SIMULATING STOCK PRICES USING GEOMETRIC BROWNIAN MOTION: EVIDENCE FROM A FRONTIER MARKET

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DECLARATION

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ABSTRACT

When looking at the simulation of the stock price, the Geometric Brownian motion model is a widely used share price prediction model in various countries. But, in the Sri Lankan context, the use of the Geometric Brownian Motion model in stock price prediction is not observable. As a filling of the gap and identifying the validity of the Geometric model in Sri Lanka were the main purposes of conducting this research

To obtain the validity of the GBM model was checked by using two hundred and fifty (250) companies in the Colombo Stock Exchange, which analyzed was forecasted from 2014 to 2018. The accuracy was verified by using the Mean Absolute Percentage Error (MAPE) value. A number of scholars used the MAPE-based judgment method to evaluate the accuracy of the forecast resulted from GBM. Since the MAPE values are between 0% and 10%, it implies that the GBM model is a highly accurate model for forecasting stock prices on the Colombo Stock Exchange in Sri Lanka. The forecast was limited only for one day. The mean value of the MAPE of the sample of 250 companies is 4.49 %. Further, 97.2% of the sample, the MAPE value was below 10%. It implies that a one-day price forecast is highly accurate in the Sri Lankan context.

Geometric Brownian motion model has been developed in the study to predict stock price behaviour, and the model has subsequently been used to exchange. The results of the simulated or forecasted prices were subsequently compared to the actual prices obtained. The results show that the model consistently predicts stock behaviour in more than 95% of the cases. A procedure to mathematically examine the probabilistic distribution of stocks has also been provided. It is expected that this scholarly work will help investors and other stakeholders, especially on the stock market in Colombo, to make informed decisions on trading and valuation. However, in this study, the forecast is limited only for one day. In other words, utilizing historical data until trading day t, someone can forecast the price of the trading day t+1.

Key Words: *Geometric Brownian Motion, Share Price Prediction, Colombo Stock Exchange*

DEDICATION

To my parents and my Supervisor, Mr Rohana Dissanayake

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GBM:	Geometric Brownian Motion
MAPE:	Mean Absolute Percentage Error

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CHAPTER 1

INTRODUCTION

1.1 Background of the research

Investing in shares has become popular among investors. In finance valuation of shares plays a major role. In practice, there are a number of methods such as technical analysis, fundamental analysis, quantitative analysis, etc. Such analytical methods have been built with the use of various sources, starting from news to prices. However, all those methods are aiming at predicting the future share prices of the companies. During the recent past, machine learning had increasing importance. It enlightened many traders to apply machine learning techniques, and some accurate results were generated from some of those techniques. (Zheng, A., & Jin, J., 2017)

There are various requirements for the prediction of share prices with machine learning. The emphasis of each study varies in three ways because targeting price changes can be near-term (shorter than a minute), short-term (tomorrow or a few days), and long-term (longer than months).

The used predictor varies from global news and financial trends to time series data of the company's unique characteristics and stock prices. Based on the work of scholars, it can be established that much improvement has been made in forecasting near and long-term price fluctuations. Especially when considering simply a limited amount of stocks in the industry, the long-term forecast has achieved more than 70% accuracy. (Reddy and Clinton, 2016)

These models that work well are often based on company-specific information, which makes it difficult to reach the general public, and they do not work in the short-term. This study focuses mainly on the domain that has the worst forecasting accuracy currently, while the short-term price estimate on the common stock is based on statistical knowledge of the share price.

Fifty to sixty per cent of all research conducted during this domain has found patterns with absolute accuracy. And they often only work for classification. Upon closer inspection, it can be observed that some papers that have good results use problematic matrices to estimate the model. Although graphs or numbers are detailed, the specific model provides a limited amount of objective steerage for evaluation. (Reddy and Clinton, 2016)

In those models, the geometric Brownian motion model provides strong empirical evidence for the accuracy of stock price estimation. This research provides validation of geometric motion models in the Sri Lankan context.

Stock represents the ownership of a shareholder in a company. Investors earn income from dividends and buy stocks with hopes of appreciating or increasing value. Shares of a wide range of companies are traded on stock exchanges. Holding stocks is trendy as stocks represent easily transferable capital ownership; through organized exchanges in stock markets. The stock exchange is an important centre in terms of raising money for the company and the country's economic growth. The Colombo Stock Exchange (CSE) of Sri Lanka is the organization responsible for managing the stock market in the country.

Daily share price changes are also important for investors, financial managers and researchers. Therefore, due to the complexity of the stock market, simulating share prices can be a very interesting yet difficult task. In the modern trading era, many studies describe several methods and pricing techniques for stock price forecasting, and all those models are used to identify profit increases and reduce risk to investors. The geometric Brownian motion model in those models provides strong empirical evidence for the accuracy of stock price estimation.

In 1827 biologist Robert Brown introduced the Brownian motion model. He discovered it during his study on pollen particles floating on water through a microscope, and observed the random movements of pollen on the water, but could not explain it, as it was applied to other sectors, including informal sectors, such as Brownian motion finance. Louis Bass was the first to apply the Brownian momentum to the stock price movement, followed by Eugene Fama and other financial analysts.

The model is based on two components of random components; the first being the deterministic (the certainty of the moment) and the latter the stochastic (uncertainty due to volatility). Future stock prices can be estimated by combining those two components. This is similar to what is presented in Equation 1.1.

Change in Price = Deterministic Component + Stochastic Component*……… *(1.1)

In addition, the model can be described as step by step using five attributes, which assumes the following characteristics for stock prices:

1.1.1. Stock prices are continuous in time and value.

This means that stock prices can be observed all the time, and are constantly changing but are not certain for a fixed period of time. As time and price change, the share price changes constantly. However, the greater the firm's plan to hold the stock, the greater the certainty of making the expected rate of return gets.

1.1.2. Stock prices follow the Markov process

The current stock price is applicable to forecast future prices; in this respect, the history of the share price is irrelevant and necessarily similar to the weak-form of the efficient market hypothesis, which maintains that the stock's future price cannot be estimated based on its price history. For example, whether a share was priced yesterday or below, nothing is said about what happens in the future. If the stock price goes up for a few days, it does not mean that it will get some um and now it is likely to increase for the next few days. Therefore, changes in stock prices cannot be ruled out depending on past price-changing patterns.

1.1.3. The proportional return for a stock over a very short period of time is normally distributed

$$\Delta S_t = S_t - (\mu \Delta t + \sigma \epsilon \sqrt{\Delta t}) \tag{1.2}$$

It shows the proportionate return of a stock consisting of two parts. In the first part, μ stands for the anticipated rate of return (unit per time, usually years) for the stock in a very short period of time. This is also called the drift rate per unit time. The first component refers to the earnings at that rate in the short period of time Δt of the stock. The second component which is stochastic or random is, a random draw from a standard normal distribution, the mean gets zero and a standard deviation of 1. б is termed “volatility of a stock”. This random part of the stock returns, multiplied by the above, is effectively taken out of the normal distribution, mean is zero and standard deviation, 1.

1.1.3.1 The price of a stock is log-normally distributed

Normal and Lognormal Distribution

Brownian motion is defined as a random-walk which has a probability of 0.5, each moving with a scale of 1 and -1. It is applied for modelling the price movement. There are certain characteristics of this model, $\boldsymbol{Z(0) = 0}$

1. With mean Z(0) and standard deviation σ, it is distributed normally.

2. Z(t) is continuous with t.
3. The variance is the sum of the time.

Now, since at $t = 0, Z(0)$ is also equal to 0; it has to be modified so that this model can represent price movements. Generally, this model is not utilized to find the expected price, but the expected movement of price.

However, the expected stock price is not necessarily the current price. Some stocks are definitely going up in the coming time. Let the expected increase rate be β at t. This is called 'drift'. Therefore, having made a modification to this model, the price $X(t)$ is:

$$\boldsymbol{X(t) - X(0) = \beta t + \sigma Z(t)} \quad \textbf{(1.3)}$$

This is reasonable and intuitive. The expected change is β multiplied by the time (thus, basically β is a rate, that is, the rate of increase of price). In addition to this, there is a deviation called 'the noise', implied by the latter right-side part of the equation. Therefore, **the price follows the normal distribution with the standard deviation of $\boldsymbol{\sigma t^{0.5}}$ and mean $\boldsymbol{X(t) + \beta t}$.**

However, there is a shortcoming in this model, which is called arithmetic Brownian Motion; it may give negative value, which is impossible for a price. Hence, further modification is needed.

Certain logical and theoretical aspects can be discussed with regard to this matter. When modelling a stock price, with the current price at hand, based on that price, the expected stock price after time t is found. Hence, it is essential to always compare the current price, $X(0)$ and the future price $X(t)$, which is unknown. How should it be compared? Mathematically,

1. Consider the difference;

2. Consider the ratio.

Then, there are two models to fit these 2 comparisons; normal distribution and lognormal distribution. Listing:

1. The difference in stock price that follows Normal Distribution
2. The ratio of the stock price that follows Normal Distribution
3. The difference in share price that follows Lognormal Distribution
4. The ratio of the stock price that follows Lognormal Distribution

Note that what has just been done so far is the first method, in which the difference in stock price that follows the normal distribution is assumed. This is intuitively agreeable, but there is a drawback; the modelled stock price can go negative, which will not happen in the real world. For this reason, seeking a better method is essential.

To use the second method, have $X(t)/X(0)$ normally distributed. Notwithstanding, it should be understood that $X(t)$and $X(0)$ must be positive, and letting their ratio follow normal distribution does not make sense since there is a 0.5 probability that the ratio can go negative according to normal distribution. Thus, this method is overlooked.

To use the third method, have $X(t) - X(0)$ log-normally distributed. This too will not make sense for some instances because $Y = X(t) - X(0)$ might be negative, and $\ln Y$ is not defined. Hence, this method is also ignored.

Finally, the fourth method, which, as mentioned above, is the best way out of the four methods to model the stock price. In this method, it is presumed that the ratio of the price of the stock is log-normally distributed:

$$\frac{\boldsymbol{X(t)}}{\boldsymbol{X(0)}} \sim \boldsymbol{Lognormal\ OR\ ln}[\boldsymbol{X\ (t)/X\ (0)}] \sim \boldsymbol{Normal} \tag{1.4}$$

Noticed that arithmetic Brownian Motion follows the normal distribution. As it is modified by exponentiation, it becomes log-normally distributed. Consequently, this modified model is identified to be Geometric Brownian Motion. Thus,

$$\boldsymbol{lnX(t) - lnX(0) = \mu t + \sigma Z(t)} \tag{1.5}$$

$$\boldsymbol{OR}$$

$$\boldsymbol{X(t) = X(0)e^{[(\alpha - 0.5\sigma^2)t} + \sigma Z(t)]} \tag{1.6}$$

Perhaps it can be wondered: Why is the mean $\mu = \alpha - 0.5\sigma^2$?

Recall that α represents the expected rate of return of the stock; with a normally distributed constantly compounded rate of return of the stock, the mean of that normal distribution is μ. This implies that stock will follow log-normal distribution which consists of a mean of $e\alpha = e(\mu + 0.5\sigma)$. By this, the above $\{X(t) = X(0)e\hat{}[(\alpha - 0.5\sigma^2)t + \sigma Z(t)]\}$ equation is derived.

According to the Arithmetic Brownian Motion, "*the difference in stock prices is normally distributed*. However, Geometric Brownian Motion states that "*the quotients of the stock prices are log-normally distributed*".

Now, the model can be represented with differentials:

1. Arithmetic Brownian Motion: $dX(t) = \alpha\, dt + \sigma\, dZ$
2. Geometric Brownian Motion: $d[\ln X] = (\alpha - \delta - 0.5\sigma^2)t + \sigma Z(t)$

$$\rightarrow \mathbf{dX(t) = \alpha\, X(t)\, dt + \sigma\, X(t)\, dZ}$$

Any process of these form is called Ito process.

Having a model to forecast the future prices of stocks, these models can be further modified, particularly Geometric Brownian Motion, so that this model can be generalized for any function $f[X(t)]$. For instance, the payoff of a call option is also a kind of function with variable $X(t)$. Generalizing the function is not simple, but later it can be observed that Ito's Lemma supports considerably in this matter.

Perhaps the second differential equation of Geometric Brownian Motion looks unusual. However, having Ito's Lemma can be helpful to relate the value of the changes in the function of the asset to the value of changes of the asset. In other words, having X following Brownian motion, it is necessary to know how $Y = e^x$ behave, and Ito's Lemma helps to relate them. In fact, the second is derived from Ito's Lemma.

Ito's Lemma

$$dC = Cs\, dS + 0.5\, Cs\, (dS)^2 + Ct\, dt \qquad (1.7)$$

Where it is given the function at time t, $C[S(t)]$ and $S(t)$ is the stock price.

Sharpe Ratio

Sharpe ratio is the risk premium of a stock divided by its volatility, or, standard deviation.

$\Upsilon - \boldsymbol{r} = (\boldsymbol{\alpha} - \boldsymbol{r})/\Omega$

In other words, the Sharpe ratio is simply:

$\varphi = (\alpha - r) / \sigma$

1.2 Problem Statement

Having a good knowledge of the share prices movement investors help to take more protective decisions which finally leads to reduce risk and increases profitability. However, the lack of knowledge of future share price changes leads to uncertainty. There are many systematic models to forecast prices, which help to stakeholders to guide future price decisions.

Out of all of them, Geometric motion models are widely used globally for stock price movement prediction, the reason being the high accuracy of interpreting results. Nonetheless, Sri Lanka uses the GM model, which is not widely observable studies which are used in a sample representing the entire sample. As a solution, this study focuses on how the Geometric Motion model is possible to be utilized to predict stock prices in the Colombo Stock Exchange, Sri Lanka.

1.3 Research Objective

The focal objective of the present study is to predict the future stock market price via the Geometric Motion model, and this research moreover considers the validity of this model in the Colombo Stock Exchange market in Sri Lanka.

1.4 Significance of Research

Compared to the pros and cons of other numerical methods, Geometric motion models have many advantages, which make it convenient and simple to implement in solving more difficult matters. Further, GM is often friendly in dealing with multi-dimensional matters because its convergence rate does not depend on the dynamics of the problem

It does not take long for GMs to implement the speed of computer programming. Identifying those advantages of this price model can explain the more accurate price predictions compared to other pricing models, which is identified to be crucial because this research is based entirely on the GM model and its variable assumptions. In the Sri Lankan context, this research is significant due to various reasons;

- It would serve as a guide to investors in making significant policy decision with regard to risky investments
- Forecasting information is very important for the government in terms of budgetary decisions.

1.5 Expected Results and Innovative Points

This research presents an extensive process of building a Geometric Motion model for stock price prediction. This research aims at;

i Guiding investors in the stock market to make profitable investment decisions.

There is much literature available on the use of Geometric Brownian motion model for the prediction of stock prices, but the applicability of the Geometric Brownian Motion (GBM) model in Sri Lanka has not been researched.

Hence, this research will be a good guideline for the investors in Sri Lanka to be motivated to invest in CSE.

ii Confirm the validity of the Geometric Brownian Motion model in Sri Lanka.

There is enough evidence to support the uses of Geometric Brownian Motion (GBM) model to forecast share prices, and it has shown results reasonably better than other forecasting techniques. In the present study, it will be observed how the Geometric Brownian Motion (GBM) model is valid in terms of stock price forecasting in Colombo stock exchange

iii Increase literature in the Geometrics motion model.

Although the literature on forecasting share price via Geometric Brownian Motion (GBM) model remains widely available, when it comes to its applicability in the Sri Lankan context, there is no strong evidence of the uses of GBM model.

1.6 Limitations

1) Inappropriate inputs, such as standard deviation and correlation, may lead to incorrect simulation results.

   GBM model is based on assumptions, and if they are wrong, predictions will be wrong. Most of the assumptions in the GBM model depends on mathematical tools such as standard deviation

2) When it comes to an investor, there are many unknowns that simulation cannot correctly account for.

3) There may be concerns about the proficiency of the model the serial correlation between what comes out and what was drawn, as controlling variables is impossible. Therefore, the user must be equipped to make the necessary alterations in case the results generated seem out of line.

1.8 Organization of the Research

This Research examines the capacity of the Brownian motion model of forecasting market share price in the CSE. This Research contains five main chapters.

Chapter 1: Introduction - This chapter delivers the basic outline of the study while discussing the research topic, research problem, objectives of the research, research questions, significance of the research, purpose of the research and limitations of the research

Chapter 2: Literature review - The theoretical background of the research is discussed in this chapter, and the main aim is to look at a number of authors and theories regarding the Brownian motion model, which have been observed by many authors and management scientists.

Chapter 3: Methodology - This segment is allocated for the collection of data and analytical techniques and methods and discusses how the research has been conducted.

Chapter 4: Analysis and Results - This section includes a comprehensive description of all the results of the study.

Chapter 5: Conclusions and Recommendations - This chapter brings a revealing critique and an in-depth discussion of the results of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Although there is a considerable corpus of literature on the valuation of securities in corporate finance, debate still continues as to which is the most consistent and reliable method. Financial investors and managers show a keen interest in simulating the value of stocks, derivatives and options in making significant financing decisions on investments. Simulating stock price means creating a price path that the stock can follow in future. Many area units that simulate stock costs as a result of future share prices are uncertain, as they are called at random, although they are believed to be at least a set of historical rules, resulting from data and stock price knowledge. Simulation and the underlying model are realistic. The model should include stock cost awareness and historical information. The aim of this literature review is to compare and study the various uses of geometric Brownian momentum models over time for stock price forecasting.

2.2 Theoretical Overview of Brownian Motion

The renowned Scottish botanist Robert Brown (1828), observed cells stuck inside the cavities of the pollen cells through the microscope and identified the rapid oscillation of the pollen grains suspended in water. Although Brown was capable of publishing the observations he made, he failed to identify the mechanisms that led to the motion.

In his groundbreaking paper, Einstein (1905) described in exact detail that the motion Brown observed was influenced by water molecules; the concept of Brownian motion. A detailed definition of Brownian Motion came much later before which Weiner (1923) developed a formal mathematical theory based on the issue, known as the Wiener process. The World Health Organization, developed by Bachelor (1900), developed a basic mathematical model of the value of stocks, which was tested using price-futures and options.

Bachelier's dynamics of stock price were to follow time-price moves without cash. Roberts (1959), Kendall (1953) and Samuelson (1965) have revised Bechleier's model, making the share price drop after the normal distribution. The Samuelson model is known today as the Geometric Brownian Motion (GBM)

Fama (1965) considered the idea of the behaviour of stock price as random. The core of the stochastic process is that the stock spends information on the trading business. If the available information gives investors the confidence that the company will grow, then confidence in the value of the stock will increase, and stock demand will increase, and thereby increase the stock price. On the other hand, if the information in hand provides investors with the confidence that trading fortunes will diminish, then investors' confidence in the stock can drop, making the demand for the stock will fall; as a result, reducing the stock price. As information willy-nilly, stock prices vary erratically, creating an arbitrary walk-in idea. If the flow of data is not constrained, and the data directly reflects the available costs, changes in tomorrow's price may merely indicate tomorrow's information and are independent of today's price changes. Fama, who is perceived by "efficient market" at all 3 levels, defines the market as the “place where large numbers of rational profit-maximizers actively compete”. Important current information is virtually readily available for all participants, who with every effort attempt to estimate market values. Fama has described those 3 levels perceived by the market to be weak type, semi-strong and strong market efficiency. He presented his opinions on Effective Market Concept (EMH).

Three forms of empirically tested EMH were reviewed by Fama (1970). The dilution type was tested first, at which point the cost was adjusted for fully accessible information, which is the historical value of the stock. The main concern is whether the prices can be adjusted efficiently with other widely accessible information, such as acquisitions, stock splits, mergers, and annual revenues. Finally, the strong form in which price behaviour was observed was tested when investors or groups had the exclusive right to use to any detail concerning the price of a stock. In the historical empirical analysis of exchange costs, Fama states that a random process is flowed by stock costs. However, other works have calculated Fama's views.; that the stock market is not spontaneous was first concluded by Kuttner (1964), while Beja (1977) revealed the efficacy of the real market to be unattainable.

Grossman and Stiglitz (1980) have emphasized that the market cannot die informatively. As the cost of information high, prices may not fully reflect the available information, for if this happens, there will be no compensation for investors who allocate funds to acquire and analyze it.

Summers (1986) have contended that numerous statistical tests conducted on market efficiency have little power, which discriminates against acceptable types of inequality.

French and Roll (1986) identified prices of an asset to be more unstable during non-trading hours than trading hours, and have attributed this to the trade-in private information on which the market makes its news.

Lo and McKinley (1988) have harshly disagreed with the random walk hypothesis for weekly stock market returns using the difference ratio test. Poterba and Summers (1988) have explained that returns of stocks demonstrate short-term positive self-reliance and negative autocorrelation over the long-term horizon. In fact, the level of market efficiency turns out to be debated and many hold to the belief that it can overwhelm the market in a very short time span. Nevertheless, EMH has presented the theoretical foundation for most of the study and empirical research in terms of assessing stock price behaviour.

Harvey (2008) have examined the association between the Ghana exchange and the interchange market to see whether the fluctuations in exchange rates in Ghana have an impact. The Exponential Generalized Autorespiratory Conditional Heteroskedasticity (EGARCH) model has been used to establish the connection between stock market volatility and exchange rate volatility.

Antwi (2012) has used statistical measures to compare the stock market listed stocks and treasury bills in Ghana with risk and return characteristics, standard deviation, average annual rate (nominal and true), and coefficient of variation.

Osei (2005) used the vector autoregressive model to examine the effect of the stock market on economic progression in Ghana. Their empirical results suggest that exchange development can lead to economic progress in Ghana and that this effort is indirect from the exchange to the economic process. Recently, several other methods have been applied to assessing and predict stock price behaviour.

Landousekas (2011) has adopted a collaborative approach under which the cost of the share falls to square measurement sculpture, derived from the model uniform distribution from Markov Chain Town (MCMC). The use of available neural networks for assessment is further investigated.

Yoon (1991), Refenes, et al. (1994) forecasted performance of share price using a Neural Network Approach., Azoff (1994), Kryzanowski, et al. (1993) Neveni et al. (2013) estimated stock prices by means of artificial neural networks. Estember and Maraña (2016) have conducted a comparative analysis of the efficiency and precision of the geometric Brownian motion with the artificial neural network method on shares listed on the Philippine Stock Exchange. The geometric Brownian motion method was observed to have an average accuracy of 6.21% or 93.79%, whereas the artificial neural network method produced an average of .83% error or 91.1% accuracy over an average of three years. This makes the geometric

Brownian motion a more improved model for predicting the behaviour priced of stocks than the artificial neural network.

2.3 Evidence of Brownian Motion

Origin Era

Bechelier (1900) introduced the Theory of Speculative; the first time the Brownian motion model was applied and introduced to evaluate stock options. Historically, the study of finance was first studied using modern mathematics. According to Bachelier, the effects of determining the movements of the stock exchange are enormous. Past, present, or eventful events often do not show a clear correlation with its ups and downs but have consequences in its course. In addition to fluctuations, natural causes and artificial causes are also included. The stock market operates on its own, and its current move is not only about the ups and downs but also about the current market situation. Determination of those fluctuations is subject to the addition of infinite things, which cannot be expected to be mathematically accurate. Contrary to these fluctuating class dimensions, conflicting opinions are divided, which means that the equal instant caregiver market is growing and sellers believe that the market is falling.

Trevor (1986) described equilibrium exchange rates, the popular model of international asset demand, and the continuous-time process models of international asset demand deal with a simple case of geometric motion processes for quality and cost rates. Here, they have adopted a single-country model, and these international models prohibit the pricing process movements by resolving the property market clearing conditions. It produces a global capital quality rating model, but it does not impose restrictions on exchange rate policies. This study has shown that the state of equilibrium in the interchange markets produces limitations that allow for the full rating of assets in multiple currencies and exchange rates. However, it is also resolved that the assumption of the geometric Brownian motion for exchange rates differs from these limits. This implies the need to put more effort into implementing additional equilibrium constraints in the model, with simpler pricing processes.

Fama (1995) has discussed Chartist theories, which states that the principles of fundamental analysis are actually market experts and, most likely, financial teachers. Historically, however, there have been academics, statisticians and economists to be precise, who advocate a fundamentally different methodology to market analysis, i.e. the theory of stochastic movements in the prices of the stock market. Random walk theorists sometimes begin with the principle that those main security exchanges are optimal models of "efficient" markets. The "efficient" market is referred to as the market, where four rational profit-maximizers compete in large numbers, with every attempt to estimate the individual securities' future market value, and essential current information is available for free to all participants or anyone. In the Semi-Strong Form Efficient Market, competition between different Intelligent Participants can at any time, stop the effects of information with regard to the events that are already happening, primarily based on the actual prices of individual securities. Reflection on events is expected to give the market a place in the future. In alternative terms, the associate degree market, for which purpose is to be protected at any time, is a good evaluation of its intrinsic value. With the uncertainties in the world, accurately determining the security's intrinsic value is difficult. Therefore, there is always the possibility of conflicts among market participants as to the intrinsic value of private security, which can lead to dissimilarities between actual prices and intrinsic value. However, in the associative degree fair market, the actions of various competing participants must lead to the specific value of security in order to turn around willy-nilly about its intrinsic value. If the differences between real costs and internal values are more systematic than random in nature, this knowledge can help intelligent market participants better assess the way real costs go toward internal values. When most intelligent traders try to harness this knowledge, they neutralize such systematic behaviour in the value chain. While the uncertainty about intrinsic values persists, the real cost of securities revolves around their internal values willy-nilly. New information comes as internal values change over time. New information may include current analysis and success factors of the development project, amendments to management, mandatory tariffs on the production of an industry in a foreign country rise in industrial production or other important or actual change. The change factor; it has the potential to make an impact on the company's interests. In the Associate Degree Affordable Market, in general, competition leads to the compelling effects of up-to-date information on real costs, which is reflected "immediately" in real costs. In fact, although there are actually two implications of "instantaneous adjustments" as a result of new information asymmetry or uncertainty, real values are initially adjusted for changes in internal values, when they are adjusted. Secondly, the gap in the full adjustment of actual costs to consecutive intrinsic values may be a degree of freelance, random variable, adjustment to real prices, which is sometimes internalized and sometimes altered before an event occurs. Basis. Later.

It is stated that the "immediate adjustment" property of the associate's degree fair market means that a series of price variations in individual securities are independent. A market that is independent of gradual price variations in individual securities, according to the definition, is a random walk market. In other words, the phenomenon of random walks suggests that the stock price is not reminiscent of a series of changes - the past history of the series may not be accustomed to predicting the future meaningfully. The future path to the price level of a security is not predictable due to the identification of any additional random number series.

The Random Walk hypothesis is unlikely to provide an accurate explanation for stock market price behaviour. However, when it comes to optimal functions, the model may be suitable, regardless of the fact that it is inconsistent with the facts. Therefore, while the sequential value changes are not strictly independent, the actual dependence is negligible. Which should be classified as not small, however, is the question at hand. For an investor or a stock trader, the criteria are clear: Knowledge of past behaviour of price changes is not accustomed to maximize the anticipated profits until the independence of the random walk model is valid. In particular, if frequent changes in price for given security are independent, no matters are come across with the timely purchase and sale of that security. Due to more sophisticated mechanisms for buying and selling cosmic orders, the general mechanism of buying and holding for security is good at any rate, which suggests that, for investment purposes, the actual reliance on a series of price changes is not enough to derive the projected benefits of "sophisticated" mechanical trading, except for an adequate explanation of the independence of the random walk model. Rule or Chartist Technique exceeds the expected benefits under the Affordable Purchase and Hold Policy. Empirical evidence on the independence of empirical tests of stochastic process theory has developed over the years.

Middle Era

Blanco et al. (2001) have discussed the development of generalized deployment models, which have contributed to the development of choice markets. Today, these models are still utilized by the market practitioners, largely due to the relative simplicity of estimating input parameters. Generally, commodity prices fluctuate over time around the cost of production and often experience large changes in prices due to shock events. Changing the overall diffusion value to capture these additional market realities at this time is the average-alternative model and the jump-diffusion model, which describes the most frequently used processes, the geometric Brownian motion, and the second and third pieces. Two processes have rapidly been accepted for a wide range of applications, including object derivatives: mean-reverse and jump-diffusion. In terms of the major uses and pitfalls of these processes, practitioners should be thorough when using these processes for pricing and managing the opportunity for different power generation structures.

According to Sengupta (2004), the Geometric Brownian Motion Model adopts or follows the following characteristics for stock prices:

As far as the company is concerned, its share prices are stable over time and in value, stocks follow the mark-off approach, which means that the current stock price is only relevant to forecasting future prices, the proportionate return of the share is log-normally distributed, and the fixed compound return for the stock is normally distributed

The greater the plan for holding the stock, the more uncertain the stock's final price, and the actual final price may be different than the expected final price. However, the greater the stock holding plan, the greater the certainty of making a return. These may seem different, but they see why they are not. The GBM resolution is explained by Sengupta. The first thing about stock prices is that they are constant in time and value, which means that stock prices are observed, and they are constantly changing but not always maintained. Markets are closed on nights and weekends, and stock prices change only in stages of multiples of absolute cents. However, this is reasonable, and it facilitates modelling stock prices. The second is that stock prices follow the Markov approach, which is analogous to the weak form of the efficient market hypothesis, which states that the future price of a stock cannot be estimated based on its price history. For example, the share price did not reveal anything yesterday (or a minute ago) or what the future holds for it. If a stock exceeds a few days, it does not mean that it has gained some momentum and is now likely to rise for the next few days. This contradicts the claims of many Wall Street experts, especially Chartists, who can predict stock prices by analyzing their price history in various sophisticated ways. There is ample evidence to show that these claims are probably wrong with a few minor exceptions. The levels of support, resistance levels, and momentum and forward positions discussed with great passion and confidence on Wall Street do not help predict future stock prices.

Rahul R. Marathe and Sara M have a different view for different data types for some data sets, and that GBM processes may be reasonable depending on the generality and independence criteria, but for some data sets, the GBM process may not have the suitable distribution. Therefore, in any model, care must be taken before the GBM process is followed by a specific data set. Analysis of data from mobile phones and the internet have identified that several data points influenced the analysis-results. Therefore, an attempt was made to collect additional data points for the example specified. In terms of internet host data and cellular phone revenue data, it was detected that the log ratio decreases over time. The drift of that time series depends on the timing and the level of the time series. Therefore, in these cases, the GBM norms were not followed. For these data, that do not follow the GBM process, can be examined for other random dispersion processes (Dixit and Pindik, 1993). In order to include the vibrant nature (and possibly volatility) parameters of the drift, the ITO process can be used for stock prices. More generalized models can also be studied. In Hull and White (1990), the scholars debate on certain extended one-state-variable interest rate models that include parameters that are time-dependent.

Dmouj (2006) have studied geometric Brownian motion models, stating it to be one of the mathematical models that are utilized in asset price modelling. The study reveals that the future price of financial stocks has a log-normal probability distribution, and therefore their future value can be predicted with a certain degree of confidence. He notes that the major financial crises of the twentieth century have provided strong intentions for much study and research with regard to financial modelling to mitigate such risks in the future. A lot of academic works have focused on this area over the years. Financial engineers and mathematicians have developed numerous mathematical models, and the geometric Brownian motion is currently widely utilized in stock price modelling, grounded on the hypothesis that market efficiency complies with the laws and regulations of the money market. The above-mentioned regulations and legislations consider that information about the efficiency of the stock is used only to ascertain the future price of this stock. As per the geometric Brownian momentum model, consecutive returns on a fixed stock are independent and usually distributed at the same time, forming the Markov process. Therefore, in principle, geometric Brownian motion looks good because of future stocks. However, practically it shows certain drawbacks, particularly when it is used to model pricing over a short period of time, which is more accurately observed when the stock price is used for modelling longer, which is due to the assumption that the rate of stock and volatility of the stock is constant. To estimate the precision of the model, these parameters are to be modelled as a random function of time, and not a constant. The former part of his work describes the mathematical structure of the geometric Brownian motion.

Factors such as the Ian Random Walk and the Ito process are used to construct and understand the geometric Brownian motion. In addition, model statistics are also obtained. In the second stage of his work, real data is utilized to estimate model parameters, test estimates, and study model accuracy. Another value of the same stock is simulated with a 95% confidence interval, depending on the actual stock price.

Modelling stock prices, as mentioned in the introduction, is relating to modelling new information with regard to stocks. The modelling is realized in this article by the quantification of the random component in the normal expression of the model. The results of the simulations performed in this work are not always consistent with this theoretical model, except that the model satisfies the rules of the financial market.

Simulation results analysis provides two important points:

1. In a one-day simulation, about 80% of the stock's real value is not a confidence interval, and the confidence intervals are small.

2. In long-run simulations, almost all real-time values are within the confidence interval of the simulated stock price. Confidence gaps are huge.

Geometric Brownian motion indicates low correctness in short-term modelling, as a result of the fact that the parameter drift and instability remain constant. Nevertheless, its accuracy can be enhanced by modelling the parameters as a random function of time and other macroeconomic factors, which affect the share price.

Turkey and Powers (2006) have investigated whether the concept of Brownian motion, which is frequently utilized to describe commodity price movements, is satisfactory. Using historical knowledge from seventeen commodity futures entails specific tests of imperfect and general Brownian motion class measurements. The analysis takes place on the null hypothesis of general Brownian motion against the substitution of continuous or egoistic fractal Brownian motion. The tests for partial Brownian motion are based on the difference ratio test. However, the standard errors based on the Monte Carlo simulations are very high, which means the acceptance area is large for the null hypothesis. The results indicate that 17 of the 14 series cannot reject the null hypothesis of normal Brownian motion. Three series that did not satisfy the test were rejected because they violated the static property of the random walk hypothesis.

Rene Carmona (The Stability of the Geometric Brownian Motion Model of Stock Prices with Asymmetric Information - 2007) focuses on the microeconomic underpinnings of modern option pricing models. They develop a model of market agent interaction, which runs on heterogeneous information, consistent with both modern pricing models and empirical facts regarding the stock price behaviour. In particular, they concentrate on the association between volatility and trading volume. They demonstrate that the geometric Brownian motion model of asset prices is consistent with agents' learning and asymmetric information. Furthermore, it is important to empirically verify the theoretical implication of the model that drives the trading volume value process: in fact, at a very high frequency, the trading volume can describe beyond one-third of the variability in the property.

Ladde and Ling (2009) established the development of a modified linear model under segmentation with or without different data jumps. Empirical comparisons between the built model and the GBM model are underlined by the Monte Carlo technique using the classical process of building models, which has improved a modified version of the GBM model with or without different data partitions. Depending on the study, some important conclusions can be drawn immediately. First, the use of the GBM model and the general data set may not provide a decent fit. Data segmentation enhances outcomes. Additionally, they show those jump models are more effective than jumpers, as a result of the accumulated errors in the model without jumping. Environmentally random disturbances lead to a change of parameters in GBM models. They further comment that the development of the revised GBM model constructed on data for the stock price is accepted by the data for the stock price of these models, of which more details are given. In monthly linear stochastic models, the length of the time interval is the same. The jumps take place at the end of each month. However, the jump does not take place at the expiration of each month in the near future at all times. In addition, they are in the process of making models of jump magnitudes and interval length using data related to leaps. Details of these will also be published. To date, they have considered only linear stochastic models. To explain the stochastic behaviour of asset prices in finance, many non-stringent random models can be used. In addition, the study of nonlinear models, which is being carried out, will be published in a different setting.

For the purpose of uncovering the outcomes of changes in trading volume on stock volatility, Dr Nidil Rasheed Birjeet (The Effect of Trading Volume on Stock Price Volatility in the Arab Economy - 2010) has examined price-volume movements in Arab stock markets. Expenses have been expressed through the integrated MAF Stock Index. Using monthly data, this research has collected eight samples of the fifteen billion stock exchanges recorded in the Arab Monetary Fund database. The study identified that the volume and stock price volatility increased with each trade, which can occur due to a recent event in the majority of Arab stock markets. According to the study, while volume-stock moves are closely linked to all designated markets, the highest connection between volume and stock price movements has been identified in the Saudi securities market, Amman stock market, Muscat stock market and Kuwait stock market, respectively. Finally, the connection between volume and cost movements is observed to be greater in oil Arab states' stock markets, compared to that in non-oil Arab states.

As a method, the present study examines the price-volume relationship in Arab stock markets to identify the effect of fluctuations in trading volume on stock price volatility. Therefore, out of fifteen billion stock exchanges, eight markets have been selected; Saudi Stock Market, Beirut Stock Market, Amman Stock Market, Kuwait Stock Market, Casablanca Stock Exchange, Bahrain Stock Exchange, Muscat Security Market and Egypt Capital Market. The sample selected comprises four oil-Arab-state and four non-oil-Arab-state stock markets. The explanation of "oil Arab states" in the study is determined on the oil revenue value; 2000 U.S. Dollars or more per capita; thus, this categorization makes Egypt a non-oil Arab state. The study summarizes the GBM model and the constant elastic variation (CEV) in key data times of crisis, including the number of listed securities, market capitalization value, 92% of the trading value of the stock markets, and Jesper Giverson and Mehdi Bendki (2010). They are designated as a continuous-time process: the GBM and constant elasticity variance (CEV) model. The objective of the present study is to study continuous-time models in diverse stock market settings. They concluded whether the equity market could change the modelling of continuous-time processes, depending on the crisis or a pre-crisis period. The S&P 500 was selected as a benchmark indicator for this study, and the duration of the sample included the 1987 Black Monday, 2001's dot-com and the recent 2007 financial crisis. In a family with continuous-time policies, this study covers GBM and CEV. Followed by the evaluation and analysis of their parameters using the maximum likelihood estimation method, the Jarque-Bera normality test and likelihood ratios are performed in two models. Contrary to what a considerable number of research that supports the use of CEV on GBM, the results of this research test suggest that no strong rationale can be found to support adding a discount factor.

When it comes to choice pricing and market forecasting, the two most popular models are GBM and Continuous Elasticity (CEV). This study identifies and compares the signalling level of the equity market fall.

The S&P 500 is considered as a case study for the equity market because of its perceived impact on global stock markets. When it comes to estimating the GBM and CEV accuracy level, the two models have their identical estimation and stochastic approaches, which are being investigated via the maximum likelihood method, likelihood ratio test and jerk-byte normality test. Irrespective of the fact that this study partly highlights the limitations of the two leading models in the fields of option pricing and financial economics, log-likelihood estimation, likelihood ratio test, and the Jarque-Bera normality test may suggest different results.

Financial research community shows a special interest in Geometric Brownian momentum as it is the foundation of the widely used Black and Scholes method for optional pricing. However, it is a good alternative to Black and Scholes due to the unchanging elasticity of the variants, which supports moving in the opposite direction.

This study endeavours to engage in a comparative study of the two models in two different stock market periods in terms of predicting similar abnormal movements in the 1987, 2001 and 2007 crises in the S&P 500 equity market. The CEV model performs a better model than the LRM, with the leverage effect, compared to the GBM, and the strength of the results is considered an appropriate and robust argument to adopt CEV in relation to GBM.

Distribution of the corresponding Wiener process is regarded in another conclusion. Generally, the GBM model has shown normality features in 2/6 cases; a test close to the statistical adoption of statistical normality, and the CEV model exhibits definite general characteristics for its stochastic process.

Some recommendations for advance studies on log-normal processes in terms of financial market modelling can be mentioned. Over the sample period of 250 trading days, especially in a highly volatile environment, it may have lagged behind inaccurate forecasting parameters before and during the stock market collapse. Two limitations, considering the use of discretionary planning in this study as a simplification of continuous-time processes, can be extended. For better accuracy of parameter estimation, it is recommended that shorter models be considered. The need to implement CEV and GBM comparisons over a sustained period should be recognized.

The use of nonparametric estimation techniques is another recommendation. These methods can solve sensitive leverage impact estimation problems, which can be specified from 0 to 1, while the maximum likelihood functions have higher numerical values.

Dhesi and Shakeel (2011) have developed a new approach called the modified Brownian motion approach for the purpose of modelling returns distribution, which states that the innovative extension of the geometric Brownian motion model is a weighting factor and incorporates random function. Strength and trigonometric functions. The simulation supported this modified Brownian movement model, with the best weight factor employed by the goodness of the work tests, which best describes the basic geometric Brownian motion model concerning the revenue distribution of the historical knowledge values. Deciding to provide an associate-in-nursing interpretation of the extra-random term and explaining the importance of this novel paradigm in irrational behaviour is also relevant in money markets.

Hidalgo (2011) has described statistical physics in modelling financial markets in previous years, with physicists achieving significant results in the areas of statistical mechanics of phase transitions, non-linear dynamics and chaotic systems. Natural rules, scaling, stochastic processes, and unpredictable time series exist in these fields and can be used as an explanation for underlying physics. With different hands, financial markets display many of the features that describe the distinctive nature complex systems. They are open systems in which many subunits operate continuously to a reaction. One hundred years ago, these concepts were successfully applied to fields outside the natural sciences. Concepts such as the law of natural distribution and stochastic processes were first used in the social sciences. In 1900, Louis Bethelier, of Poincare, developed the first method of spontaneous walking. In his thesis, "Speculation Theory", Bechleier proposed to explain price variations in the financial market, developing the mathematics of Brownian motion as a model for the evolution of asset prices. He resolved the possibility of price change by writing the Chapman-Kolmogorov equation and verifying the Wiener method by satisfying the expansion equation (Einstein the year after its rediscovery).

The first theoretical description of the stochastic process was made by Einstein in 1901, and in the following years, its arithmetic was hardened by Weiner. The scientific community did not recognize Bachler's work at the time, probably due to its application to financial markets. His theory had actually been forgotten until 1922, when Ito used his calculations and the mathematician Brownian Momentum from the 1910s, inspired by the introduction of the version of the Brownian motion, became interested in modelling due to stock market prices. The Bachelor's Original Proposition, which changes the value of distributed mathematicians, is transformed into a model in which stock costs are logically distributed. In 1991, Black, Scholes and Merton employed the geometric Brownian movement to formulate a theory to resolve the value of stock options. This theory marks the milestones of mathematical finance today, although it is clear that the model is trying to improve its application by providing only a basic approximation to what is observed in real data. As a result of this reason, many different models have been evaluated.

One of them is Mandelbrot's hypothesis which suggests the price change levies are consistently distributed. In addition to modelling stock market prices, factors such as turbulence have been considered in understanding the behaviour of financial markets. Mantegna and Stanley performed a parallel analysis of price dynamics and liquid velocity. In particular, they analyzed the time evolution of the S&P 100 index and the speed of the turbulent fluid at a high Reynolds number.

Conversely, a formal analogy is proposed by Ghashghai et al., between the velocity of the turbulent liquid and the exchange rate of the foreign stock exchange market.

The results of these investigations are discussed in financial markets and turbulence. Moreover, the simultaneous investigation of the stock price time series has been understood to be another area of interest. The existence of interrelationships or contradictions between stocks has long been known, and they play an important role in determining the most important financial portfolio. Furthermore, how important these correlations are is to determine the amount of synchronization in the dynamics of a pair of stocks exchanged in the financial market.

This approach discussed correlations and anti-correlations between stocks. Measuring and controlling financial risks is a major concern in the financial world. Several risk measures have been introduced to reduce risks and allow these risks to be traded as well. However, scientific definitions weaken "rare occurrences" where there are real monetary risks. In Appendix Risk Measurement, certain scientific ideas on economic risk have been reviewed to explain their weakness and then explore some theoretical ideas that explain these "rare occurrences." Some fields investigated by physicists include the full characteristic of the stochastic process of financial asset price changes. Other areas of research deal with rational pricing of derivatives, while some canonical estimates of the Black-Scholes model are relaxed and focused on modelling securities market costs with the right portfolio option. They begin with a review of the statistical components of the financial time series and the stochastic process, and finally, they refer to the use of these concepts in analyzing and modelling financial markets (Black-Scholes theory)

In the review of Geometric Brown Motion in Estimating Share Prices in Bursa Malaysia, conducted by Abidin and Zafar (2012), they analyzed a month’s stock data on the Ba stock market. The market capitalization of RM10 to RM50 million makes this model very suitable for at least two weeks of investment, they said. According to them, GBM offers a worthy chance to make new decisions and make a profit after followed by two weeks of investment.

Furthermore, according to their methods, GBM is very accurate because the mean absolute error (MAPE) values are less than 10%. GBM is easy to calculate and requires fewer data compared to other prediction models used to predict future closing prices. Despite the advantages, certain weaknesses in the GBM model can be observed, but in the present case, it gives the exact same price as the actual price. He, therefore, stated that GBM is the best model to be used for predicting future cancellations for at least two weeks. Finally, Bursa Malaysia is expected to invest in the next two weeks to forecast future share prices. It, therefore, gives investors a particular space to evaluate the decision they have made at the moment, and to make a profit within the maximum two weeks of investing.

McNihols and Rizzo (2012) have examined stochastic GBM methods. Market price modelling applies the GBM model to simulate future market prices. They are the Cox - Ingersoll - Ross method; a method to simulate market prices and derive comprehensive interest rate generators from it. This method generates the distributions and their parameters that are needed to effectively measure the level of capital risk and the fair value premium and the best-expected risk balances. The modelled results provide reliable estimates for risk-based and economic capital valuation purposes. With these distributions of value results, analysts can easily measure the underlying portfolio leverage and effectively manage this type of financial risk expense.

Gazda and Vyomukanska (2013) discuss the geometric Brownian motion with a fixed waiting time, stating that one of the earliest systems used for property price characterization was the Black-Scholes model. It is supported by the geometric Brownian movement, and it has been used as a tool for the evaluation of many monetary instruments. However, once the knowledge statement is included, the geometric Brownian motion is unable to capture many of the assets of the current financial markets. For example, fixed values have a name here. They, therefore, support another approach that supports the subordinate tempered stationary geometric Brownian movement, which is the inverse of the popular geometric Brownian movement and the instinctively subordinate. In this paper, they introduce the stated procedure and demonstrate its main features. They also propose an estimation procedure and test the analyzed system with a constant temperate expectation in real data subdivision geometric Brownian motion, and it is the most an appropriate model for intermediate cases between the sub and general propagation. They have highlighted the key features of the analysis system and introduced the new assessment process in detail. The models for data describing German interbank rates have been successfully researched. They believe that the proposed model and the presented method serve as one of the useful tools in real data analysis.

Pedersen (2013) interprets Monte Carlo simulations in financial estimates as the simplest equity with the resumption of historical financial data, to assess the long-term equity, income, and potential distribution of payments to companies. The Monte Carlo simulation of the growth model is then employed to evaluate the probability distribution of future returns on stocks and stock options. Model S&P uses a market index of five hundred securities and is, therefore, Coca-Cola Company. The relationship between USA government bonds, the S&P 500 index and the Dow Jones Venture Capital Index (DGV) was also studied, and it was identified that no reliable and maintainable relationship exists between the US government-bonds and the S&P 500 and DVVC. Although no risk premium is identified, a substantial correlation between the monthly return of the S&P 500 and the DJVC index has been observed. The study utilized a general equity growth model in combination with historical equity data for future equity, earnings, and Monte Carlo simulations on the S&P 500 Stock Index and Coca-Cola Company Payments. It estimates the probability distribution of equity, income, and payables, utilized to estimate the annual return rate with diverse holding periods and stock-option values. The distortion effect of using averages in the present value calculation is also demonstrated. It has also studied the returns on the US government bonds and the DJVC Capital Index from the S&P 500 Index. No, statistically significant correlation was observed between the monthly return of US government bonds and the S&P 500 and the DVVC index on fixed and affordable risk premiums, except between S&P monthly returns 500 and DJVC index between 1991 and 2010. There are many assumptions made in this study, and interpreting results are to be carried out cautiously. Computer source code and data files are provided over the internet to enable readers to experiment with others.

The modern Era

Allabadi (2015) conducted a study on the capital of the Jordan Securities Market, which examines the potential of Monte Carlo simulations (MCs) to predict stock market returns on the Amman Stock Exchange (ASE). The research compared the model estimation efficiency of MC with simple and exponential moving average methods. Data for the study include ASE's daily normalized float index sum (2003–2012). Prediction accuracy is measured by four proxies: Root Mean squared error (RMSE), Mean Absolute error (MAE), MAPE and their odds coefficients. The results indicate that MC is the most accurate prediction technique, among other investigations. Besides, ASE appears to be weak at a weak level, as technical analysis provides investors with an estimate of securities market returns.

Reddy (2016) described the stock price referring to evidence of geometric Brownian motion from Australian companies and tested whether duplicate stock prices equated to real stock returns. The daily stock price information is obtained from Thomson, and a Gregorian calendar month is a sum of information from 2013 to thirty-first of the Gregorian calendar month in 2014. The results are encouraging, given the fact that the total misstatement of the stock value for a limited period frightens the prospects of GBM occupancy, a direction that is equal to the actual stock cost over 50%. However, the results improved slightly when the portfolio was created. This study explores geometric Brownian momentum models for the simulation of the stock-price paths and offers three ways to assess the validity of the model. The correlation coefficient between pseudo-stock-prices and real stock-prices is calculated in the first method. Most of the previous studies have suggested a weak relationship between the two variables, reporting a correlation statistic in the short duration of the simulation, which turns out to be positive with a longer forecast. Fake and real stock prices are created by noise or volatility in the market, to have a negative correlation in the short term, while stock-prices increase the long-run correlation between fake and real stock costs. Nevertheless, the coefficient of correlation still represents the weakest relationship at best. The mean absolute error (MAPE) technique is the second technique used, which yields very different results for the first method because MAPE values have shorter durations overall. MAPE was found to be negligible during the simulation period of one week, two weeks and one month, but the error increases when the horizon is considered. The third and final method used a simple approach to test whether simulated daily stock prices display directional movement similar to real stock prices. Consequently, the outcomes are somewhat hopeful, given the fact that total time stock price offers, GBM occupancy is the same direction as the actual stock cost is only 50% larger. However, when the divisions were formed, it was later discovered that the situation had only worsened. However, this may be a preliminary study, and therefore the literature regarding testing for GBM estimates may be very limited. Therefore, these limitations in the research give prospective areas for future analysis. For instance, this study utilized a sample of large listed companies from the same country. Thus, alternative countries at the same time can give completely different results and increase the validity of the larger sample resolution. Future research with different start-dates can be taken into account. Other changes for the reliability of the model, such as a model having a jump, are also varied. Besides, it is attractive to compare the correctness of the RIM and GBM models in estimating share costs.

Goodmundson (2016) has conducted a study known as the stock price movement model, which aims at modelling stock prices as a random process of substituting the equilibrium point, where the balance is determined by the firm's primary data point. Stochastic models are compared with the standard approach of using geometric Brownian motion for the purpose of simulating stock-prices, considering the autocorrelations of a set of stocks. It developed the technique of modifying the stochastic model of stock movements to include autocorrelation, by incorporating the term autoreactive. Since the beginning of the index term, the method of obtaining index behaviour for a set of simulated shares has been developed. This can be added to a random sample of stock movements. VRM has introduced a different drift term than GBM, which is more precise in simulating stock-price movements and relates the stock-price flow to the value given by the company's basic data points. Compared to GBM, it only examines the existence of drift in share price and introduces a model, without elucidating the mechanism that explains why it occurs. VRM, therefore, provides a better indication of future share price than GBM but also brings together new problems in computing, such as the company's need for basic data points. VRM is not the ideal model, but it must be included in the model of the company's basic data points to get a correct model of the stock market. As an initial model, GBM behaves similar to stock price and is a functional first estimate of the stock movements. GBM can be conveniently used for future extrapolations using approximation parameters. However, its convenience of being used does account for a high degree of accuracy in GBM in terms of predicting. Both GBM and VRM can provide a good model of stock movements when a single stock is observed. However, when a group of shares is considered and when they form an index, VRM and GBM are insufficient, because GBM and VRM do not form indicator behaviour, but form a smooth line. By initializing the index term, it is possible to simulate an index that performs similarly to real data. The automation of stocks is generally considered minimal and can be ignored. Nevertheless, when we look at the mean value of the autocorrelation coefficient for a set of stocks, it is certain that autocorrelation actually exists and should not be ignored. It is possible to include the behaviour of autocorrelation in a stochastic model, utilizing the autoregressive term.

Damptey (2017) investigated the suitability of the geometric Brownian motion model for estimating stock-prices on the Ghana Stock Exchange; in statement stock. Secondary data received from the Stock Exchange (GSE) of Ghana were analyzed and evaluated in a quantitative approach. The target population included 36 listed firms that instructed the top ten market actors for the study. The study depended on the closing supply price from January 2008 to July 2015 for research knowledge. Chi-square test was employed to test the hypothesis. Moreover, stock-prices were simulated by means of models in Microsoft Excel and HR software. After simulating weekly stock prices, it was found that seven of the ten listed companies did not have real value in duplicate price confidence intervals. The study was incapable of accepting the null-hypothesis of the test. In addition, because all MAPE values were found to be between 0% and 10%, it suggested that the GBM model is the most precise model for estimating stock prices on the Ghana Stock Exchange. Therefore, many experiments have established that the geometric movement (GBM) model is an adequate model for estimating share prices on the Ghana Exchange. Deliberate striking has led to the creation of appropriate investment decisions, methods and models, and the use of various methods such as evaluating analysts in an attempt to predict stock prices. Geometric Brownian motion models served as the basic model for performing such tasks. According to the study, mimicking weekly stock-prices, the true values of nearly ten companies are not in duplicate price confidence intervals, and confidence intervals are very low. After assessing the values and the suitability of the model, this study failed to agree with the null-hypothesis tested, and consequently, the stock of the Ghana Model Exchange is based on several tests conducted in favour of estimating the GBM model prices. As a recommendation, he proposed to use this model to estimate daily share prices in a short time span, as it is capable of giving more accurate forecasts. In addition, the model should be utilized to examine various sample-sizes to examine the precision of its model.

Oh (2017) has established a structure to assess the validity of a specific model, using information based on Monte Carlo simulations and model distributions. Using this framework, they claim that geometric Brownian motion alone does not produce many models in the distribution of wealth creation and stock returns. His work discusses an often disregarded deviation from the old-style way of validating asset-pricing models with suggestions for derivative, parameter calibration, and quantitative data. Instead, they seek to maximize the power of large numbers by carrying out multiple simulations, assessing the possibility that they have a real stock market, in which their first contribution is to gain empirical knowledge on the implications of the model by increasing the data set that had to be compared. They introduced three categories of empirical data, pooled revenue distribution, time series of monthly cross-sectional moments, and quantitative measures for the distribution of wealth creation by individual firms. The use of such comprehensive statistics specifically allows one to identify areas where a model can succeed and fail. The second contribution is to provide quantitative measurements of how effectively the model captures the empirical data. Although it is simple, this approach brings to light a regularly unnoticed departure from the old-fashioned method of validating asset-pricing models, with suggestions for derivatives, parameter calibration and point magnitudes compared to data. Instead, the advantage of the inequality in cross-sectional characteristics and equity returns is given to assess the likelihood that a given model will produce stock markets. They achieve this through hypothesis testing by sampling the distribution of data obtained from simulations. Instead of recognizing the difference as a puzzle, they can claim that the implications of the model are unrealistic. It is worth noting that the relative performance of competing models for a given metric is, by comparison, the magnitude of the p-value from each check.

Tie et al. (2017) were concerned with the right strategy to trade a pair of shares in Paris. The idea of a couple's commercialism is observing their price movements and comparing their relative strength in relation to time. The attempted trade is triggered by the deviation of their costs and contains a pair of positions to decrease strong stock and keep weak longer. Such a strategy bet on the decline of their pricing powers. In every perspective of technical tractability, specific pair-trading models generally assume differences in stock prices, satisfying the mean-regression equation. This work considers the optimal pair-trade matter by allowing stock prices to follow simple geometric Brownian motions. Its goal is to trade pairs over-time to boost the total revenue at a fixed commission cost for each transaction. The corresponding procedure is described by the threshold curves obtained by the corresponding HJB equations. Following the geometric Brownian motion, the pair-trade problem is studied, and the closed-form solution is obtained. The main advantage of a pair-business is its risk-neutral nature

Antvi (2017) describes the stochastic modelling of Ghana's stock-price behaviour. The Stock Exchange examined the stock-price behaviour on the GSE exchange and developed a random model to estimate the stock price behaviour on the Monte Carlo simulation.

In this study, they examine various justifications and models of the first part, which contain complex stock behaviour and its distribution in a different place. It draws on the basics of stochastic process as a tool for estimating stock price behaviour from Louis Bachelor, who considers stock price behaviour by considering Fattche's French doctoral thesis through the works of Samilson's extraordinary behaviour and random walk. They then create the geometric

Brownian motions to simulate stock price behaviour for all stocks listed on the GSE for the upcoming year by means of historical volatility and previous year returns. While the show results confirm that the model constantly forecasts stock behaviour in more than 80% of instances, there is sufficient evidence that the random model unfailingly forecasts stock price behaviour on the exchange in more than 80% of listed stocks. A mathematical examination of the distribution of shares is also provided. This work is expected to help inform investors and other stakeholders about stock trading, particularly in the Ghanaian stock market.

Hussain (2017) describes the gold-stock price of the dispossessed Saham Malaysia as one of the stochastic equation models identified in mathematical finance. Here they have used two parameter estimation methods for the geometric Brownian model (GBM); the first one, historical and the second, discrete method. Historical method explains the statistical method of utilizing the property of independent and general logarithmic returns, which gives simple parameter estimates. The discrete method is a function of the transition density obtained from the normal density process and the maximum likelihood method. Both methods are additive to square measurement, which measures the parameters of the information of the Malayanas gold share model, such as the Financial Times and the Securities Market (FTSE). As a result of the smallest root mean square error (RMSE) value, it is observed that the discrete method produces better parameter estimates compared to the historical method. After considering the two models of gold share price, FBM Emas and FBM Emas Syariah, the results substantiate that the discrete method, which yields the lowest RMSE compared to the historical method for both data, provides the best estimate. Therefore, it is determined that the discrete method is more precise in assessing the parameters of the Black-Scholes model. The Black-Scholes model generally does the appropriate job of fitting the FBM EAMS data. The model, which can be identified in the original gold-stock price, indicates the same "roughness" in its paths. Good-o-fit testing has confirmed that, at certain interludes, the model is important for real data. However, for FBM Emas Sharia, the model is not compatible with all values; i.e. the model does not fit the data. At this phase, a number of factors are to be considered, for in this data set, volatility is likely to change over time, but volatility in the GBM is expected to be stable or returns that are not normally distributed.

Khamis et al. (2017) examins Biometric assessment of volatility of financial data by means of Geometric Brownian Motion in Malaysia. According to him, the stock market is the fundamental platform for investors to get involved in a particular company and own some of their shares. Changes in daily share prices cause the stock market to be more volatile and difficult to toss, due to the economic factors of the country. It covers, the Malaysian stock market, the Kuala Lumpur Stock Exchange (FTSE KLCI), which started in July 1997 with a declining trend, falling below the psychological level of 1000 points. The calamity arose in 1997 as a result of the contagious and degrading effects of ULA attendance activities on Thai Bath. Based on the Economic Report of 1997/98, in September 1997, KLCI hit a low point rate of 675.15 since April 1993. In September 1998, the KLCI collapsed from 1077.3 points in June 1997 to 262.7 points after implementing exchange controls on 1 June 1998. In relation to the dot-com bubble, this is a historical speculative bubble around 1997-2000. With the peak on 10 March 2000, it exploded in March 2000 and swiftly stuck the progress of the Malaysian economy. KLCI recovered from the 1997 crisis but faced a different crash. From 2003 to 2007, the index of the KLCI started to surge again and ultimately exceeded the 1500 mark in early 2008. However, in 2008, the global recession crisis that started with the housing bubble of the United States spread to Malaysia and KLCI. In September 2008 it once again fell below the 1000 mark. Hence, the research is carried out with two objectives; the first is to set a model for estimating index prices in FTSE KLCI Bursa Malaysia, utilizing the Geometric Brownian motion.

This goal was accomplished by obtaining samples from the Brownian motion, the Wiener process and the derivative of the random walk.

The second objective was to estimate the financial data using geometric Brownian motion to obtain the most precise prediction data for index prices in FTSE KLCI Bursa Malaysia. The model derived from the Geometric Brownian Motion was employed to estimate Bursa Malaysia share prices for the year 2016. The result disclosed that the geometric Brownian motion is very accurate for estimating short-term index prices. The drift rate and volatility rate from the first quarter of 2016 were calculated based on the three sets of reference data, the forecast accuracy, the MAD and the RMSE value. Therefore, the year 2016 was estimated using a simulation of the geometric Brownian motion model.

Asiri (2018) discusses on the study of the geometric Brownian motion, which is considered the model of the Black and Scholes stock price, and the solution of this model is obtained, which is used in the derivation of the Black - Scholes formula. They begin this study with a brief overview of some of the mathematical foundations necessary to understand the stock price model and the world of black-schools. In the third chapter, he introduces the European call of plain vanilla and places the pricing options using the formula. Thereafter, they study the put-call analogy used in the etymology of the put option. The fourth chapter demonstrates the risk-neutral derivative of the Black-Scholes formula. After that, they explain some of the components of the Black-Scholes formula in order to obtain a better picture of it. The purpose of the fifth chapter is to describe the model of the stock-price and take in to account some justifications of this model. He started with the efficient market hypothesis. Then, they made attempts to present the model in a simpler way. Subsequently, they constructed the Brownian motion from the discrete random walk example, and they described some of its properties. Finally, they discussed geometric Brownian motion.

Liden (2018) study estimates the geometric Brownian Motion Apple stock price and the closing price of the S&P 500 Index. Using the combined ARMA GARCH time series model using 10-year historical closing values between 2008–2018, not only the GBM model, but also the closing prices are estimated, and the forecasted estimates are also made with the stock prices. Model Validity of prediction Models. In addition to the estimated drift and volatility, the estimates are made utilizing Monte Carlo methods to simulate the path values of the GBM, through fitted values based on the ARMA GARCH time series model. The estimated results show the GBM using a 50% accuracy rate with up or downdrift and volatility, and the combined ARMA GARCH models also show weak dependence between Apple stock price and financial time series data intervals and historical intervals. Fluctuations can affect future value fluctuations. Both Apple stock data and the S&P 500 index show proof of long-term dependence. The generality of the log-return, which is B, is clearly invalid. Mandelbrot (1963) and Dhesi et al. (2016) are also in line with the results. Therefore, the Gaussian kernel function and kernel density estimator (KDE) is fitted utilizing the Gaussian kernel function. The kernel density is best matched depending on the chi-square goodness-of-fit tests. Both the normality and the couch distribution assumption are rejected, KDE accepted.

The nonparametric standard bootstrapping method is used to provide paths and versions for both the Apple Stock and the S&P 500 Index. The standard bootstrap method is based on the assumptions, and the standard bootstrap method is used because the dependency between logs is very weak, although this assumption is not very valid. Using 10 000 bootstraps replicate models to produce mean and variance distributions, compared to the sample mean and variance, is generally not improved, as the drift sample is estimated using only the mean, but the standard bootstrap method has slight confidence intervals for small sample sizes

The bootstrap estimates of the drift are nearly identical when utilizing the sample mean, and therefore, utilizing the standard bootstrap method produces approximately identical mean errors. The Apple stock price and the S&P 500 estimates at one point predict the upward movement of more than 50%, and therefore, with the drift, the GBM2500 price has certain predictive power based on the sample size.

This is also similar to the results reached by K. Reddy and V. Clinton (2016). One-time phase estimates provide the best results when using 60 prediction days for Apple stock and 300 prediction days for the S&P 500 index. Cauchy Distribution assumption, utilizing the position and scale parameters to estimate the location and the drift and the volatility did not significantly improve estimates, as observed in the Monte Carlo method in 2008–2018. As an S&P 500 Index

Srinaganya (Using the Stock Market's Stochastic Geometric Brownian Motion - Using R Programming 2018) predicts stock-price movement using a continuous-time model. The author believes that continuous models are sufficient to identify the unpredictable dynamics of stock-prices. One of the key concepts in building such an economic model is to understand the geometric Brownian motion model, which is an exceptional case of Brownian motion. In his research, the first section introduces partial differential equations and certain related concepts and examples in the Hurst Index and then sets out the geometric Brownian motion random differential equations in the stock market. In the next section, based on the proposed random differential equation, they give the same in principle. And they perform an empirical analysis of the quasi-order formulas of the stock-price process using the Geometric Brownian Motion (GBM) simulation method, and they perform a comparative analysis of the formula under the random walk method based on the stochastic differential equation of Geometric Brownian Motion.

This paper studied a continuous-time agency model in which the agent controls the drift of the geometric Brownian motion. The size of the dynamic company gives a partial incentive, which is consistent with the grant of agent equity shares through continued payment. When the agent is as patient as investors, performance-based stock grants execute the right deals.

They discuss the process of examining if the given time series is compatible with the GBM process. The methods used to eliminate seasonal variation from the statistical analyzes of the four industries explored whether the historical time series for the use of established services, meet the criteria of the GBM; however, data for the development of emerging services is not a geometric Brownian motion, but perhaps correlated. He also studied the proper interval problem: the interval was found to be super paused at all finite intervals, a problem solved by McDonald and Siegel. However, he made perfect conditions for his results. He provided new proof of his solution to the use of difference inequalities, and the writer solved the dimensionless case when some of the parameters were satisfied so that the additional terms were the time of the existence of the global and the differential equations of the multidimensional, differential equations. The uniqueness of the K solution proves the equation driven by the partial Brownian motion with the result-based, random differential Hurst parameters. It is also revealed that the solution has limited moments. The result is based on the deterministic existence and specific theory, whose proof uses contraction theory and basic approximation. A particle trapped in a hole and, through the shuttling action of pedesis, escapes the appropriate model to elucidate the image of the transition state method in order to calculate the rate of the chemical reaction.

In short, they followed a few steps to complete the research work and first identify the user and then calculated the stock price equivalence using R programming based on the GBM process of random walk process and stock price. The conclusion of this research is that the longer the graph of the timeline, the lower the GBM than its expected value.

2.6 Conclusion

The GBM model is the most broadly utilized method for estimating stock price changes in the world because it gives high accuracy results when considering other estimation methods. There are many uses of the GBM model, but considering the Sri Lankan context, the GBM model still has researchable gaps to be filled in the prediction of future share prices regarding the application of the model in the CSE.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The methodology is the process, which should be followed to accomplish the research objective of the research. It always presents a comprehensive notion as to how the study will be carried out, which includes the study design, type of data, data collecting method, population, sample selection methods, data presentation tools, and data-analysis methods.

3.2 Research Design

This research investigates the validity of the geometric Brownian motion model in the Sri Lankan stock market for stock price prediction. The quantitative approach is employed for daily stock price prediction, which was calculated using simulated stock price along with actual daily prices.

3.3 Hypothesis Development

For the purpose of achieving the research objectives, i.e. measure the relationship between key variables based on the available literature and research design, the below-mentioned hypothesis was developed. In the present study, the following hypothesis was tested using statistical models, which are as follows,

H1: No significant difference exists between the actual stock prices and the simulated prices predicted using the GBM model over the sample period.

3.4 Types of Data, Population, and Sample

3.4.1 Types of Data

Data can be collected from primary sources or secondary sources. Primary information refers to data collected by the investigator on the variables of interest for the particular purpose of the research. Secondary data refers to information gathered from sources that are already existing (Sekaran, 2006). This research is based mainly on readily available secondary data, collected from the CSE publicity available database. In addition, the secondary data such as reports obtained from data warehouse of CSE report and Bank reports have been used. Internet resources were also used

3.4.2 Population

The study population encompass of all companies listed in the Colombo Stock Exchange. The table is included in the Appendix. (Table A.1 Market Capitalization of Listed Companies as of June 30th, 2018)

3.4.3 Sample Size

A sample is a subcategory of individuals selected out of a larger set. In which any individual is selected randomly. Every individual has an identical likelihood of being selected at any phase during the sampling process, and each subcategory of subjects carries the same probability of being selected for the sample, just as same as that of any other subcategory of individuals (Yates, Daniel S.; David S.Moore, Daren S. Starnes (2008).

Table 3.2: List of Sample of Companies

No	COMPANY NAME	No	COMPANY NAME
1	COMMERCIAL BANK	2	HARISCHANDRA
3	DIALOG	4	DUNAMIS CAPITAL
5	HNB	6	AMAYA LEISURE
7	JOHN KEELS	8	SATHOSA MOTORS
9	NESTLE	10	C T LAND
11	TOBACCO	12	EAST WEST
13	DISTILLERIES	14	HOTELS CORP.
15	COLD STORES	16	NUWARA ELIYA
17	SAMPATH	18	PRINTCARE PLC
19	HHL-HEMAS	20	TAL LANKA
21	CARGILS	22	ALLIANCE
23	CARGILS	24	THREE ACRE FARMS
25	LION BREWERY	26	AMF CO LTD
27	SLT	28	MTD WALKERS
29	C T HOLDINGS	30	EQUITY TWO PLC
31	CEYLINCO INS.	32	LANKA VENTURES
33	CARSONS	34	HUNTERS
35	DFCC	36	SOFTLOGIC FIN
37	ASIRI	38	RADIANT GEMS
39	SOFTLOGIC	40	LEE HEDGES
41	PEOPLES LEASING	42	ORIENT FINANCE
43	RICH PIERIS EXP	44	HAYLEYS FABRIC
45	TEXTURED JERSEY	46	BAIRAHA FARMS
47	AHOT PROPERTIES	48	PARAGON
49	NDB	50	DURDANS
51	NTB	52	BROWNS BEACH
53	CENTRAL FINANCE	54	HDFC

55	VALLIBEL ONE	56	RICH PIERIS EXP
57	AITKEN SPENCE	58	KELANI CABLES
59	BUKIT DARAH	60	NAMUNUKULA
61	OVERSEAS REALTY	62	HUEJAY
63	CHEVRON	64	RENUKA CITY HOT.
65	LANKA IOC	66	LUCKY LANKA
67	TRANS ASIA	68	SEYLAN DEVTS
69	LB FINANCE	70	C.W.MACKIE
71	A I A INSURANCE	72	MERCHANT BANK
73	HAYLEYS	74	RENUKA HOLDINGS
75	ACCESS ENG SL	76	EDEN HOTEL LANKA
77	SEYLAN BANK	78	PELWATTE
79	LOLC FINANCE	80	ELPITIYA
81	CEYLON BEVERAGE	82	PRIME FINANCE
83	COMM LEASE & FIN	84	ON'ALLY
85	UNION BANK	86	LIGHTHOUSE HOTEL
87	SINGER SRI LANKA	88	CONVENIENCE FOOD
89	UNION ASSURANCE	90	PANASIAN POWER
91	DILMAH CEYLON	92	AMANA TAKAFUL
93	KEELLS HOTELS	94	ABANS FINANCIAL
95	COM.CREDIT	96	KEGALLE
97	ROYAL CERAMIC	98	MADULSIMA
99	A.SPEN.HOT.HOLD.	100	SWISSTEK
101	ORIENT GARMENTS	102	BOGALA GRAPHITE
103	TOKYO CEMENT	104	MALWATTE
105	BROWNS INVSTMNTS	106	MILLENNIUM HOUSE
107	SEYLAN BANK	108	CITRUS HIKKADUWA
109	UNITED MOTORS	110	TALAWAKELLE
111	AMANA BANK	112	ARPICO INSURANCE
113	SOFTLOGIC LIFE	114	RENUKA AGRI
115	SHALIMAR	116	AGSTAR PLC
117	EXPOLANKA	118	SERENDIB HOTELS
119	MERCANTILE INV	120	RESUS ENERGY
121	MERCANTILE INV	122	ARPICO
123	SUNSHINE HOLDING	124	FORTRESS RESORTS
125	PDL	126	SIERRA CABL
127	LMF	128	BOGAWANTALAWA
129	JETWING SYMPHONY	130	PALM GARDEN HOTL
131	LAUGFS GAS	132	AUTODROME
133	PAN ASIA	134	DANKOTUWA PORCEL
135	SENKADAGALA	136	LANKEM CEYLON
137	ODEL PLC	138	COLOMBO CITY
139	INDO MALAY	140	MORISONS
141	CEYLINCO INS.	142	ASIA ASSET
143	NAWALOKA	144	REGNIS

145	CEYLON GUARDIAN	146	DOLPHIN HOTELS
147	KOTMALE HOLDINGS	148	COMMERCIAL DEV.
149	R I L PROPERTY	150	LAUGFS GAS
151	ASIRI SURG	152	ASIA CAPITAL
153	BROWNS CAPITAL	154	TANGERINE
155	LVL ENERGY	156	MASKELIYA
157	SANASA DEV. BANK	158	SWARNAMAHAL FIN
159	S M B LEASING	160	CIC
161	VALLIBEL	162	C M HOLDINGS
163	WATAWALA	164	TEA SMALLHOLDER
165	AMBEON CAPITAL	166	MULTI FINANCE
167	JANASHAKTHI INS.	168	LANKA CERAMIC
169	LANKA TILES	170	LANKA ALUMINIUM
171	LANKA WALLTILE	172	CHEMANEX
173	DIPPED PRODUCTS	174	ROYAL PALMS
175	DOCKYARD	176	PEGASUS HOTELS
177	ACL	178	TESS AGRO
179	GOOD HOPE	180	RENUKA CAPITAL
181	PEOPLE'S INS	182	KOTAGALA
183	PIRAMAL GLASS	184	CITRUS KALPITIYA
185	BIMPUTH FINANCE	186	MAHAWELI REACH
187	TOKYO CEMENT	188	PEOPLE'S MERCH
189	ALUMEX PLC	190	PC PHARMA
191	CDB	192	CARGO BOAT
193	NATIONS TRUST	194	LANKEM DEV.
195	KINGSBURY	196	RAIGAM SALTERNS
197	TRADE FINANCE	198	CITRUS LEISURE
199	BPPL HOLDINGS	200	CDB
201	VALLIBEL FINANCE	202	CITRUS WASKADUWA
203	HAYCARB	204	NATION LANKA
205	CIC	206	CEYLON TEA BRKRS
207	GALADARI	208	UNION CHEMICALS
209	DIMO	210	E - CHANNELLING
211	GRAIN ELEVATORS	212	SINGHE HOSPITALS
213	CEYLON INV.	214	CENTRAL IND.
215	SOFTLOGIC CAP	216	UDAPUSSELLAWA
217	COLOMBO LAND	218	SINHAPUTHRA FIN
219	MORISONS	220	KELSEY
221	BROWNS	222	DURDANS
223	SELINSING	224	LANKA CEMENT
225	AMBEON HOLDINGS	226	EASTERN MERCHANT
227	E B CREASY	228	SERENDIB LAND
229	KEELLS FOOD	230	GUARDIAN CAPITAL
231	VIDULLANKA	232	LOTUS HYDRO
233	LANKA ASHOK	234	CFT

235	KELANI TYRES	236	HUNAS FALLS
237	FORT LAND	238	CAPITAL LEASING
239	KANDY HOTELS	240	MARAWILA RESORTS
241	FIRST CAPITAL	242	AGALAWATTE
243	SINGER FINANCE	244	LAKE HOUSE PRIN.
245	COLOMBO TRUST	246	ACL PLASTICS
247	KAHAWATTE	248	PC HOUSE
249	KELANI VALLEY	250	RENUKA FOODS

The total sample size of this study was limited to 250 companies that represent the highest market capitalization as of June 30th, 2018, depending on the availability of data for the time period considered. For simulation, the period was considered from 2014 January to 2018 July, and the closing daily market prices are considered for the companies in the above sample.

3.5. The Model Framework of the Study

The geometric Brownian motion model is a recognized method for estimating the value at risk relative to an asset class. This basic simulation is an application of geometric Brownian motion, a special kind of Wiener process. The stochastic process models the stochastic behaviour of the stock-price at a continuous-time. The geometric Brownian motion fits the following random differential equation for continuous-time and random variables:

$$dS_t = \mu S_t dt \; + \; \sigma S_t dWt \qquad (3.1)$$

where:

S_t= Stock price at time t

μ = drift

σ= volatility

W_t= Wiener process

However, the future stock price measured in working trading days in Excel. So adjusting this equation for the discrete-time case:

$$\Delta S_t = S_t - (\mu \Delta t + \sigma \epsilon \sqrt{\Delta t}) \qquad (3.2)$$

Where the new terms are:

ΔS_t= Change in the stock price per unit of time

Δt= Time interval. In this study one day

ε= Standard normal random number

As it is observed, on the right side of the equation, the stock price is actually given from the previous day, which allows the terms in parentheses to be drift and shock, respectively.

It is imperative to understand that this geometric Brownian motion is a Markov process because the price of tomorrow depends only on today's price and not the past.

The property gives certain information on the market efficiency (even in its weak form), which indicates that all the previous information is already relevant at today's price and that the future price depends entirely on the current and future events.

The last formula is a log-normal continuously compounded periodic return of the stock ((S_t/ S_{t-1})); consequently, this lognormal random variable will be approximately normally distributed with mean$\left(\mu - \frac{\sigma^2}{2}\right) t$ and variance $\sigma^2 t$. This is the reason for the price ratios to be log-normal, making the geometric Brownian motion a lognormal diffusion process.

The equivalent (and simpler) formula that was applied in the model is mentioned below:

$$(S_t/S_{t-1}) = \alpha_t + Z_t \tag{3.3}$$

Where:

α= The deterministic component, drift

$z_t\sigma$= the stochastic component, where z_t is the generated random variable for the stock price which will be scaled by its correspondent stochastic volatility at time t.

This equation signifies the foundation of the simulation. In the present matter, the daily expected return is positive, since if the positive expected returns over time, the share price will move up. In a basic model, α_t is not a purely deterministic but a random variable because it is dependent on random instability. Furthermore, stock values are determined for volume S_0 and volatility σ_1 prior to starting the initial price simulation.

The stochastic part is named Random Shock, which is a function of both random stock price and random volatility, which permits the random process to get different price paths each time.

3.6. Data Presentation Tools

The following methods of data presentation have been used in the research.

3.6.1. Tabular method / Using Microsoft Excel

In tabular form, the classification of data takes place in terms of time or other variables.

3.6.2. Graphical method / Descriptive statistics

Graphs and descriptive statistics were also utilized in this research.

3.6.3. Implementation in Excel

Initially, it is illustrated as to how each word is set as input to an Excel sheet.

3.6.4. Expected Daily Drift (Mean):

In the first stage, the value of the annual drift or the return on the stock is set in one cell, and then, in another cell, the value of the daily drift is calculated by dividing the annual drift by 252, giving 252 days in a year.

Finally, the daily drift is converted into the "expected" daily drift by subtracting one-half of the variance at time t in another cell. In simple mathematics: daily drift$-\frac{\sigma_t 2}{2}$. This is geometric average, and since it is used the stochastic volatility, α can´t be a constant, but now it has become a function of t as well, beginning with α_1 as the initial value.

The reason for this calculation is the decrease in stochastic volatility returns, due to the main by-product of the idea of spontaneous walking: it is expressed in return percentages.

3.6.5. Expected Daily volatility ($\boldsymbol{\sigma_t}$):

First, the value of the risk of the stock's annual volatility or expected risk is set in the cell; in another cell, the value of the initial daily volatility is made by dividing the annual volatility by the square root of 252 trading days. Because of the square root, the volatility is measured by the square root of time, but the difference over time is straightforward.

Next, it is to be started running to acquire the successive volatilities, but before the deterministic drifts in and θ are set, to generate the standard normal random number ε_t at time t, i.e. an especial Excel function named: NORMSINV (RAND ()) is used, RAND provides the probability between 0 and 1 which NORMSINV translates into the inverse standard normal cumulative distribution that will generally give a value between 3 and 3. This number appears in the cell named.

The rationale behind "**N (0, 1) vol**", is to randomize the next period volatility that results multiplying this number by$\sqrt{\sigma_{t-1}}\sqrt{\Delta t}$ and later adding the remaining terms in that are known.

This process runs *n* times according to the number of nodes (time steps in trading days) choose to have. It can be identified that all this is for just one simulation (iteration or single path).

3.6.6. Generated random variable for the stock price,

The process to generate z_t is used NORMSINV (RAND ()) once again. Usually, it should indicate a random value between -3 and 3 as well, and this number appears in the cell named **"N (0, 1) Price."**

3.6.7. Steps in Excel

3.6.7.1. Gathering Daily closing prices of the sample companies in the Sri Lankan stock market.

The CSE website or Publicity available data about the daily closing price for the sample period were used, and data were copied to the Excel worksheet

3.6.7.2. Find periodic Daily Returns

In order to find the daily return, the following formula in Excel is used;

=LN (Today's Closing Price/Yesterday closing prices) select and drag the formula to the end

3.6.7.3. Then variance and standard deviation in Excel are found and calculated using the periodic daily return mean,

Mean in Excel **=AVERAGE** (Range of periodic daily return)

Variance in Excel **=VAR.P** (Range of periodic daily return)

Standard Deviation = **STDEV.P** (Range of periodic daily return)

(Standard Deviation is the quantity as to how much a particular value differ from the mean value)

3.6.7.4. Then Applied GM Model formula commonly known with two components

$$\Delta S_t = S_{t-1}(\mu\Delta t + \sigma\varepsilon\sqrt{\Delta t}) \quad \textbf{(3.4)}$$

The first to calculate is the Drift (certain components) variable **= Average-(variance/2)**

The next to calculate is the uncertain variable = **Previous day stocks price* EXP (Drift+ S.D* NORMSINV (RAND ()))**

Then, two variables are combined, and stock prices are forecasted using the following formula:

Change Stock Price = Average-(variance/2) + Previous day stocks price* EXP (Drift +S.D* NORMSINV (RAND ()))

3.7 Data Analyzing Techniques

3.7.1. Test of Hypothesis

Chi-square test is employed to test the hypoth esis; to checks the "goodness-of-fit" between the observed share-price values and the projected ones. This test facilitates determining whether there are significant differences between the expected (foretasted) and observed (actual) stock prices. The equation is given below.

$$x = \frac{observed - expected}{expected} \qquad (3.5)$$

The p-value (the deviation of the observed value from the observed-value only randomly) is calculated against the probability 0.05. If the p-value is less than 0.05, the null hypothesis is rejected, and if not accepted.

3.7.2. Measures

Data were analyzed using the Microsoft Excel package. This study mediates the fixed parameters in the geometric Brownian motion model. Additionally, stock prices with 95% confidence intervals were compared with the duplicate value and real stock prices. The predicted precision of the model was then determined via the mean absolute percentage error, which measures the deviation between expected prices and actual stock prices. (Reddy and Clinton, 2016).

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A-F}{A}\right| \qquad (3.6)$$

F and **A** represent the forecasted values and actual values. And *n* represents the number of observations.

The scale of the judgment of forecast accuracy is as follows.

MAPE Judgment of forecast accuracy. (Source: (Reddy and Clinton, 2016).

<10% (Less than 10%) - highly accurate

11% to 20% - Good accurate

21% to 50% - Reasonable forecast

>51% - Inaccurate forecast

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter is allocated to present data analysis and discussions related to how well the simulated stock prices are similar to actual stock prices.

The main intention of this chapter is to investigate any significant difference between actual stock prices and duplicate ones, by observing stocks on a per-share basis and using the GBM model as a whole.

4.2 Summary of Results

Table 4.1 presents the summary results of the analysis. MAPE value of the entire 250 sample of companies and variance and return data are presented.

Table 4.1: Summary of the results of the simulation

No	Company Name	MAPE	Average Daily Return	Annualized return	Variance	SD (Volatility)	Annualized Volatility	Drift	Graph (Appendix)
1	Commercial Bank	0.0567	-0.0002	-0.0518	0.0044	0.0662	1.0501	-0.0023	A.G.1
2	Dialog	0.0142	0.0004	0.1674	0.0002	0.0133	0.2104	0.0003	A.G.2
3	HNB	0.1540	0.0001	0.0417	0.0316	0.1776	2.8198	-0.0157	A.G.3
4	John Keels	0.1377	-0.0012	-0.3452	0.0265	0.1628	2.5844	-0.0144	A.G.4
5	Nestle	0.0146	-0.0002	-0.0685	0.0002	0.0137	0.2178	-0.0003	A.G.5
6	Tobacco	0.0141	-0.0001	-0.0208	0.0002	0.0131	0.2074	-0.0001	A.G.6
7	DISTILLERIES	0.0666	-0.0024	-0.5839	0.0051	0.0716	1.1372	-0.0050	A.G.7
8	COLD STORES	0.0351	0.0009	0.3672	0.0014	0.0377	0.5982	0.0002	A.G.8
9	Sampath	0.0108	0.0007	0.2676	0.0001	0.0098	0.1558	0.0006	A.G.9
10	HHL-Hemas	0.0167	0.0011	0.5145	0.0002	0.0153	0.2426	0.0010	A.G.10
11	Cargils	0.0338	0.0003	0.1230	0.0013	0.0361	0.5735	-0.0003	A.G.11
12	Cargils	0.0215	0.0007	0.2686	0.0004	0.0193	0.3063	0.0005	A.G.12
13	LION BREWERY	0.0218	0.0006	0.2396	0.0005	0.0212	0.3358	0.0004	A.G.13
14	SLT	0.0191	-0.0004	-0.1303	0.0003	0.0176	0.2791	-0.0005	A.G.14
15	C T HOLDINGS	0.0238	0.0003	0.1204	0.0005	0.0221	0.3507	0.0001	A.G.15
16	CEYLINCO INS.	0.0000	-0.0009	-0.2699	0.0018	0.0425	0.6746	-0.0018	A.G.16
17	CARSONS	0.0000	-0.0011	-0.3364	0.0009	0.0305	0.4843	-0.0016	A.G.17

18	DFCC	0.0000	-0.0001	-0.0481	0.0002	0.0145	0.2302	-0.0002	A.G.18
19	ASIRI	0.0000	0.0000	-0.0034	0.0004	0.0203	0.3220	-0.0002	A.G.19
20	SOFTLOGIC	0.0219	0.0010	0.4183	0.0004	0.0197	0.3134	0.0008	A.G.20
21	PEOPLES LEASING	0.0000	0.0001	0.0428	0.0002	0.0129	0.2042	0.0000	A.G.21
22	RICH PIERIS EXP	0.0000	0.0012	0.5594	0.0007	0.0269	0.4265	0.0009	A.G.22
23	TEXTURED JERSEY	0.0000	0.0023	1.3263	0.0049	0.0696	1.1051	-0.0001	A.G.23
24	AHOT PROPERTIES	0.0215	-0.0002	-0.0690	0.0004	0.0192	0.3049	-0.0004	A.G.24
25	NDB	0.0332	-0.0013	-0.3776	0.0011	0.0330	0.5230	-0.0018	A.G.25
26	NTB	0.0260	0.0003	0.1238	0.0008	0.0278	0.4410	-0.0001	A.G.26
27	CENTRAL FINANCE	0.0566	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.27
28	VALLIBEL ONE	0.0210	0.0001	0.0457	0.0004	0.0191	0.3029	-0.0001	A.G.28
29	AITKEN SPENCE	0.0273	-0.0008	-0.2641	0.0007	0.0266	0.4224	-0.0012	A.G.29
30	BUKIT DARAH	0.0227	-0.0010	-0.3048	0.0005	0.0219	0.3476	-0.0012	A.G.30
31	OVERSEAS REALTY	0.0156	-0.0002	-0.0623	0.0002	0.0143	0.2263	-0.0003	A.G.31
32	CHEVRON	0.0222	-0.0014	-0.4061	0.0006	0.0236	0.3738	-0.0017	A.G.32
33	LANKA IOC	0.0213	-0.0001	-0.0374	0.0004	0.0194	0.3087	-0.0003	A.G.33
34	TRANS ASIA	0.0340	0.0001	0.0452	0.0009	0.0301	0.4782	-0.0003	A.G.34
35	LB FINANCE	0.0247	0.0001	0.0517	0.0007	0.0255	0.4045	-0.0002	A.G.35
36	A I A INSURANCE	0.0371	0.0005	0.2093	0.0012	0.0352	0.5588	-0.0001	A.G.36
37	HAYLEYS	0.0584	-0.0026	-0.6080	0.0037	0.0612	0.9711	-0.0044	A.G.37
38	ACCESS ENG SL	0.0171	-0.0004	-0.1199	0.0003	0.0162	0.2567	-0.0005	A.G.38
39	SEYLAN BANK	0.0230	-0.0001	-0.0314	0.0005	0.0231	0.3661	-0.0004	A.G.39
40	LOLC FINANCE	0.0298	0.0002	0.0581	0.0007	0.0271	0.4297	-0.0002	A.G.40
41	CEYLON BEVERAGE	0.0475	0.0001	0.0500	0.0020	0.0452	0.7168	-0.0009	A.G.41
42	COMM LEASE & FIN	0.0444	-0.0001	-0.0378	0.0017	0.0411	0.6527	-0.0010	A.G.42
43	UNION BANK	0.0276	-0.0001	-0.0333	0.0009	0.0296	0.4697	-0.0005	A.G.43
44	SINGER SRI LANKA	0.0249	0.0003	0.1014	0.0005	0.0222	0.3524	0.0000	A.G.44
45	UNION ASSURANCE	0.0376	0.0004	0.1344	0.0013	0.0365	0.5800	-0.0003	A.G.45
46	DILMAH	0.0254	0.0001	0.0246	0.0005	0.0229	0.3629	-0.0002	A.G.46
47	KEELLS HOTELS	0.0224	0.0001	0.0401	0.0005	0.0229	0.3627	-0.0002	A.G.47
48	COM.CREDIT	0.0252	0.0013	0.5810	0.0005	0.0232	0.3674	0.0010	A.G.48
49	ROYAL CERAMIC	0.0110	0.0001	0.0411	0.0001	0.0100	0.1589	0.0001	A.G.49
50	A.SPEN.HOT. HOLD.	0.0280	-0.0007	-0.2245	0.0008	0.0283	0.4499	-0.0011	A.G.50

51	ORIENT GARMENTS	0.0863	0.0009	0.3961	0.0099	0.0997	1.5824	-0.0041	A.G.51
52	TOKYO CEMENT	0.0270	0.0004	0.1474	0.0008	0.0273	0.4339	0.0000	A.G.52
53	BROWNS INVSTMNTS	0.0466	0.0001	0.0518	0.0020	0.0448	0.7107	-0.0009	A.G.53
54	SEYLAN BANK	0.0302	0.0001	0.0203	0.0009	0.0306	0.4855	-0.0004	A.G.54
55	UNITED MOTORS	0.0555	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.55
56	AMANA BANK	0.0690	-0.0002	-0.0530	0.0044	0.0665	1.0548	-0.0024	A.G.56
57	Softlogic Life	0.0493	0.0003	0.1151	0.0022	0.0472	0.7487	-0.0008	A.G.57
58	SHALIMAR	0.0882	0.0005	0.2063	0.0071	0.0840	1.3337	-0.0030	A.G.58
59	EXPOLANKA	0.0204	-0.0002	-0.0654	0.0004	0.0197	0.3131	-0.0004	A.G.59
60	MERCANTILE INV	0.0386	-0.0010	-0.3135	0.0016	0.0397	0.6300	-0.0018	A.G.60
61	MERCANTILE INV	0.0680	-0.0017	-0.4651	0.0049	0.0701	1.1124	-0.0042	A.G.61
62	SUNSHINE HOLDING	0.0399	0.0004	0.1624	0.0017	0.0417	0.6618	-0.0005	A.G.62
63	PDL	0.0633	0.0006	0.2595	0.0036	0.0598	0.9491	-0.0012	A.G.63
64	LMF	0.0194	0.0000	-0.0155	0.0003	0.0174	0.2762	-0.0002	A.G.64
65	JETWING SYMPHONY	0.0550	-0.0017	-0.4594	0.0037	0.0605	0.9611	-0.0035	A.G.65
66	LAUGFS GAS	0.0203	-0.0001	-0.0253	0.0004	0.0203	0.3220	-0.0003	A.G.66
67	PAN ASIA	0.0193	-0.0001	-0.0242	0.0003	0.0171	0.2716	-0.0002	A.G.67
68	SENKADAGA LA	0.0582	-0.0011	-0.3333	0.0038	0.0612	0.9717	-0.0030	A.G.68
69	ODEL PLC	0.0300	0.0001	0.0170	0.0008	0.0284	0.4509	-0.0004	A.G.69
70	INDO MALAY	0.1618	0.0000	0.0072	0.0204	0.1428	2.2672	-0.0102	A.G.70
71	CEYLINCO INS.	0.0507	-0.0005	-0.1575	0.0029	0.0539	0.8548	-0.0019	A.G.71
72	NAWALOKA	0.0287	-0.0001	-0.0426	0.0007	0.0269	0.4266	-0.0005	A.G.72
73	CEYLON GUARDIAN	0.0564	-0.0016	-0.4325	0.0040	0.0636	1.0096	-0.0036	A.G.73
74	KOTMALE HOLDINGS	0.0554	-0.0022	-0.5466	0.0037	0.0605	0.9604	-0.0040	A.G.74
75	R I L PROPERTY	0.0549	-0.0021	-0.5316	0.0037	0.0605	0.9610	-0.0039	A.G.75
76	ASIRI SURG	0.0159	-0.0003	-0.0961	0.0003	0.0159	0.2520	-0.0004	A.G.76
77	BROWNS CAPITAL	0.0574	-0.0002	-0.0553	0.0026	0.0509	0.8079	-0.0015	A.G.77
78	LVL ENERGY	0.0565	-0.0021	-0.5375	0.0037	0.0605	0.9610	-0.0039	A.G.78
79	SANASA DEV. BANK	0.0566	-0.0016	-0.4392	0.0041	0.0637	1.0117	-0.0036	A.G.79
80	S M B LEASING	0.0552	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.80
81	VALLIBEL	0.0269	-0.0001	-0.0270	0.0007	0.0255	0.4052	-0.0004	A.G.81
82	WATAWALA	0.0274	0.0005	0.1971	0.0008	0.0277	0.4394	0.0001	A.G.82
83	AMBEON CAPITAL	0.0575	-0.0016	-0.4495	0.0039	0.0628	0.9962	-0.0036	A.G.83

84	JANASHAKTHI INS.	0.0128	0.0000	-0.0021	0.0002	0.0121	0.1912	-0.0001	A.G.84
85	LANKA TILES	0.0407	0.0000	0.0089	0.0019	0.0433	0.6871	-0.0009	A.G.85
86	LANKA WALLTILE	0.0394	0.0000	-0.0029	0.0018	0.0424	0.6731	-0.0009	A.G.86
87	DIPPED PRODUCTS	0.0605	-0.0016	-0.4492	0.0043	0.0652	1.0347	-0.0038	A.G.87
88	DOCKYARD	0.0561	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.88
89	ACL	0.0257	-0.0001	-0.0166	0.0007	0.0268	0.4256	-0.0004	A.G.89
90	GOOD HOPE	0.0484	-0.0002	-0.0558	0.0032	0.0563	0.8937	-0.0017	A.G.90
91	PEOPLE'S INS	0.0155	0.0006	0.2395	0.0002	0.0146	0.2324	0.0005	A.G.91
92	PIRAMAL GLASS	0.0114	0.0010	0.4183	0.0004	0.0197	0.3134	0.0008	A.G.92
93	BIMPUTH FINANCE	0.0788	-0.0010	-0.3048	0.0005	0.0219	0.3476	-0.0012	A.G.93
94	TOKYO CEMENT	0.0582	0.0002	0.0581	0.0007	0.0271	0.4297	-0.0002	A.G.94
95	ALUMEX PLC	0.0203	-0.0007	-0.2245	0.0008	0.0283	0.4499	-0.0011	A.G.95
96	CDB	0.0634	-0.0010	-0.3135	0.0016	0.0397	0.6300	-0.0018	A.G.96
97	NATIONS TRUST	0.0530	0.0000	0.0072	0.0204	0.1428	2.2672	-0.0102	A.G.97
98	KINGSBURY	0.0248	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.98
99	TRADE FINANCE	0.0535	-0.0002	-0.0558	0.0032	0.0563	0.8937	-0.0017	A.G.99
100	BPPL HOLDINGS	0.0555	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.100
101	VALLIBEL FINANCE	0.0238	-0.0001	-0.0395	0.0005	0.0220	0.3494	-0.0004	A.G.101
102	HAYCARB	0.0580	-0.0022	-0.5434	0.0037	0.0605	0.9604	-0.0040	A.G.102
103	CIC	0.0653	-0.0009	-0.2831	0.0047	0.0684	1.0858	-0.0033	A.G.103
104	GALADARI	0.0234	0.0001	0.0476	0.0005	0.0218	0.3466	-0.0001	A.G.104
105	DIMO	0.0237	0.0003	0.0964	0.0005	0.0233	0.3704	0.0000	A.G.105
106	GRAIN ELEVATORS	0.0548	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.106
107	CEYLON INV	0.0561	-0.0018	-0.4739	0.0038	0.0617	0.9790	-0.0037	A.G.107
108	SOFTLOGIC CAP	0.0262	-0.0001	-0.0231	0.0006	0.0238	0.3776	-0.0004	A.G.108
109	COLOMBO LAND	0.0360	-0.0003	-0.0927	0.0011	0.0334	0.5302	-0.0008	A.G.109
110	MORISONS	0.0589	-0.0025	-0.6002	0.0041	0.0640	1.0161	-0.0046	A.G.110
111	BROWNS	0.0272	0.0002	0.0898	0.0007	0.0257	0.4075	-0.0001	A.G.111
112	SELINSING	0.0547	0.0001	0.0261	0.0027	0.0521	0.8268	-0.0013	A.G.112
113	AMBEON HOLDINGS	0.0562	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.113
114	E B CREASY	0.0534	0.0003	0.1214	0.0026	0.0508	0.8067	-0.0010	A.G.114
115	KEELLS FOOD	0.0557	-0.0002	-0.0661	0.0027	0.0524	0.8312	-0.0016	A.G.115
116	VIDULLANKA	0.0196	-0.0001	-0.0476	0.0004	0.0187	0.2966	-0.0003	A.G.116
117	LANKA ASHOK	0.0338	0.0001	0.0234	0.0012	0.0347	0.5512	-0.0005	A.G.117

118	KELANI TYRES	0.0273	-0.0002	-0.0559	0.0007	0.0256	0.4058	-0.0005	A.G.118
119	FORT LAND	0.0204	0.0001	0.0205	0.0003	0.0177	0.2809	-0.0001	A.G.119
120	KANDY HOTELS	0.0335	-0.0001	-0.0480	0.0010	0.0314	0.4977	-0.0006	A.G.120
121	FIRST CAPITAL	0.0367	-0.0009	-0.2708	0.0011	0.0336	0.5339	-0.0014	A.G.121
122	SINGER FINANCE	0.0241	0.0002	0.0867	0.0006	0.0244	0.3865	-0.0001	A.G.122
123	COLOMBO TRUST	0.0555	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.123
124	KAHAWATTE	0.0384	0.0001	0.0169	0.0012	0.0346	0.5492	-0.0006	A.G.124
125	KELANI VALLEY	0.0656	-0.0013	-0.3877	0.0052	0.0724	1.1494	-0.0040	A.G.125
126	HARISCHAN DRA	0.0442	0.0001	0.0376	0.0023	0.0483	0.7666	-0.0011	A.G.126
127	DUNAMIS CAPITAL	0.0374	-0.0002	-0.0681	0.0012	0.0348	0.5522	-0.0008	A.G.127
128	AMAYA LEISURE	0.0637	-0.0013	-0.3670	0.0048	0.0692	1.0990	-0.0037	A.G.128
129	SATHOSA MOTORS	0.0583	-0.0024	-0.5848	0.0038	0.0614	0.9748	-0.0043	A.G.129
130	C T LAND	0.0262	0.0002	0.0925	0.0006	0.0241	0.3823	-0.0001	A.G.130
131	EAST WEST	0.0297	0.0002	0.0702	0.0008	0.0283	0.4486	-0.0002	A.G.131
132	HOTELS CORP.	0.0420	-0.0001	-0.0456	0.0014	0.0378	0.6003	-0.0008	A.G.132
133	NUWARA ELIYA	0.0179	0.0001	0.0167	0.0004	0.0196	0.3107	-0.0002	A.G.133
134	PRINTCARE PLC	0.0555	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.134
135	TAL LANKA	0.0356	-0.0002	-0.0820	0.0014	0.0371	0.5893	-0.0009	A.G.135
136	ALLIANCE	0.0660	-0.0011	-0.3398	0.0053	0.0729	1.1570	-0.0038	A.G.136
137	THREE ACRE FARM	0.0162	0.0010	0.4193	0.0004	0.0209	0.3317	0.0007	A.G.137
138	AMF CO LTD	0.0542	-0.0028	-0.6450	0.0049	0.0702	1.1141	-0.0053	A.G.138
139	MTD WALKERS	0.0326	-0.0001	-0.0267	0.0016	0.0403	0.6394	-0.0009	A.G.139
140	EQUITY TWO PLC	0.0748	0.0004	0.1373	0.0053	0.0729	1.1571	-0.0023	A.G.140
141	LANKA VENTURES	0.0380	0.0000	-0.0075	0.0017	0.0409	0.6490	-0.0009	A.G.141
142	HUNTERS	0.0460	-0.0001	-0.0308	0.0026	0.0510	0.8095	-0.0014	A.G.142
143	SOFTLOGIC FIN	0.0335	-0.0005	-0.1688	0.0012	0.0341	0.5412	-0.0011	A.G.143
144	RADIANT GEMS	0.0571	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.144
145	LEE HEDGES	0.0774	0.0000	0.0082	0.0069	0.0833	1.3225	-0.0035	A.G.145
146	ORIENT FINANCE	0.0359	0.0001	0.0481	0.0011	0.0334	0.5293	-0.0004	A.G.146
147	HAYLEYS FABRIC	0.0560	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.147
148	BAIRAHA FARMS	0.0564	-0.0018	-0.4783	0.0037	0.0611	0.9701	-0.0037	A.G.148
149	PARAGON	0.1238	-0.0023	-0.5689	0.0159	0.1262	2.0037	-0.0103	A.G.149

150	DURDANS	0.0617	-0.0016	-0.4501	0.0042	0.0649	1.0298	-0.0037	A.G.150
151	BROWNS BEACH	0.0266	0.0002	0.0898	0.0007	0.0257	0.4075	-0.0001	A.G.151
152	HDFC	0.0515	0.0001	0.0501	0.0029	0.0543	0.8614	-0.0013	A.G.152
153	RICH PIERIS EXP	0.0743	0.0004	0.1443	0.0060	0.0776	1.2323	-0.0026	A.G.153
154	KELANI CABLES	0.0376	0.0001	0.0413	0.0013	0.0362	0.5744	-0.0005	A.G.154
155	NAMUNUKU LA	0.0516	-0.0014	-0.4049	0.0032	0.0566	0.8978	-0.0030	A.G.155
156	HUEJAY	0.0572	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.156
157	RENUKA CITY HOT.	0.0545	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.157
158	LUCKY LANKA	0.0557	-0.0022	-0.5527	0.0037	0.0606	0.9616	-0.0040	A.G.158
159	SEYLAN DEVTS	0.0189	-0.0001	-0.0221	0.0003	0.0178	0.2822	-0.0002	A.G.159
160	C.W.MACKIE	0.0571	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.160
161	MERCHANT BANK	0.0192	0.0001	0.0173	0.0003	0.0179	0.2843	-0.0001	A.G.161
162	RENUKA HOLDINGS	0.0536	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.162
163	EDEN HOTEL LANKA	0.0387	0.0000	0.0065	0.0015	0.0382	0.6063	-0.0007	A.G.163
164	PELWATTE	0.0564	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.164
165	ELPITIYA	0.0324	0.0005	0.1987	0.0010	0.0310	0.4923	0.0000	A.G.165
166	PRIME FINANCE	0.0543	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.166
167	ON'ALLY	0.0447	-0.0002	-0.0706	0.0017	0.0417	0.6616	-0.0011	A.G.167
168	LIGHTHOUSE HOTEL	0.0419	-0.0001	-0.0247	0.0017	0.0410	0.6513	-0.0009	A.G.168
169	CONVENIENC E FOOD	0.0578	-0.0023	-0.5644	0.0038	0.0618	0.9807	-0.0042	A.G.169
170	PANASIAN POWER	0.0332	0.0000	-0.0138	0.0009	0.0296	0.4696	-0.0005	A.G.170
171	AMANA TAKAFUL	0.0504	0.0001	0.0409	0.0023	0.0475	0.7537	-0.0010	A.G.171
172	ABANS FINANCIAL	0.0603	-0.0015	-0.4310	0.0040	0.0635	1.0086	-0.0036	A.G.172
173	KEGALLE	0.0282	-0.0003	-0.1146	0.0009	0.0295	0.4682	-0.0008	A.G.173
174	MADULSIMA	0.0125	0.0010	0.4491	0.0002	0.0128	0.2026	0.0009	A.G.174
175	SWISSTEK	0.0551	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.175
176	BOGALA GRAPHITE	0.0478	-0.0004	-0.1437	0.0023	0.0480	0.7617	-0.0016	A.G.176
177	MALWATTE	0.0347	-0.0001	-0.0173	0.0010	0.0308	0.4888	-0.0005	A.G.177
178	MILLENNIUM HOUSE	0.0328	0.0000	-0.0109	0.0009	0.0302	0.4800	-0.0005	A.G.178
179	CITRUS HIKKADUWA	0.0669	-0.0006	-0.2038	0.0039	0.0626	0.9944	-0.0026	A.G.179
180	TALAWAKEL LE	0.0317	-0.0003	-0.1170	0.0010	0.0313	0.4961	-0.0008	A.G.180
181	ARPICO INSURANCE	0.0545	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.181

182	RENUKA AGRI	0.0284	0.0000	-	0.0007	0.0257	0.4079	-0.0003	A.G.182
183	AGSTAR PLC	0.0327	-0.0001	-0.0435	0.0010	0.0313	0.4966	-0.0006	A.G.183
184	SERENDIB HOTELS	0.0566	-0.0003	-0.1117	0.0028	0.0525	0.8340	-0.0017	A.G.184
185	RESUS ENERGY	0.0227	0.0002	0.0620	0.0005	0.0222	0.3516	-0.0001	A.G.185
186	ARPICO	0.0597	-0.0016	-0.4347	0.0041	0.0637	1.0113	-0.0036	A.G.186
187	FORTRESS RESORTS	0.0280	0.0003	0.1328	0.0007	0.0263	0.4168	0.0000	A.G.187
188	SIERRA CABL	0.0548	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.188
189	BOGAWANT ALAWA	0.0353	0.0005	0.2198	0.0012	0.0340	0.5403	0.0000	A.G.189
190	PALM GARDEN HOTL	0.0556	-0.0021	-0.5410	0.0037	0.0606	0.9617	-0.0040	A.G.190
191	AUTODROME	0.1991	-0.0022	-0.5584	0.0421	0.2052	3.2568	-0.0233	A.G.191
192	DANKOTUW A PORCEL	0.0337	-0.0004	-0.1208	0.0011	0.0326	0.5169	-0.0009	A.G.192
193	LANKEM CEYLON	0.0409	-0.0009	-0.2742	0.0016	0.0397	0.6298	-0.0017	A.G.193
194	COLOMBO CITY	0.0356	0.0005	0.1916	0.0011	0.0336	0.5330	-0.0001	A.G.194
195	MORISONS	0.0563	-0.0021	-0.5410	0.0037	0.0606	0.9617	-0.0040	A.G.195
196	ASIA ASSET	0.0381	-0.0001	-0.0173	0.0012	0.0339	0.5388	-0.0006	A.G.196
197	REGNIS	0.0259	0.0001	0.0394	0.0006	0.0243	0.3855	-0.0002	A.G.197
198	DOLPHIN HOTELS	0.0325	0.0000	0.0127	0.0009	0.0298	0.4732	-0.0004	A.G.198
199	COMMERCIA L DEV.	0.0566	-0.0021	-0.5305	0.0037	0.0606	0.9619	-0.0039	A.G.199
200	LAUGFS GAS	0.0267	0.0001	0.0187	0.0007	0.0260	0.4119	-0.0003	A.G.200
201	ASIA CAPITAL	0.0386	-0.0003	-0.1115	0.0013	0.0357	0.5665	-0.0010	A.G.201
202	TANGERINE	0.0467	0.0000	0.0072	0.0019	0.0432	0.6859	-0.0009	A.G.202
203	MASKELIYA	0.0287	0.0003	0.1160	0.0007	0.0267	0.4245	-0.0001	A.G.203
204	SWARNAMA HAL FIN	0.0356	0.0000	-	0.0010	0.0313	0.4965	-0.0005	A.G.204
205	CIC	0.0398	0.0003	0.1088	0.0017	0.0407	0.6467	-0.0006	A.G.205
206	C M HOLDINGS	0.0632	-0.0013	-0.3810	0.0045	0.0672	1.0662	-0.0036	A.G.206
207	TEA SMALLHOLD ER	0.0565	-0.0017	-0.4680	0.0039	0.0628	0.9968	-0.0037	A.G.207
208	MULTI FINANCE	0.0529	-0.0004	-0.1204	0.0027	0.0515	0.8167	-0.0017	A.G.208
209	LANKA CERAMIC	0.0620	-0.0001	-0.0187	0.0030	0.0550	0.8723	-0.0016	A.G.209
210	LANKA ALUMINIUM	0.0477	0.0005	0.2130	0.0023	0.0483	0.7674	-0.0006	A.G.210
211	CHEMANEX	0.0355	-0.0002	-0.0740	0.0010	0.0323	0.5126	-0.0007	A.G.211
212	ROYAL PALMS	0.0469	0.0003	0.1242	0.0018	0.0422	0.6701	-0.0006	A.G.212

213	PEGASUS HOTELS	0.0561	-0.0021	-0.5427	0.0037	0.0606	0.9624	-0.0040	A.G.213
214	TESS AGRO	0.0380	-0.0001	-0.0269	0.0023	0.0482	0.7653	-0.0012	A.G.214
215	RENUKA CAPITAL	0.0484	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.215
216	KOTAGALA	0.0411	-0.0009	-0.2763	0.0019	0.0438	0.6947	-0.0018	A.G.216
217	CITRUS KALPITIYA	0.0575	-0.0017	-0.4681	0.0038	0.0616	0.9770	-0.0036	A.G.217
218	MAHAWELI REACH	0.0397	0.0004	0.1454	0.0015	0.0389	0.6169	-0.0004	A.G.218
219	PEOPLE'S MERCH	0.0494	0.0000	0.0149	0.0022	0.0463	0.7352	-0.0010	A.G.219
220	PC PHARMA	0.2589	-0.0014	-0.4081	0.1072	0.3274	5.1977	-0.0550	A.G.220
221	CARGO BOAT	0.0407	-0.0001	-0.0180	0.0015	0.0392	0.6221	-0.0008	A.G.221
222	LANKEM DEV.	0.0390	0.0002	0.0549	0.0014	0.0369	0.5852	-0.0005	A.G.222
223	RAIGAM SALTERNS	0.0408	0.0002	0.0585	0.0014	0.0368	0.5846	-0.0005	A.G.223
224	CITRUS LEISURE	0.0558	-0.0021	-0.5368	0.0037	0.0606	0.9613	-0.0039	A.G.224
225	CDB	0.0482	0.0004	0.1349	0.0026	0.0512	0.8133	-0.0010	A.G.225
226	CITRUS WASKADUW	0.0294	0.0001	0.0353	0.0007	0.0266	0.4219	-0.0003	A.G.226
227	NATION LANKA	0.0321	0.0000	-0.0159	0.0010	0.0323	0.5128	-0.0006	A.G.227
228	CEYLON TEA BRKRS	0.0237	0.0002	0.0652	0.0005	0.0219	0.3478	-0.0001	A.G.228
229	UNION CHEMICALS	0.0928	-0.0001	-0.0386	0.0069	0.0829	1.3159	-0.0035	A.G.229
230	E - CHANNELLIN G	0.0208	0.0001	0.0213	0.0004	0.0200	0.3177	-0.0001	A.G.230
231	SINGHE HOSPITALS	0.0564	-0.0029	-0.6559	0.0038	0.0620	0.9841	-0.0048	A.G.231
232	CENTRAL IND.	0.0551	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.232
233	UDAPUSSELL AWA	0.0498	-0.0002	-0.0580	0.0022	0.0471	0.7481	-0.0013	A.G.233
234	SINHAPUTHR A FIN	0.0892	-0.0021	-0.5312	0.0086	0.0930	1.4759	-0.0064	A.G.234
235	KELSEY	0.0503	0.0010	0.4236	0.0024	0.0487	0.7738	-0.0002	A.G.235
236	DURDANS	0.0407	-0.0002	-0.0552	0.0015	0.0388	0.6152	-0.0009	A.G.236
237	LANKA CEMENT	0.0604	0.0001	0.0284	0.0037	0.0607	0.9633	-0.0018	A.G.237
238	EASTERN MERCHANT	0.0366	-0.0001	-0.0206	0.0013	0.0356	0.5647	-0.0007	A.G.238
239	SERENDIB LAND	0.0547	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.239
240	GUARDIAN CAPITAL	0.0348	0.0003	0.1146	0.0011	0.0324	0.5145	-0.0002	A.G.240
241	LOTUS HYDRO	0.0532	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.241
242	CFT	0.0375	-0.0001	-0.0502	0.0012	0.0342	0.5433	-0.0007	A.G.242
243	HUNAS FALLS	0.0500	0.0001	0.0188	0.0020	0.0448	0.7113	-0.0010	A.G.243

244	CAPITAL LEASING	0.0542	-0.0021	-0.5306	0.0037	0.0605	0.9611	-0.0039	A.G.244
245	MARAWILA RESORTS	0.0240	0.0001	0.0423	0.0005	0.0221	0.3509	-0.0001	A.G.245
246	AGALAWATT E	0.0441	-0.0003	-0.0908	0.0016	0.0399	0.6327	-0.0011	A.G.246
247	LAKE HOUSE PRIN.	0.0541	0.0004	0.1433	0.0024	0.0491	0.7791	-0.0008	A.G.247
248	ACL PLASTICS	0.0533	0.0004	0.1398	0.0029	0.0534	0.8474	-0.0011	A.G.248
249	PC HOUSE	0.3367	-0.0013	-0.3865	0.0945	0.3074	4.8793	-0.0486	A.G.249
250	RENUKA FOODS	0.0322	-0.0001	-0.0377	0.0011	0.0327	0.5191	-0.0006	A.G.250

The graphical illustrations are attached to the appendix, and the relevant number is mentioned in the final column of the table.

4.3 Descriptive Analysis of the results

Table 4.2: Descriptive statistics (sample of 250 companies) of the MAPE

	MAPE
Mean	0.044922
Median	0.039797
Maximum	0.346306
Minimum	0.000000
Std. Dev.	0.033935
Skewness	4.562109
Kurtosis	34.77141
Sum	11.23048
Sum Sq. Dev.	0.286738
Observations	250

The mean value of the MAPE is 4.49% of the sample. As per the criteria for judging the accuracy, if MAPE value is lower than 10%, the forecast is accurate. However, the sample is further analyzed with the frequencies.

Table 4.3: Frequencies of MAPE of the sample

Tabulation of MAPE				
Number of categories: 4				
			Cumulative	Cumulative
Value	Count	Per cent	Count	Per cent
[0, 0.1) (Below 10%	**243**	**97.20**	**243**	**97.20**
[0.1, 0.2) (10% - 20%)	4	1.60	247	98.80
[0.2, 0.3) (20% - 30%)	2	0.80	249	99.60
[0.3, 0.4) (30% - 40%)	1	0.40	250	100.00
Total	250	100.00	250	100.00

According to Table 4.3, MAPE value of the sample, 97.2% (243 companies out of 250 companies) is below 10%. It reveals that the prediction is accurate for 97.2% of the sample. The same results are illustrated in Figure 4.1.

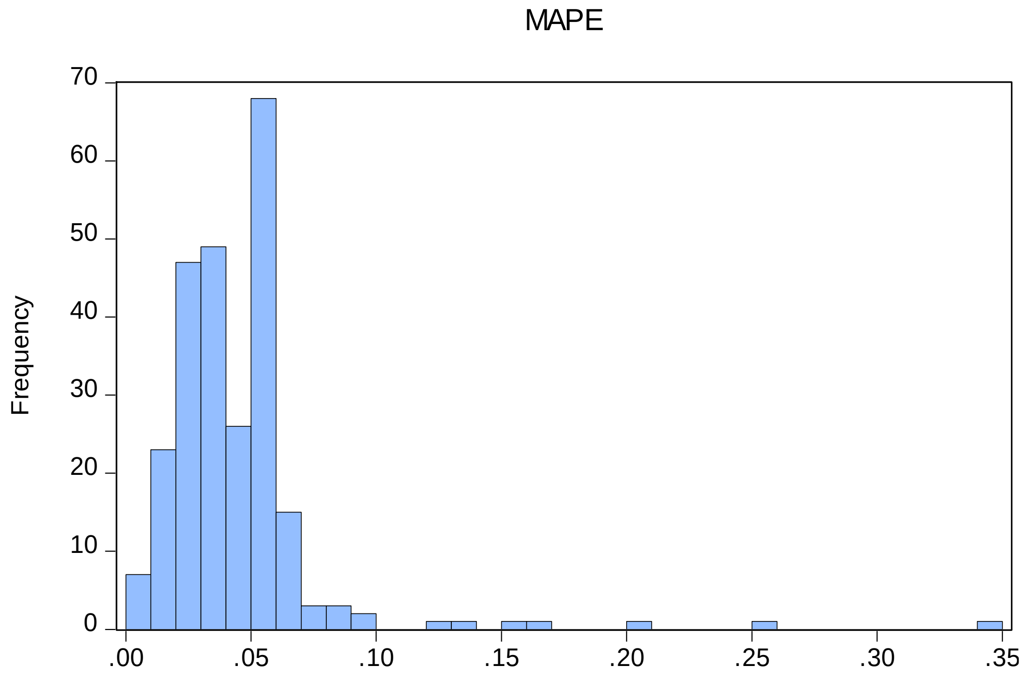

Figure 4.1: MAPE values of the sample of 250 Securities

The horizontal axis represents the MAPE values. Figure 4.1 discloses that the majority of the MAPE is in the 0%-10% range.

4.4 Analysis of selected individual securities.

Selected 6 securities are analyzed individually. Graphical analysis is attached in the appendix for the remaining securities in the sample.

4.4.1 Commercial Bank

The 4.4 Table shows a forecasted average, variance, standard deviation and drift variable output data table for simulation stock prices from 2014 to 2018 in Commercial Bank

Table 4.4: Statistical test values

Average Daily Return	Variance	Stand Deviation	Drift
(0.00015)	0.00438	0.06615	(0.00233)

Table 4.5 displays the results for the 2018 January month simulation, which shows that no significant difference in the Actual closing price and simulated stock-prices calculated via Geometric Brownian motion model can be observed.

Table 4.5: Sample of actual prices, Forecast prices in Commercial Bank

Day	Closing Price	Daily Return	Simulated Price
3-Jan-18	137.9	(0.00)	151.74
4-Jan-18	140	0.02	130.89
5-Jan-18	140.5	0.00	145.85
8-Jan-18	141	0.00	144.61
9-Jan-18	142	0.01	142.83
10-Jan-18	141.7	(0.00)	138.76
11-Jan-18	142.2	0.00	142.80
12-Jan-18	141.5	(0.00)	159.18
16-Jan-18	140	(0.01)	155.16
17-Jan-18	140	-	143.69
18-Jan-18	136.1	(0.03)	142.14
19-Jan-18	136.7	0.00	135.02
22-Jan-18	136.1	(0.00)	125.42
23-Jan-18	138	0.01	131.89
24-Jan-18	138	-	143.24
3-Jan-18	137.9	(0.00)	151.74

4-Jan-18	140	0.02	130.89
5-Jan-18	140.5	0.00	145.85
8-Jan-18	141	0.00	144.61

Figure 4.2 presents real stock price changes in Commercial Bank since 2014 to 2018, which implies that since 2014 stock prices gradually increased till 2015 and then onwards gradually decreased and remained stable over the rest of the years.

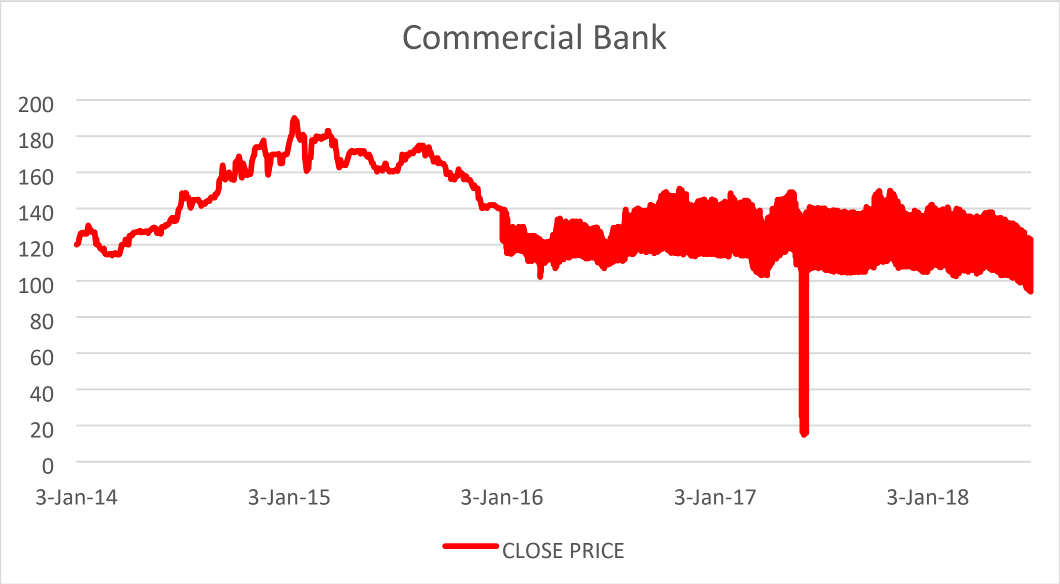

Figure 4.2: Real Stock prices data for Commercial Bank from 2014 to 2018

Figure 4.2 presents the simulated stock price changes in Commercial Bank from 2014 to 2018. It implies that since 2014 stock prices gradually increased till 2015 and afterwards they gradually decreased and remained stable. However, considering the actual price data, not much of a gradually increases in prices are observed.

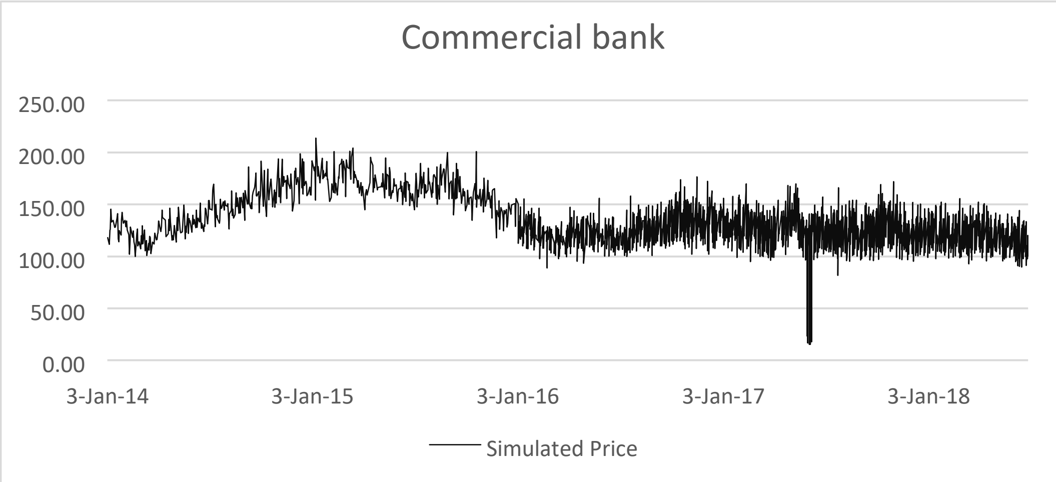

Figure 4.3: Simulated Stock prices data for Commercial Bank from 2014 to 2018

Figure 4.3. presents simulated stock prices and actual stock price changes graphically. According to the graph, simulated stock prices go on actually stock price line and do not show more changes with real prices in the long-time horizons uses GBM model in commercial bank highly accurate

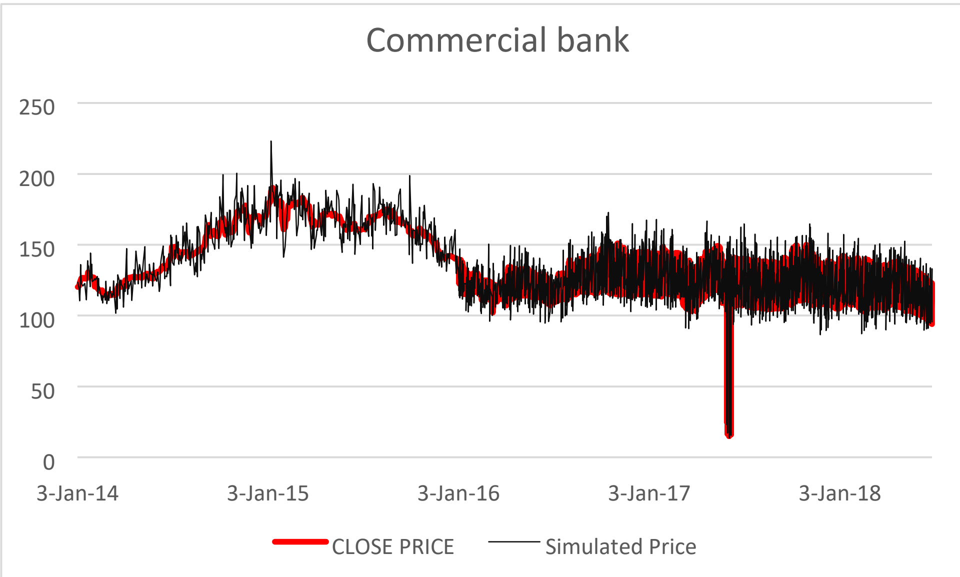

Figure 4.4: Comparison of real stock prices vs simulated stock prices

4.4.2 Dialog Axiata PLC

Table 4.6 shows the forecasted average, variance, standard deviation, and drift variable output data table for simulation stock prices from 2014 to 2018 in Dialog Axiata PLC.

Table 4.6: Statistical Test Values

Average Daily Return	Variance	Stand Deviation	Drift
0.00042	0.00018	0.01326	0.00034

Table 4.7 shows results for the 2018 January month simulation; no significant difference in actual closing prices and simulated stock-prices have been calculated by means of the Geometric Brownian motion model.

Table 4.7: Sample of actual prices, forecast prices in Dialog

Day	Closing Price	Daily Return	Simulated Price
2-Jan-18	13.4	0.022642477	12.98
3-Jan-18	13.2	-0.015037877	13.46
4-Jan-18	13.1	-0.007604599	13.32
5-Jan-18	13.5	0.030077455	12.93
8-Jan-18	13.5	0	13.63
9-Jan-18	13.5	0	13.65
10-Jan-18	13.4	-0.007434978	13.43
11-Jan-18	13.4	0	13.34
12-Jan-18	13.5	0.007434978	13.26
16-Jan-18	13.4	-0.007434978	13.77
17-Jan-18	13.4	0	13.42
18-Jan-18	13.2	-0.015037877	13.54
19-Jan-18	13.1	-0.007604599	13.03
22-Jan-18	13.1	0	13.15
23-Jan-18	13.1	0	13.19
24-Jan-18	13.1	0	13.40
25-Jan-18	13.4	0.022642477	13.22
26-Jan-18	13.6	0.014815086	13.40
29-Jan-18	13.5	-0.007380107	13.30
30-Jan-18	13.7	0.014706147	13.51

Figure 4.5 presents the real stock prices changes in Dialog Axiata from 2014 to 2018.

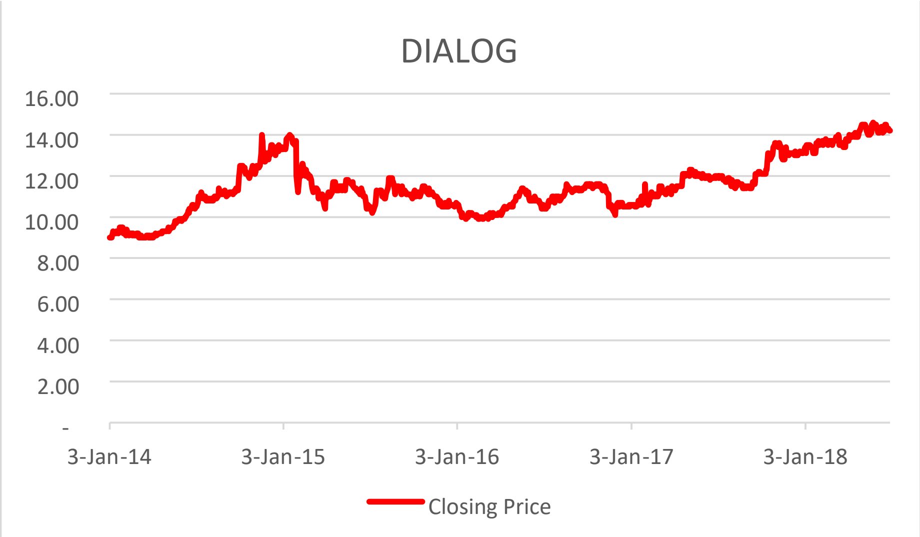

Figure 4.5: Real Stock prices data for Dialog Axiata from 2014 to 2018

Figure 4.6 presents simulated stock prices changes in Dialog Axiata from 2014 to 2018.

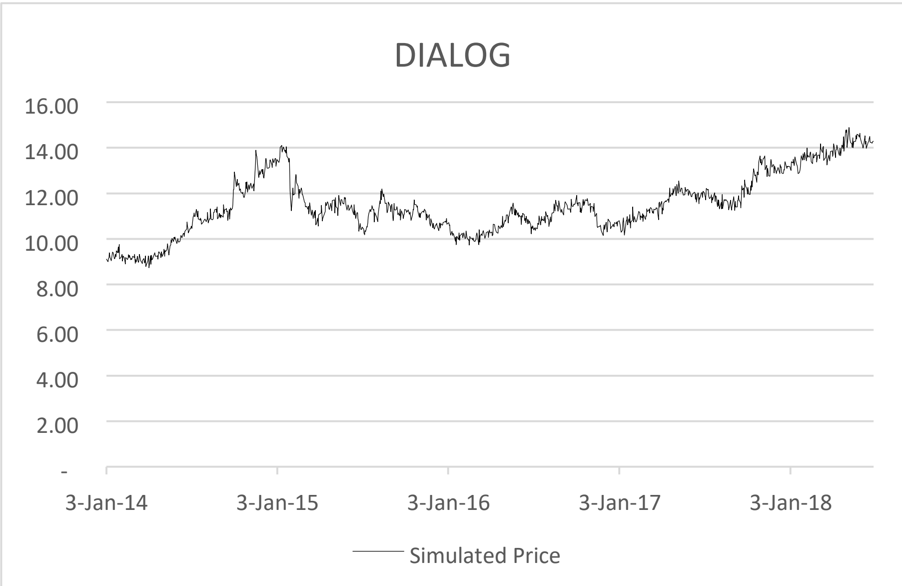

Figure 4.6: Simulated Stock prices data for Dialog Axiata from 2014 to 2018

Figure 4.7 represents simulated stock prices and actual stock price changes in graphically. It shows simulated stock prices go on actually stock price line and not implies more changes with real price changes.in long time horizons uses GBM model Dialog Axiata PLC highly accurate

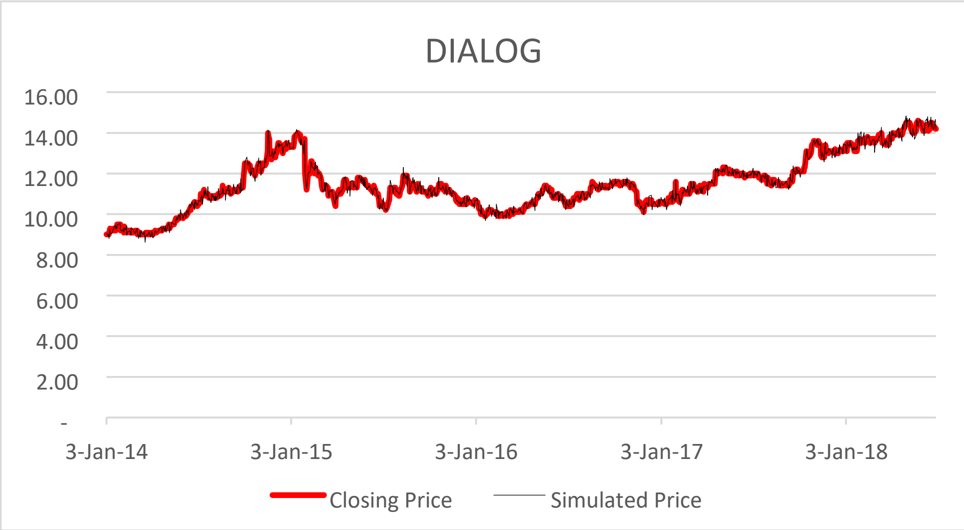

Figure 4.7: Comparison of real stock prices vs simulated stock prices

4.4.3 Hatton National Bank

Table 4.8 shows a forecasted average, variance, standard deviation and drift variable output data table for simulation stock prices from 2014 to 2018 in Hatton National Bank

Table 4.8: Statistical test values

Average Daily Return	Variance	Stand Deviation	Drift
0.00011	0.03155	0.17763	(0.01566)

Table 4.9 shows results for the 2018 January month simulation.

Table 4.9: Sample of actual prices, Forecast prices in HNB

Day	Closing Price	Daily Return	Simulated Price
3-Jan-18	250	0.248461359	218.89
4-Jan-18	250.5	0.001998003	276.65
5-Jan-18	254.9	0.017412391	260.08
8-Jan-18	255	0.000392234	252.05
9-Jan-18	255	0	193.17
10-Jan-18	253	-0.007874056	211.23
11-Jan-18	257	0.015686596	184.26
12-Jan-18	255	-0.00781254	280.98
16-Jan-18	252	-0.011834458	302.96
17-Jan-18	253	0.003960401	313.95
18-Jan-18	252.9	-0.000395335	237.34

19-Jan-18	252.8	-0.000395491	290.77
22-Jan-18	250	-0.011137744	280.05
23-Jan-18	250	0	295.82
24-Jan-18	249.8	-0.00080032	298.10
25-Jan-18	250	0.00080032	288.80
26-Jan-18	248.3	-0.006823225	187.95
29-Jan-18	248	-0.001208946	242.55
30-Jan-18	248	0	254.73

Figure 4.8 presents real stock price changes in HNB from 2014 to 2018.

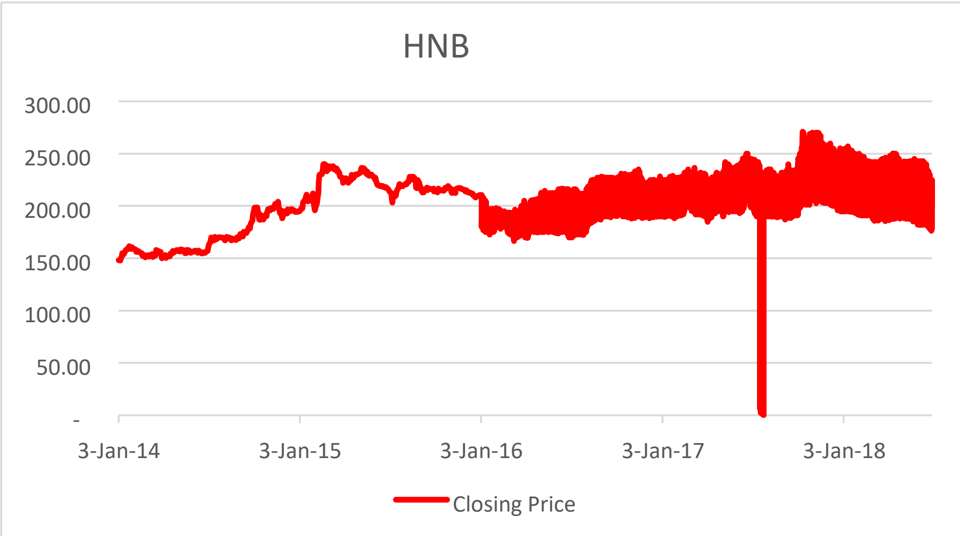

Figure 4.8: Real Stock price data for Hatton National Bank from 2014 to 2018

Figure 4.9 presents simulated stock price changes in HNB from 2014 to 2018. The results are more fractured than the actual stock price change, but align with real stock prices

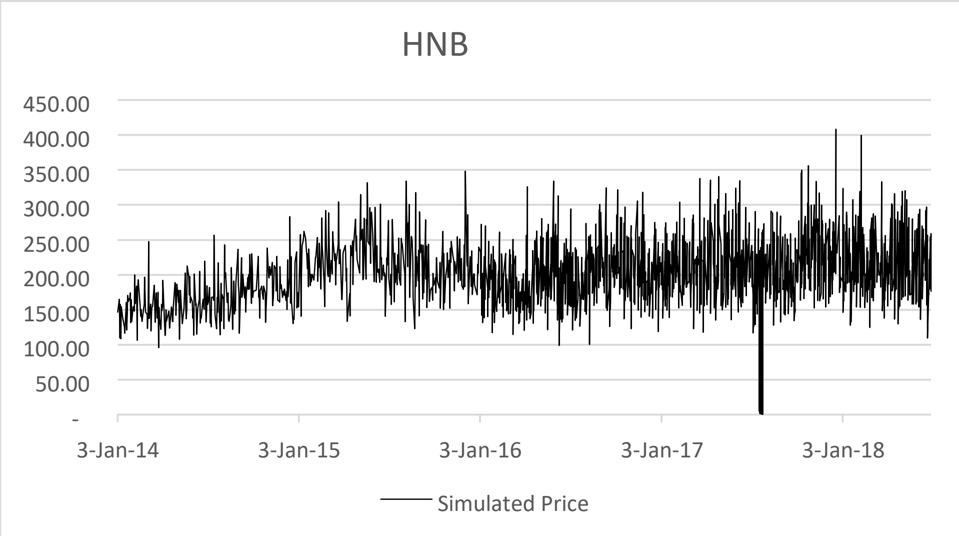

Figure 4.9: Simulated Stock price data for Hatton National Bank from 2014 to 2018

Figure 4.10 presents the simulated stock prices, and actual stock price changes graphically. It shows simulated stock prices go with the actual stock price line, and they do not imply more changes in the real price.

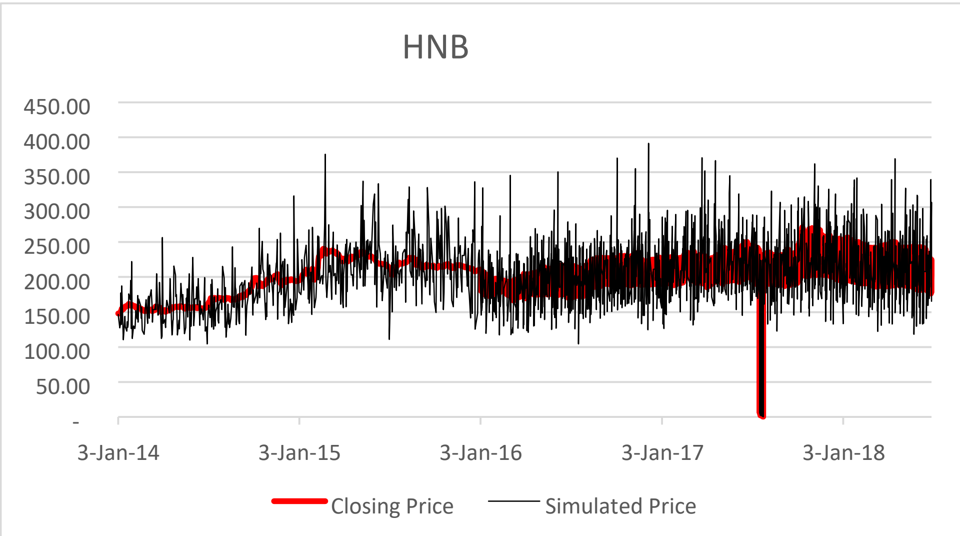

Figure 4.10: Comparison of real stock prices vs simulated stock prices

4.4.4 John Keels Holding PLC

The 4.10 Table shows a forecasted average, variance, standard deviation and drift variable output data table for the simulation stock prices from 2014 to 2018 in John Keels Holding PLC

Table 4.10: Statistical test value

Average Daily Return	variances	Stand Deviation	Drift
(0.00116)	0.02650	0.16280	(0.01441)

Table 4.11 shows results for the 2018 January month simulation. It shows there is no significant difference in actual closing prices and simulated stock prices calculated using the Geometric Brownian motion model

Table 4.11: Sample of actual prices, Forecast prices in John Keels

Day	Closing Price	Daily Return	Simulated Price
3-Jan-18	55.6	-0.98374765	178.05
4-Jan-18	56	0.007168489	60.73
5-Jan-18	58	0.03509132	50.11
8-Jan-18	58	0	51.30
10-Jan-18	55	-0.05310983	59.67
11-Jan-18	55	0	44.94
12-Jan-18	55	0	49.18
16-Jan-18	56.9	0.033962156	49.93
17-Jan-18	56.5	-0.0070547	42.88
18-Jan-18	54	-0.04525659	61.81
19-Jan-18	55.3	0.023788862	42.34
23-Jan-18	56.5	0.02146773	56.34
24-Jan-18	56.5	0	54.25
25-Jan-18	57.2	0.01231326	54.10
26-Jan-18	57.2	0	58.54
29-Jan-18	57.4	0.003490405	63.61
30-Jan-18	57.5	0.001740644	50.76

Figure 4.11 represents real stock prices changes in John Keels PLC from 2014 to 2018.

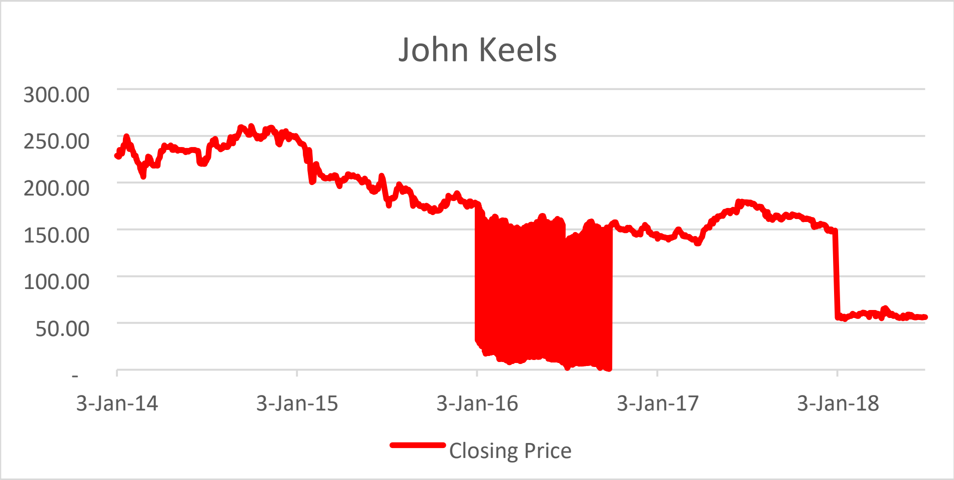

Figure 4.11: Real Stock prices data for John Keels from 2014 to 2018

Figure 4.12 represents simulated stock prices changes in John Keels PLC from 2014 to 2018, which turns out to be fractured than the actual stock price change but align with real stock prices.

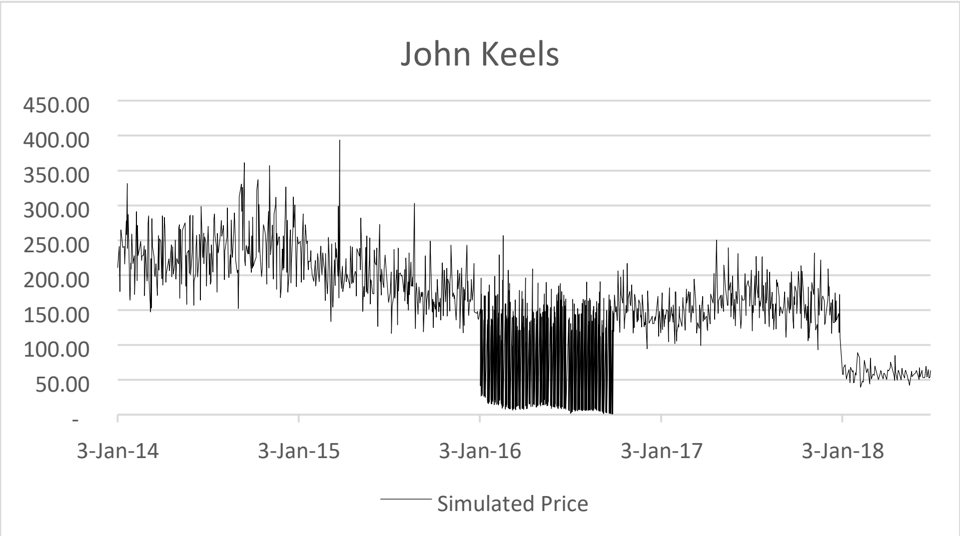

Figure 4.12: Simulated Stock prices data for John Keels from 2014 to 2018

Figure 4.13 represents simulated stock-prices, and actual stock price changes graphically. It shows simulated stock-prices fluctuate with the stock price line, and they do not indicate more changes with real price changes.

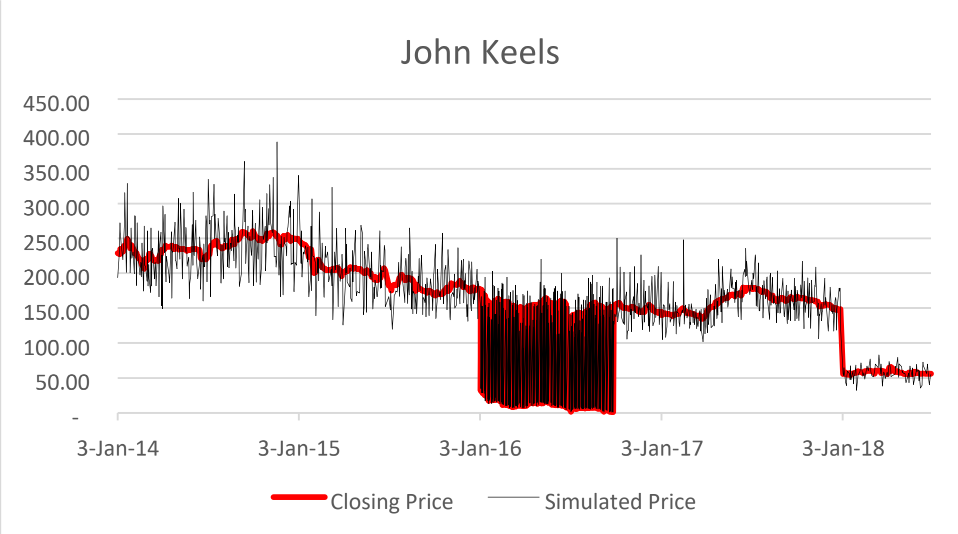

Figure 4.13: Comparison of real stock prices vs simulated stock prices

4.4.5 Nestle Lanka PLC

Table 4.12 shows the forecasted data average, variance, standard deviation, and drift variable output data table for simulation stock prices from 2014 to 2018 in John Nestle Lanka PLC.

Table 4.12: Statistical test value

Average Daily Return	Variances	Stand Deviation	Drift
(0.00019)	0.00019	0.01372	(0.00029)

Table 4.13 shows results for the 2018 January month simulation.

Table 4.13: Sample of actual prices, forecast prices in Nestle

Day	Closing Price	Daily Return	Simulated Price
1/2/18	1,626.00	0.000553659	1,594.90
1/3/18	1,630.40	0.002702372	1,622.17
1/5/18	1,640.00	0.005870858	1,606.20
1/8/18	1,697.70	0.034578152	1,640.35
1/9/18	1,697.70	-	1,662.17
1/11/18	1,699.20	0.000883158	1,697.92
1/12/18	1,699.20	-	1,694.36

1/16/18	1,680.80	-0.010887682	1,683.76
1/17/18	1,700.00	0.011358381	1,676.77
1/19/18	1,700.00	-	1,682.60
1/22/18	1,700.00	-	1,677.10
1/23/18	1,700.00	-	1,702.97
1/24/18	1,700.00	-	1,711.14
1/25/18	1,700.00	-	1,679.93
1/26/18	1,700.00	-	1,696.35
1/29/18	1,699.90	(0.00)	1,714.36

Figure 4.14 presents the real stock prices changes in Nestle from 2014 to 2018.

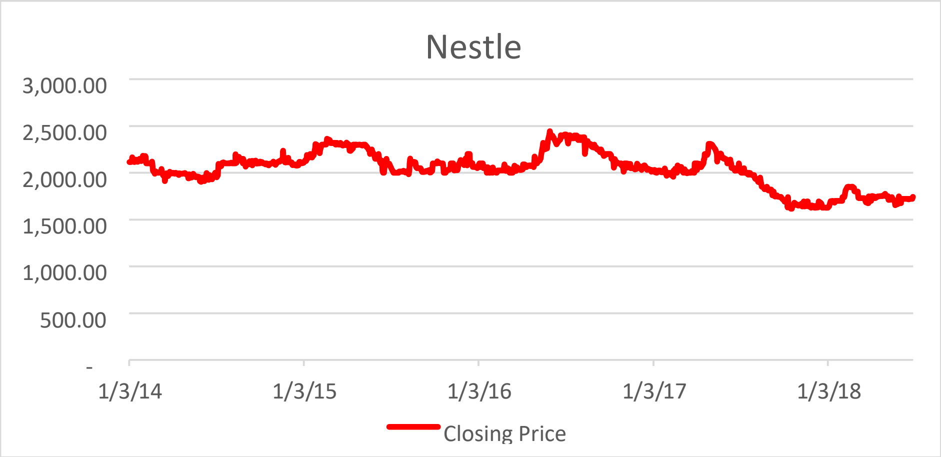

Figure 4.14: Real Stock prices data for Nestle from 2014 to 2018

Figure 4.15 presents the simulated stock prices changes in Nestle from 2014 to 2018.

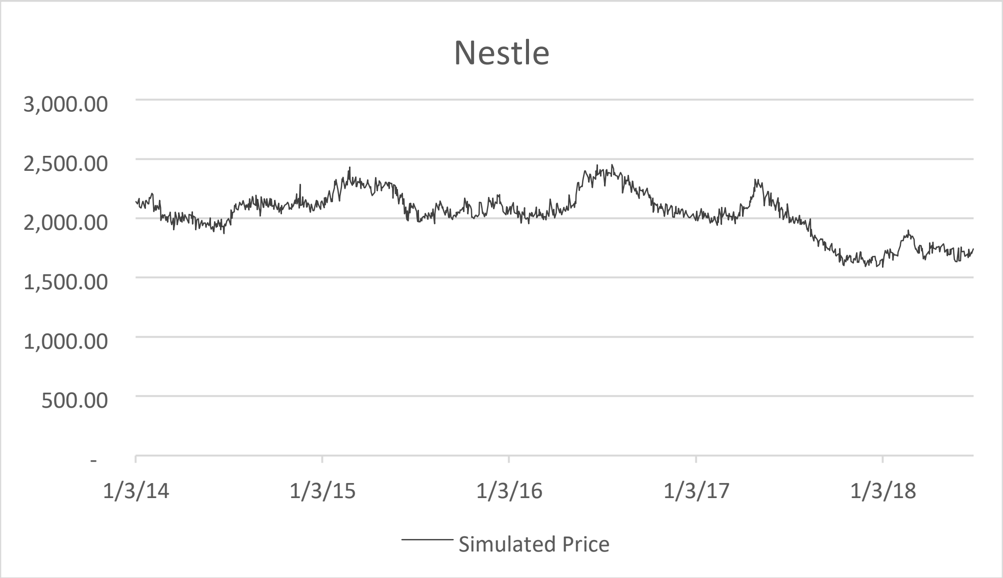

Figure 4.15: Simulated Stock prices data for Nestle from 2014 to 2018

Figure 4.16 presents the simulated stock prices, and actual stock price changes graphically.

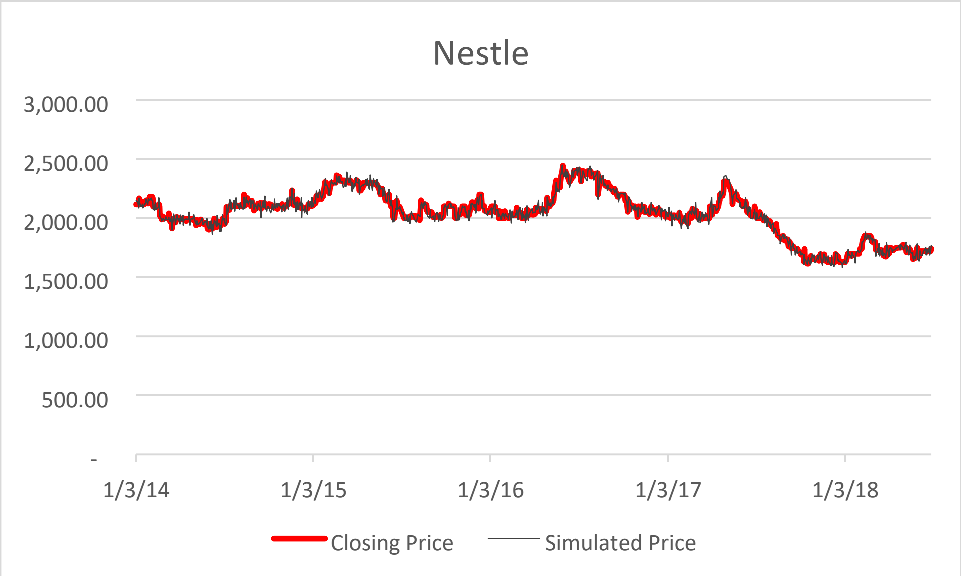

Figure 4.16: Comparison of real stock prices vs simulated stock prices

4.4.6 Ceylon Tobacco Company

Table 4.14 shows a forecasted average, variance, standard deviation and drift variable output data table for simulation stock prices from 2014 to 2018 in Ceylon Tobacco Company

Table 4.14: Statistical test value

Average Daily Return	Variance	Stand Deviation	Drift
(0.00006)	0.00017	0.01307	(0.00014)

Table 4.15 shows results for the 2018 January month simulation.

Table 4.15: Sample of actual prices, forecast prices in Tobacco

Day	Closing Price	Daily Return	Simulation Price
2-Jan-18	1,060.00	0.053779003	985.82
3-Jan-18	1,079.40	0.018136423	1,055.19
4-Jan-18	1,065.00	-0.01343053	1,058.35
5-Jan-18	1,065.00	0	1,041.09
8-Jan-18	1,065.00	0	1,048.59
9-Jan-18	1,065.00	0	1,086.30
10-Jan-18	1,030.00	-0.033416	1,080.30
16-Jan-18	1,030.00	0	1,034.90
17-Jan-18	1,030.00	0	1,015.31
19-Jan-18	1,029.20	-0.000777	1,044.22
22-Jan-18	1,029.90	0.000679909	1,021.67
23-Jan-18	1,031.30	0.001358432	1,034.47
24-Jan-18	1,076.70	0.043080665	1,038.22
25-Jan-18	1,080.00	0.003060233	1,077.46
26-Jan-18	1,079.70	-0.00027782	1,053.79
29-Jan-18	1,080.00	0.000277816	1,069.96

Figure 4.17 represents real stock prices changes in Ceylon Tobacco PLC from 2014 to 2018.

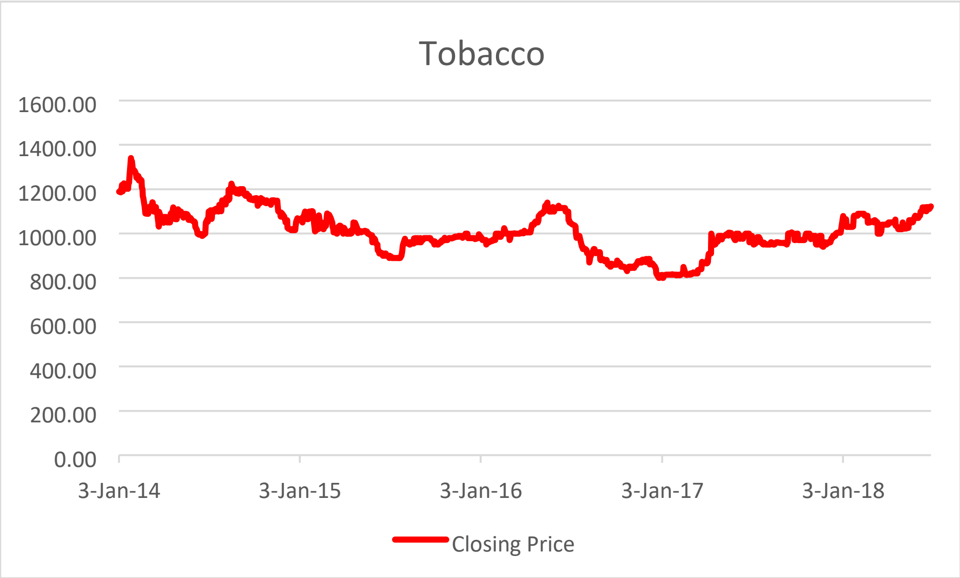

Figure 4.17: Real Stock prices data for Tobacco from 2014 to 2018

Figure 4.18 presents simulated stock prices changes in Ceylon Tobacco PLC from 2014 to 2018.

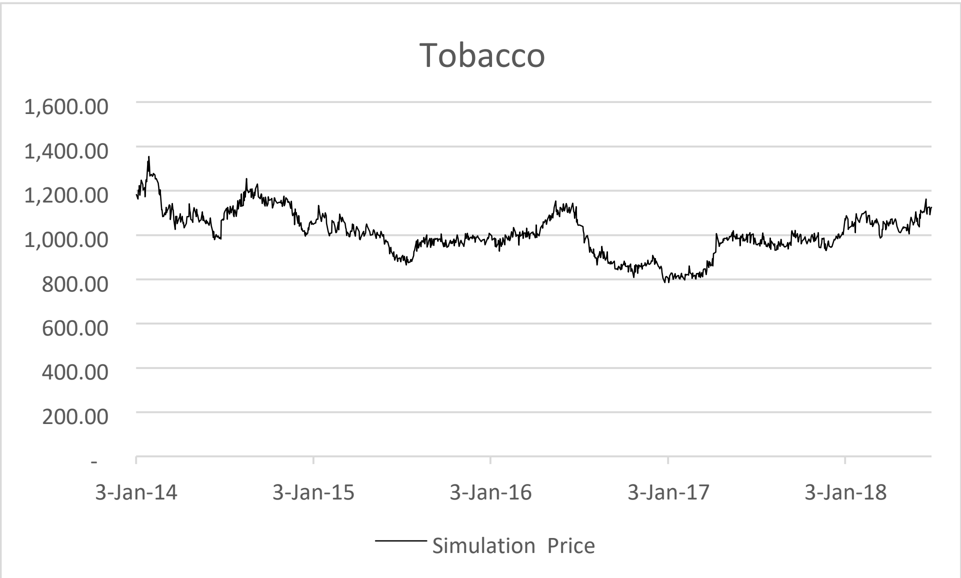

Figure 4.18: Simulated Stock prices data for Tobacco from 2014 to 2018

Figure 4.19 represents simulated stock prices, and actual stock price changes graphically.

Figure 4.19: Comparison of the real stock prices vs simulated stock prices

CHAPTER 5

CONCLUSION

5.1 Introduction

The stock exchange is a man-made system that fluctuates over time. Therefore, it is challenging to find a model that completely describes the stock market. The main challenge is that each company has only one real stock price path for a period. Thus, a company's share price path can be identified as an irrevocable experiment, because it is difficult to replicate all initial terms and repeat the initial public offering of the same company. Instead, many companies have to use stock paths, different parameters and starting conditions to determine what is a good model of stock-price movements.

Considering the simulation of the stock price, the Geometric Brownian motion model is understood to be widely using a share prices prediction model in various countries. However, in the Sri Lankan context, the use of the Geometric Brownian Motion model in stock price prediction is not observable. Filling this gap and identifying the validity of the Geometric model in Sri Lanka were the main purposes of conducting this research

5.2 Findings and Discussion

To obtain the validity of GBM model, it was checked using two hundred and fifty (250) companies in Colombo Stock Exchange, of which the analysis was forecasted in 2014 to 2018. The accuracy was verified using the MAPE value. A number of scholars used the MAPE based judgment method to evaluate the accuracy of the forecast resulted from GBM (Reddy and Clinton, 2016). MAPE values being between 0% and 10%, indicates that the GBM model is an extremely precise model for predicting stock prices on the Colombo Stock Exchange in Sri Lanka. The forecast was limited only for one day. The mean value of the MAPE of a sample of 250 companies, is 4.49 % (Table 4.2). Further, for 97.2% of the sample, the MAPE value was below 10% (Table 4.3).,which implies that the one-day price forecast is highly accurate in the Sri Lankan context.

5.3 Conclusion and Recommendation

Geometric Brownian motion models were developed in the research to forecast the behaviour of the stock price, and then the model was used for exchange. Simulated or forecasted results, compared to actual prices, were received later. The results indicate the model consistently predicts stock behaviour in 95% of cases. A mathematical examination of the probabilistic distribution of shares is also provided. The work of these scholars is expected to help investors and other stakeholders, in particular, in gaining information on trading and valuation in the Colombo Stock Exchange. However, in this study, the forecast is limited only for one day; in other words, utilizing historical data until trading day *t*, someone can forecast the price of the trading day *t+1*.

5.4 Limitations and Further Research

In this study, the predictability of one day ahead is tested. Prediction for longer periods such as weekly, monthly, semiannually or annually shall be examined in further research. Furthermore, the industry effect and other economic factors were not considered in this research. In addition, to obtain a high level of correctness, the number of simulations to be run should be improved, and at the same time, the historical period should be increased. Further, it is assumed the stock prices are normally distributed, and hence the random number generation based on normal distribution is utilized in the GBM. If this assumption is not valid, the forecast may not be accurate.

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APPENDIX

Table A.1: Market Capitalization of Listed Companies as of June 30th, 2018

Se. No.	Company Code	Company Name	Indexed Price (Rs)	Indexed Quantity (No)	Market Cap (Rs)
1	CTC	CEYLON TOBACCO	1,121.70	187,323,751	210,121,051,497
2	JKH	JKH	147.50	1,387,528,658	204,660,477,055
3	HDEV	HOTEL DEVELOPERS	94.80	2,046,645,686	194,022,011,033
4	COMB	COMMERCIAL BANK	123.00	945,655,332	116,315,605,836
5	DIAL	DIALOG	14.20	8,143,778,405	115,641,653,351
6	DIST	DISTILLERIES	20.90	4,600,000,000	96,140,000,000
7	CCS	COLD STORES	992.00	95,040,000	94,279,680,000
8	NEST	NESTLE	1,743.30	53,725,463	93,659,599,648
9	HNB	HNB	225.00	395,451,248	88,976,530,800
10	SAMP	SAMPATH	303.10	280,902,248	85,141,471,369
11	HHL	HEMAS HOLDINGS	113.10	574,933,259	65,024,951,593
12	MELS	MELSTACORP	52.50	1,165,397,072	61,183,346,280
13	CARG	CARGILLS	199.60	255,999,927	51,097,585,429
14	LOLC	LOLC	98.50	475,200,000	46,807,200,000
15	LION	LION BREWERY	570.00	80,000,000	45,600,000,000
16	SLTL	SLT	24.80	1,804,860,000	44,760,528,000
17	CTHR	C T HOLDINGS	175.10	201,406,978	35,266,361,848
18	CINS	CEYLINCO INS.	1,680.00	20,000,000	33,600,000,000
19	CARS	CARSONS	165.10	196,386,914	32,423,479,501
20	ASIR	ASIRI	26.00	1,137,533,596	29,575,873,496
21	DFCC	DFCC BANK PLC	104.80	265,097,688	27,782,237,702
22	SHL	SOFTLOGIC	23.00	1,192,543,209	27,428,493,807
23	PLC	PEOPLES LEASING	15.30	1,579,862,482	24,171,895,975
24	RICH	RICHARD PIERIS	11.10	2,035,038,275	22,588,924,853
25	TJL	TEEJAY LANKA	31.00	701,956,580	21,760,653,980
26	AHPL	AHOT PROPERTIES	48.70	442,775,300	21,563,157,110
27	NDB	NAT. DEV. BANK	120.80	177,463,062	21,437,537,890
28	NTB	NATIONS TRUST	90.00	236,599,023	21,293,912,070
29	CFIN	CENTRAL FINANCE	97.60	216,758,888	21,155,667,469
30	VONE	VALLIBEL ONE	19.30	1,086,559,353	20,970,595,513
31	SPEN	AITKEN SPENCE	51.50	405,996,045	20,908,796,318
32	BUKI	BUKIT DARAH	202.40	102,000,000	20,644,800,000
33	OSEA	OVERSEAS REALTY	15.50	1,243,029,582	19,266,958,521
34	LLUB	CHEVRON	76.50	240,000,000	18,360,000,000
35	LIOC	LANKA IOC	32.90	532,465,705	17,518,121,695
36	TRAN	TRANS ASIA	86.90	200,000,000	17,380,000,000
37	HNB	HNB	178.50	97,199,341	17,350,082,369
38	LFIN	LB FINANCE	120.30	139,651,428	16,800,066,788
39	CTCE	A I A INSURANCE	524.60	30,749,370	16,131,119,502

40	HAYL	HAYLEYS	213.80	75,000,000	16,035,000,000
41	AEL	ACCESS ENG SL	15.90	1,000,000,000	15,900,000,000
42	SEYB	SEYLAN BANK	81.00	184,104,010	14,912,424,810
43	LOFC	LOLC FINANCE	3.50	4,200,000,000	14,700,000,000
44	BREW	CEYLON BEVERAGE	700.00	20,988,090	14,691,663,000
45	CLC	COMM LEASE & FIN	2.30	6,377,711,170	14,668,735,691
46	UBC	UNION BANK	12.70	1,091,406,249	13,860,859,362
47	SINS	SINGER SRI LANKA	35.00	375,628,830	13,147,009,050
48	UAL	UNION ASSURANCE	222.90	58,928,572	13,135,178,699
49	CTEA	DILMAH CEYLON	596.00	20,737,500	12,359,550,000
50	KHL	KEELLS HOTELS	8.20	1,456,146,780	11,940,403,596
51	LHCL	LANKA HOSPITALS	51.60	223,732,169	11,544,579,920
52	COCR	COM.CREDIT	34.20	318,074,365	10,878,143,283
53	RCL	ROYAL CERAMIC	93.00	110,789,384	10,303,412,712
54	AHUN	A.SPEN.HOT.HOLD.	29.80	336,290,010	10,021,442,298
55	NIFL	BRAC LNKA FNANCE	40.00	237,943,274	9,517,730,960
56	TKYO	TOKYO CEMENT	35.00	267,300,000	9,355,500,000
57	BIL	BROWNS INVSTMNTS	2.40	3,720,000,000	8,928,000,000
58	SEYB	SEYLAN BANK	49.00	181,995,082	8,917,759,018
59	UML	UNITED MOTORS	85.00	100,900,626	8,576,553,210
60	ABL	AMANA BANK	3.40	2,501,390,534	8,504,727,816
61	AAIC	SOFTLOGIC LIFE	22.40	375,000,000	8,400,000,000
62	SHAL	SHALIMAR	1,497.60	5,397,840	8,083,805,184
63	EXPO	EXPOLANKA	4.00	1,954,915,000	7,819,660,000
64	MERC	MERCANTILE INV	2,580.30	3,006,000	7,756,381,800
65	SUN	SUNSHINE HOLDING	54.54	137,631,614	7,506,428,228
66	PDL	PDL	113.00	66,000,000	7,458,000,000
67	LMF	LMF	170.00	39,998,000	6,799,660,000
68	JETS	JETWING SYMPHONY	13.40	502,188,559	6,729,326,691
69	LGL	LAUGFS GAS	20.00	335,000,086	6,700,001,720
70	PABC	PAN ASIA	15.00	442,561,629	6,638,424,435
71	SFCL	SENKADAGALA	89.00	72,475,061	6,450,280,429
72	ODEL	ODEL PLC	23.60	272,129,431	6,422,254,572
73	INDO	INDO MALAY	1,300.00	4,811,400	6,254,820,000
74	COMB	COMMERCIAL BANK	94.00	65,013,174	6,111,238,356
75	CINS	CEYLINCO INS.	950.00	6,414,480	6,093,756,000
76	NHL	NAWALOKA	4.30	1,409,505,596	6,060,874,063
77	GUAR	CEYLON GUARDIAN	72.10	82,978,868	5,982,776,383
78	LAMB	KOTMALE HOLDINGS	190.00	31,400,000	5,966,000,000
79	RIL	R I L PROPERTY	7.10	800,000,000	5,680,000,000
80	AMSL	ASIRI SURG	10.10	528,457,545	5,337,421,205
81	FLCH	BROWNS CAPITAL	3.90	1,368,000,000	5,335,200,000
82	LVEF	LVL ENERGY	9.10	582,278,117	5,298,730,865

83	SDB	SANASA DEV. BANK	94.00	56,308,252	5,292,975,688
84	HASU	HNB ASSURANCE	104.00	50,000,000	5,200,000,000
85	VPEL	VALLIBEL	6.90	747,109,731	5,155,057,144
86	WATA	WATAWALA	25.20	200,962,555	5,064,256,386
87	TAP	AMBEON CAPITAL	5.00	1,002,724,815	5,013,624,075
88	JINS	JANASHAKTHI INS.	22.00	226,526,153	4,983,575,366
89	TILE	LANKA TILES	92.50	53,050,410	4,907,162,925
90	LWL	LANKA WALLTILE	89.30	54,600,000	4,875,780,000
91	DIPD	DIPPED PRODUCTS	79.00	59,861,512	4,729,059,448
92	DOCK	DOCKYARD	65.20	71,858,924	4,685,201,845
93	ACL	ACL	38.60	119,787,360	4,623,792,096
94	GOOD	GOOD HOPE	1,172.00	3,883,782	4,551,792,504
95	PINS	PEOPLE'S INS	22.00	200,000,000	4,400,000,000
96	GLAS	PIRAMAL GLASS	4.60	950,086,080	4,370,395,968
97	BLI	BIMPUTH FINANCE	39.70	107,733,344	4,277,013,757
98	TKYO	TOKYO CEMENT	32.00	133,650,000	4,276,800,000
99	ALUM	ALUMEX PLC	14.10	299,302,840	4,220,170,044
100	CDB	CDB	85.10	46,299,223	3,940,063,877
101	NTB	NATIONS TRUST	95.00	41,148,113	3,909,070,735
102	SERV	KINGSBURY	16.00	242,000,000	3,872,000,000
103	TFIL	TRADE FINANCE	68.00	56,800,400	3,862,427,200
104	BPPL	BPPL HOLDINGS	12.50	306,843,357	3,835,541,963
105	VFIN	VALLIBEL FINANCE	65.00	58,863,350	3,826,117,750
106	HAYC	HAYCARB	127.00	29,712,375	3,773,471,625
107	CIC	CIC	51.60	72,900,000	3,761,640,000
108	GHLL	GALADARI	7.50	500,829,564	3,756,221,730
109	DIMO	DIMO	421.30	8,876,437	3,739,642,908
110	GRAN	GRAIN ELEVATORS	61.50	60,000,000	3,690,000,000
111	CINV	CEYLON INV.	36.70	99,451,059	3,649,853,865
112	SCAP	SOFTLOGIC CAP	5.30	688,160,000	3,647,248,000
113	CLND	COLOMBO LAND	18.20	199,881,008	3,637,834,346
114	MORI	MORISONS	625.00	5,808,290	3,630,181,250
115	BRWN	BROWNS	49.20	70,875,000	3,487,050,000
116	SELI	SELINSING	613.40	5,678,247	3,483,036,710
117	GREG	AMBEON HOLDINGS	9.70	356,869,666	3,461,635,760
118	EBCR	E B CREASY	1,357.90	2,535,458	3,442,898,418
119	KFP	KEELLS FOOD	134.80	25,500,000	3,437,400,000
120	VLL	VIDULLANKA	4.10	837,785,465	3,434,920,407
121	JKL	JOHN KEELLS	56.10	60,800,000	3,410,880,000
122	ASHO	LANKA ASHOK	929.80	3,620,843	3,366,659,821
123	TYRE	KELANI TYRES	39.00	80,400,000	3,135,600,000
124	CFLB	FORT LAND	17.10	180,000,000	3,078,000,000
125	KHC	KANDY HOTELS	5.20	577,500,000	3,003,000,000
126	CFVF	FIRST CAPITAL	29.50	101,250,000	2,986,875,000

127	SFIN	SINGER FINANCE	14.30	202,074,075	2,889,659,273
128	CALF	COLOMBO TRUST	39.90	72,233,816	2,882,129,258
129	KAHA	KAHAWATTE	36.00	79,889,805	2,876,032,980
130	KVAL	KELANI VALLEY	84.50	34,000,000	2,873,000,000
131	HARI	HARISCHANDRA	1,351.10	1,919,600	2,593,571,560
132	CSEC	DUNAMIS CAPITAL	20.70	122,997,050	2,546,038,935
133	CONN	AMAYA LEISURE	49.00	51,876,976	2,541,971,824
134	SMOT	SATHOSA MOTORS	420.00	6,033,622	2,534,121,240
135	CTLD	C T LAND	30.00	81,250,000	2,437,500,000
136	EAST	EAST WEST	17.40	138,240,000	2,405,376,000
137	CHOT	HOTELS CORP.	13.20	180,030,942	2,376,408,434
138	NEH	NUWARA ELIYA	1,078.40	2,186,040	2,357,425,536
139	CARE	PRINTCARE PLC	27.10	85,966,670	2,329,696,757
140	TAJ	TAL LANKA	16.50	139,637,494	2,304,018,651
141	ALLI	ALLIANCE	68.00	33,696,000	2,291,328,000
142	TAFL	THREE ACRE FARMS	96.80	23,545,000	2,279,156,000
143	AMF	AMF CO LTD	400.00	5,608,355	2,243,342,000
144	KAPI	MTD WALKERS	13.00	167,647,568	2,179,418,384
145	ETWO	EQUITY TWO PLC	69.30	31,000,000	2,148,300,000
146	LVEN	LANKA VENTURES	42.00	50,000,000	2,100,000,000
147	HUNT	HUNTERS	402.10	5,145,000	2,068,804,500
148	CRL	SOFTLOGIC FIN	30.00	67,928,384	2,037,851,520
149	RCH	RENUKA HOTELS	50.00	40,297,530	2,014,876,500
150	SHAW	LEE HEDGES	77.00	25,602,730	1,971,410,210
151	BFN	ORIENT FINANCE	13.10	148,018,370	1,939,040,647
152	MGT	HAYLEYS FABRIC	9.30	207,740,888	1,931,990,258
153	BFL	BAIRAHA FARMS	120.20	16,000,000	1,923,200,000
154	SWAD	SWADESHI	12,812.50	149,333	1,913,329,063
155	CHL	DURDANS	72.00	25,527,272	1,837,963,584
156	BBH	BROWNS BEACH	14.10	129,600,000	1,827,360,000
157	HDFC	HDFC	28.00	64,710,520	1,811,894,560
158	REXP	RICH PIERIS EXP	160.40	11,163,745	1,790,664,698
159	KCAB	KELANI CABLES	82.00	21,800,000	1,787,600,000
160	NAMU	NAMUNUKULA	75.00	23,750,000	1,781,250,000
161	HPL	HATTON	7.50	236,666,671	1,775,000,033
162	RENU	RENUKA CITY HOT.	250.00	7,000,000	1,750,000,000
163	COCO	RENUKA FOODS	14.50	117,960,106	1,710,421,537
164	CSD	SEYLAN DEVTS	11.50	147,964,860	1,701,595,890
165	CWM	C.W.MACKIE	46.80	35,988,556	1,684,264,421
166	MBSL	MERCHANT BANK	10.00	165,717,222	1,657,172,220
167	RHL	RENUKA HOLDINGS	18.50	89,034,626	1,647,140,581
168	EDEN	EDEN HOTEL LANKA	15.40	105,600,000	1,626,240,000
169	SUGA	PELWATTE	23.50	67,976,891	1,597,456,939
170	ELPL	ELPITIYA	21.90	72,866,428	1,595,774,773

171	GSF	PRIME FINANCE	19.90	79,200,000	1,576,080,000
172	ONAL	ON'ALLY	90.00	17,500,770	1,575,069,300
173	LHL	LIGHTHOUSE HOTEL	33.00	46,000,000	1,518,000,000
174	SOY	CONVENIENCE FOOD	535.30	2,750,000	1,472,075,000
175	PAP	PANASIAN POWER	2.90	500,000,000	1,450,000,000
176	ATL	AMANA TAKAFUL	0.80	1,800,001,296	1,440,001,037
177	AFSL	ABANS FINANCIAL	21.00	66,561,573	1,397,793,033
178	KGAL	KEGALLE	55.10	25,000,000	1,377,500,000
179	MADU	MADULSIMA	8.00	169,501,097	1,356,008,776
180	PARQ	SWISSTEK	49.00	27,372,000	1,341,228,000
181	BOGA	BOGALA GRAPHITE	14.00	94,632,904	1,324,860,656
182	MAL	MALWATTE	6.40	202,792,331	1,297,870,918
183	MHDL	MILLENNIUM HOUSE	9.50	134,681,320	1,279,472,540
184	CITH	CITRUS HIKKADUWA	6.20	204,782,354	1,269,650,595
185	TPL	TALAWAKELLE	52.30	23,750,000	1,242,125,000
186	AINS	ARPICO INSURANCE	18.70	66,230,407	1,238,508,611
187	RAL	RENUKA AGRI	2.10	561,750,000	1,179,675,000
188	AGST	AGSTAR PLC	3.80	307,526,310	1,168,599,978
189	SHOT	SERENDIB HOTELS	15.30	75,514,738	1,155,375,491
190	HPWR	RESUS ENERGY	19.40	58,390,263	1,132,771,102
191	ARPI	ARPICO	150.10	7,437,500	1,116,368,750
192	RHTL	FORTRESS RESORTS	9.80	110,886,684	1,086,689,503
193	SIRA	SIERRA CABL	2.00	537,512,430	1,075,024,860
194	BOPL	BOGAWANTALAWA	12.80	83,750,000	1,072,000,000
195	PALM	PALM GARDEN HOTL	24.00	43,267,000	1,038,408,000
196	AUTO	AUTODROME	86.50	12,000,000	1,038,000,000
197	DPL	DANKOTUWA PORCEL	6.30	162,552,920	1,024,083,396
198	LCEY	LANKEM CEYLON	30.20	33,853,200	1,022,366,640
199	ASPM	SPENCEPLANTATION	45.50	21,300,000	969,150,000
200	PHAR	COLOMBO CITY	750.50	1,272,857	955,279,179
201	HAPU	HAPUGASTENNE	20.60	46,315,789	954,105,253
202	MORI	MORISONS	531.70	1,742,490	926,481,933
203	AAF	ASIA ASSET	1.10	839,207,833	923,128,616
204	REG	REGNIS	81.70	11,267,863	920,584,407
205	STAF	DOLPHIN HOTELS	29.00	31,621,477	917,022,833
206	COMD	COMMERCIAL DEV.	73.30	12,000,000	879,600,000
207	LGL	LAUGFS GAS	16.80	52,000,000	873,600,000
208	ACAP	ASIA CAPITAL	6.60	131,329,995	866,777,967
209	TANG	TANGERINE	43.00	20,000,000	860,000,000
210	MASK	MASKELIYA	15.90	53,953,489	857,860,475
211	SFS	SWARNAMAHAL FIN	1.70	500,000,140	850,000,238
212	CIC	CIC	38.30	21,870,000	837,621,000

213	COLO	C M HOLDINGS	55.00	15,200,000	836,000,000
214	TSML	TEA SMALLHOLDER	27.80	30,000,000	834,000,000
215	MFL	MULTI FINANCE	13.10	63,610,181	833,293,371
216	CERA	LANKA CERAMIC	138.00	6,000,000	828,000,000
217	LALU	LANKA ALUMINIUM	60.00	13,702,823	822,169,380
218	CHMX	CHEMANEX	52.10	15,750,000	820,575,000
219	RPBH	ROYAL PALMS	16.30	50,000,000	815,000,000
220	PEG	PEGASUS HOTELS	26.70	30,391,538	811,454,065
221	ESL	ENTRUST SEC	24.00	33,000,014	792,000,336
222	KZOO	RENUKA CAPITAL	4.30	173,798,500	747,333,550
223	KOTA	KOTAGALA	9.80	75,225,000	737,205,000
224	CITK	CITRUS KALPITIYA	4.50	161,200,010	725,400,045
225	MRH	MAHAWELI REACH	15.20	47,066,447	715,409,994
226	PMB	PEOPLE'S MERCH	10.20	67,500,000	688,500,000
227	CABO	CARGO BOAT	65.10	10,200,036	664,022,344
228	ALHP	ANILANA HOTELS	1.30	493,308,514	641,301,068
229	LDEV	LANKEM DEV.	5.30	120,000,000	636,000,000
230	RWSL	RAIGAM SALTERNS	2.20	282,207,320	620,856,104
231	REEF	CITRUS LEISURE	6.40	96,650,427	618,562,733
232	CDB	CDB	77.10	8,005,984	617,261,366
233	CITW	CITRUS WASKADUWA	3.00	201,746,915	605,240,745
234	CSF	NATION LANKA	0.80	753,489,783	602,791,826
235	CTBL	CEYLON TEA BRKRS	3.30	182,400,000	601,920,000
236	UCAR	UNION CHEMICALS	400.00	1,500,000	600,000,000
237	ECL	E - CHANNELLING	4.90	122,131,415	598,443,934
238	SINH	SINGHE HOSPITALS	1.50	398,225,895	597,338,843
239	SEMB	S M B LEASING	0.50	1,191,766,772	595,883,386
240	CIND	CENTRAL IND.	30.00	19,768,428	593,052,840
241	UDPL	UDAPUSSELLAWA	29.60	19,398,850	574,205,960
242	SFL	SINHAPUTHRA FIN	9.10	62,958,930	572,926,263
243	KDL	KELSEY	32.60	17,429,274	568,194,332
244	CHL	DURDANS	68.00	8,345,454	567,490,872
245	LCEM	LANKA CEMENT	3.20	173,510,748	555,234,394
246	ATLL	AMANA LIFE	1.10	500,000,000	550,000,000
247	EMER	EASTERN MERCHANT	4.60	117,446,000	540,251,600
248	SINI	SINGER IND.	139.90	3,846,300	538,097,370
249	SLND	SERENDIB LAND	1,481.70	360,000	533,412,000
250	SHOT	SERENDIB HOTELS	14.80	36,011,056	532,963,629
251	HOPL	HORANA	21.30	25,000,000	532,500,000
252	WAPO	GUARDIAN CAPITAL	20.50	25,833,808	529,593,064
253	HPFL	LOTUS HYDRO	4.80	109,088,112	523,622,938
254	CFT	CFT	3.70	140,196,000	518,725,200
255	HEXP	HAYLEYS FIBRE	64.50	8,000,000	516,000,000

256	HUNA	HUNAS FALLS	89.80	5,625,000	505,125,000
257	ASIY	ASIA SIYAKA	1.90	260,000,000	494,000,000
258	BERU	BERUWALA RESORTS	0.80	600,000,000	480,000,000
259	AMCL	CAPITAL LEASING	22.40	20,000,000	448,000,000
260	SIL	SAMSON INTERNAT.	105.80	4,232,771	447,827,172
261	BALA	BALANGODA	18.50	23,636,363	437,272,716
262	LITE	LAXAPANA	10.80	39,000,000	421,200,000
263	CIT	CIT	62.50	6,588,636	411,789,750
264	MARA	MARAWILA RESORTS	1.80	228,000,000	410,400,000
265	ABAN	ABANS	77.00	5,110,560	393,513,120
266	AGAL	AGALAWATTE	15.50	25,000,000	387,500,000
267	OGL	ORIENT GARMENTS	7.00	54,916,656	384,416,592
268	LPRT	LAKE HOUSE PRIN.	130.00	2,937,245	381,841,850
269	ASCO	ASCOT HOLDINGS	28.90	12,657,555	365,803,340
270	APLA	ACL PLASTICS	86.30	4,212,500	363,538,750
271	SIGV	SIGIRIYA VILLAGE	38.50	9,000,000	346,500,000
272	HVA	HVA FOODS	5.10	66,428,660	338,786,166
273	CFI	CFI	50.00	6,604,000	330,200,000
274	RFL	RAMBODA FALLS	16.30	20,000,000	326,000,000
275	HSIG	HOTEL SIGIRIYA	52.00	5,859,000	304,668,000
276	SING	STANDARD CAPITAL	54.00	5,540,828	299,204,712
277	GEST	GESTETNER	109.00	2,657,812	289,701,508
278	TWOD	TOUCHWOOD	2.60	106,905,600	277,954,560
279	BRR	BANSEI RESORTS	5.00	53,728,000	268,640,000
280	LLMP	LUCKY LANKA	1.40	176,028,410	246,439,774
281	IDL	SERENDIB ENG.GRP	7.50	32,383,250	242,874,375
282	ASPH	INDUSTRIAL ASPH.	344.70	666,562	229,763,921
283	MULL	MULLERS	0.80	283,000,000	226,400,000
284	ALUF	ALUFAB	18.40	12,058,200	221,870,880
285	ACME	ACME	5.20	41,161,913	214,041,948
286	TESS	TESS AGRO	0.60	339,797,287	203,878,372
287	MEL	MACKWOODS ENERGY	2.00	100,000,000	200,000,000
288	MSL	MERC. SHIPPING	69.10	2,844,990	196,588,809
289	TFC	THE FINANCE CO.	3.20	57,966,232	185,491,942
290	RHL	RENUKA HOLDINGS	13.70	12,856,830	176,138,571
291	MIRA	MIRAMAR	61.90	2,750,000	170,225,000
292	TFC	THE FINANCE CO.	1.50	100,000,000	150,000,000
293	BLUE	BLUE DIAMONDS	0.60	206,601,782	123,961,069
294	SEMB	S M B LEASING	0.20	614,066,101	122,813,220
295	MAL	MALWATTE	5.40	20,250,660	109,353,564
296	PCHH	ADAM CAPITAL	0.40	252,000,242	100,800,097
297	AINV	ADAM INVESTMENTS	0.10	898,552,400	89,855,240

298	AGST	AGSTAR PLC	5.00	17,473,690	87,368,450
299	CIFL	CIFL	0.80	83,426,733	66,741,386
300	YORK	YORK ARCADE	88.20	750,000	66,150,000
301	CHOU	CITY HOUSING	4.70	13,379,850	62,885,295
302	OFEQ	OFFICE EQUIPMENT	73.60	833,560	61,350,016
303	BLUE	BLUE DIAMONDS	0.30	194,633,623	58,390,087
304	HUEJ	HUEJAY	31.60	1,800,000	56,880,000
305	VANI	VANIK INCORP PLC	0.80	65,481,650	52,385,320
306	PARA	PARAGON	48.00	1,000,280	48,013,440
307	COCO	RENUKA FOODS	10.00	4,773,346	47,733,460
308	RGEM	RADIANT GEMS	17.90	2,400,000	42,960,000
309	PCH	PC HOUSE	0.10	343,400,001	34,340,000
310	CPRT	CEYLON PRINTERS	51.00	600,170	30,608,670
311	TESS	TESS AGRO	0.50	50,000,000	25,000,000
312	LLMP	LUCKY LANKA	0.70	24,000,000	16,800,000
313	PCP	PC PHARMA	0.10	101,000,020	10,100,002
314	VANI	VANIK INCORP PLC	0.80	11,737,290	9,389,832

(Source: CSE Data Library)

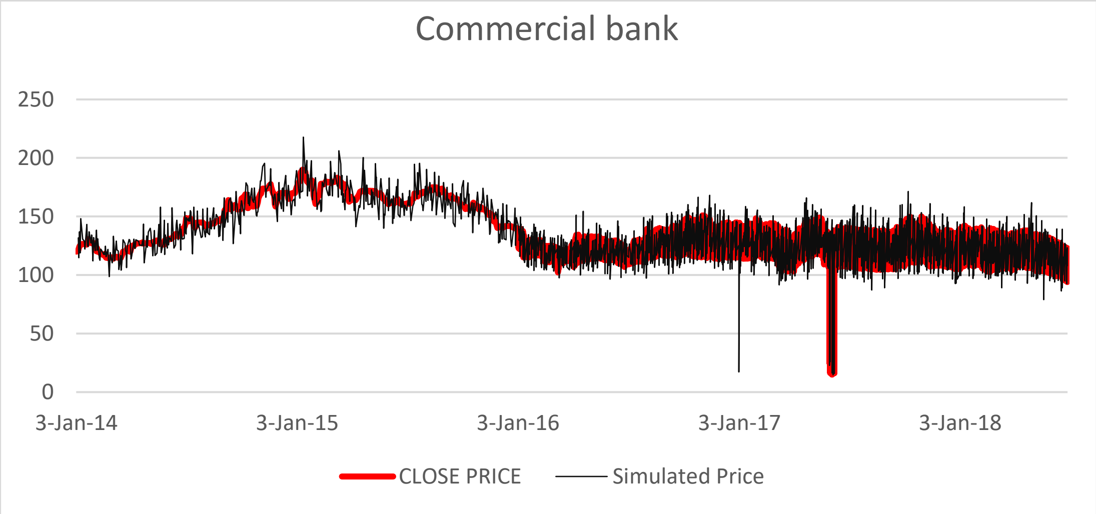


Figure A.G.1. Commercial Bank

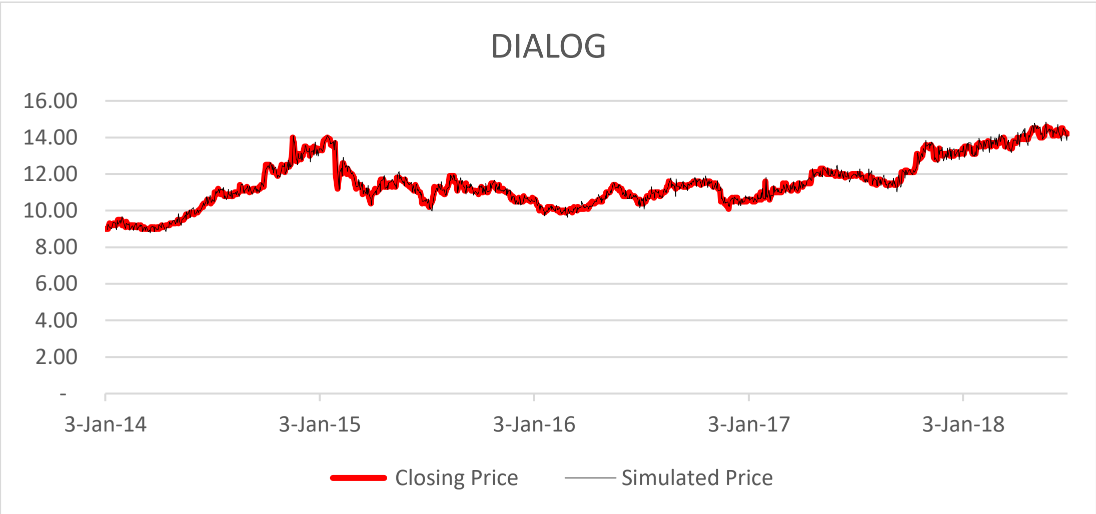
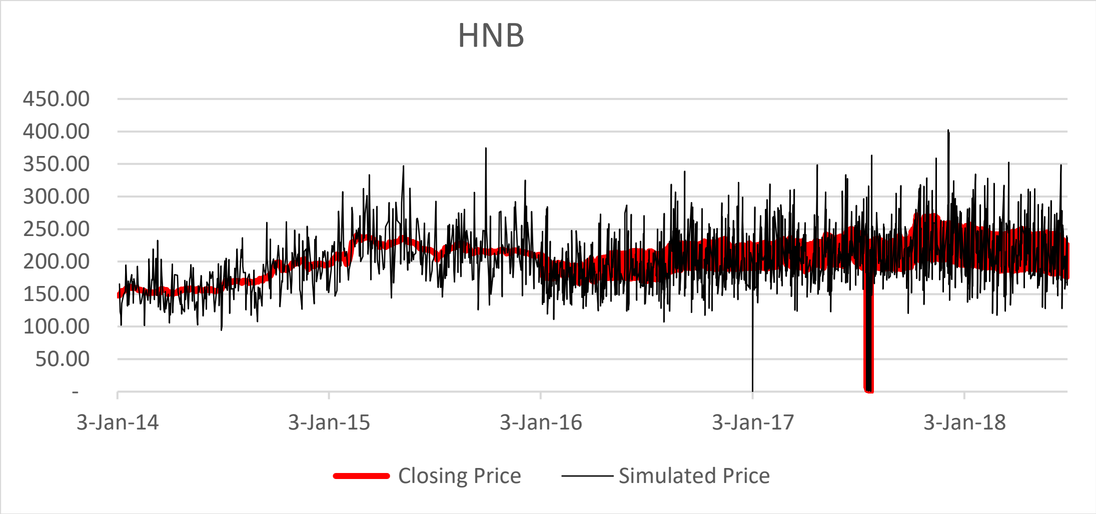


Figure A.G.2. Dialog



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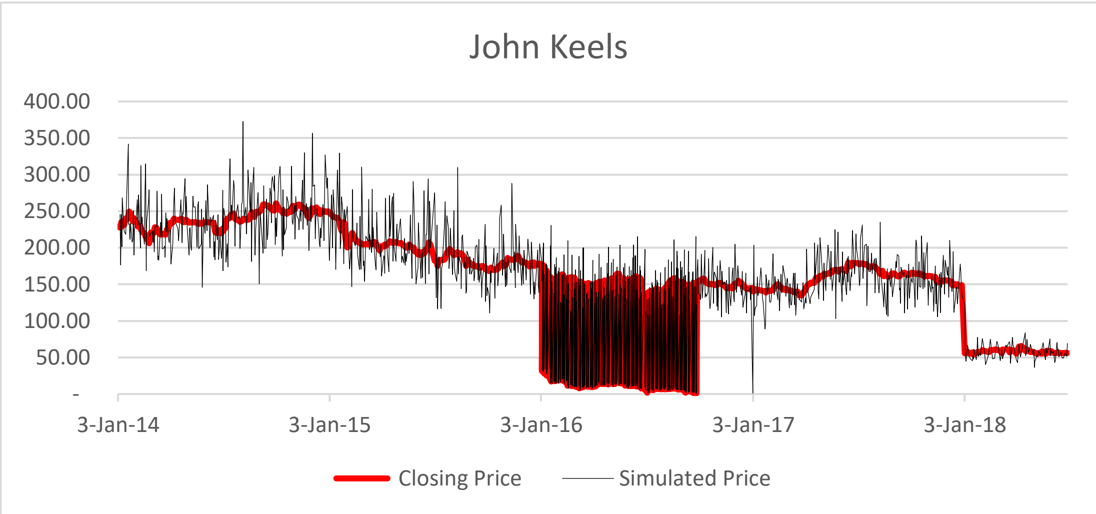
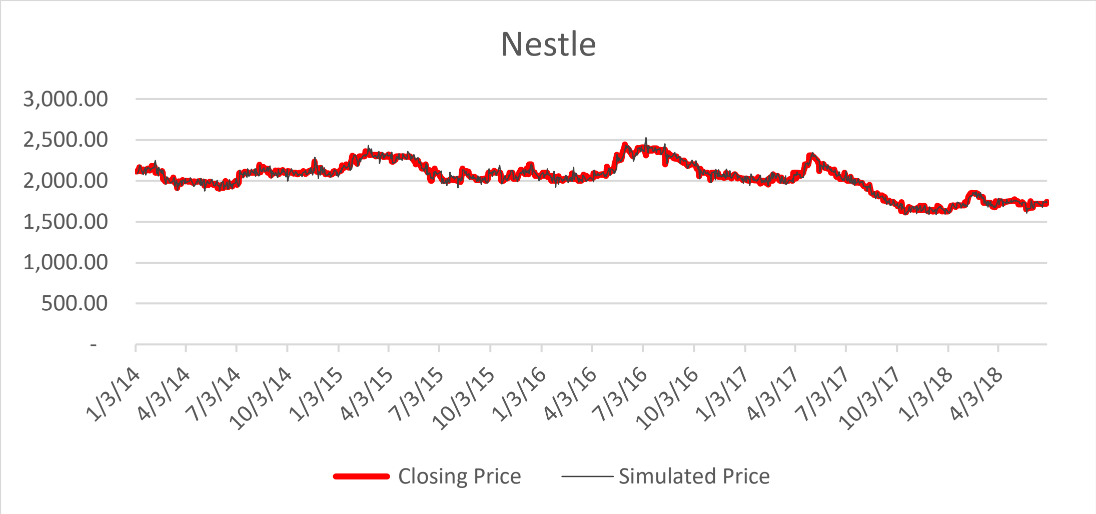


Figure A.G.4. John Keels



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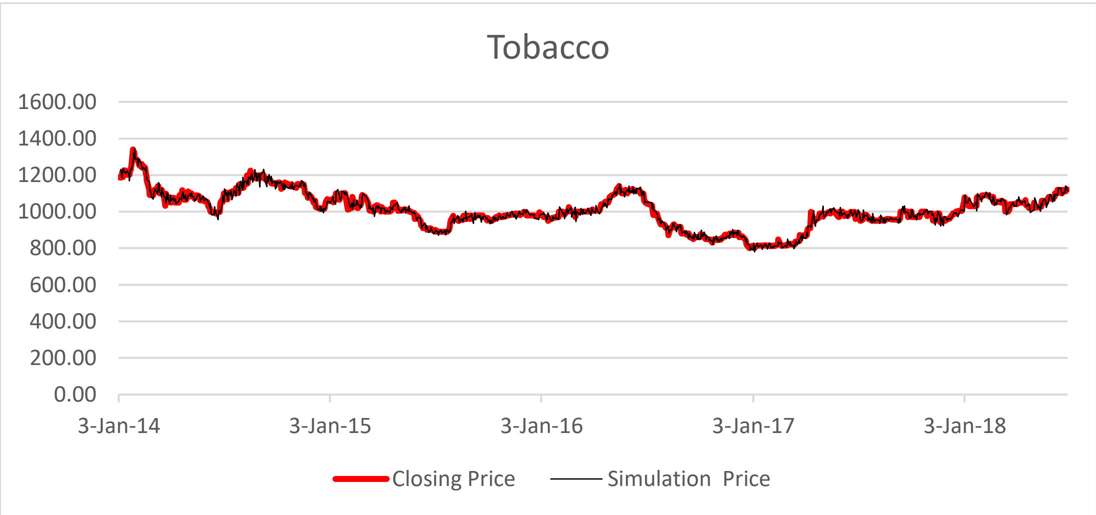


Figure A.G.6. Tobacco

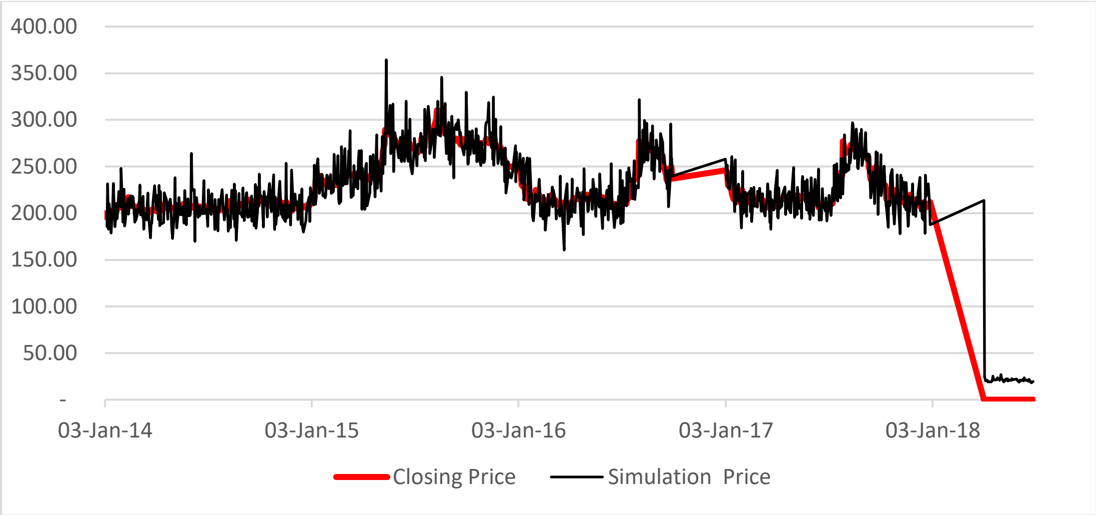


Figure A.G.7. Distilleries

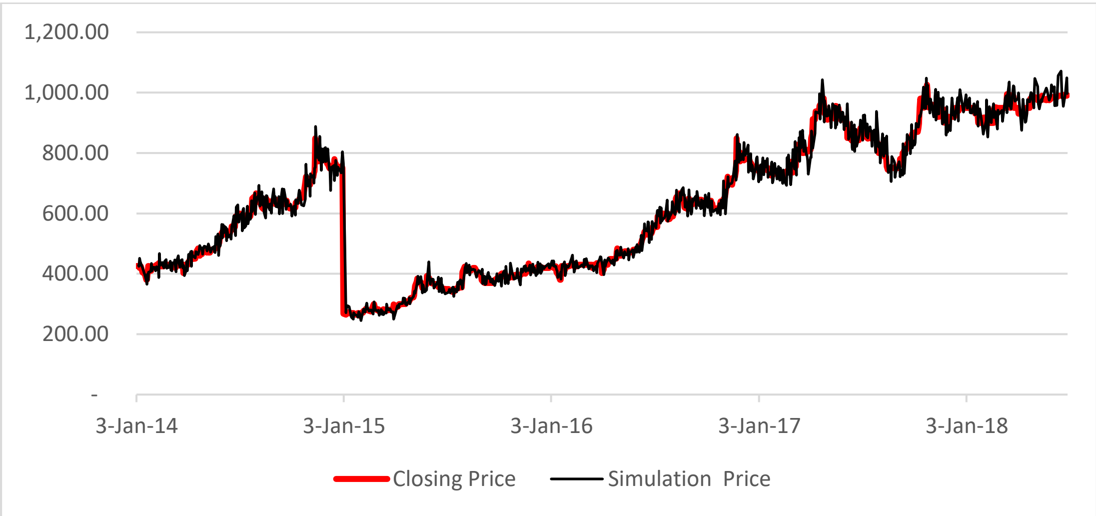


Figure A.G.8. Cold Stores

Figure A.G.9. Sampath

Figure A.G.10. HHL-Hemas

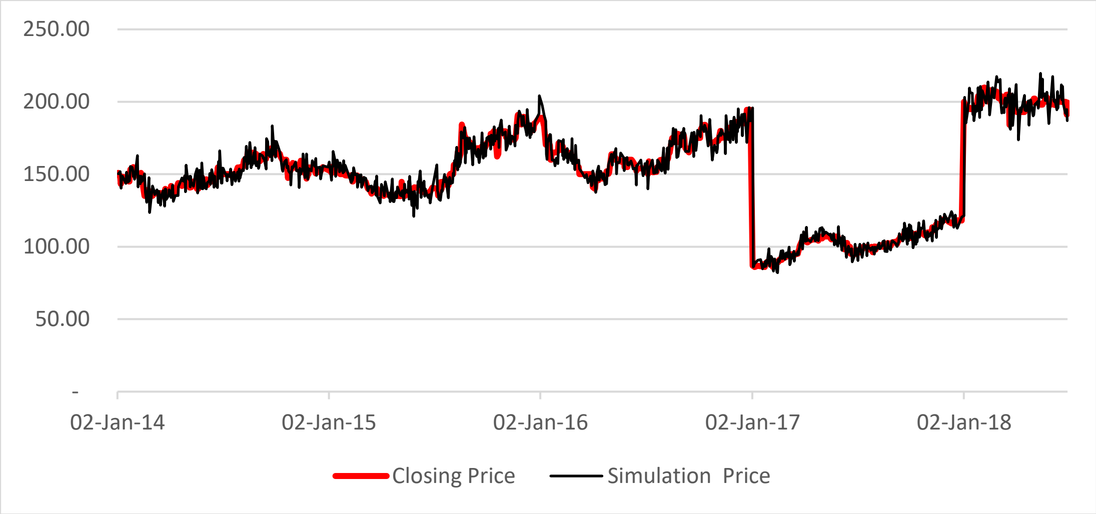


Figure A.G.11. Cargils

Figure A.G.12. Cargils

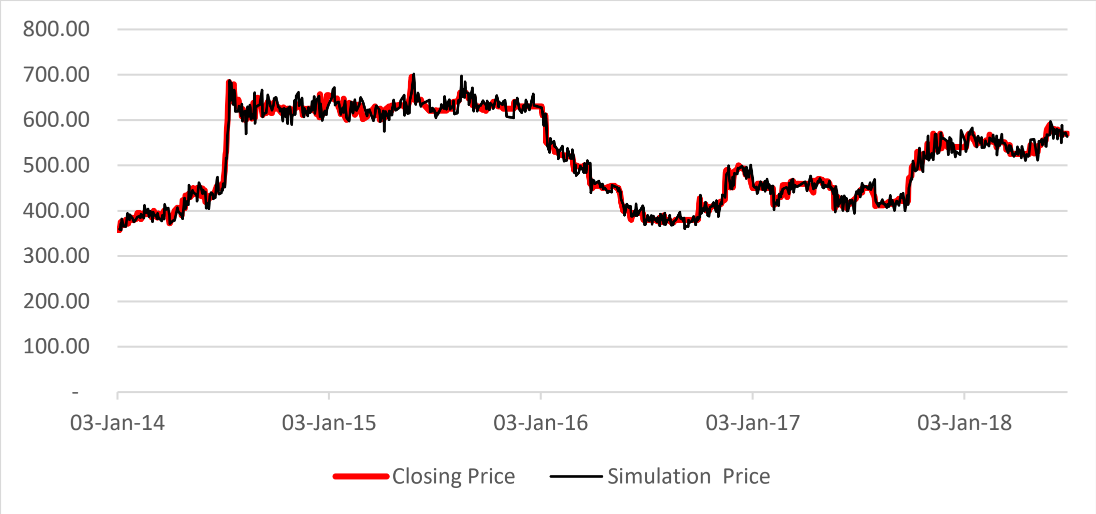


Figure A.G.13. Lion Brewery

Figure A.G.14. SLT

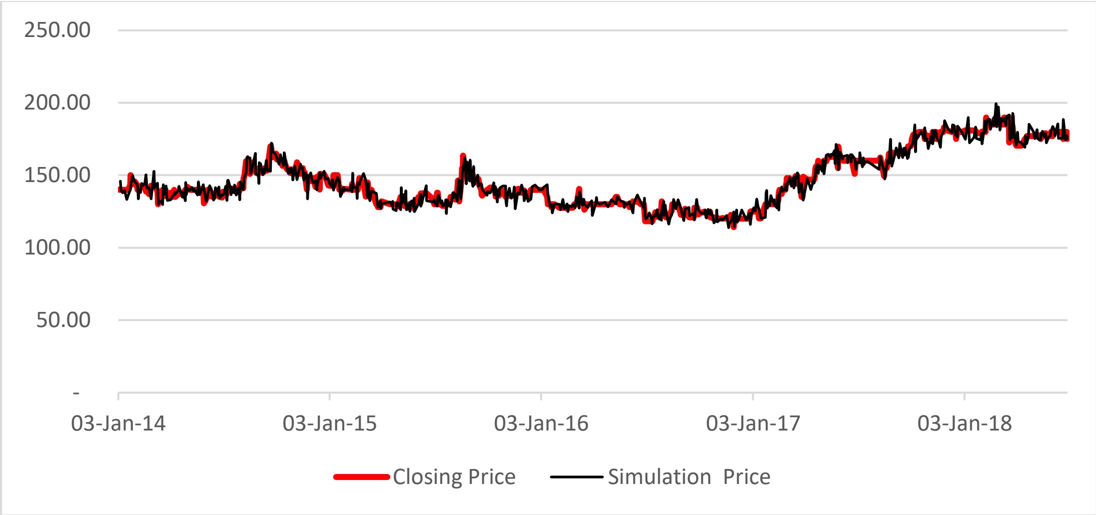


Figure A.G.15. C T Holdings

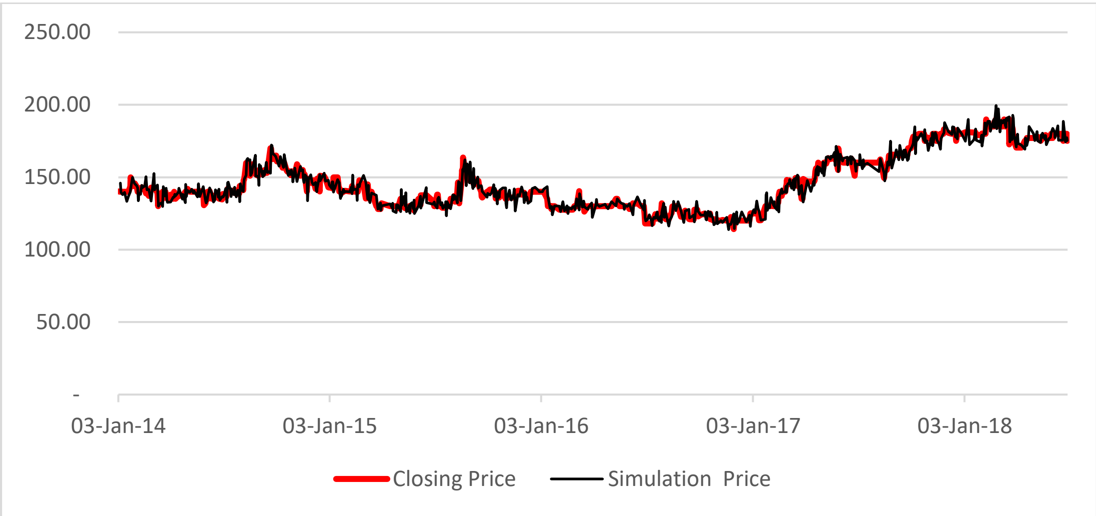


Figure A.G.16. Ceylinco Ins.

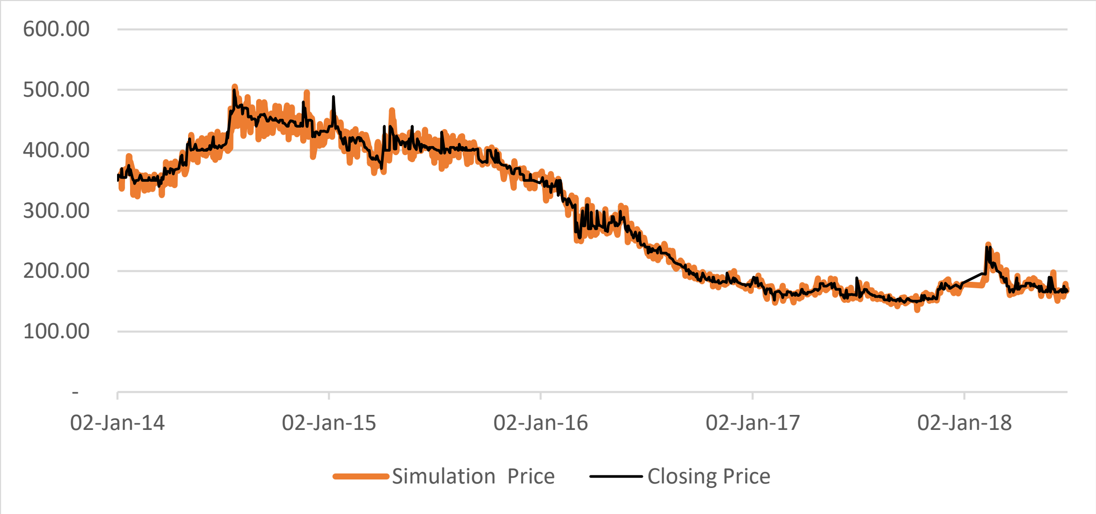


Figure A.G.17. Carsons

Figure A.G.18. DFCC

Figure A.G.19. Asiri

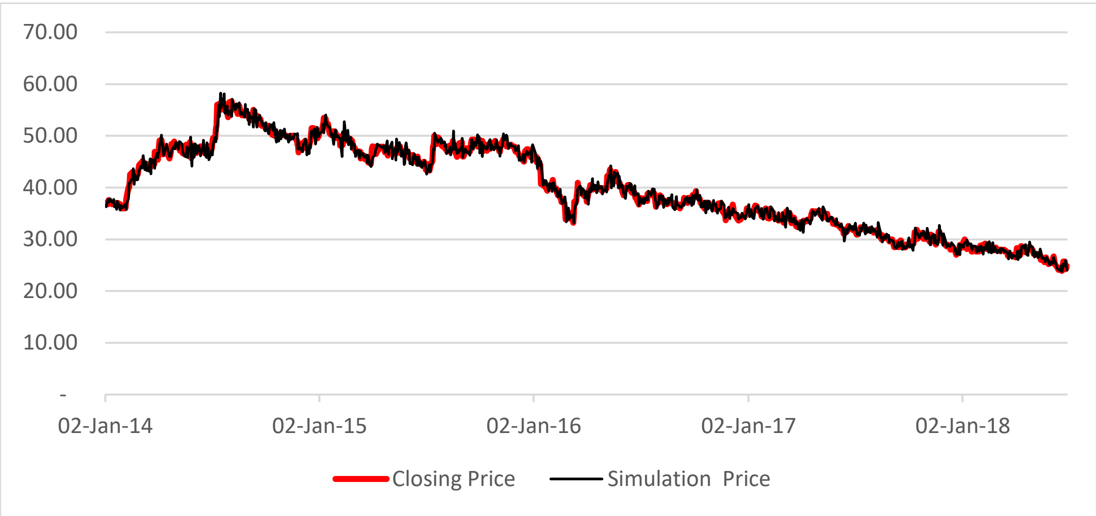


Figure A.G.20. Softlogic

Figure A.G.21. Peoples Leasing

Figure A.G.22. Rich Pieris Exp

Figure A.G.23. Textured Jersey

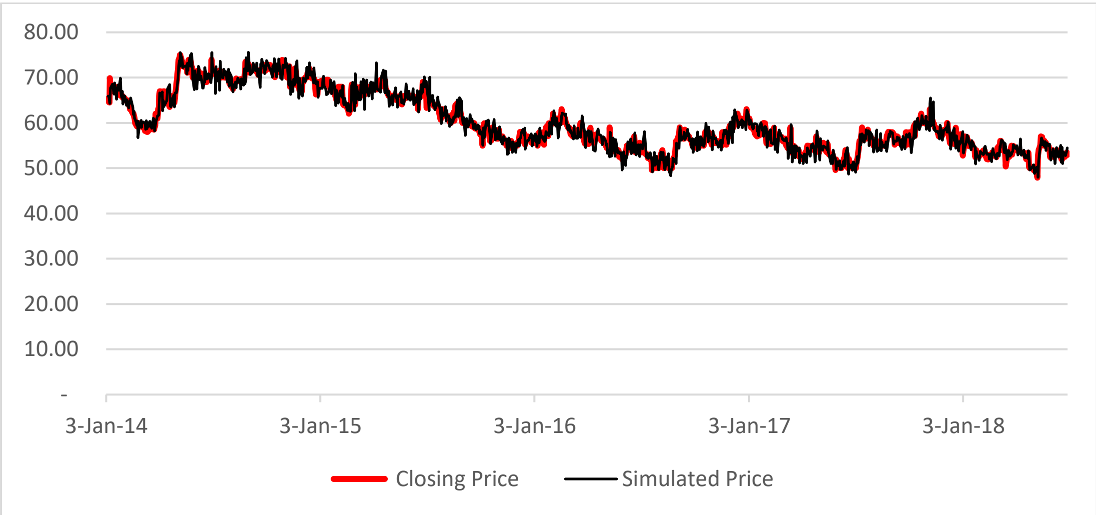
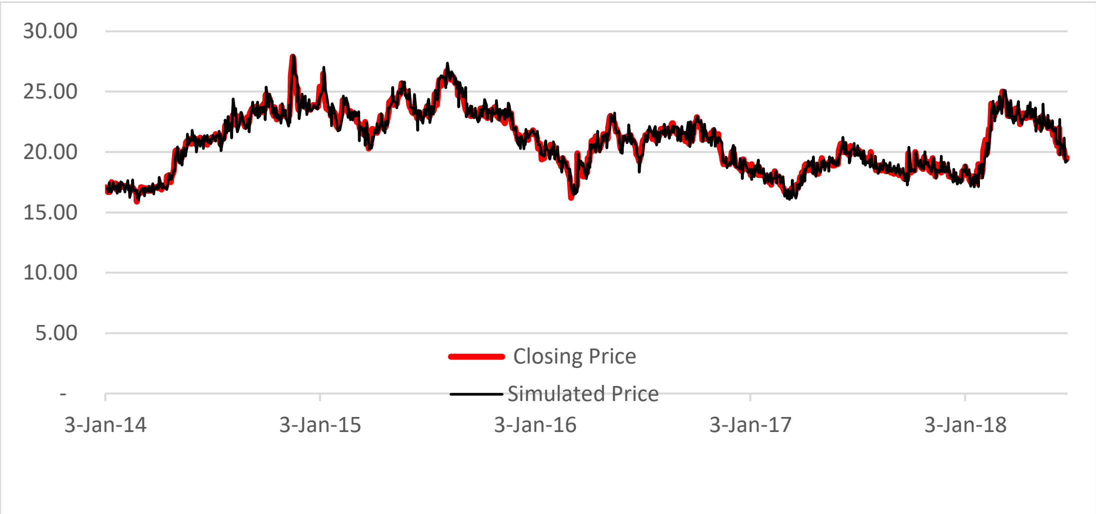


Figure A.G.24. Ahot Properties

Figure A.G.25. NDB

Figure A.G.26. NTB

Figure A.G.27. Central Finance



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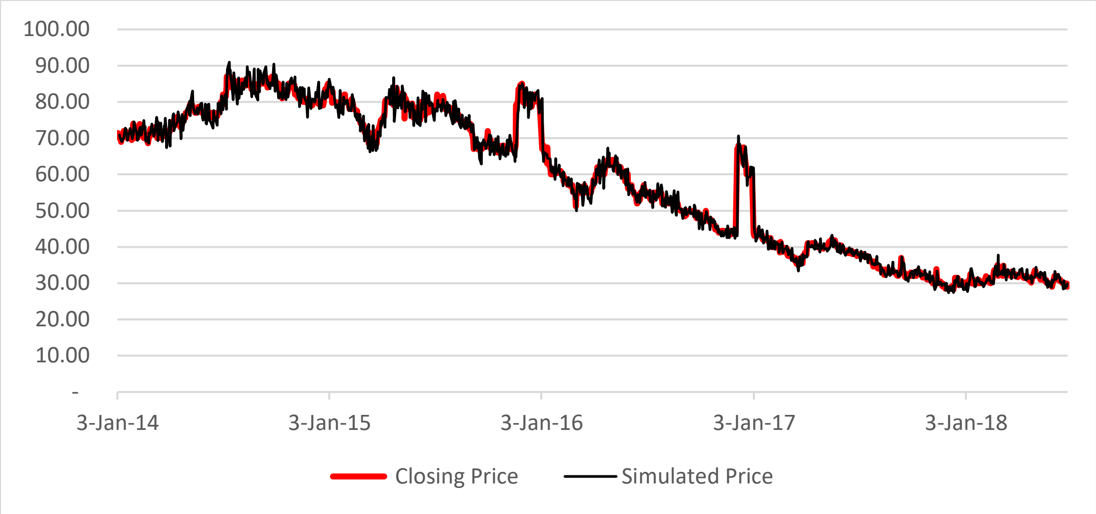

Figure A.G.29. Aitken Spence

Figure A.G.30. Bukit Darah

Figure A.G.31. Overseas Realty

Figure A.G.32. Chevron

Figure A.G.33. Lanka IOC

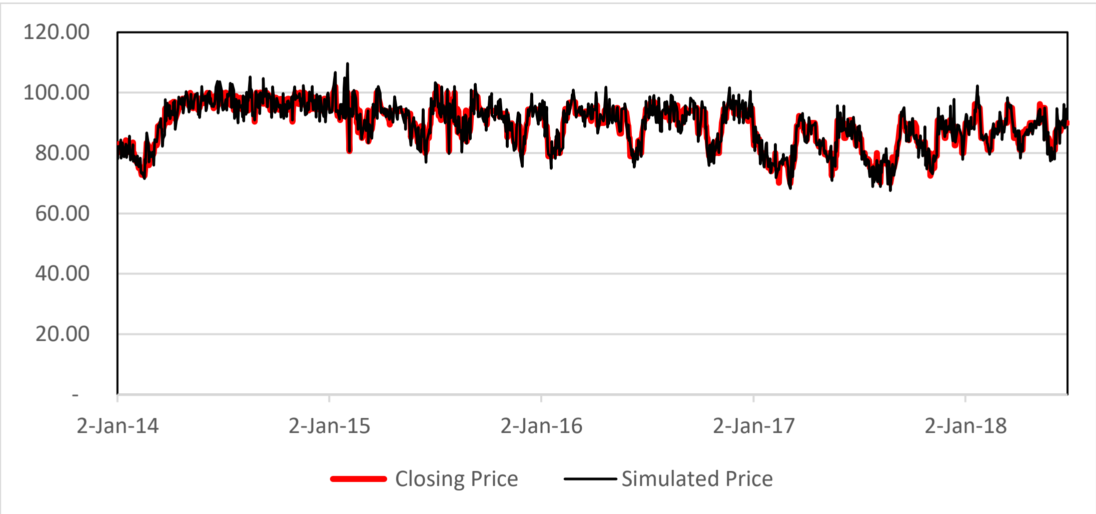

Figure A.G.34. Trans Asia

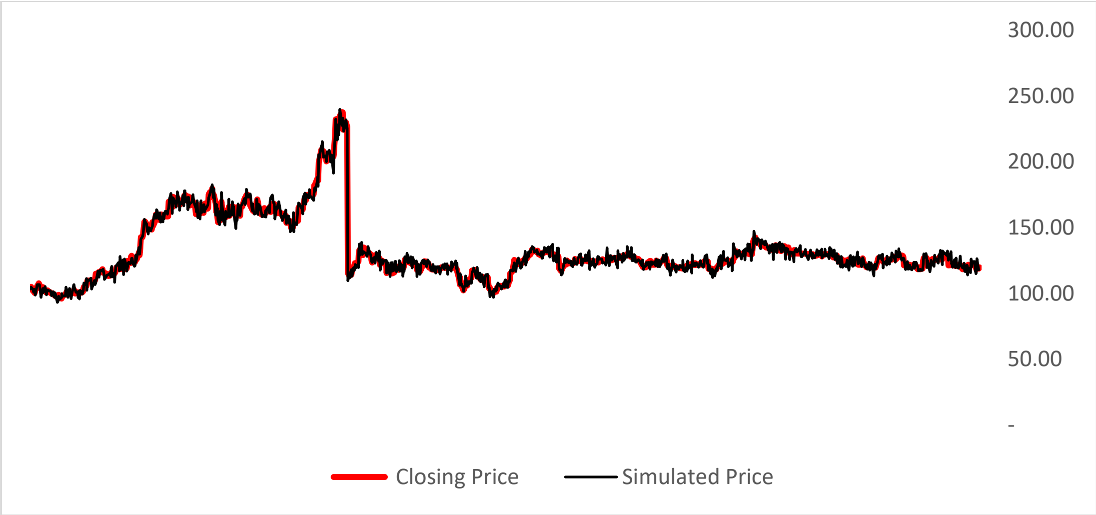

Figure A.G.35. Lb Finance

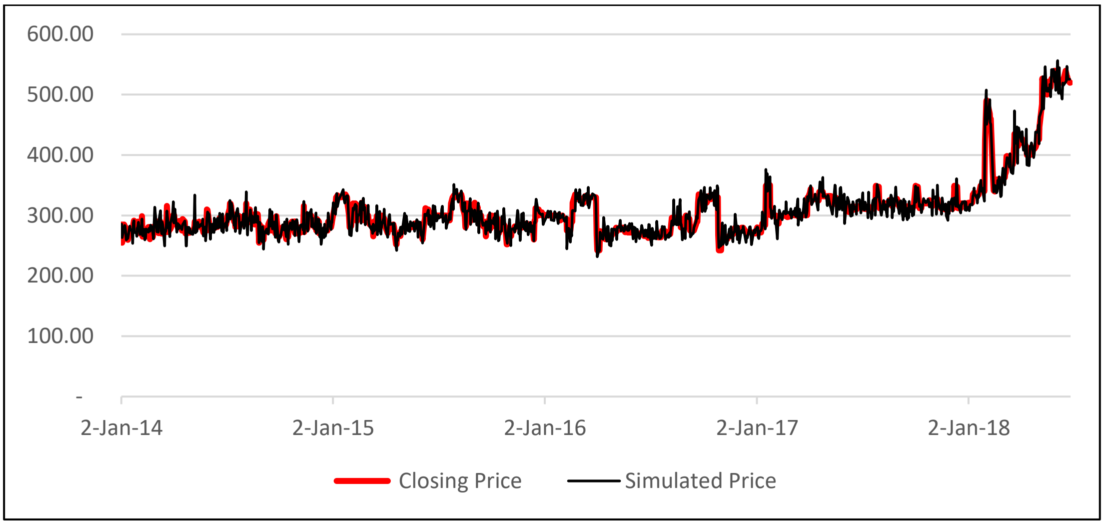

Figure A.G.36. A I A Insurance

Figure A.G.37. Hayleys

Figure A.G.38. Access Eng Sl

Figure

A.G.39. Seylan Bank

Figure A.G.40. LOLC Finance

Figure A.G.41. Ceylon Beverage

Figure A.G.42. Comm Lease & Fin

Figure A.G.43. Union Bank

Figure A.G.44. Singer Sri Lanka

Figure A.G.45. Union Assurance

Figure A.G.46. Dilmah Ceylon

Figure A.G.47. Keells Hotels

Figure A.G.48. Com.Credit

Figure A.G.49. Royal Ceramic

Figure A.G.50. A.Spen.Hot.Hold.

Figure A.G.51. Orient Garments

Figure A.G.52. Tokyo Cement

Figure A.G.53. Browns Invstmnts

Figure A.G.54. Seylan Bank

Figure A.G.55. United Motors

Figure A.G.56. Amana Bank

Figure A.G.57. Softlogic Life

Figure A.G.58. Shalimar

Figure A.G.59. Expolanka

Figure A.G.60. Mercantile Inv

Figure A.G.61. Mercantile Inv

Figure A.G.62. Sunshine Holding

Figure A.G.63. PDL

Figure A.G.64. LMF

Figure A.G.65. Jetwing Symphony

Figure A.G.66. Laugfs Gas

Figure A.G.67. Pan Asia

Figure A.G.68. Senkadagala

Figure A.G.69. Odel Plc

Figure A.G.70. Indo Malay

Figure A.G.71. Ceylinco Ins.

Figure A.G.72. Nawaloka

Figure A.G.73. Ceylon Guardian

Figure A.G.74. Kotmale Holdings

Figure A.G.75. R I L Property

Figure A.G.76. Asiri Surg

Figure A.G.77. Browns Capital

Figure A.G.78. LVL Energy

Figure A.G.79. Sanasa Dev. Bank

Figure A.G.80. S M B Leasing

Figure A.G.81. Vallibel

Figure A.G.82. Watawala

Figure A.G.83. Ambeon Capital

Figure A.G.84. Janashakthi Ins.

Figure A.G.85. Lanka Tiles

Figure A.G.86. Lanka Walltile

Figure A.G.87. Dipped Products

Figure A.G.88. Dockyard

Figure A.G.89. ACL

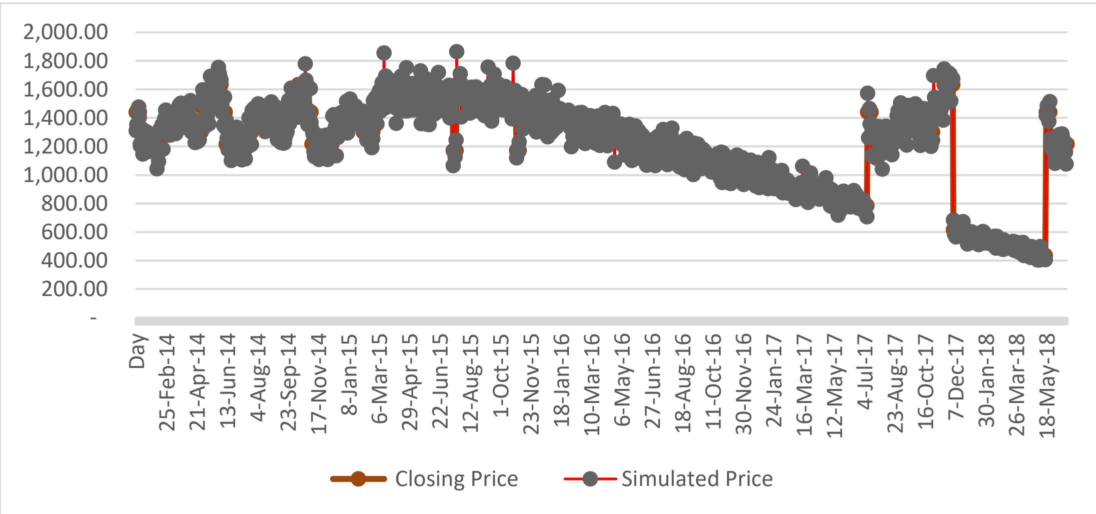

Figure A.G.90. Good Hope

Figure A.G.91. People's Ins

Figure A.G.92. Piramal Glass

Figure A.G.93. Bimputh Finance

Figure A.G.94. Tokyo Cement

Figure A.G.95. Alumex Plc

Figure A.G.96. CDB

Figure A.G.97. Nations Trust

Figure A.G.98. Kingsbury

Figure A.G.99. Trade Finance

Figure A.G.100. Bppl Holdings

Figure A.G.101. Vallibel Finance

Figure A.G.102. Haycarb

Figure A.G.103. CIC

Figure A.G.104. Galadari

Figure A.G.105. Dimo

Figure A.G.106. Grain Elevators

Figure A.G.107. Ceylon Inv.

Figure A.G.108. Softlogic Cap

Figure A.G.109. Colombo Land

Figure A.G.110. Morisons

Figure A.G.111. Browns

Figure A.G.112. Selinsing

Figure A.G.113. Ambeon Holdings

Figure A.G.114. E B Creasy

Figure A.G.115. Keells Food

Figure A.G.116. Vidullanka

Figure A.G.117. Lanka Ashok

Figure A.G.118. Kelani Tyres

Figure A.G.119. Fort Land

Figure A.G.120. Kandy Hotels

Figure A.G.121. First Capital

Figure A.G.122. Singer Finance

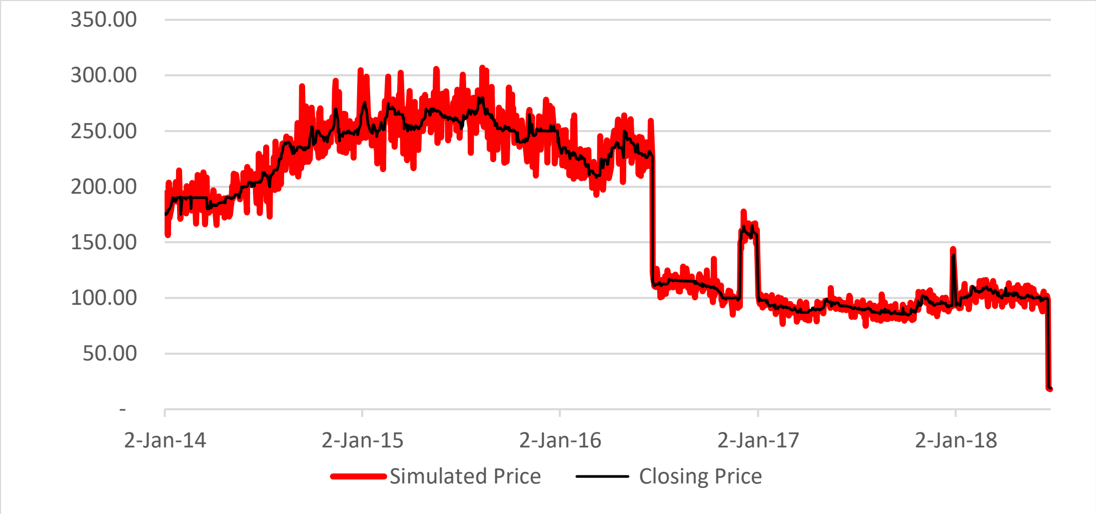

Figure A.G.123. Colombo Trust

Figure A.G.124. Kahawatte

Figure A.G.125. Kelani Valley

Figure A.G.126. Harischandra

Figure A.G.127. Dunamis Capital

Figure A.G.128. Amaya Leisure

Figure A.G.129. Sathosa Motors

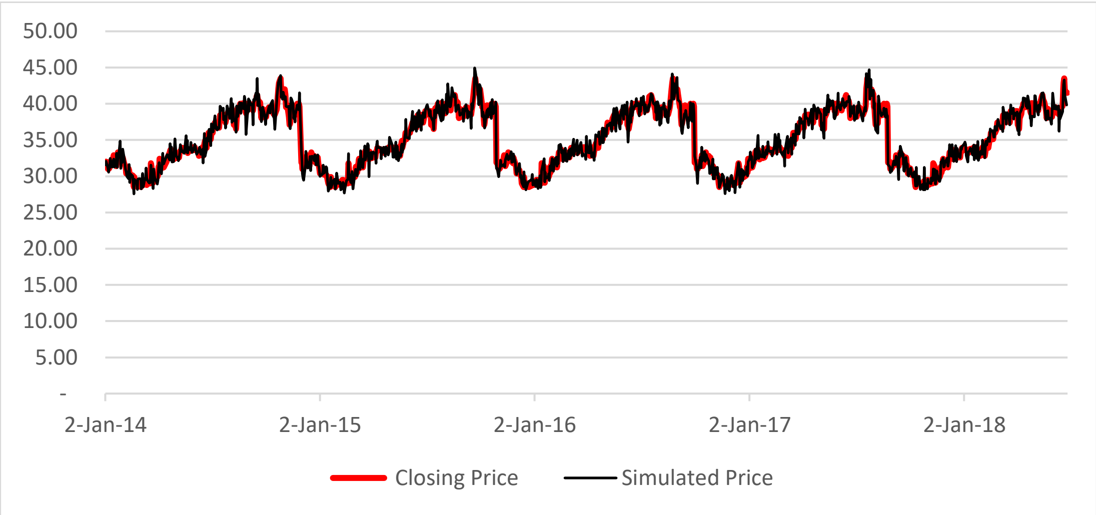

Figure A.G.130. C T Land

Figure A.G.131. East West

Figure A.G.132. Hotels Corp.

Figure A.G.133. Nuwara Eliya

Figure A.G.134. Printcare Plc

Figure A.G.135. Tal Lanka

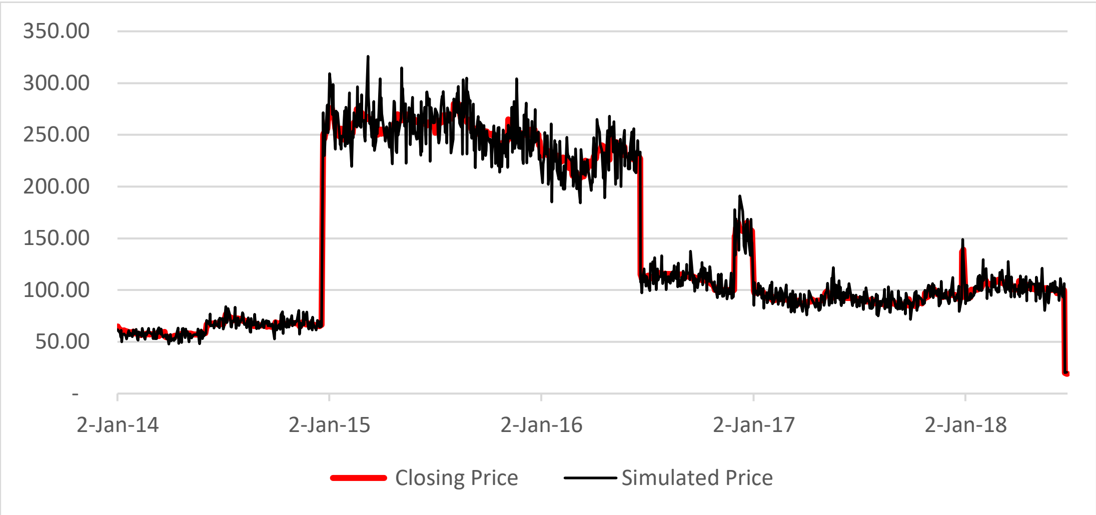

Figure A.G.136. Alliance

Figure A.G.137. Three Acre Farms

Figure A.G.138. AMF Co Ltd

Figure A.G.139. MTD Walkers

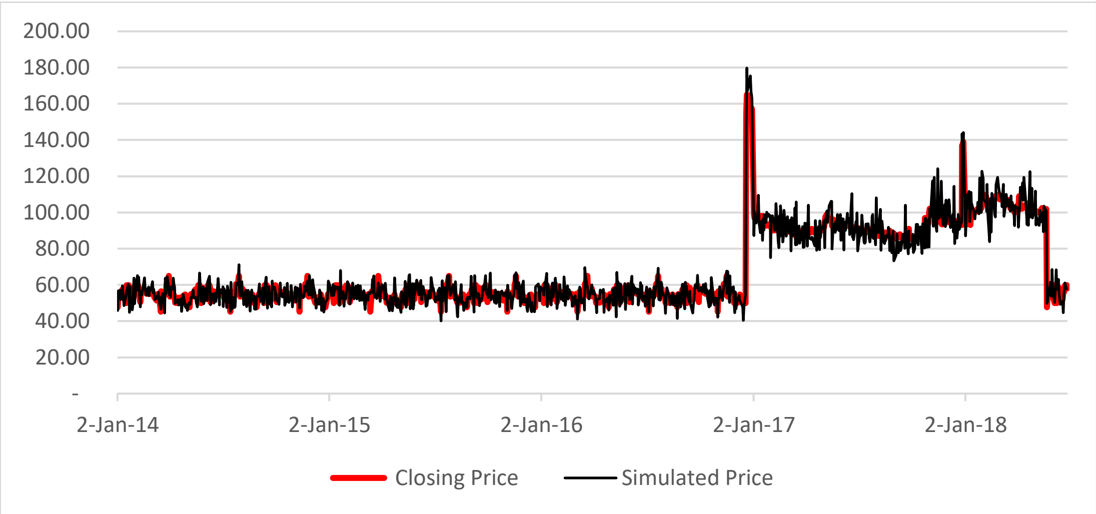

Figure A.G.140. Equity Two Plc

Figure A.G.141. Lanka Ventures

Figure A.G.142. Hunters

Figure A.G.143. Softlogic Fin

Figure A.G.144. Radiant Gems

Figure A.G.145. Lee Hedges

Figure A.G.146. Orient Finance

Figure A.G.147. Hayleys Fabric

Figure A.G.148. Bairaha Farms

Figure A.G.149. Paragon

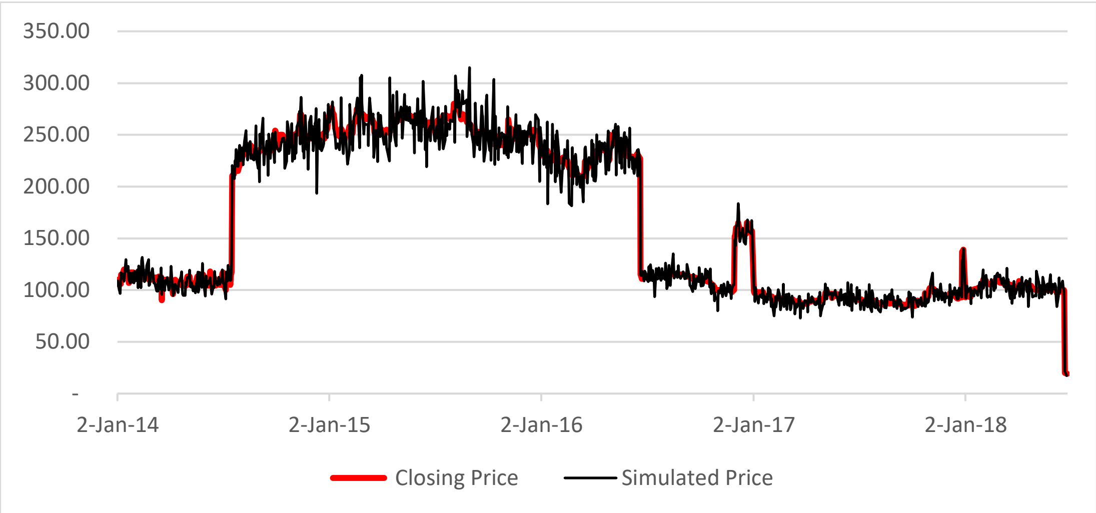

Figure A.G.150. Durdans

Figure A.G.151. Browns Beach

Figure A.G.152. HDFC

Figure A.G.153. Rich Pieris Exp

Figure A.G.154. Kelani Cables

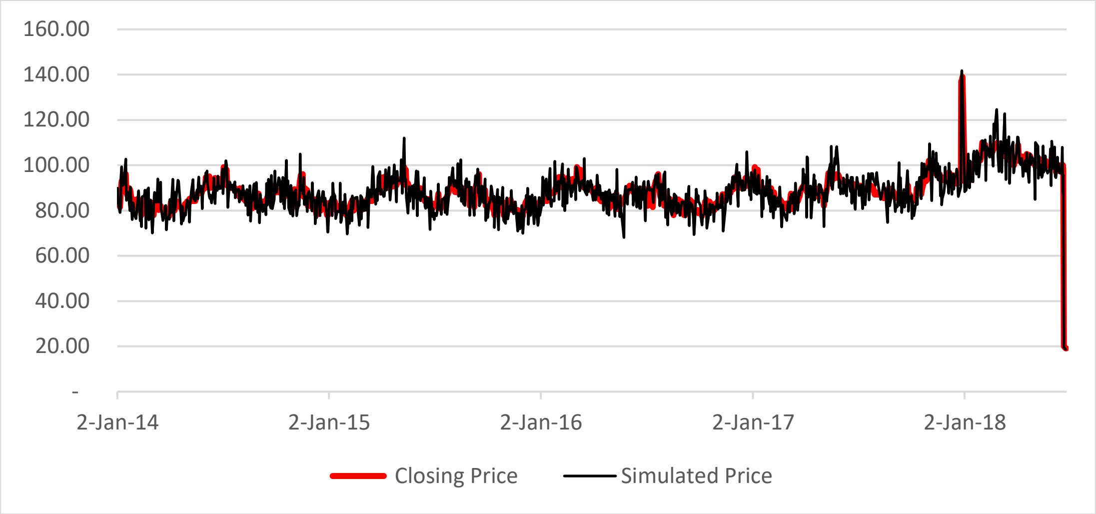

Figure A.G.155. Namunukula

Figure A.G.156. Huejay

Figure A.G.157. Renuka City Hot.

Figure A.G.158. Lucky Lanka

Figure A.G.159. Seylan Devts

Figure A.G.160. C.W.Mackie

Figure A.G.161. Merchant Bank

Figure A.G.162. Renuka Holdings

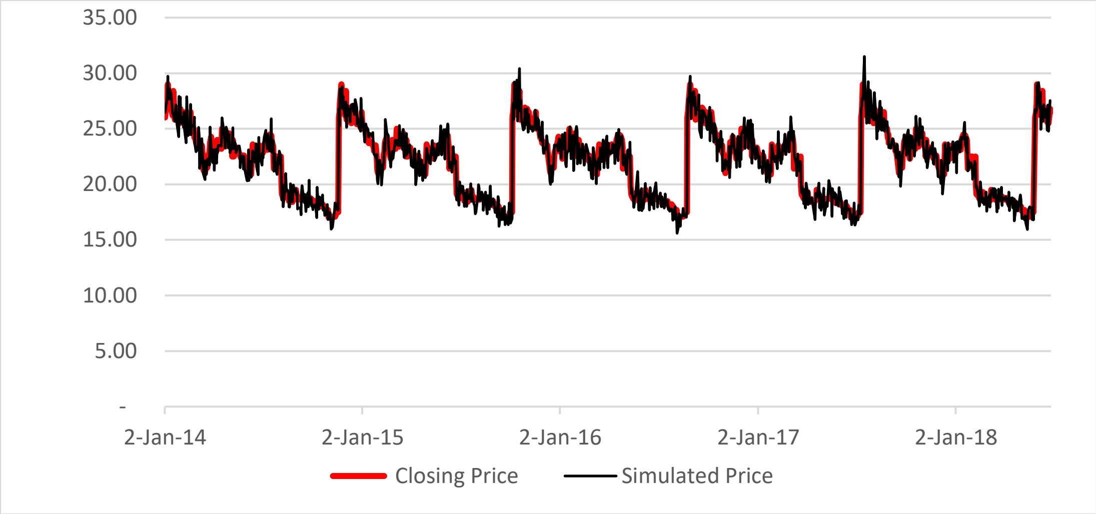

Figure A.G.163. Eden Hotel Lanka

Figure A.G.164. Pelwatte

Figure A.G.165. Elpitiya

Figure A.G.166. Prime Finance

Figure A.G.167. On'ally

Figure A.G.168. Lighthouse Hotel

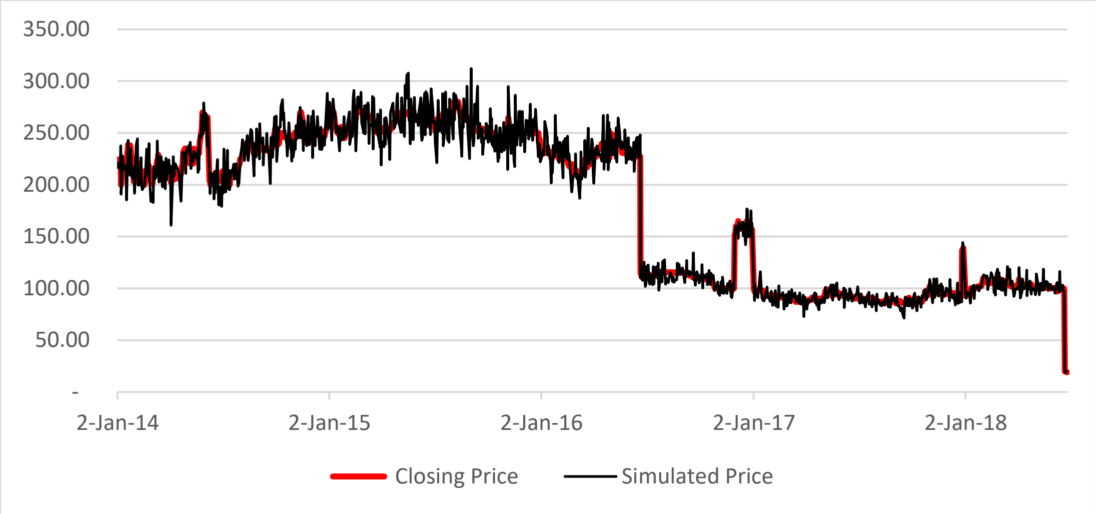

Figure A.G.169. Convenience Food

Figure A.G.170. Panasian Power

Figure A.G.171. Amana Takaful

Figure A.G.172. Abans Financial

Figure A.G.173. Kegalle

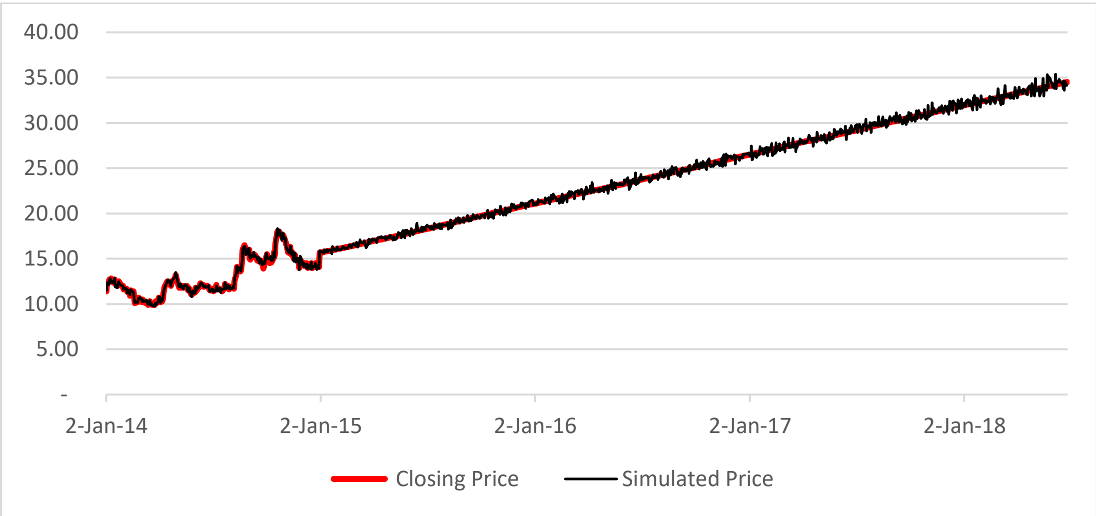

Figure A.G.174. Madulsima

Figure A.G.175. Swisstek

Figure A.G.176. Bogala Graphite

Figure A.G.177. Malwatte

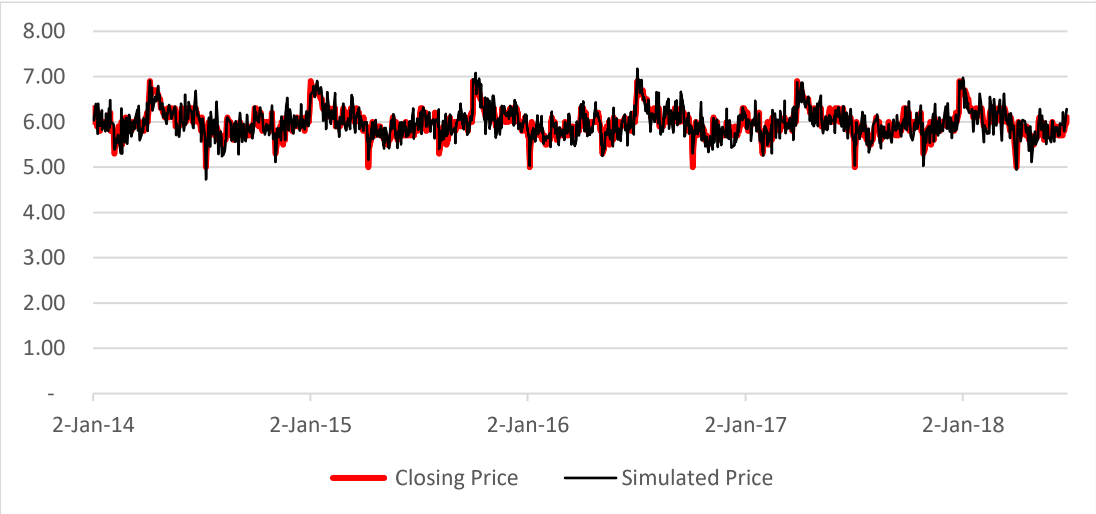

Figure A.G.178. Millennium House

Figure A.G.179. Citrus Hikkaduwa

Figure A.G.180. Talawakelle

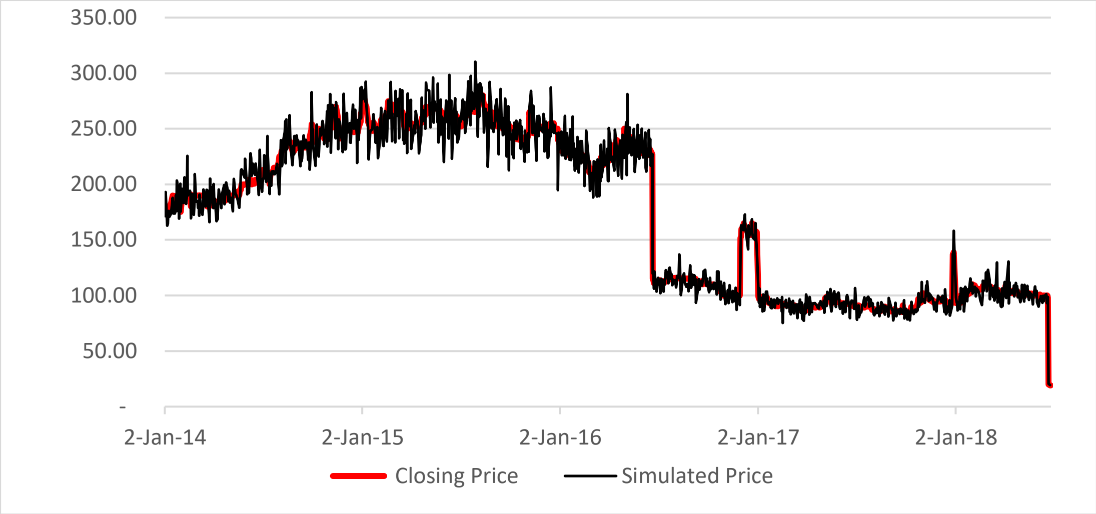

Figure A.G.181. Arpico Insurance

Figure A.G.182. Renuka Agri

Figure A.G.183. Agstar Plc

Figure A.G.184. Serendib Hotels

Figure A.G.185. Resus Energy

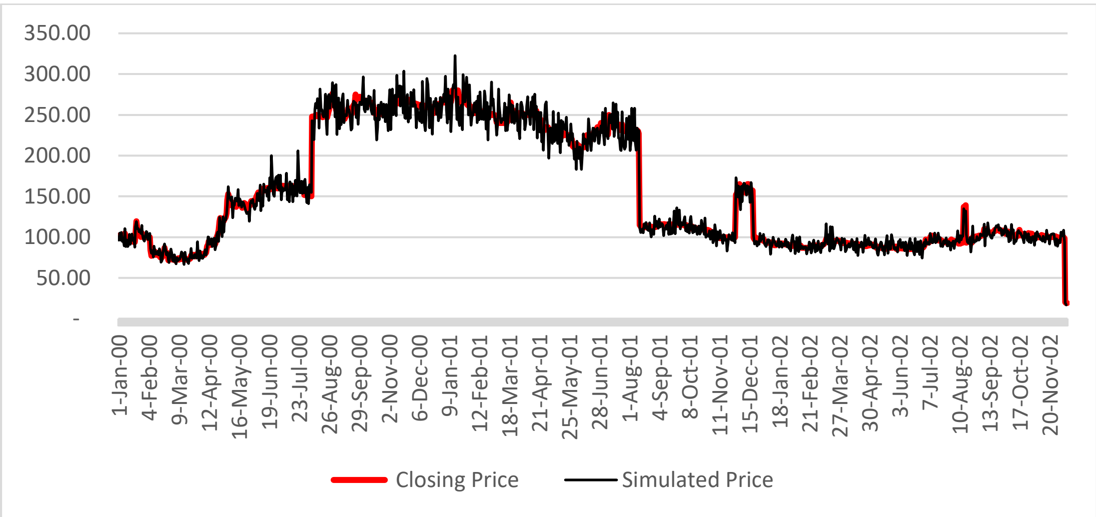

Figure A.G.186. Arpico

Figure A.G.187. Fortress Resorts

Figure A.G.188. Sierra Cabl

Figure A.G.189. Bogawantalawa

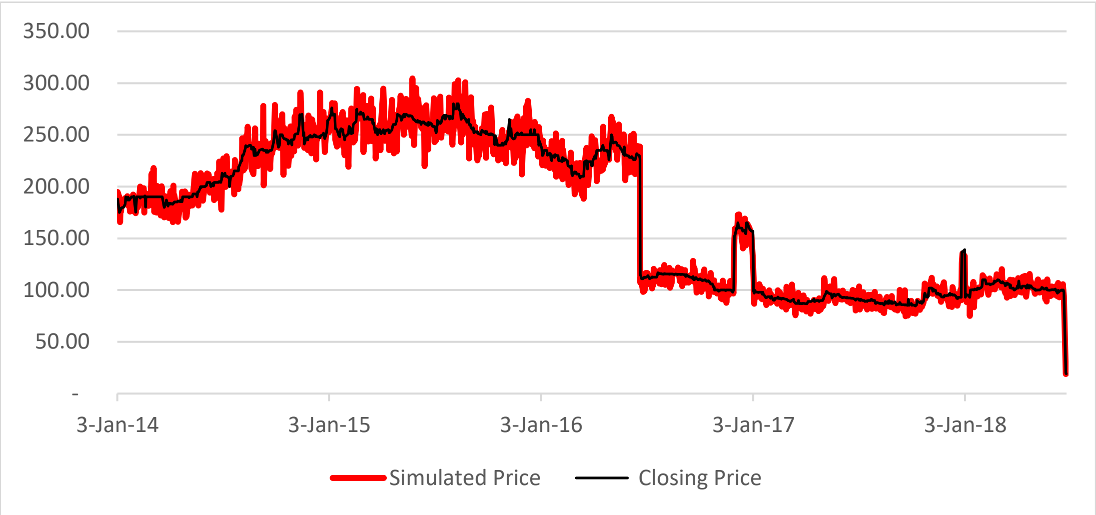

Figure A.G.190. Palm Garden Hotl

Figure A.G.191. Autodrome

Figure A.G.192. Dankotuwa Porcel

Figure A.G.193. Lankem Ceylon

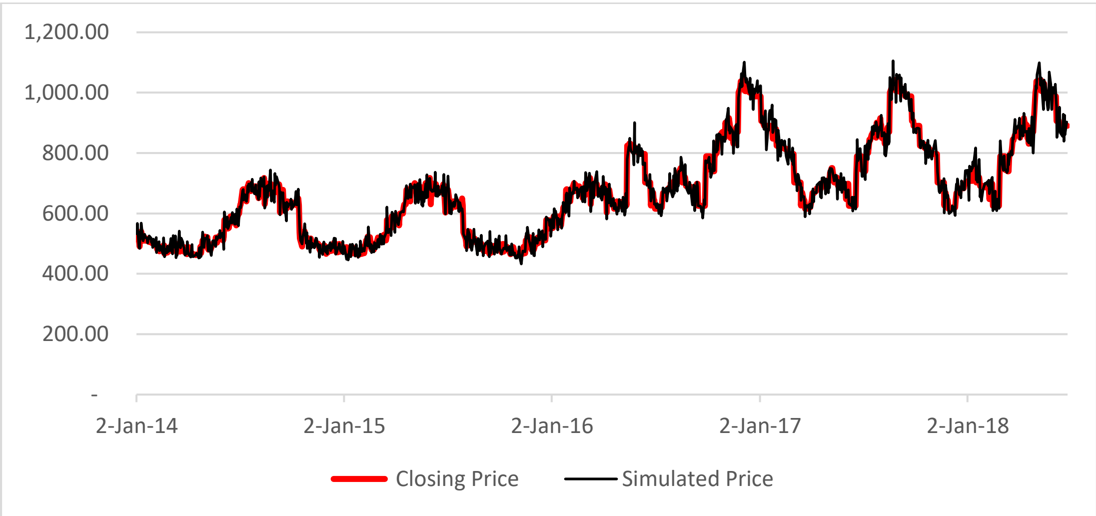

Figure A.G.194. Colombo City

Figure A.G.195. Morisons

Figure A.G.196. Asia Asset

Figure A.G.197. Regnis

Figure A.G.198. Dolphin Hotels

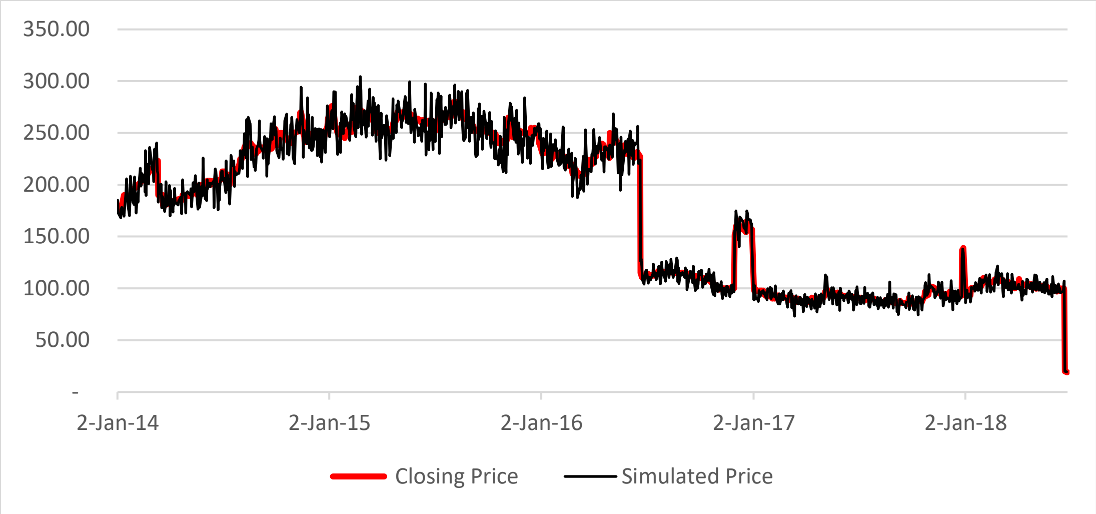

Figure A.G.199. Commercial Dev.

Figure A.G.200. Laugfs Gas

Figure A.G.201. Asia Capital

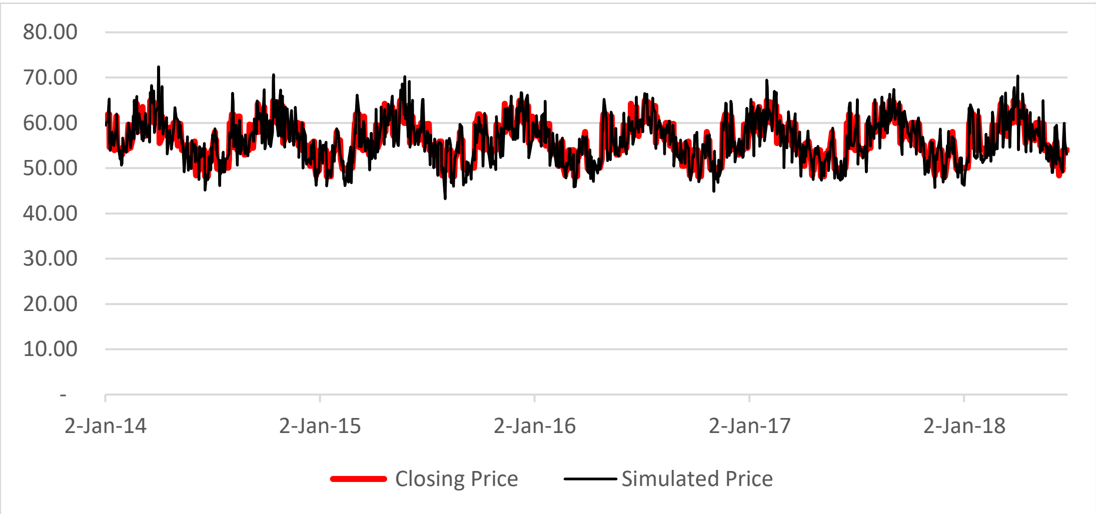

Figure A.G.202. Tangerine

Figure A.G.203. Maskeliya

Figure A.G.204. Swarnamahal Fin

Figure A.G.205. CIC

Figure A.G.206. C M Holdings

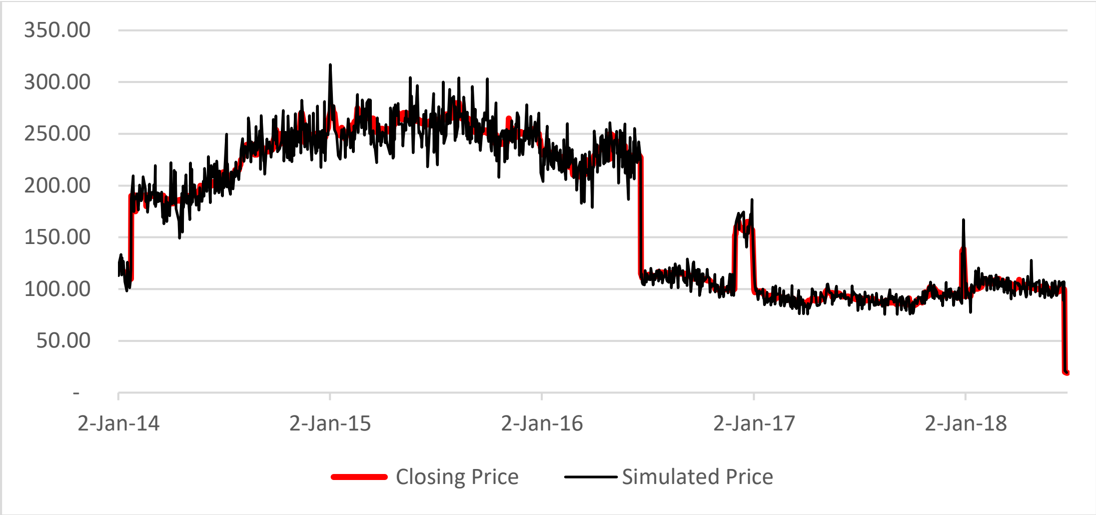

Figure A.G.207. Tea Smallholder

Figure A.G.208. Multi Finance

Figure A.G.209. Lanka Ceramic

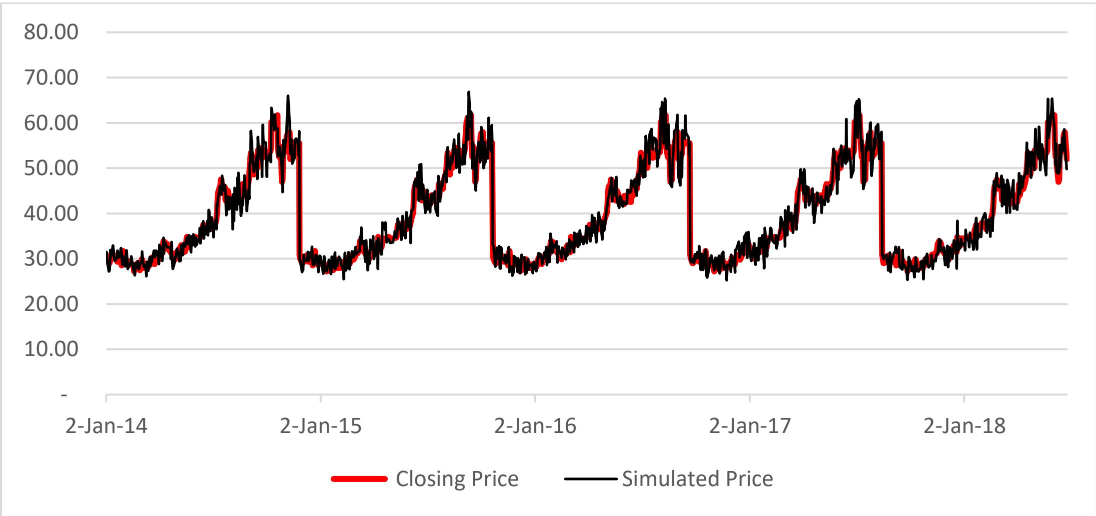

Figure A.G.210. Lanka Aluminium

Figure A.G.211. Chemanex

Figure A.G.212. Royal Palms

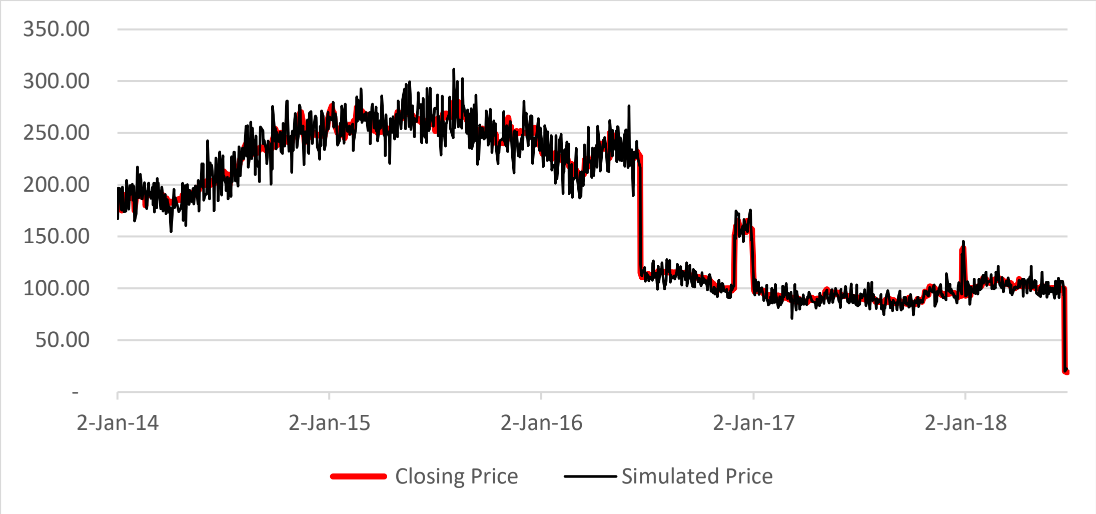

Figure A.G.213. Pegasus Hotels

Figure A.G.214. Tess Agro

Figure A.G.215. Renuka Capital

Figure A.G.216. Kotagala

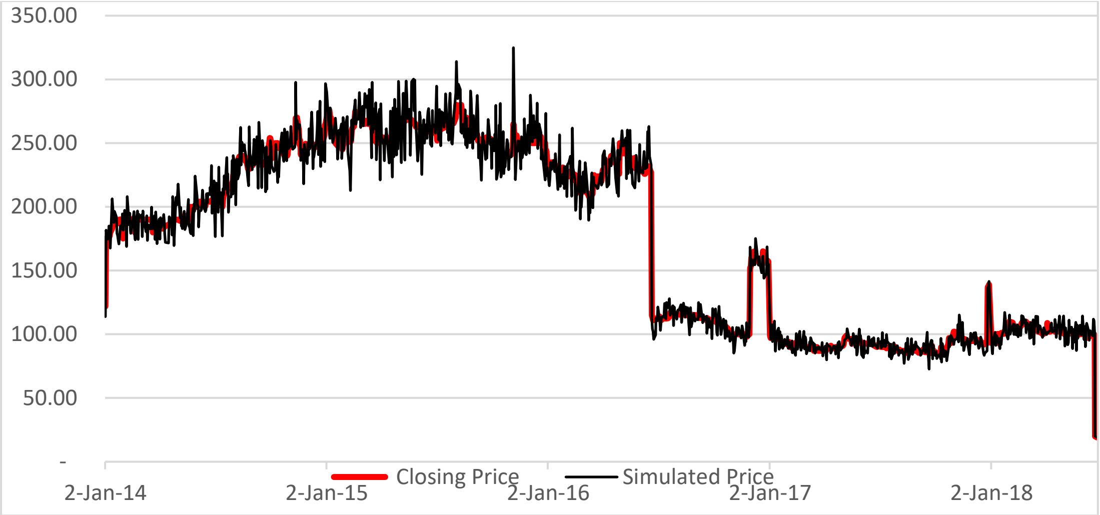

Figure A.G.217. Citrus Kalpitiya

Figure A.G.218. Mahaweli Reach

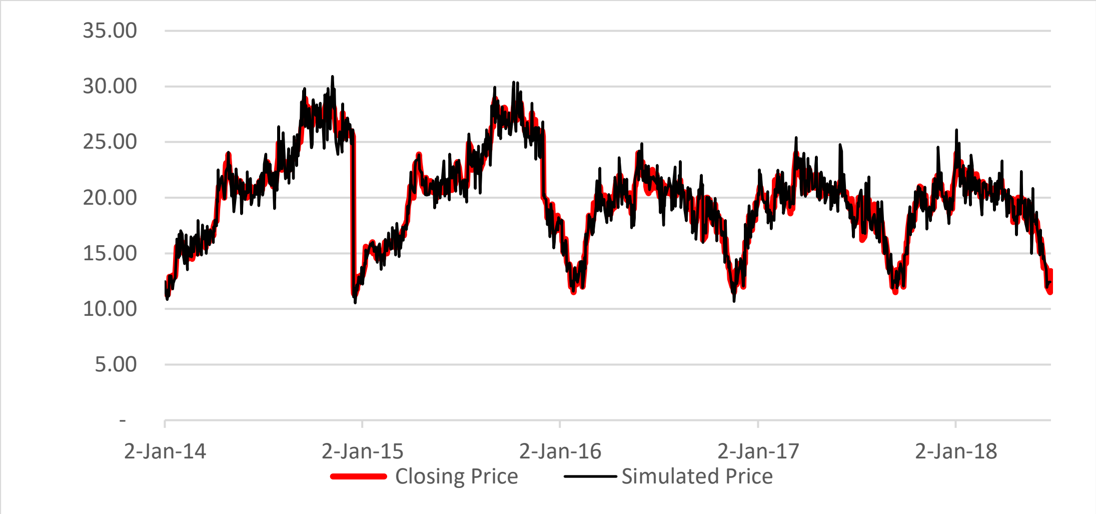

Figure A.G.219. People's Merch

Figure A.G.220. PC Pharma

Figure A.G.221. Cargo Boat

Figure A.G.222. Lankem Dev.

Figure A.G.22 . Raigam Salterns

Figure A.G.224. Citrus Leisure

Figure A.G.225. CDB

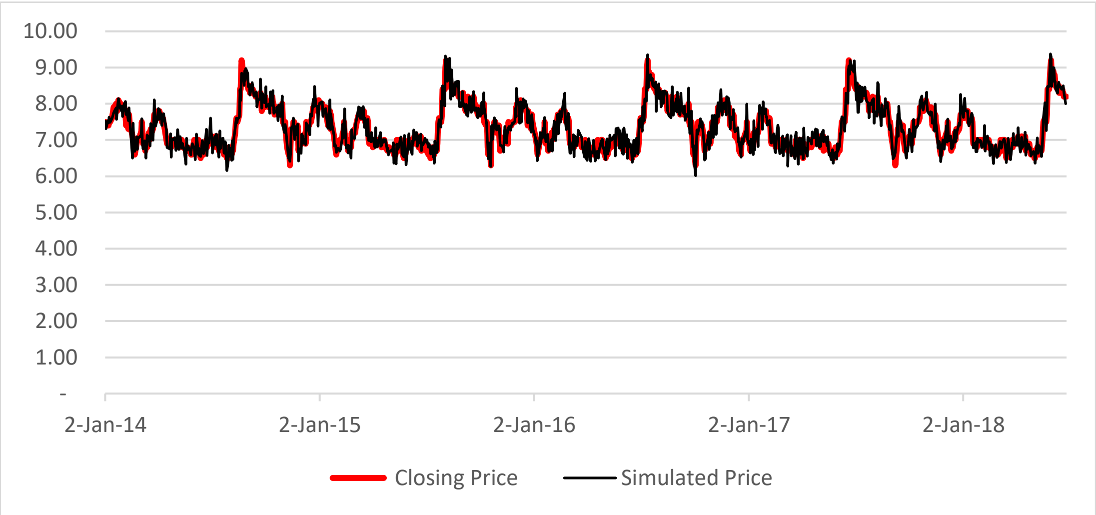

Figure A.G.226. Citrus Waskaduwa

Figure A.G.227. Nation Lanka

Figure A.G.228. Ceylon Tea Brkrs

Figure A.G.229. Union Chemicals

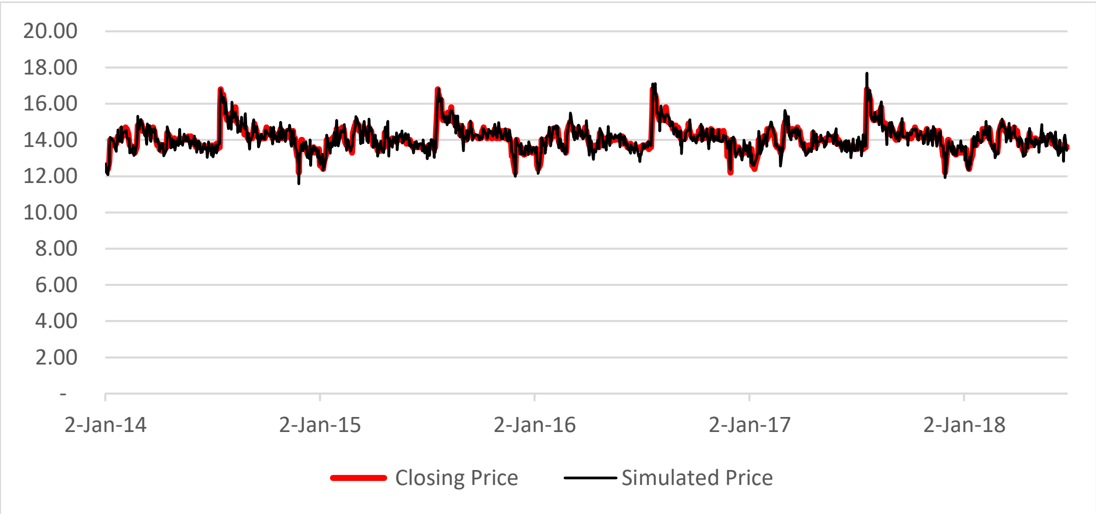

Figure A.G.230. E - Channelling

Figure A.G.231. Singhe Hospitals

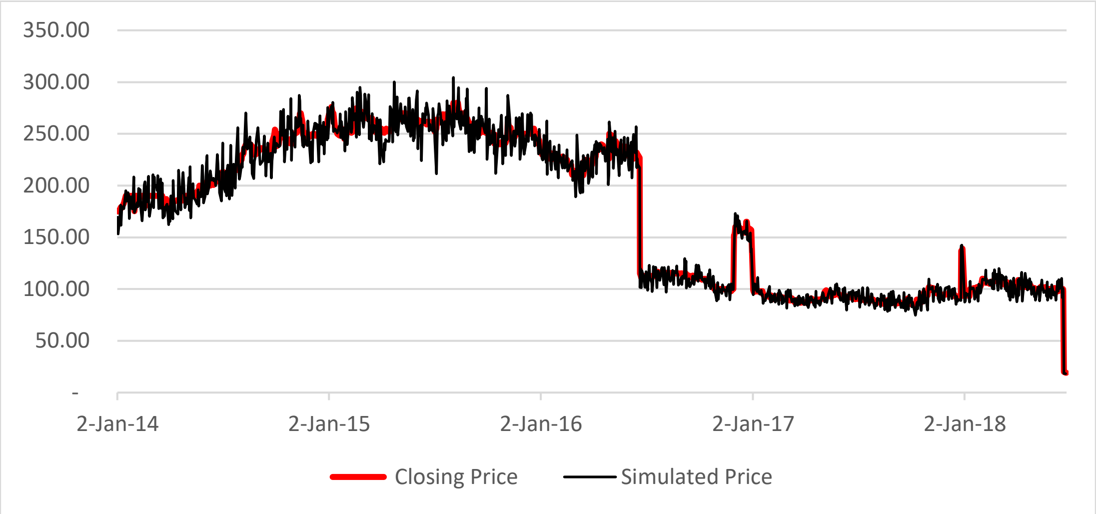

Figure A.G.232. Central Ind.

Figure A.G.233. Udapussellawa

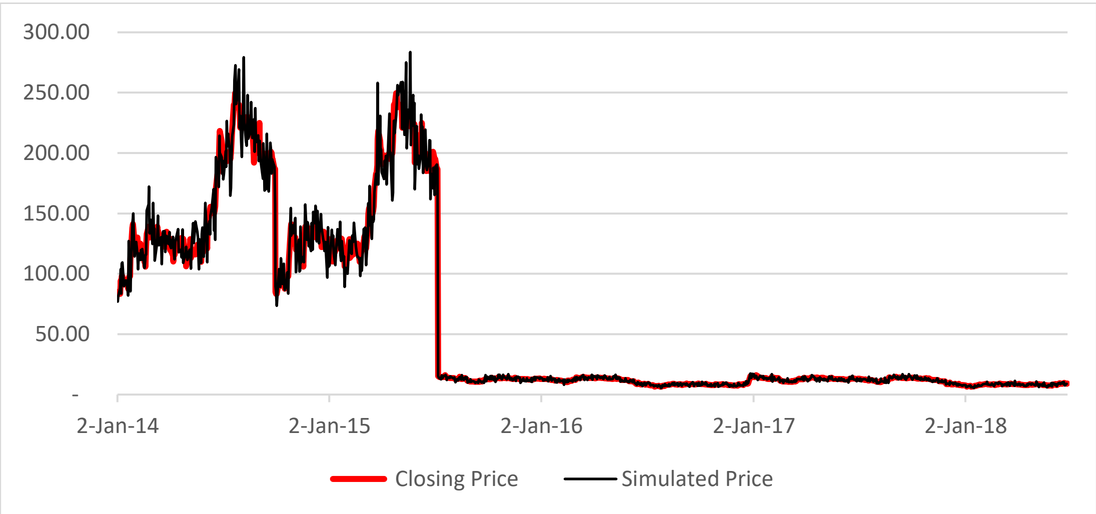

Figure A.G.234. Sinhaputhra Fin

Figure A.G.235. Kelsey

Figure A.G.236. Durdans

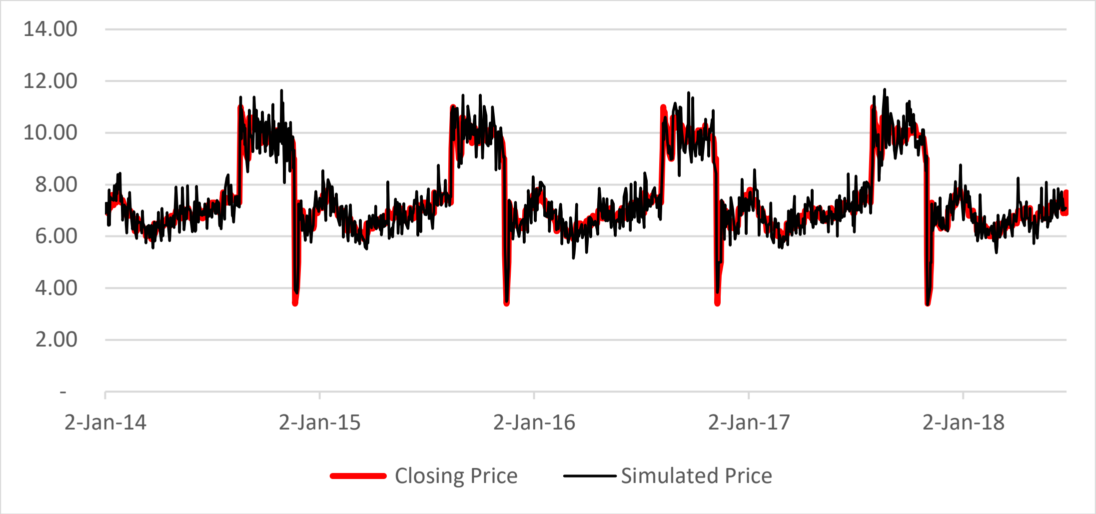

Figure A.G.237. Lanka Cement

Figure A.G.238. Eastern Merchant

Figure A.G.239. Serendib Land

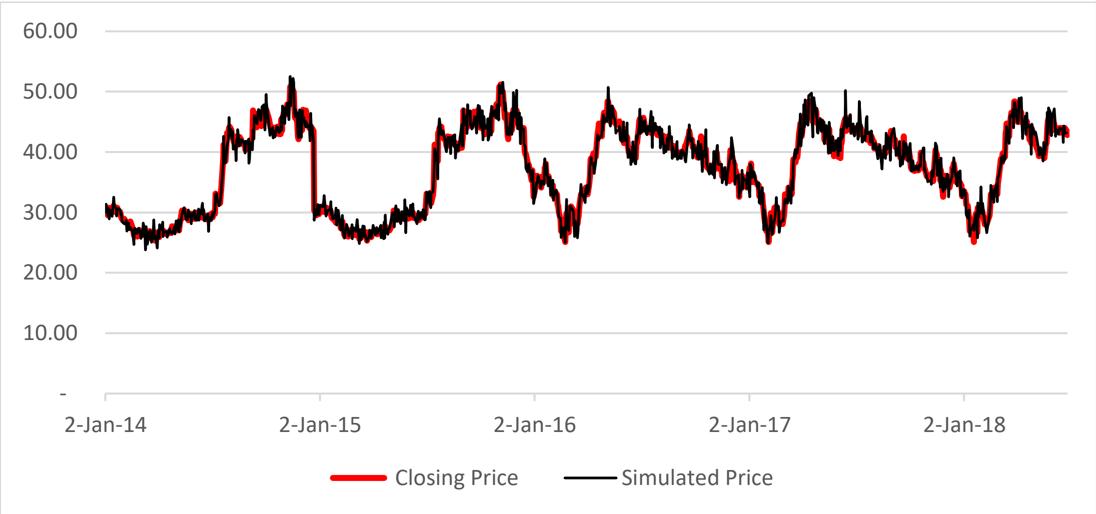

Figure A.G.240. Guardian Capital

Figure A.G.241. Lotus Hydro

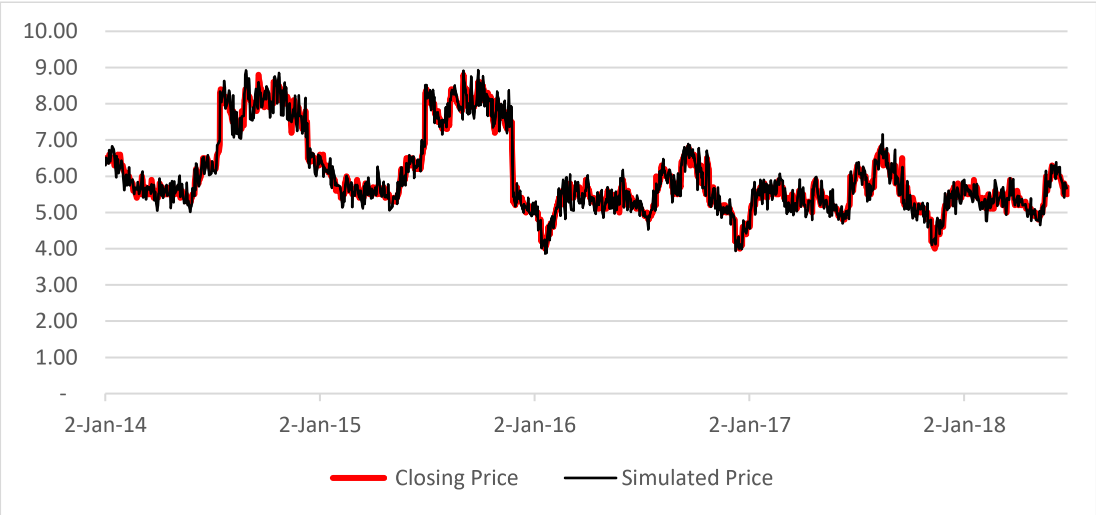

Figure A.G.24. CFT

Figure A.G.243. Hunas Falls

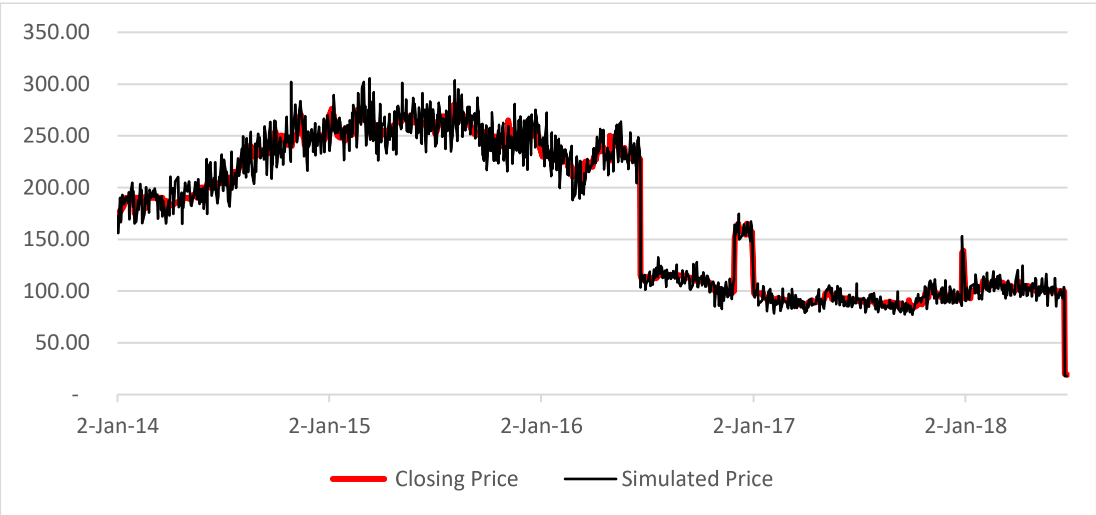

Figure A.G.244. Capital Leasing

Figure A.G.245. Marawila Resorts

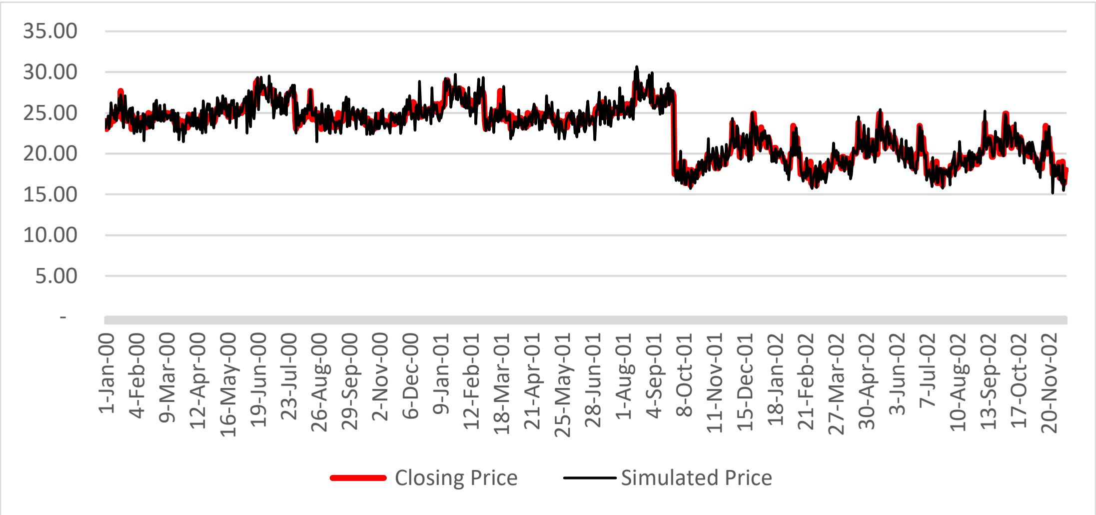

Figure A.G.246. Agalawatte

Figure A.G.247. Lake House Prin.

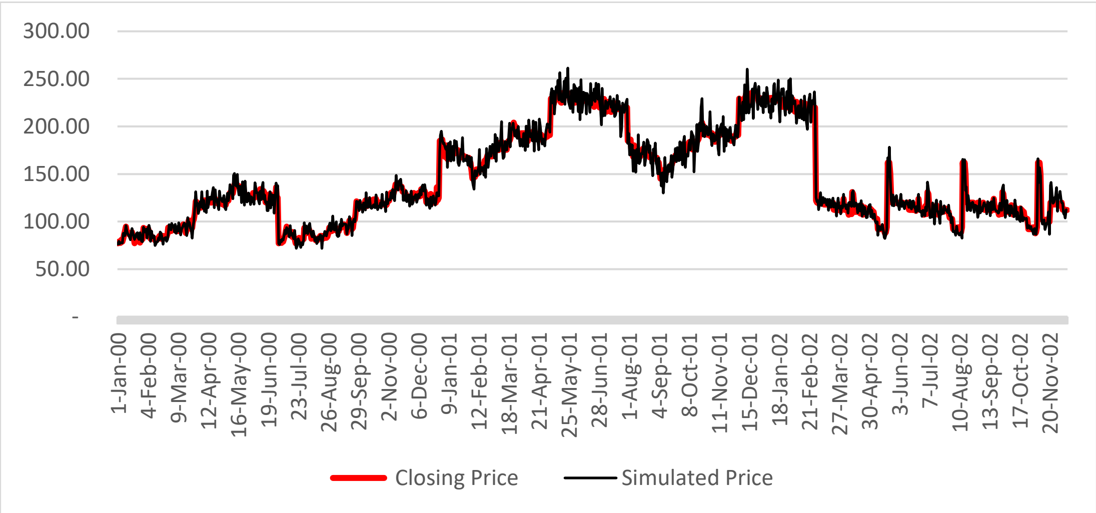

Figure A.G.248. ACL Plastics

Figure A.G.249. PC House

Figure A.G.250. Renuka Foods