\text{t}|}{\text{r}_\text{t}} \times 100 \tag{2.13}$$

$$\text{MAE} = \frac{\sum_{\text{t=1}}^{\text{T}}|\text{r}_\text{t} - \hat{\text{r}}_\text{t}|}{\text{T}} \tag{2.14}$$

$$\text{RMSE} = \sqrt{\frac{1}{\text{T}}\sum_{\text{t=1}}^{\text{T}}(\text{r}_\text{t} - \hat{\text{r}}_\text{t})^2} \tag{2.15}$$

The MAPE value is a measure that is often used in the literature. If the MAPE value is below 10%, then the model is excellent, and the range of 10% and 20% is classified as good (Cetin & Yavuz, 2021; Chai & Draxler, 2014).

In checking the normality of model errors, the Shapiro-Wilk test which converges to the t distribution can be used to test the hypothesis that $e_t \sim N(\mu, \sigma^2)$ using the following equation.

$$W = \frac{\left(\sum_{t=1}^{T} a_t r_{(t)}\right)^2}{\sum_{t=1}^{T}(r_t - \bar{r})^2} \tag{2.16}$$

where $r_{(1)} \leq r_{(2)} \leq \cdots \leq r_{(T)}$ are the sequential values of log returns $r_1, r_2, \ldots, r_t$, and a_t being the tabulated coefficients (Hanusz et al., 2016). The hypothesis is accepted, when $W < W_{(\alpha,T)}$ with $W_{(\alpha,T)}$ being the critical point with a significance value of α. To check the homogeneity of the model errors, the Ljung-Box test is used which tests the hypothesis that $\sigma_{\varepsilon_1}^2 = \sigma_{\varepsilon_2}^2 = \cdots = \sigma_{\varepsilon_m}^2 = 0$ using the following equation.

$$Q_m = T(T-2)\sum_{k=1}^{m}\frac{\hat{\rho}_k^2}{T-k} \tag{2.17}$$

where $m < T$, and $\hat{\rho}_k^2$ are the autocorrelation with the k −th lag. The hypothesis is accepted, when $Q_m < \chi_m^2$ (Ljung & Box, 1978).

$$Q_m = T(T-2)\sum_{k=1}^{m}\frac{\hat{\rho}_k^2}{T-k} \tag{2.17}$$

ADES.JK is the stock of PT Akasha Wira International Tbk, which produces and distributes bottled drinking water and cosmetic products in Indonesia and internationally. The company provides bottled drinking water under the Nestle Pure Life and Vica Royal brands; soya milk under the Pureal brand; and beauty care products, such as hair energy and hair restoration products under the Makarizo and Wella brands. The company was

founded in 1985 and is headquartered in Jakarta, Indonesia. PT Akasha Wira International Tbk is a subsidiary of Water Partners Bottling S.A (Yahoo Finance, 2024).

ERAA.JK is the stock of PT Erajaya Swasembada Tbk, together with its subsidiaries, engaged in the distribution and trading of telecommunications equipment in Indonesia. The company offers mobile phones and tablets, subscriber identity module cards, mobile network operator top-up vouchers, accessories, Internet of Things devices, and Google Play card vouchers, computers and other electronic equipment, and sportswear, as well as other outdoor-related products. The company also trades in medical equipment; sells beauty, healthcare, and pharmaceutical products; and provides value-added services, including mobile phone protection and handset rental services. In addition, it is also engaged in information technology systems; management consulting; outsourcing; property business; and offering management and customer relationship services. In addition, it operates a chain of restaurants, cafes, bakeries, and grocery stores, as well as food and beverages; and trades in cosmetics, sports, and diving equipment. The company was founded in 1996 and is headquartered in West Jakarta, Indonesia. PT Erajaya Swasembada Tbk operates as a subsidiary company of PT Eralink International (Yahoo Finance, 2024).

FAST.JK is the stock of PT Fast Food Indonesia Tbk engaged in the food and restaurant business in Indonesia. The company has the rights to establish and operate Kentucky Fried Chicken and Taco Bell outlets. PT Fast Food Indonesia Tbk was founded in 1978 and is headquartered in Jakarta, Indonesia (Yahoo Finance, 2024).

MTDL.JK is a stock of PT Metrodata Electronics Tbk, together with its subsidiaries, engaged in information and communication technology (ICT) in Indonesia. The company operates through two divisions, namely the Distribution division, and the Solutions and Consulting division. The Distribution division sells hardware and software, as well as basic peripherals, such as data storage devices, terminals, memory, and peripherals. The Solutions and Consulting division provides maintenance services; sells hardware, system management software, middleware, serverware, and system-level software; offers professional services for consulting, implementation, and training; and sells software products. The company also offers assembly services in the fields of computer or wireless communication equipment; system integration services; and software consulting, as well as distributes information technology products and sells personal computer products.

The company was founded in 1975 and is based in Jakarta, Indonesia (Yahoo Finance, 2024).

UNVR.JK stock is the stock of PT Unilever Indonesia Tbk produces, markets, and distributes consumer goods in Indonesia. The company offers soaps, detergents, dairy-based foods, ice cream, snacks, soy sauce, cosmetic products, tea-based beverages, and fruit juices. The company provides its products under the brands Axe, Bango, Buavita, Cif, Citra, Clear, Clear Men, Close Up, Cornetto, Dove, Feast, Glow & Lovely, Hellmann's, Jawara, Knorr, Lifebuoy, Lipton, Love Beauty & Planet, Lux, Magnum, Molto, Paddle Pop, Pepsodent, Pond's, Pond's Men, Populaire, Rexona, Rinso, Royco, Sari Wangi, Seru, Simple, St. Ives, Suave, Sunlight, Sunsilk, Superpell, TRESemmé, The Vegetarian Butcher, Unilever Professional, Vaseline Men, Viennetta, Vixal, Wall's, Wipol, Zwitsalm, and other brands. The company also rents out office space. PT Unilever Indonesia Tbk was founded in 1933 and is headquartered in Tangerang, Indonesia. PT Unilever Indonesia Tbk operates as a subsidiary of Unilever PLC (Yahoo Finance, 2024).

MAPB.JK stock is a stock of PT Map Boga Adiperkasa Tbk, through its subsidiaries, is engaged in the operation of cafes and restaurants in Indonesia. The company operates a portfolio of Starbucks, Marzano Pizza, Krispy Kreme, Cold Stone Creamery, Godiva, PAUL Bakery, Genki Sushi, and Subway brands. The company was previously known as PT Creasi Accessories Indonesia. The company was founded in 2013 and is headquartered in Jakarta, Indonesia. PT Map Boga Adiperkasa Tbk is a subsidiary of PT Mitra Adiperkasa Tbk (Yahoo Finance, 2024).

Data Type and Source

This study uses secondary data consisting of 6 company stocks, and closing stock prices from 9 October 2023 to 10 January 2024. The data is taken from the website https://finance.yahoo.com/ which in detail describes the use of company stock name variables in Table 1.

Table 1 Company Stock Names

Stock	Description
ADES.JK	PT Akasha Wira International Tbk
E	PT Erajaya Swasembada

Stock	Description
RAA.JK	Tbk
FAST.JK	PT Fast Food Indonesia Tbk
MTDL.JK	PT Metrodata Electronics Tbk
UNVR.JK	PT Unilever Indonesia Tbk
MAPB.JK	PT. Map Boga Adiperkasa Tbk

source: https://finance.yahoo.com/

Data Analysis Procedure

The following procedure needs to be done in the analysis using the non-seasonal Holt-Winters method.

1. Calculating the log return of the closing stock price using (2.2).
2. Checking data stationarity using the Augmented Dickey-Fuller (ADF) test in (2.4). If the data is stationary, then the analysis can continue. If the data is not stationary, then the appropriate transformation is performed in (2.5)-(2.7).
3. Perform parameter estimation of the non-seasonal Holt-Winters (α, β) model in (2.9)-(2.12).
4. Measuring the fit and accuracy of the model by calculating the MAPE, MAE, and RMSE values in (2.13)-(2.15).
5. Checking the normality of the error and the homogeneity of the error variance sequentially using (2.16)-(2.17).
6. In this study, the analysis uses R software, package "tseries", function "adf.test" in (Trapletti et al., 2023) to check the stationarity of the data; package "forecast", function "HoltWinters" in (Hyndman et al., 2023) to estimate the non-seasonal Holt-Winters parameters.
7. Interpretation of results and discussion.

RESULTS AND DISCUSSION

BDS actions in Indonesia against products affiliated with Israel resulted in the company's stock price falling. In this study, 6 companies were taken that were affected by the BDS action. Based on Figure Figure 1, the closing stock prices of 6 companies in Indonesia relatively decreased at the end of October or at the beginning of November 2023, except for MTDL.JK stock of PT Metrodata Electronics Tbk which offers many products, services in the field of technology has increased. After this period of time, the stock price was relatively stable, with no drastic increase or decrease. However, for MAPB.JK stock of a company engaged in the operation of cafes and restaurants in Indonesia, there was relatively no continuous increase or decrease during this period.

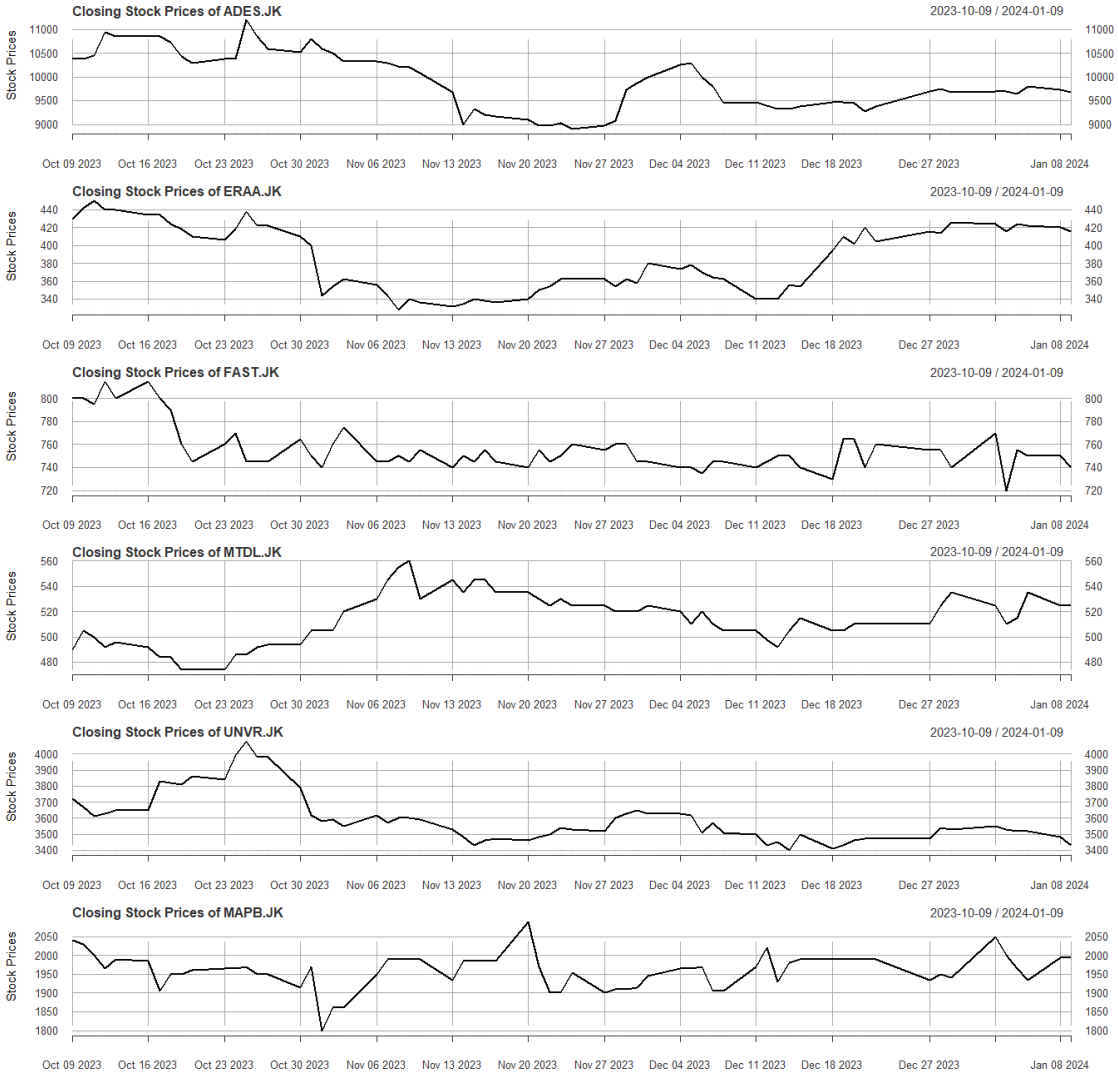


Figure 1 : Plot of Closing Stock Prices of 6 company stocks

The stock price that is usually used in the analysis is in the form of the log return value of the stock price. From the calculation of the log return value of the six stocks using Equation (2.2), the first step before analyzing the time series is to check the stationary assumption on the stock price log return data using the ADF test. The results of the test can be seen in detail in Table 2.

Table 2 ADF test on log stock price return data with $\alpha = 0{,}05$

Stock	ADF t statistic	p values	Decision	Interpretation
ADES.JK	-3.6452	0.03668	Reject H_0	The assumption of data stationarity is fulfilled
ERAA.JK	-3.6617	0.03529		
FAST.JK	-4.6446	0.01		
MTDL.JK	-3.6015	0.04039		
UNVR.JK	-3.932	0.01844		
MAPB.JK	-4.8334	0.01		

Source: Augmented Dickey-Fuller (ADF) calculation using R Software

In Table 2, it is found that the log returns of the six companies' stock prices produce the p values greater than the α significance value. From all these results, the null hypothesis cannot be accepted. This means that the log return data of the six stocks are stationary. After obtaining this information, the smoothing parameters (α, β) are estimated. In this case, the transformation is used for the smoothing effect in modeling the data, so as to obtain model errors that converge to the Normal Distribution. Since the six stocks have different characteristics, different transformations are implemented for each data. Thus, good estimation results will be obtained. The following are the estimated smoothing parameters, coefficients of the non-seasonal Holt-Winter method, and the type of transformation used for each stock.

Table 3 Estimation of smoothing parameters on log stock price return data

Stock	*SP		Coefficient		Transformation
	α	β	a	b	
ADES.JK	0,3768179	0,1110602	1,0015148790	0,0003660371	Standard Exponential
ERAA.JK	0,2434096	0,1410671	2,711406011	-0,004886763	Double Exponential
FAST.JK	0,08884285	0,7987575	0,99744429	-0,00100217	Exponential Series

Stock	*SP		Coefficient		Transformation
	α	β	a	b	
MTDL.JK	0,4335876	0,5153095	1,0010057004	-0,0007993196	Exponential Series
UNVR.JK	0,3070342	0,05062582	0,9930796675	-0,0003871075	Exponential Series
MAPB.JK	0,1416539	0,4978719	0,999906223	0,001294924	Exponential Series

Source: Estimation of smoothing parameters using Software R

*SP : Smoothing Parameters

: the largest estimated parameter value for each of the smoothing parameters

: the highest coefficient for level(a) and trend(b) components

From Table 3, it is obtained that the highest smoothing parameter estimation value for the level (α) of the six stocks is located on MTDL.JK stocks, namely PT Metrodata Electronics Tbk of 0.43. The parameter estimate value means that the estimated value of the log return transformation of stocks engaged in information and communication technology (ICT) in Indonesia at this time is slightly more influenced by the estimated value of the log return transformation of stocks at some time further back than the estimated value of the latest log return transformation. In addition, when looking at the overall parameter estimates for the level component, none of the parameter values of the six stocks are more than 0.5. This means a large influence of the estimated value of the log stock return transformation at some time further back to the estimated value of the current log stock return transformation. In contrast, the highest smoothing parameter estimation value for trend (β) can be seen in Table 3. There is a parameter estimation value and at the same time one of the parameter values whose magnitude is more than 0.5, namely in the FAST.JK stock of PT Fast Food Indonesia Tbk. The estimated parameter value of 0.799 can provide information that the estimated value of the log stock return transformation of the company that founded and operates Kentucky Fried Chicken (KFC) outlets is strongly influenced by the estimated value of the latest log stock return transformation and sometime further back.

A high coefficient value results in lower smoothing and thus, responsiveness to variations in the data. In Table 3, it can be seen that the value of the coefficient "b" for the trend is very small. This indicates that there is very little trend component. This is by the

stationarity of the log return values. Furthermore, more details of the comparison plot results between the transformed log return values and the predicted transformed log return values of the six stocks can be seen in Figure 2.

Judging from the six stock plots in Figure 2, it can be seen graphically that the comparison between the log return transformation value and the predicted log return transformation value of the six stocks provides a variation of results. If seen more carefully, the stock UNVR.JK from PT Unilever Indonesia Tbk produces more accuracy in estimation. This is seen from the accuracy of the volatility variation graph of the predicted log return transformation value by the log return transformation value. This is also supported by the three measures of suitability and accuracy of the estimate, namely the MAPE, MAE, and RMSE values in Table 4, which show the smallest value among the other six stocks. Although the non-seasonal Holt-Winters estimation results of all stocks are categorised as excellent. This category is shown in the MAPE value of less than 10% for all stocks.

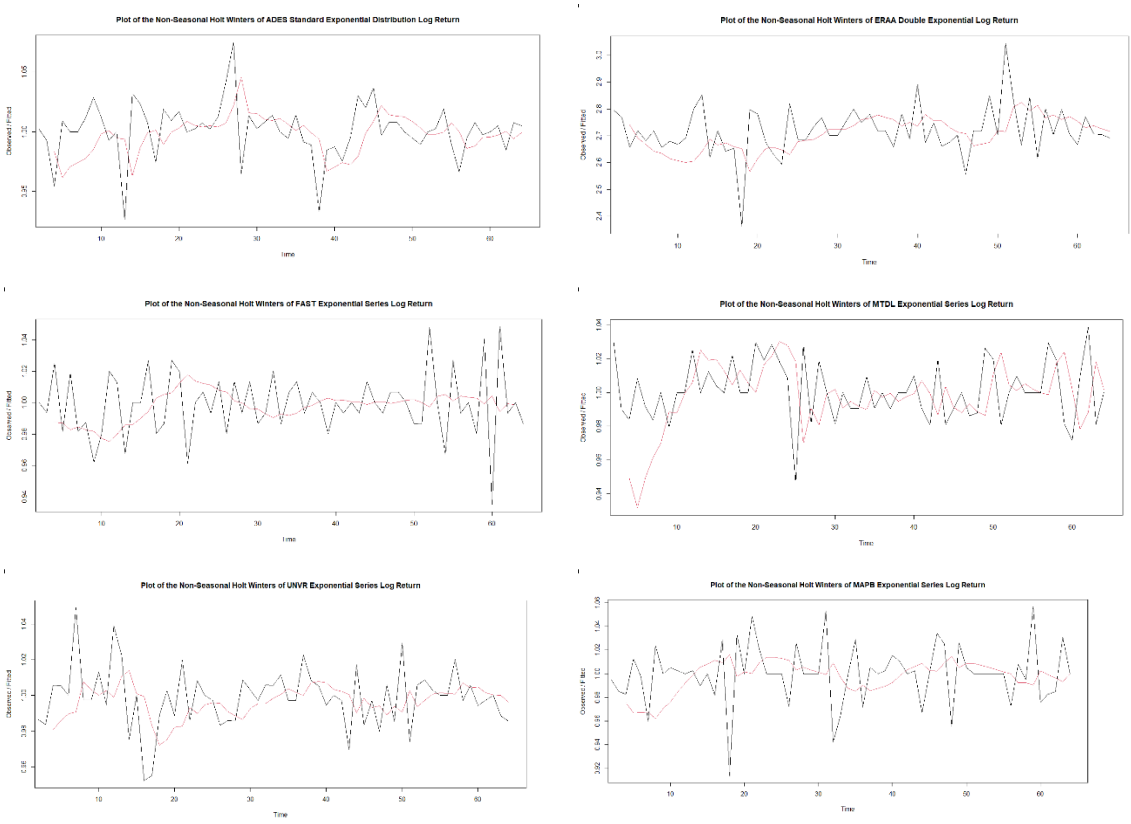


Figure 2 : Plot of Non-Seasonal Holt-Winters Estimation Results of 6 stocks

_____ : the predicted values of log return transformation

_____ : the transformed log return values

Based on Table 3 and Table 4, it is known that the variation of log returns on 4 company stocks in the study period has similar characteristics. This is indicated by the similarity of the type of transformation used, namely the exponential series transformation. The four stocks are stocks of companies engaged in the food business, operating cafes, and restaurants, in the field of information and communication technology (ICT), to the production, marketing, and distribution of consumer goods in Indonesia. It is known that all six of these companies (IMC News.id, 2023) are affiliated with Israel. The actions of Israeli Zionism have rendered tens of thousands of human beings lifeless. Related to the transformation of data that can be seen in Tables 3 can also provide information that the BDS action carried out by many countries including Indonesia is one of the factors in providing a relatively similar influence on the four stock prices. For the other two stocks engaged in the production and distribution of bottled drinking water and cosmetic products in Indonesia and internationally, to the distribution and trading of telecommunications equipment in Indonesia, they have a different influence on each other. BDS actions are regularly and continuously promoted by people in many countries, which is one form of effort to put economic pressure on Israel to give equal rights to Palestine. Because the death toll of the conflict (Hamas) and Israel continues to grow to this day.

Table 4 Calculation of MAPE, MAE, and RMSE on non-seasonal Holt-Winter model

Stock	Transformation	MAPE*(%)	MAE	RMSE	Category*
ADES.JK	Standard Exponential	2.015263	0.02011571	0.02716542	Very good model
ERAA.JK	Double Exponential	2.784892	0.07584143	0.1043345	
FAST.JK	Exponential Series	1.696058	0.01695933	0.0230561	
MTDL.JK	Exponential Series	1.866544	0.01866547	0.02560702	
UNVR.JK	Exponential Series	1.403559	0.01404757	0.01887717	
MAPB.JK	Exponential Series	2.213748	0.02204602	0.02990338	

Source: Calculation of MAPE, MAE, and RMSE using Software R

: the smallest values of the non-seasonal Holt-Winters method estimation fit and accuracy measure

Testing the estimation results of a model is needed to see the suitability of the model. This is done by testing the model error, namely the non-seasonal Holt-Winters model. What needs to be tested is the normality of the error and the homogeneity of the error variance in the non-seasonal Holt-Winters model. In Table 5, the test results show that the error variance is homogeneous or it can be said that the model errors of the six stocks are mutually independent. In addition, all modeling results provide errors that converge to the Normal distribution which can also be seen in Table 5. This is the last stage which shows that the modeling results of the six stocks affiliated with Israel using the non-seasonal Holt-Winters method can be categorized as very good. From this result, it can provide good forecasting results for some time to come, especially in the context of adjusting the Holt-Winters method is more suitable for short-term forecasting (Luo et al., 2022). For this reason, in this study, log return forecasting is carried out for the next 5 days for the six stocks. The detailed forecasting results can be seen in Table 6.

Table 5 Ljung-Box and Shapiro Wilks tests on non-seasonal Holt-Winter log return model errors

Stock	Q(Ljung-Box Test)	p_Q values	Decision	Interpretation	W(Shapiro-Wilks Test)	p_W values	Decision	Interpretation
ADES.JK	3,7385	0,9584	Accept H_0	Mutually independent model error	0,96189	0,05482	Accept H_0	Normally distributed model error
ERAA.JK	9,7331	0,4642			0,96167	0,05346		
FAST.JK	11,449	0,3236			0,96499	0,07825		
MTDL.JK	1,5143	0,9989			0,97581	0,2679		
UNVR.JK	12,147	0,2754			0,97682	0,2991		
MAPB.JK	7,8148	0,6469			0,96382	0,06838		

Source: Shapiro-Wilks testing using Software R

p_Q : Probability values for Q

p_W : Probability values for W

Forecasting that has been done using the model that has been formed from the non-seasonal Holt-Winters analysis shows that of the six stocks of the company, almost all of them have decreased stock price returns. Only one stock of PT Map Boga Adiperkasa Tbk has increased.

Table 6 Forecasting results of log returns 5 days ahead

Stock	Log Return of Day					Trend
	1	2	3	4	5	
ADES.JK	-0.001879149	-0.002244433	-0.002609582	-0.002974599	-0.003339482	Descending
ERAA.JK	-0.004346031	-0.006162736	-0.007986046	-0.009816002	-0.011652647	Descending
FAST.JK	-0.003564228	-0.004570482	-0.005577751	-0.006586034	-0.007595336	Descending
MTDL.JK	0.000206359 6	-0.000593114 6	-0.001393228	-0.002193982	-0.002995379 1	Descending
UNVR.JK	-0.007334270	-0.007724303	-0.008114489	-0.008504826	-0.008895316	Descending
MAPB.JK	0.001200426	0.002492961	0.003783827	0.005073029	0.006360571	Increasing

Source: Results of forecasting log returns 5 days ahead using Software R

: the decreasing trend of the forecasting results of each stock

: increasing trend of forecasting results of each stock

When viewed on the website https://finance.yahoo.com/ the forecasting period experienced stock price volatility. Finally, on 24 January 2024, five of the company's stocks experienced a decline in the stock price chart. There is only one company stock that has increased, namely PT Map Boga Adiperkasa Tbk. In detail, the stock price volatility of the six companies can be seen in Figure 3.



Figure 3 : Stock Price Chart of 6 Companies on Yahoo Finance Website

: the decreasing trend of stock price

: increasing trend of stock price

In Figure 3, the stock price of PT Unilever Indonesia Tbk experienced the sharpest decline compared to the other 4 stocks. For PT Fast Food Indonesia Tbk and PT Map Boga Adiperkasa Tbk, the similarity of stock price volatility is relatively not too significant. In addition, the similarity of stock price volatility is experienced by the three stocks of companies from PT Akasha Wira International Tbk, PT Erajaya Swasembada Tbk, and PT Metrodata Electronics Tbk. The volatility of these three stocks is relatively high every hour, but overall there is neither an increasing trend nor a decreasing trend.

CONCLUSION

The non-seasonal Holt-Winters method implemented in the forecasting of stock price returns of companies affected by BDS actions obtained very good results. This can be seen from the MAPE value of modeling the six Israel-affiliated stocks of no more than 10%. A measure of the suitability and accuracy of the resulting model can be a consideration for using this method when there are data limitations in forecasting. In addition, the use of

stock price return transformation, in this case, is very useful in modeling to obtain appropriate error assumptions. Forecasting from the model formed follows the overall trend in the stock price of each company. To produce good forecasting results using this method, it is recommended to do forecasting in the short term. The forecasting results show that of the six company stocks, almost all experienced a decrease in stock price returns. Only one stock of PT Map Boga Adiperkasa Tbk has increased. This also illustrates that the BDS action influences these companies

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