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Modelling Dividend per Share in Nairobi Securities Exchange Using Autoregressive Integrated Moving Average Model

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Abstract*: Autoregressive Moving Averages {ARIMA (p,d,q)} model consist of autoregressive terms (AR), integrated terms (I) and the Moving averages terms (MA). According to Box and Jenkins, time series can be used to identify previous random errors in a time series which interact to create a pattern hence may be used for future forecasting. This can be identified using autocorrelation and partial autocorrelation graphs and spikes of time series. The number of lags required for data to be stationary I (d) can be identified by differencing of time series and if the data becomes stationary after differencing, then the I(d) terms exist. Similarly, when the autocorrelation and partial autocorrelation graphs are none zero and decays gradually, the AR terms and the MA terms exist hence the model can be used for forecasting the future. ARIMA (p, d, q) guided this study by identifying the model which is suitable for forecasting dividend per share. Furthermore, the model helped in data transformation of dividend per share into stationary. The current study therefore sought to model dividend per share using Autoregressive Integrated Moving Average Model. Reviewed studies focused on modeling variables using individual firm data while the present study modeled dividend per share using industry or macro- level quarterly data. Therefore, the nature of forecasting models when data at macro-level is used was not known; the modeling is therefore imperative. The study revealed that ARIMA (P,d, q) model can be used to predict dividend per share; the identified ARIMA (p, d, q) model is ARIMA (1,1,1). The study concludes that investors, financial analysts and managers should use ARIMA (1, 1,1) to forecast dividend per share. The study is important to policy makers, regulators, investors and scholars.*

Keywords: - ***ARIMA, Stock Return, Dividend Per Share, Nairobi Securities Exchange, time series.***

1. INTRODUCTION (*Heading 1*)

Dividend per share is a very important ratio in finance and accounting field. It is mostly used as a barometer by investment analysts, management of firms, National Security exchanges and investors to know the performance of firms or a group of firms forming a portfolio. According to Lilianti (2018), dividend per share ratio measures the distribution of dividend in relation to the number of outstanding shares in a given year. Therefore, mathematically, dividend per share is calculated by dividing cash dividend by the number of shares outstanding. Empirical studies link dividend per share to stock return in security exchanges, for instance, Nekesa, Ouma , and Njuguna, (2021) observed that dividend policy infleunce share prices of commercial banks in Kenya. Other emperical studies such as Garba (2014) Adam *et al.* (2014) Jagongo *et al.* (2014), Jafaru *et al.* (2013), Kang *et al.* (2019) and Pierre (2012) have also revealed that dividend per share influence stock return. It is from the foregoing that modeling dividend per share became imperative.

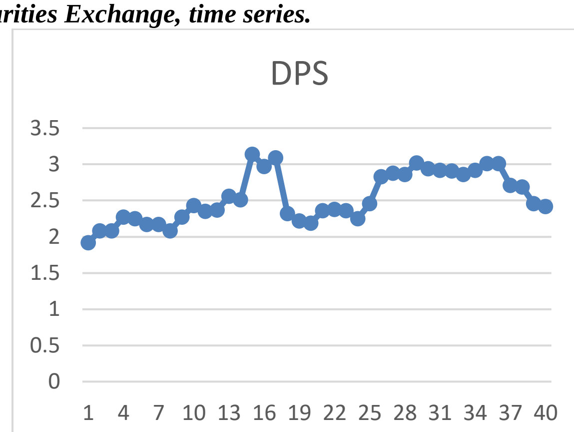

Figure 1: Trend of Dividend Per Share in Nairobi Securities Exchange
Source: Data from Nairobi Securities Exchange

Figure 1 reveal that dividend per share portrayed downward performance and then increased through to around the fifth quarter (1st quarter, 2010). Dividend per share then displayed a sluggish performance in quarter nine which is the first quarter of 2011; this is the year the burse suffered a bearish performance. The trend then portrayed an upward trajectory and spiked around quarter 15 and 17; that is, around the last quarters of 2012 and first quarter of 2013. The trend thereafter displayed a downward trend before again improving from quarter 26 (the second quarter of the year 2015; most importantly, first quarter of 2015 (quarter 25) revealed a low performance before peaking towards the end of the last quarters of the same year. This low performance of dividend per share coincides with the 2015 bear run.

2. Literature Review

Yipeng (2024) studied ARIMA (*p, d, q*) Model, Discounted Cash flow Analysis (DCF), and Dividend Discount Model (DDM). The research tested the power of these models to accurately forecast stock prices of well known technological companies. The study used historical secondary data which were applied on each model. The study used a head-to-head comparison to check dependability and applicability of the models. Resulsts revealed that ARIMA model is valuable in forecasting changes of prices in the short run. However, the results revealed that DCF and DDM can provide a more comprehensive view of the long-term intrisic value of the stock of the firm. The study however concluded that the applicability of the models differed across the firms under study hence recommended a keen choice of an appropriate model to be used in the process of forecasting stock prices. Besides, the current study focused on forecasting dividend per share as opposed to forecasting stock prices. The present study therefore has been done to give insights to shareholders in the process of making investment decisions.

Phillip & Hugo (2020) evaluated and compared different ARIMA (*p, d q*) models and their ability to focus stock prices. The study opined that the use of models to focus stock prices and predicting stock prices has been a debate for quite some time now hence forecasting stock prices using ARIMA (*p, d, q*) models to know which models are appropriate is vital. Results of the study revealed that models suggested by SPSS peformed better in forecasting the indices as comapred to the models with worst fit, based on the data; comparing with models used in a previous study, the performamnces in the out of sample forecast in the study are in accordance to those that are in the previous study.

Petrusevich (2019) studied welfare changes in Rusia. Monthly wage index on the dynamic series of macroeconomic statistics of Rusia between 2000 and 2018 were used. Arima (*p, d,q*) models consisting p and q les than or equal to 5 were compared with predictions of models with parametres p =6 or q =6. The resultant models are found to have made better forecasts than the obvious fittited ARIMA ones with p, q less than 6. The comparision was based on two matrics which are Akaike and Bayes information Creterion (AIC & BIC). The forecasts explained the nature of wages in Russia; factors such as vacations are well explained in the forecast trends. However the study only focused on trying to identify the best model using ARIMA (*p, d, q*) and explaining why the forecast trends shown the trend without stating recommendations about welfare changes in Russia and how it may be improved.

Ahmar, et al., (2018) Studied Consumer Price Index using ARIMA (*p, d, q*) in Indonesia. The study used algorithms as was popularized by Hyndman and Khandakar (2018). The study concluded that the most suitable time series model is ARIMA (1,0,0). However, the study was done in Indonesia, the Consumer Price Index in Indonesia may be different from the conusmer price Index in Kenya; factors that affect inflation in Kenya may be different from factors which affect inflation in Indonesia. Besides, the study focused on Consumer Price Index instead of focusing on dividend per share, hence modeling dividend per share is imperative.

Al- Chalabi, Al-Douri, & Lundberg (2018) modelled mining price drilling rig. The study emphasized the need for a better ARIMA (*p, d, q*) model. The study outlined that other artificial intelligence such as a multiobjective genetic algorithms based on Autoregressive Integrated Moving Averages could provide desirable forecasted models. The study concludes that ARIMA *(p, d, q)* models being popular models in many fields, can be used to model life cycle, cost analysis and estimate the optimal replacement time of the rig. The current study focused on modelling dividend per share and also revealed essential insights to investors, management in listed firms and policy makers.

Reviewed studies by previous scholars modelled different variables and arrived at varied results. For example, Reddy (2019) focused in modelling market index. He used weekly data to model market index using data from 2014 to 2017. The study arrived at ARIMA (0,1,0) model meaning that the partial autocorrelation and autocorrelation graphs were not none zero and were also not gradually decaying given lack of Autoregressive (AR) and moving averages (MA) terms. On the other hand, Githingi (2013) focused on modelling Consumer Price Index (CPI) for a period of ten years, the study identified ARIMA (0,1,1) which imply that the Autoregressive term is not existing in the model hence Partial Autocorrelation function is not none zero and it is also not gradually decaying. Consequently, in USA, Jarett (1989) modelled earning per share, the study revealed existence of Autoregressive (AR) terms and Moving average (MA) terms meaning that both Partial Autocorrelation and Autocorrelation functions were none zero and were gradually decaying. The study concluded that ARIMA (*p, d , q*) is appropriate for forecasting. Murrithi *et al* (2014) modeled Gross Domestic Product (GDP) using data spanning 1960 to 2011 (51 years). They arrived at ARIMA (2, 1, 2) meaning that Autoregressive (AR), integrated term I(d) and Moving average (MA) terms existed and that the partial Autocorrelation and Autocorrelation functions were none zero and are gradually decaying. Pandey and Abhishek (2019) deviated from the rest to compare the forecasting power of both ARIMA (*p, d q*) model and Artificial Neural Networks (ANN) models. They observed that the Artificial Neural Networks are powerful predictors as compared to ARIMA (*p, d, q*) models even though ARIMA (*p, d, q*) models are still good model for forecasting the future. These studies however were different in their approach. They used data from different period of time; they used different variables such as Market Index, Consumer Price Index (CPI), Gross Domestic Product and Earnings per Share. The study deviated and focused on comparing forecasting power of Artificial Neural Networks (ANN) with that of ARIMA (*p, d, q*) models. However, this study sought to establish forecasting models for dividend per share in Nairobi Securities Exchange in Kenya.

3.Methods

3.1. Research Design and Research Philosophy

Research design is defined as a blueprint which is geared towards fulfilling research objectives and answering research questions (Kothari, 2004, Coopers and Schindler, 2014). In this study, longitudinal time series research design and Quantitative paradigm is used to model dividend per share (Philips 1987, Creswell 1994, Smith, 1983). However, based on arguments among scholars who favored triangulation and pragmatism genre of research philosophy (Creswell & Clark, 2011, Tashakkori & Teddlie, 1998, Goles & Hirschheim 2000, Maxcy, 2003), this paradigm was selected based on the nature of data and ensuring validity and reliability and not based on convenience.

3.2. Sources and Type of Data

Quarterly secondary data of dividend per share from the year 2009 to 2018 were sourced from Nairobi Securities. The data was transformed into their natural logarithms for standardization before being transformed into their differences to achieve stationarity.

3.3. Model Specification

AR assumes that the current time series value, X_t can be expressed as a linear combination of past values of the series such that;

$X_t{-}1, X_t{-}2, \ldots, X_t{-}p,$ ……………………………...1

The AR (p) term can be written as;

$X_t = \varphi 1 X_t{-}1 + \varphi 2 X_t{-}2 + \cdots + \varphi p X_t{-}p + w_t = X\, p\, i = 1\, \varphi i X_t{-}i + w_t$ ………………………… 2

$where;$ X_t is stationary, $w_t \sim wn(0, \sigma 2\, w), and\ \varphi 1, \varphi 2, \ldots, \varphi p\ (\varphi p\ 6 = 0)$ are model parameters.

The backshift operator is defined as;

$BXt = X_t{-}1$..……………………………………...…3

This may be extended to,

$B\,2X_t = B(BX_t) = B(X_t{-}1) = X_t{-}2$ …………………….……....………………….......................4

Thus, $B\,kX_t = X_t{-}k$ ....………………………………...5

We therefore define the forward shift operator by implementing $B\ -1B = 1,$ such that; $X_t = B\ -1BX_t = B\ - 1X_t{-}1$ ………………………...6

A moving average model of order q, or MA(q), is defined to be

$Xt = w_t + \theta 1 w_t{-}1 + \theta 2 w_t{-}2 + \cdots + \theta q w_t{-}q = w_t + X\, q\, j = 1\, \theta j w_t{-}j$…... $3.16 where;\ wt \sim wn(0, \sigma 2\, w)$, and θ1, θ2, . . . , θq (θq 6= 0) are parameters. Although it looks like a regression model, the difference is that the wt is not observable.

Moving Average Operator – Equivalent to autoregressive operator, we define moving average operator as:

$\theta(B) = 1 + \theta 1B + \theta 2B\,2 + \cdots + \theta qB\,q$ ………………………………………………...7

where B stands for backshift operator, thus B(wt) = wt−1. Therefore, the moving average model can be rewritten as:

$Xt = w_t + \theta 1 w_t{-}1 + \theta 2 w_t{-}2 + \cdots + \theta q w_t{-}q\ X_t = (1 + \theta 1B + \theta 2B\,2 + \cdots + \theta qB\,q)$ w_t…………………...8

4.Results

TABLE 1: AUTOCORRELATION AND PARTIAL AUTOCORRELATION OF DIVIDEND PER SHARE

Source: Field Data 2019.

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.0329	-0.0328	.04564	0.8308		
2	0.1552	0.1615	1.0862	0.5809		
3	-0.3609	-0.3635	6.5549	0.0875		
4	-0.0306	-0.0665	6.5975	0.1587		
5	-0.0126	0.1074	6.605	0.2517		
6	0.1624	0.0541	7.8827	0.2468		
7	-0.1531	-0.2492	9.0534	0.2488		
8	-0.1601	-0.2565	10.376	0.2396		
9	-0.1738	-0.0783	11.986	0.2141		
10	0.0445	-0.0144	12.096	0.2787		
11	0.0918	-0.1038	12.577	0.3215		
12	0.0656	-0.1777	12.832	0.3814		
13	0.1023	0.1972	13.476	0.4117		
14	-0.1064	-0.2908	14.2	0.4349		
15	-0.0285	-0.3384	14.254	0.5063		
16	-0.0680	-0.2429	14.576	0.5559		
17	0.0150	-0.1029	14.592	0.6248		

Results in Table 1 reveal that the ARIMA model for dividend per share is ARIMA (1,1,1,) with AR (1), I (1), and MA (1). Table 1 used time-series data with a present value (outcome) variable predicted by one preceding value (predictor) to ascertain autocorrelation. Given that in all the variables, the data became stationary after the first differencing, I(d) is also 1 given that the first differencing of natural logarithms of the series were stationary. As seen in Table 1, the PACF is none zero and it is gradually decaying, q is also 1 that is MA (1).

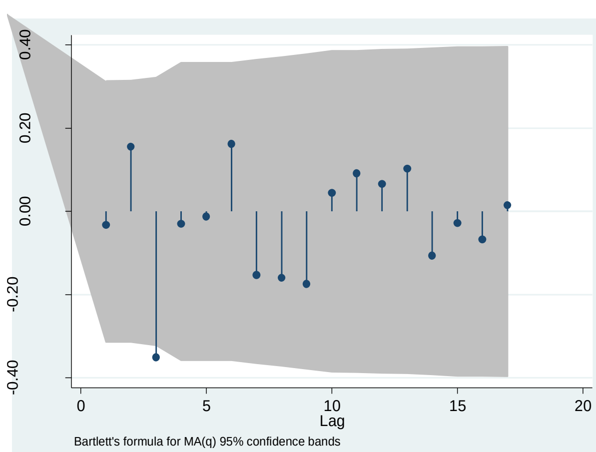

FIGURE 2 AUTOCORRELATION OF DIVIDEND PER SHARE.
Source: Field Data 2019

Figure 2 shows autocorrelation spikes of dividend per share, the figure reveal existence of ARIMA (*p, d, q*). It is imperative to note that figure 2 can be interpreted together with the autocorrelation and partial autocorrelation table 1. It can be used to explain the fact that in table 1, the partial autocorrelation graphs are gradually decaying. The study therefore concludes that the most appropriate ARIMA (*p, d, q*) to be used to forecast dividend per share is ARIMA (1, 1, 1).

5. Conclusion

The study revealed that appropriate model for forecasting Dividend Per Share is ARIMA (1, 1,1). Furthermore, the number of autoregressive terms can be identified by the partial autocorrelation function of the series and number of moving averages is usually identified by use of autocorrelation function; the partial autocorrelation function of the series is decaying gradually. In conclusion, the most appropriate ARIMA (p, d, q) is ARIMA (1,1,1). Therefore, managers, financial analysts, investors and various stakeholders can use the identified model for forecasting.

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