

Forecasting stock prices on the Zimbabwe Stock Exchange (ZSE) using Arima and Arch/Garch models

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Abstract

The main thrust of this study is to find out whether the stock prices on the ZSE can be predicted using ARIMA and ARCH/GARCH models. The ZSE currently does not have a model that predicts stock price movements. Thus this study attempts to explore econometrics models to predict future stock prices on the Zimbabwe Stock Exchange (ZSE) selected counters. Stock price data is differenced and tested for stationarity using KPSS test and the Augmented Dickey Fuller test. The final models are found to be Econet Wireless, ARIMA(1,1,0), Dairiboard, ARIMA(1,1,0), Delta, ARIMA(1,1,1), SeedCo, ARIMA(1,1,1) and Old Mutual, ARIMA(1,1,0). The GARCH(1,1) model for all the counters forecast better than ARIMA models considering the minimum deviations of the forecasted values from the actual ones. This is because the ARCH/GARCH models incorporate new information and analyses the series based on conditional variances where users can forecast future values with up to date information. Old Mutual had the best ARIMA model with the lowest error where as Dairiboard had the best GARCH model as shown by the minimum Schwarz criterion value of 1.365. We conclude that GARCH(1, 1) model outperforms ARIMA models in modeling stock prices in this study.

Keywords: stock prices, ARIMA, GARCH/ARCH, Zimbabwe Stock Exchange.

1. Introduction

For quite some time now, the question of whether stock prices past data is essential in predicting the future price of a stock has been a hub for controversy among academics and stock market professionals. There are those in the belief that stock prices tend to follow a certain pattern while others argue that stock prices are no more predictable than the outcomes of tossing a coin. Patrons of this subject of the study of predicting stock prices state that, the fundamental things from their findings are that; in an attempt to predict stock prices, many different time series models can be constructed using different base periods, launch years, and sets of assumptions and each implies a different set of prediction intervals for each forecast horizon (Box and Jenkins, 1976; Nelson, 1973, Litterman, 1986; Stockton and Glassman, 1987; Nadal-De Simone, 2000). These researchers mostly concentrated their work in developed countries with limited studies on emerging markets.

The methodologies used were different and the conclusions they drew differed. This research seeks to broaden the subject to developing markets like Zimbabwe. It seeks to find a predictive Univariate Autoregressive Integrated Moving Average (ARIMA), Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models for stocks on the Zimbabwean Stock market with effort on predicting future stock movement. It seeks to tap into virgin markets such as the Zimbabwe Stock Exchange (ZSE) where such models have not been tried. The research seeks to use a methodology that is different from previous researches done in an attempt to predict future stock price movements as this one looks at the current stock prices.

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The main aim of this research therefore is to find a predictive ARIMA and ARCH/GARCH models for the selected companies on the ZSE. To achieve this objective, this chapter provides insight to the background of the study, the objectives of study, the statement of the problem, the hypothesis statement and the scope of study.

In a dynamic economy, accuracy in prediction of stock prices or at least predicting the trends correctly is of crucial importance for any future investment. The use of econometrics based models for making predictions has been proved extremely successful in recent times. The Zimbabwe Stock Exchange (ZSE) market has been recently experiencing continuous depressions where the main industrial index declined by 9.67 percent, while the mining index declined by 26 percent in the first half of 2012, (Anand, 2012). Despite a large number of companies reporting strong growth in earnings, the market remains depressed with most stocks declining (Anand, 2012). Companies such as Delta (7 percent), Hippo Valley (9 percent), SeedCo (22 percent), OK Zimbabwe (9 percent) and Barclays (30 percent) declined in the first half of the year (Anand 2012).

Foreign activity remains depressed, with most foreigners emerging more as sellers as compared to the prior comparable periods (Simon, 1996). Total foreign sales in 2012 amounted to US 124 million dollars compared to US 68 million dollars in 2011, (Anand, 2012). This can largely be attributed to the on-going indigenization threats and capital redemptions due to the global financial crisis especially in the Euro- zone.

It is thus imperative that investors be able to predict movement of stock prices as they wish to be sure whether the stock that they are putting their money on is able to pay back its liabilities, has enough working capital and is generally in good state of financial health. Stock markets in the world individually and collectively play a critical role in most national economies. Most recently a lot of interest was taken on the growing importance of the close-knitness of the economy to stock price movements as evidenced by increase in the aggregate economy to stock market capitalization to Gross Domestic Product (GDP) ratio over the last two decades (Simon, 1996). The degree to which these two variables are interwoven implies that any movement in the stock has a direct impact on the real economy.

Since the stock exchange plays an important role in controlling dynamics of the economy an appropriate prediction of stock price movement is crucial. A well performing stock market is helpful for economic activity through growth and saving and the efficient allocation of investment which may attract foreign direct investment. The stock market gives confidence to savers by providing domestic households investment funds, innovation in financial instruments, which diversifies their better sharing in investment projects. Furthermore the efficiency of stock market probes economic growth and prosperity in a nation. In other words the stock market is very significant in speeding up liquidity of financial assets, diversification of risk and for investors to make a wiser investment decision (Aggarwal *et al.*, 1999)

However if the capital market performance remains low it may be time to turn over a new leaf, employ new tactics to redeem the times and this may imply using econometric models such the Univariate ARIMA and ARCH/GARCH models. Currently several companies on the ZSE are heavily undercapitalized, a condition that has hampered performance for most listed companies. Raising fresh equity remains essential for ZSE listed companies at the height of the current liquidity constraints. To raise equity there is need to revitalize investor confidence and this can be achieved by having an accurate and correct prediction of future stocks. Besides the main aim of finding a predictive Univariate ARIMA and Arch/Garch model for the stocks on the ZSE, the research also seeks to broaden studies previously done on the Univariate ARIMA models as well as the ARCH/GARCH models. Intensive studies have been done for developed countries and justice has not been done for developing markets like the Zimbabwe stock market. Previous methodologies used have isolated the Univariate ARIMA models due to their challenging and complex nature. The findings are expected to assist investors, industrial bodies other stakeholders as well as the ZSE in strategic planning and general economic growth.

Nelson (1975) asserts that prediction is a very difficult art, especially when it involves the future. The debate of whether predictions are necessary or not in a stock market crops up from time to time. In all, the inescapable conclusion is that no matter what type of enterprise you are in, or what function you perform,

there is need for some kind of future estimate upon which to build a strategic plan. Stock price movements are affected by many factors such as inflation which causes changes in demand for certain stocks and not others. Market sentiments also referred to as the psychology of market participants affect movement of stock price. The uncertain mass reaction of individuals to developments affecting the stock market is one of the factors that handicaps stock market predictions. The researcher is therefore motivated to find whether the ZSE stocks are predictable using the Univariate ARIMA and ARCH/GARCH models.

The aim of this study is to forecast stock prices on the ZSE using ARIMA and ARCH/GARCH models. The main objective of this research is to broaden the study of ARIMA and ARCH/GARCH models to developing countries. With particular interest this research seeks to

- i) fit ARIMA model to selected counters on the ZSE, To fit ARCH/GARCH models on selected counters on the ZSE, To forecast future stock prices using ARIMA and ARCH/GARCH models,
- ii) compare forecasts from the ARIMA and ARCH/GARCH with actual data.

This study seeks to answer the following questions: Can the stocks of the ZSE be modeled with ARIMA and ARCH/GARCH models? Are there deviations between the actual stock prices and the forecasted stock prices, if so by what magnitude?. The primary advantage of predicting future stock prices is that it provides various stakeholders with valuable information that can be used to make decisions about the future. Other beneficiaries of the research include investors, whose knowledge of stock movement provides an insight to investors who buy and sell stocks with the main motive of making profit. The results of the research will go a long way to help the managers of financial portfolios to understand. This will further boost the confidence of stakeholders in the financial industry to do more business with less risk. Positive finding from the research will motivate small and medium investors to invest in the ZSE. Furthermore knowledge from this research will create a window for the implementation of innovative financial products at the stock prices on the ZSE as the model itself is a new product. The findings of this study will be of immense benefit not only to investors and related stakeholders, but also upcoming scholars interested in understanding and broadening the study of Univariate ARIMA models and ARCH/GARCH models, with the hope of extending it to other sections of the economy in Zimbabwe.

2. Research Models

The methodology in this study is used to establish whether the stock prices on the ZSE have a predictive ARIMA, and ARCH/GARCH models. A clear enumeration of the methodological approach is given that will help answer the research questions.

Data on stock prices under study were obtained from the Zimbabwe Stock Exchange. The study conveniently sampled 5 counters out of 79. Secondary data was used and it can be accessed from the ZSE website and the Securities Exchange Commission website for verification. The stock prices used were taken from the historically adjusted prices used to calculate market capitalization of the respective counters. Market capitalization to a counter indicates value of stocks on issue. This is because market capitalization is a good way to quickly value a counter and measure a company's size and efficiency.

Minitab and E-Views were used in the analysis of the research data.

Arima

The research employs ARIMA, the dynamic time series model to examine if the stock prices depend not only on its past values of the return series but also on past and current disturbance terms. Theoretically the weak-form efficiency of the market persists when we cannot predict the stock prices from its historical price information. When the stock prices can be predicted on the basis of data on past returns and on forecasted errors together this gives rise to the ARMA (1,1) model. That is to mean if stock price is a function of past values of stock prices itself or the current and past values of the disturbance term. We use the ARIMA model instead of ARMA because it includes the integration process. Moreover, the random walk model needs to fit the model ARIMA (0, 1, 0), where the future value of stock prices cannot be determined on the basis of past

information. Specifically, future stock prices will not depend on past (lag) values of stock prices or on the disturbance terms. The significant coefficients different from 0 suggest dependency of the stocks. The Autoregressive moving average process, ARIMA model is formed by combining terms of AR and MA models. The ARMA (p, d, q) model can be written as

$$\Phi(B) = \Theta(B)a_t + C \quad (1)$$

where,

$$\Phi(B) = 1 - \Phi_1(B) - \Phi_2(B^2) - \dots - \Phi_p(B^p) \Theta(B),$$

y_t is the current price,

$$\Theta(B) = 1 - \Theta_1(B) - \Theta_2(B^2) - \dots - \Theta_p(B^p),$$

a_t is a constant,

where equation (1) can be written as

$$1 - \Theta_1(B) - \Theta_2(B^2) - \dots - \Theta_p(B^p) = 1 - \Theta_1(B) - \Theta_2(B^2) - \dots - \Theta_p(B^p), \quad (2)$$

Equation (1) can be rewritten as

$$y_t = \Theta_1(y_{t-1}) + \Theta_2 y_{t-2} - \dots - \Theta_p y_{t-p} - \Theta_1 y_{t-1} - \Theta_2 (y_{t-2}) - \dots - \Theta_q y_{t-q} \quad (3)$$

Garch Models

GARCH models were developed to account for the empirical irregularities in financial data. Many financial time series have a number of characteristics in common. Stock prices are generally non stationary whereas returns are usually stationary. Return series usually show little or no autocorrelation. The serial independence between the squared values of the series is often rejected pointing towards the existence of non-linear relationships between subsequent observations. Volatility of the return series appear to be clustered. Normality has to be rejected in favour of some thick tailed distribution. The standard GARCH (1,1) process is specified as:

$$y_t = \sigma_t \varepsilon_t, \quad (4)$$

$$\sigma_t^2 = a_0 + \alpha_1 y_{t-1}^2 + \beta_1 \sigma_{t-1}^2, \quad (5)$$

where,

$$a_0 > 0,$$

$$\alpha_1, \beta_1 > 0.$$

The conditional variance equation of GARCH (1,1) model contains a constant term a_0 , $\alpha_1 y_{t-1}^2$, and $\beta_1 \sigma_{t-1}^2$ are the Garch terms. The (1,1) in Garch(1,1) refers to the presence of first order GARCH term (the first term in parenthesis) and a first order ARCH term. The unconditional mean and variance of a GARCH (1,1) process can be obtained by using the law of iterative expectations such that:

$$E(y_t) = E[E(y_t|w)] = 0, \quad (6)$$

$$\text{Var}(y_t) = E(\sigma_t^2) = \alpha_1 E(y_t^2) + \beta_1 E(\sigma_{t-1}^2) \quad (7)$$

As in the ARCH process, in the GARCH (1,1) model the marginal distribution of y_t is leptokurtic even if the conditional distribution is normal (Kuan, 2003). The more general GARCH (p,q) model is as illustrated in Enders (1995),

$$y_t = \delta_t \varepsilon_t \quad (8)$$

$$\sigma_t^2 = a_0 + \sum_{i=1}^n a_i y_{t-i}^2 + \sum_{j=1}^n \beta_j \sigma_{t-j}^2 \quad (9)$$

Any GARCH (d,q) process can be written in an ARMA (d,q) representation. AGARCH (d, q) has a polynomial $\beta(L)$ of order p the autoregressive term and polynomial $\alpha(L)$ of order q the moving average term (Kuan, 2003). Peters (2003) states that the GARCH type models are estimated by using a maximum likelihood (ML) approach. First the conditional distribution of y_t has to be specified. The standard approach is to use conditional normal density. However as shown earlier on, the marginal distribution of y_t will be leptokurtic even if the conditional distribution is normal because financial time series often have excess kurtosis and skewness.

3. Data Presentation and Analysis

The major highlight was construction for ARIMA and GARCH models for the five chosen counters on the Zimbabwe Stock Exchange.

Tests for Stationarity

In order to have a visual impression of the raw data, the Runs Sequence Plot (S-Plot) was used. The graphs below suggest that data indicated strong and positive autocorrelation. There does not seem to be a significant trend or any obvious seasonal pattern in the data thus the data was non-stationary.

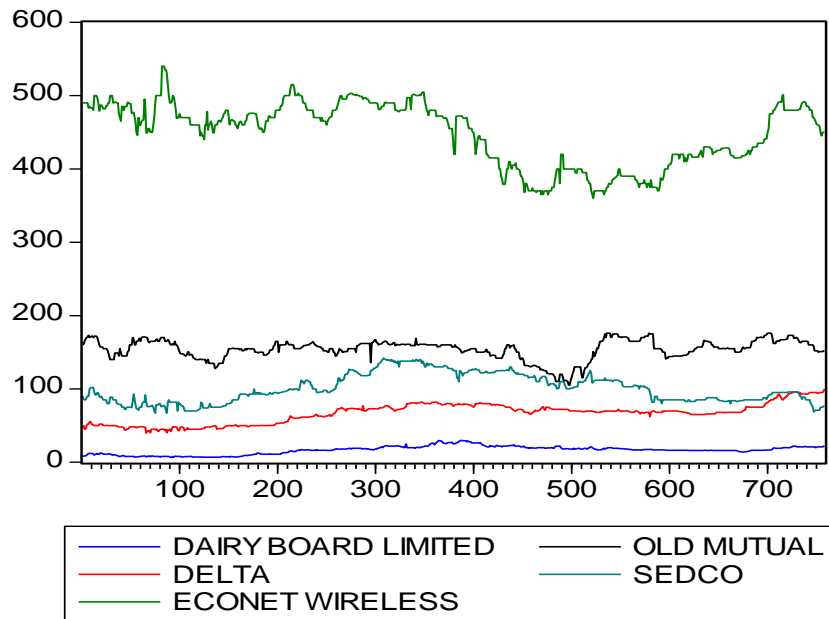


Figure 1: Runs Sequence Plot Indicating Raw Non-Differenced Data

Data was differenced once in an effort to remove the non-stationarity element and the results are shown in the graph below. The runs sequence plot of the differenced data shows that the mean of the differenced data was around zero, with the differenced data less auto correlated than the original data.

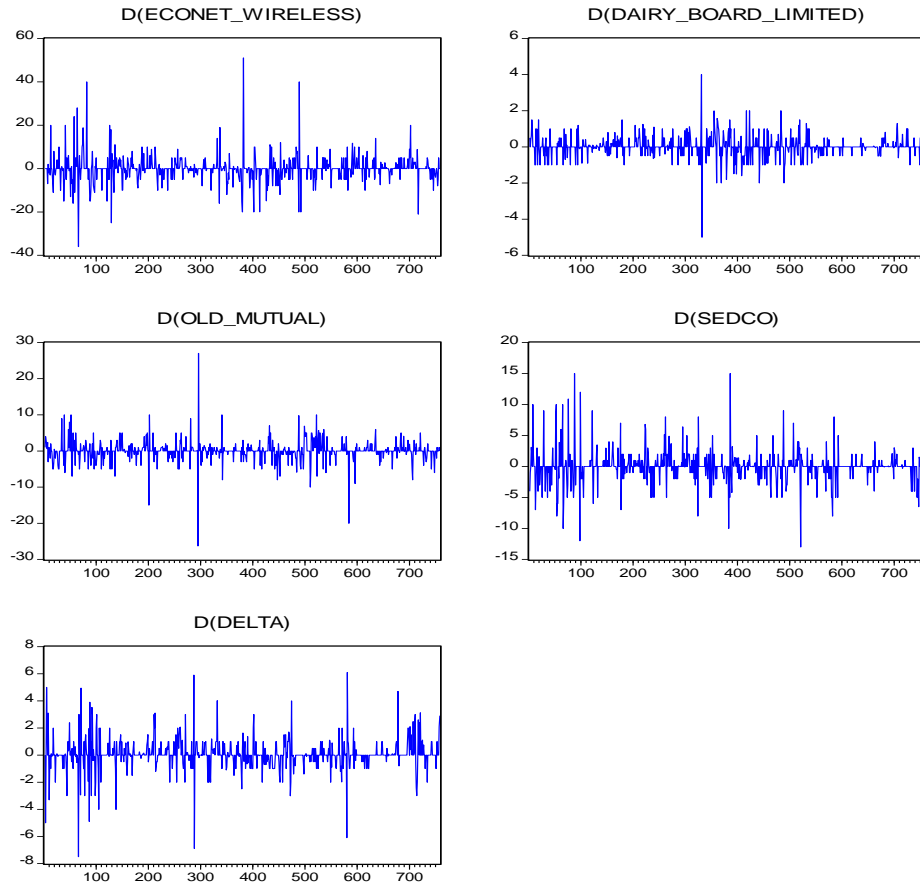


Figure 2: Runs Sequence Plots Indicating (First Differential) Differenced Data

From the graphs above stationarity was achieved since the prices are now to oscillating around zero and the general trend lines are parallel to the x-axis.

Augmented Dickey-Fuller (ADF) Test

The Dickey-Fuller test was applied first to the series of total daily stock prices. The value of the t-statistic for non-differenced data turned out to be -2.859 and ADF value 0.2146, which shows that our null hypothesis of daily stock prices stationarity was rejected and we concluded that daily stock prices were not stationary.

Table 1: ZSE First Differential the ADF Test at 95% Confidence limit

Counter	t-Statistic	Probability (p)	ADF-Stat	Hypothesis Test	Decision
Dairibord limited	-2.865	0.00	-29.287	$t > ADF$	stationary
Econet Wireless	-2.865	0.00	-26.959	$t > ADF$	stationary
Delta	-2.865	0.00	-28.65	$t > ADF$	stationary
Old Mutual	-2.865	0.00	-30.241	$t > ADF$	stationary
SEEDCO	-2.865	0.00	-28.12	$t > ADF$	stationary

After taking the first difference the tests were applied again. This time the Augmented Dickey-Fuller as shown in Table 4.1 above highlights that the ZSE counters stock price data test gives -29.287 for Dairi board limited , -26.959 for Econet Wireless , -28.650 for Delta , -30.241 for Old Mutual and -28.12 for Seed Co with ADF value -2.865 value. Since the ADF absolute value of the calculated t-statistics was greater than critical value of the ADF-Statistic tested at 95% confidence, the null hypothesis of non-stationary was rejected and it holds true that the data was now stationery.

As part of finding stationarity the p-value were greater than 0.05 ranging from 0.392 to 0.845 for all the counters from the result of the KPSS test is enough to accept the null hypothesis at 5% level of significance. It can be concluded that the stock prices were now stationary using KPSS.

Selection of the Parameters

After deciding about the stationarity of the series, the next step was to decide about the parameters p and q of the ARIMA (p, d, q) model. Data became stationary at first difference hence “d” in the model is 1, the values of p and q are determined from the graphs of the estimated autocorrelation and partial autocorrelation function.

Table 2 Estimated Models

Counter	Autocorrelation (AR) p	Difference D	Moving Average (MA) q
Dairibord limited	2	1	0
Econet Wireless	1	1	0
Delta	2	1	0
Old Mutual	1	1	0
Seedco	1	1	0

Model Formulation

Estimated parameters are:

Dairibord Limited Arima (2, 1, 0)

The resultant model becomes:

$$Y_t^* = 0.1836 - 0.0662Y_{t-1}^* + \varepsilon_t \quad (10)$$

The equation was presented in a standard format and we see in the model and we notice that the since MA was equal to zero there are no moving average parameters.

Econet Wireless Arima(2,1,0)

The standard error for the two coefficient values (0.0364 and 0.036388) for AR and constant shows that the two values are very significant for the model. Thus the model was given by

$$Y_t^* = 4.0754 + .0991Y_{t-1}^* + \varepsilon_t$$

Delta Arima (2,1,0)

The results above shows that ARIMA (1,1,1) was the most significant model. We have all p-values zero or near to zero and also the standard errors are small. The constant has a probability of 0.050 which was very insignificant making the model significant. The resultant model as shown in the above table was of the form:

Seedco Arima (1, 1, 0)

The model obtained was:

$$Y_t^* = 0.00472 + 0.7346Y_{t-1}^* + 0.7931U_t + \varepsilon_t$$

Old Mutual Arima (1,1,0)

As we notice above Old Mutual has the best model as the models p-values are very close to 1 however the probability for the constant was very high at 0.911 hence we removed the constant to increase the models accuracy. Therefore the final model became:

$$Y_t^* = -0.0117 - 0.0953Y_{t-1}^* + \varepsilon_t$$

Forecasting Models

The following are the final models for respective counters.

Dairibord

$$Y_{t+1} = Y_t + 0.1836 - 0.0662(Y_{t-1} - Y_t) + \varepsilon_t$$

Econet Wireless

$$Y_{t+1} = Y_t + 4.0754 + .0991(Y_{t-1} - Y_t) + \varepsilon_t$$

Delta

$$Y_{t+1} = Y_t + 0.0168 + 0.7409(Y_{t-1} - Y_t) + 0.7914U_t + \varepsilon_t$$

Old Mutual

$$Y_{t+1} = 0.00472 + 0.7346(Y_{t-1} - Y_t) + 0.7931U_t + \varepsilon_t$$

Seedco

$$Y_{t+1} = -0.0117 - 0.0953(Y_{t-1} - Y_t) + \varepsilon_t$$

Forecasting Accuracy Measurement (F.A.M)

Theil's U-Statistic

F.A.M	Dairibord Arima (1,1,0)	Econet Wireless Arima(1,1,0)	Delta Ari Ma (1,1,1)	Old Mutual Arima(1,1,0)	Seedco Arima (1,1,1)
Theil U	0.377812	0.063447	0.181940	0.047622	0.203667

The above error test shows that the models were good. If a Theil's U value of less than 0.5 shows a good model. All the values were less than 0.5 therefore they were all good models.

Stock Price Predictions Using Garch (1,1) Models

The following GARCH (1 1) Models were generated from the stationary data(obtained after the first difference) used in the construction of the respective ARIMA models.

Garch (1,1) Model For Dairibord

From the output the Schwarz Criteria (1.365826) value for Dairiboard is small(minimum) hence a good GARCH(1 1) Model has been fitted. Even the standard errors for the variance equation are very small.

Garch (1,1) Model For Delta

A Shwarz criterion value of 2.931942 is considered as minimum hence Delta's GARCH(1 1) model is well fitted. Even the standard errors are within a reasonable range.

Garch(1, 1) Model For Econet

The model fitted for Econet Wireless is relatively poor considering a Schwarz criterion value of 6.208760.

Garch (1, 1) Model for Old Mutual

This is a relatively a good model considering 4.902708 Schwarz value. From these results Dairiboard is the one fitted with the best model since it has the smallest Schwarz criterion value of 1.365826, followed by Delta with 2.93142, Seedco with 4.474388, Old Mutual with 4.902708 and lastly Econet with 6,208760. Even if check with the table below with respective forecasts we can see that Dairiboard's forecasts have minimum deviations from the actual value.

Forecasting Using Arima and Garch Models

Per Iod	Counter	Arima Forecast	Garch Forecast	Actual
759	Dairiboard	21.0845	21.0450	21
760	Dairiboard	21.0973	21.0643	20
761	Dairiboard	21.1148	21.0133	21
759	Delta	99.798	99.0856	99
760	Delta	99.674	99.974	100
761	Delta	99.574	99.546	100
759	Econet	449.948	446.045	445
760	Econet	449.895	446.398	445
761	Econet	449.842	445.098	445
759	Seedco	151.988	1552.024	152
760	Seedco	151.978	152.043	155
761	Seedco	151.967	152.067	155
759	Old Mutual	76.8275	77.086	77
760	Old Mutual	76.6956	77.043	77

From the table above we can deduce that GARCH (1 1) models seem to forecast well considering the minimum deviations of the forecasted value from the actual. In fact GARCH forecast interval is quite closer as compared to that for ARIMA. This is because ARCH/GARCH models incorporate new information and analyses the series based on conditional variances where users can forecast future values with up to date information.

4. Comparison of Arima and Garch Models

The correlation co-efficient of the Arima forecasted values and GARCH forecasted values is 1. This means that the forecasted values for both models are consistent with each other. The correlation co-efficient of the Arima forecasted values and actual values is 0.98 and correlation co-efficient between GARCH and actual values is 1. This implies both models are very good models for forecasting as correlation Data Presentation and Analysis 59 co-efficient values of 0.98 and 1 indicate consistency between values Arima and GARCH forecasted and the actual values. It also indicates that GARCH model out performs ARIMA models in modelling financial time series in terms of correlation coefficients. According to literature GARCH(1,1) is a better model due to its ability to capture volatility by the non-constant of conditional variance (Nian, 2009).

5. Conclusion

The main objectives of the study was to fit the ARIMA models and GARCH models on selected counters on the ZSE and to forecast stock prices using these models. A comparison of the two models was also carried out.

Arima Modeling and Forecasting

The prediction interval at 95% confidence within the first five days shows that the model was strongly predictive for some counters than others. SeedCo's forecasted share was \$76.82 and the actual share price was \$77.00. This showed a percentage error of 0.23%. Output for Delta proved to be strongly predictive with the forecasted price of \$99.84 and the actual being \$99.00. Old Mutual had forecasted share price of \$151.988 and the actual share price was 152. For Dairibord the model predicted a share price of \$21.08 and the actual share price was \$21. The model was not accurately predictive though strong positively predictive for Econet Wireless. The forecasted value was \$449.948 and the actual value was \$445.00, however the model can still be considered to be predictive for Econet as the difference between the prediction and the actual share price lies within the lower and upper limit bounds of the confidence intervals, that is lower limit 438.277 and upper limit 461.620. Longer horizons create greater uncertainty and larger errors because they provide more opportunities for growth to deviate from predicted trends. Similar results have been reported in the studies of Voss et al. (1981). In their application of ARIMA in Real Estate conducted at the University of Hong Kong they found that ARIMA Models were most predictive in the first few intervals.

In the findings stock price data for all the counters became stationary on first differential Augmented Dickey Fuller (ADF) and KPSS tests were found to be implicitly important for proving stationarity of the data with all the counter having t-statistic of -2.865 for ADF and a p-Value that is less than 0.05 for KPSS test. ACF and PACF graphs were instrumental in models be predicting the model. These results were consistent those of Cummins and Griepentrog (1985). Cummins and Griepentrog (1985) found that data can be made stationery after differencing once in their study of quarterly automobile insurance paid claim costs.

The models for the five counters were found to be good models and all the Theil's U values ranged from 0.06 to 0.38. Dairibord had 0.38, Delta 0.18, Econet Wireless 0.06, Old Mutual 0.05 and SeedCo 0.20. This objective was attained as we managed to get the best models. January 2013 was used as a bench mark to test the above models for the different counters. The model managed to forecast the month's prices with small margin of error. Stock prices for January 2013 were forecasted with low margin of error. The error was found to be less than 5% for all the counters but they were all in the lower to upper range.

Garch Modelling and Forecasting

Respective GARCH(1,1) Models for Dairibord, Delta, Econet, Old Mutual and Seedco were fitted. Dairibord had the best fitted model as shown by a very small Schwarz criterion value of 1.365826. Even the forecasts for Dairibord had very minimum deviations from the actual. Delta was second in terms of the goodness of fit of the model. It had a value for the Schwarz criterion value of 2.931942. Econet had the worst fitted model as Schwarz value of 6.208760. Even estimates from the model deviated a lot from the actual. It was also deduced that GARCH Models seem to have a better predictive power than ARIMA as shown by the minimum deviations in forecasting stock prices.

Comparison of Arima and Garch Models

One of the main objectives of the study was to compare the forecasted values of ARIMA and GARCH models to the actual values. The forecasted values for both models are consistent with the actual data and with each other. The GARCH model out performs ARIMA models in modelling financial time series. According to Nian (2009) GARCH model is a better model due to its ability to capture volatility by the non-constant of conditional variance.

Recommendations to Policy Makers and the Government

The research was carried out during a period when Zimbabwe was economically in transition. Due to the introduction of multicurrency the economy had not stabilised yet it was still faced with a series of challenges. Top of the list are the liquidity challenges in the market that caused investors on the stock exchange to hold back their trading on the stock exchange. Also, an unstable political environment saw some investors failing to engage in capitalising the economy. An increase in interest rates showed a negative relationship with the stock market prices and vice versa. As interest rates in the money market increased, the stock market is negatively affected making the money market more attractive than the stock market. The ZSE

was also affected by information announcements and other various activities taking place. Speculators and noise traders abused and manipulated the stock market to profiteer or gain from insider trading. Another significant challenge in the economy was that of the national debt. Developing countries like Zimbabwe should plan very carefully about the factors that affect stock prices predictiveness. In principle such challenges stifles trading in the ZSE and thus systemically affects stock price prediction.

Addressing the Liquidity Challenges

Strengthening the Banking Sector

Zimbabwe's banking sector is significant for many reasons; they dominate the financial system and contribute significantly to economic growth. Banks are also the most important source of finance for the majority of firms due to underdeveloped capital markets. Addressing the liquidity crisis will require strengthening the banking sector and creating conditions that induce long-term deposits in the domestic market. The payment system should encourage the use of alternative payment solutions, discourage cash transactions and increase the capacities of the RTGS system. New liquidity policies will require banks to place less reliance on short-term wholesale funding particularly from foreign sources and the restoration of the RBZ's lender of last resort function.

Privatisation of State Owned Firms

An important factor behind this move is of possibly privatization is the well documented poor performance of the public enterprise that the country has seen from 1990 to date. This can be pointed to enterprises like Air Zimbabwe and NRZ. The use of revenues from privatization can improve government finance. This move if initiated and conducted properly will see money supply increases as a result of injection of fresh capital into the economy. Another beneficial point of looking at the benefit of privatisation is that employees can benefit from the share schemes, therefore increasing the expandable household income level. Apart from the increasing money supply. The privatization move will increase productivity levels in the industrial and mining sectors thereby increase levels of GDP. This will also create a pathway for long term finance into the economy reducing the effects of liquidity that has gripped the economy.

Dual Listing

Zimbabwe is a volatile economy due to many variables such as policy changes, weather conditions and politics. These and other variables turn to affect the Stock prices on the market and undervalue some values. Stocks with dual listing, such as Old Mutual, turn to be more stable and therefore easier to predict. This research found out that Old Mutual stock price was more stable than the others. It is suggested that Multivariate ARIMA be carried out to include other variables. ZSE has a number of foreign investors who are playing a role in the stock prices. It would be of interest to find out how much they influence the stock market.

Dealing with National Debt

The nation accumulated large amounts of debt in the hyper-inflationary period this has largely affected the stock market predictability and recommendations to government or economies that are faced with similar ouster environments may find this useful. There is need for policies, revision of laws e.g. the banking laws and several schemes to enable the national debt to be cleared and for the IMF to start interventions in the resuscitation of the economy. Also the central needs to come with policies that deal with the debt that it owes to several banks in the economy.

Arima and Garch Calculators

The univariate ARIMA and GARCH indicated some form of predictiveness for the ZSE counters under study for the 5 days. After making predictions the models were highly predictive for most of the counters for the first five days with least error and almost no deviation and for those with deviations the deviations fell within the upper and lower limit. The researcher thus designed a model that an investor could use to make predictions.

Stock Price Predictor is a model that is designed in JAVA programming language to enable the investor to predict stock prices. This model is designed from the ARIMA or GARCH Model. It is designed in such way that the investor uses the coefficients of the counters from the final ARIMA and GARCH Models to make predictions.

The interface of the predictor gives the investors commands the first argument is to Press 1 to run the calculator or Press 2 to exit the calculator. The investor makes a selection from these two commands. If he/she chooses to run the calculator they have to press 1. The calculator then prompts the investor to enter the name of his/her counter of choice in this case he/she needs to choose from the 5 counters under study. It further prompts the investor to enter the number of historical stock price the investor wishes to predict. The investor enters the historical stock prices upon which the prediction will be made. The investor has an option of entering as many stock prices as he/she may want for the prediction. It then prompts the investor to enter the number of forecast required. The researcher designed the predictor in such a way that it predicts values for only a maximum of 5 future stock prices because the results from the ARIMA or GARCH Models indicated that the models are most predictive for the first 5 days. The investors then press enter and predictions are made. Then he/she takes the second command to exit the calculator

Assumption of the Stock Price Calculator

The stock price predictor assumes that of the 5 outcomes predicted the first prediction may be considered to be a true representative of the market outcome regardless of the four other outcomes. Even if all five predictions match the actual outcome the first stock price should be considered. This is because stock prices are very stochastic the second to the fifth stock price may be distorted at anytime because stock price sensitivity to news, market behaviour, investor expectation and government policies of the list.

6. Recommendations to Future Researchers

Technically Reasoning

The markets we're investigating may not always be in the weak form sometimes they may be relatively in a strong form of efficiency. What this means is that if the price history contained information sufficient to systematically predict even the direction of the price series, it would be possible for investors to trade on that information and the moment they did, that new information would update the price. This happens until the price contains so much of investors' thoughts about the future that it corresponds perfectly with them then there's nothing to predict. Future researchers to further this study they could structure this model in such a way that it is independent of investor perception and forecasts can instantaneously incorporate macro and micro economic variables that may cause share price deviations.

Accuracy Measures

The Univariate ARIMA Model so far is only a single, naive, and not particularly informative, rather standard econometric model. It's a one variable forecasting model it forecasts Y_t from trend alone thus gives us a basic setup. Future researchers should consider forecasting using a multivariate (many variables) model such that it forecasts Y_t from trend and other variables $X_1 X_2 \dots$. This Allows for "what if" scenario forecasting. This may improve the models accuracy. Slutsky (1948) came up with a theorem showing that, by using ARIMA type computation, and perhaps adding a trend line or two, you can take random noise into any time series. This basically means that you may fit the data magnificently, but the ARIMA fit could still be totally untrue. Future researchers should however increase their error handling when modelling includes the error matrix.

Philosophical Reasoning

Furthermore even if the Univariate ARIMA model was able to perfectly encapsulate the dynamics, the competing forces and capture mathematically perfectly how past events will play out in the future—what it does not and cannot ever hope to capture, just like any mathematical model is the simple fact that the future has not happened yet and there remain unknown. Even if the model were excellent to some extent the future

may be different from the past to the extent that the way the future differs from the past may very well be different from the way in which the future has historically ever differed from the past. Hence to come up with a more addible future forecasts the researchers can extend this study through encapsulating this econometric model with other non-econometrics models such Neural Networks and Market Efficiency hypothesis.

Commercial Disclosure

The researcher emphases that the intended purpose of this forecast is strictly non-financial .It is not for use in any trading strategy at this point, or considered it to have any bearing on buying or selling activity. This is mainly due to the limited time in which it was conducted. For now it should be treated as simply the publication of the result of a standard and relatively naïve econometric model demonstrating how the current mechanics of the market are pricing future activity as of today. Future researchers are argued to perform more rigorous test in addition to the ones tested and devote much time to the study before qualifying the model as perfect.

Conclusion

This research managed to find the predictive Univariate ARIMA and GARCH using the five counters as bench marks for the Zimbabwe Stock Exchange listed Counters. The models found managed to predict the January prices with less than 5% margin of error. Old Mutual had the best ARIMA model with the lowest error and the model for Econet Wireless was not precise. Dairiboard had the best GARCH model as shown by the minimum Schwarz criterion value of 1.365. We conclude that GARCH(1,1) model outperforms ARIMA models in modelling financial time series.

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