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AN APPLICATION OF GEOMETRIC BROWNIAN MOTION (GBM) IN FORECASTING STOCK PRICE OF SMALL AND MEDIUM ENTERPRISES (SMEs)

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1. Introduction

The uncertainty and unpredictability of stock prices make investors face difficulty forecasting the future price. There might be a great return or loss in stock investment, which is quite risky for investors. Therefore, to assist investors to make a better decision, this study focuses on how to forecast stock prices of Small and Medium Enterprises (SMEs). Normally, the stock price of SMEs is affordable for all levels of investors since the price is lower (Abidin & Jaffar, 2014). The stock price of SMEs is also more volatile compared to the big and stable companies. Accordingly, there is a need to forecast the future price of the SMEs. There are many methods used to forecast stock prices such as by using fuzzy system (Wang, 2002; Jandaghi et al. 2010) and machine learning (Abolhassani & Yaghoobi, 2010; Patel et al. 2015;). Since stock prices have unpredictable pattern and it follows the random walk, thus Geometric Brownian Motion (GBM) approach is introduced here to forecast stock prices of SMEs. According to Abidin and Jaafar (2014), the two weeks investment duration is the best range to estimate the stock prices. This is because the forecasted prices are found much closer to the actual prices for two weeks duration. This is equivalent to the statement made by Wattanarat et al. (2010) where GBM model is said suitable to forecast in a short period. Therefore, the aim of this study is to forecast stock prices of SMEs for two weeks using the GBM model. In addition, the Mean Absolute Percentage Error (MAPE) is used to calculate the accuracy of the forecasting prices.

2. Geometric Brownian Motion (GBM) model

Brownian motion is defined as a continuous-time limit of the discrete time random walk (Wilmott, 2007). Suppose the changes in stock prices, S is defined as a stochastic differential equation given below:

$$dS = \mu S dt + \sigma S dW, dW = \phi\sqrt{dt} \tag{1}$$

where μ is the expected asset returns, σ is the volatility of the asset, and dW is the normal random variable known as Wiener Process to generate Brownian motion. Since S is log-normally distributed, thus S can be written as $F(S) = \log S$. By using the Itô's lemma, equation (1) is expressed as a differential version of Itô's calculus below:

$$dF = \frac{dF}{dS}dS + \frac{1}{2}\frac{d^2F}{dS^2}(dS)^2 \tag{2}$$

Substitute (1) into (2) and rearranging to get:

$$dF = \left(\mu - \frac{1}{2}\sigma^2 \right) dt + \sigma dW \tag{3}$$

Integrating this stochastic differential equation (3), a GBM stochastic differential equation is obtained:

$$S(t) = S(0) e^{\left(\left(\mu - \frac{1}{2}\sigma^2 \right) t + \sigma (W(t) - W(0)) \right)} \tag{4}$$

This equation (4) is very important in stochastic field application such as shown in the study in forecasting stock price.

3. Data Implementation

Sample data of historical prices was obtained from The Financial Times Ltd (2015) where 10 SMEs have been chosen. The 10 SMEs are Cocoaland Holdings Bhd, Hartalega Holdings Bhd, KNM Group Bhd, London Biscuits Bhd, Ornapaper Bhd, Pentamaster Engineering (M) Bhd, PRG Holdings Bhd, SKB Shutters Manufacturing Bhd, Takaso Resources Bhd and Top Glove Corporation Bhd. All these SMEs are from the manufacturing sectors. We utilized SMEs from the manufacturing sectors since they are considered to have high values and acknowledged based sector (Ordoñez de Pablos, 2014). In addition, the study focuses on the sales turnover not exceeding RM20 million or full-time employed not exceeding than 75 workers. The timeframe of the data collected is between October 2014 to February 2015.

The data collected is then being implemented into the GBM model. Only the first two weeks data is utilized, whereas the rest is reserved for validation process. The two weeks data was used to calculate the expected asset returns, μ and the volatility of the asset, σ before it can be substituted into equation (4). The timestep t is referring to the interval for the whole year of stock prices with a total of 250 trading days. Therefore, the timestep between days used is 1/250 which is equivalent to $t = 0.0038$. The asset price model generates a different random number for $W(t)$ as it been implemented using Microsoft Excel command *RAND( )*.

Lastly, the accuracy of the forecasting is determined based on the Mean Absolute Percentage Error (MAPE) that denoted as follows:

$$MAPE = \frac{\sum \left| \frac{Y_t - F_t}{Y_t} \right|}{n} \tag{5}$$

where Y_t is an actual value at time t, F_t is the forecast value at time t, and n is the number of periods forecast. Next is the scale of the judgement of forecast accuracy for MAPE as given in Table 1.

Table 1: A scale of judgement of forecast accuracy

MAPE	Accuracy
< 10%	Highly accurate
11% - 20%	Good forecast
21% - 50%	Reasonable forecast
> 51%	Inaccurate forecast

4. Results

Table 2 shows the MAPE of 10 SMEs that is used to validate the stock price forecasted using the GBM model.

Table 2: The MAPE values of 10 SMEs

No	Company	MAPE (%)
1	Hartalega Holdings Bhd	1
2	Cocoaland Holdings Bhd	1
3	PRG Holdings Bhd	2
4	Takaso Resources Bhd	2
5	Top Glove Corporation Bhd	4
6	Pentamaster Engineering (M) Bhd	4
7	KNM Group Bhd	4
8	Wong Engineering Bhd	6
9	London Biscuit Bhd	8
10	Ornapaper Bhd	8

The graphs of the actual and forecasted price for two weeks period of top four SMEs according to the MAPE values, are given in Figure (1).

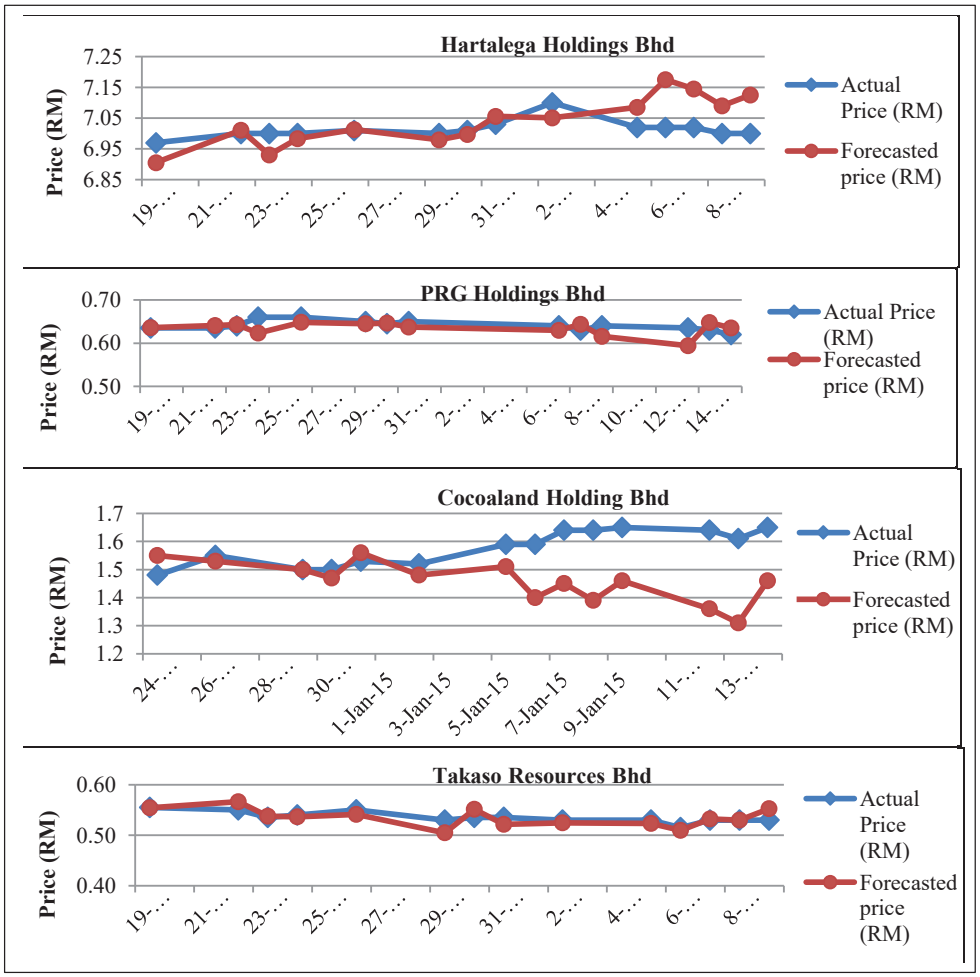

Figure 1: The Graphs of the Actual and Forecasted Price of Top Four SMEs

5. Conclusion

The behavior of stock prices creates Geometric Brownian Motion (GBM) as a right model to forecast stock prices of Small and Medium Enterprises (SMEs). Sample data of historical prices of 10 SMEs companies for two weeks is utilized to forecast the future prices of the next two weeks. The forecasted stock prices are found close to the actual with a maximum difference of only as much as 0.4. This is verified by the MAPE values of all 10 companies that are below 10%, indicating a highly accurate forecast. This study also supports the previous study done by Abidin and Jaffar (2014) on the ability of GBM to predict stock prices within a two-week period. Overall, the GBM model is said to be a valid model to be used in predicting the stock prices of SMEs.

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