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THE RELATIONSHIP BETWEEN STOCK MARKET AND THE MACROECONOMY: EVIDENCE FROM BOTSWANA

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Contents

1.0 ACKNOWLEDGEMENT 1

2.0 ABSTRACT 2

3.0 INTRODUCTION 4

4.0 OBJECTIVES 9

5.0 SIGNIFICANCE OF STUDY 9

6.0 BACKGROUND 11

7.0 LITERATURE REVIEW. 12

8.0 DATA 21

9.0 METHODOLOGY 23

9.1 Baseline Model 23

9.2 Testing long -run relationship 24

9.3 Testing for Volatility spill overs 25

10.0 RESULTS 27

TABLE 1: STATIONARITY TESTS 27

TABLE 2: DESCRIPTIVE STATISTICS 29

TABLE 3: CORRELATION RESULTS 30

TABLE 4: OLS REGRESSION RESULTS 31

TABLE 8: MODEL SELECTION 34

TABLE 9: Estimation Results of ARMA (p,q)-GARCH(p,q) Models 37

11.0 DISCUSSION 39

12.0 CONCLUSION 44

13.0 REFERENCES 46

14.0 APPENDICES 53

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2.0 ABSTRACT

This study investigates the relationship between macroeconomy and stock market. The specific objectives are to: (a) find out the macroeconomic determinant of stock returns, (b) establish long term relationship of macroeconomic and (c) find out if there are volatility spill overs between macroeconomic volatilities and stock returns volatility. Domestic Company Index (DCI) is used to represent stock returns and (a) Consumer Price Index to represent inflation, (b) USD/BWP as exchange rates, (c) Bank rates as interest rates and (d) M2 to represent money supply as macroeconomic variables. The relevance of Gross Domestic Product (GDP) is highly acknowledged but due to limited data, it was excluded from the study.

The study used monthly data of the said variables from January 1994 to December 2014 to investigate the relationship. Classic Linear Regression model is applied to establish the explanatory power of macroeconomic variables on stock returns. Auto-Regressive Distributed Lag (ARDL) is used to find out the long term relationship and lastly GARCH (1,1) is applied to find out if there is volatility spill overs between macroeconomic volatilities and stock returns volatilities.

This research established that exchange rates have a negative relationship with stock returns and money supply has a positive relationship with stock returns. It was also noted

that there is no long term relationship between macroeconomic variables and stock returns. Lastly, it was noted that inflation volatility and money supply volatility have a spill over effect on stock returns volatility.

Keywords: macroeconomic variables, stock returns, volatility.

3.0 INTRODUCTION

Modern financial theory has brought a lot of insight on the relationship of risk and return. It asserts that there is a risk that the market is willing to compensate for and the one that is not compensated by the market (Bora and Adhikary, 2015). This theory stems from the work of Markowitz (1952), who developed the basic portfolio theory and described linearity between risk and return (Pamane and Vikpossi, 2014). Markowitz's work has triggered a lot of research around the subject. Researches are usually in two folds: some researches are interested in establishing if indeed the relationship between risk and return are linear, whereas others want to establish what risk is, what composite the risk, which risk is compensated by the market and which one is not.

Empirical evidence shows that indeed there is a relationship between risk and return. Chiang and Doong, 1999 and Garza-Gomez and Kunimura, 2000 argue that the relationship between risk and return is linear. However, there is limited literature that speaks of the contrary. In another dimension, risk is defined as the uncertainty of the future outcomes (Bora and Adhikary, 2015). Portfolio theory states that there are two types of risk: systematic risk and unsystematic (idiosyncratic) risk. Systematic risk is due to market factors whereas unsystematic risk is caused by circumstance peculiar to the company. Systematic risk will always remain but unsystematic risk can be eliminated

through portfolio diversification (Bora and Adhikary, 2015). Since systematic risk cannot be eliminated, investors are always requiring compensation for bearing it.

Macroeconomic activities are known to directly impact asset prices since firms' cash flow and risk-adjusted discount rates change with economic conditions (Ya-Wen, 2017). Chen *et al* (1986), and, Bora and Adhikary (2015) argue that systematic risk comprises macroeconomic variables. Modigliani and Pogue, 1973; Guo and Whitelaw, 2003 argue that there is a linear relationship between systematic risk and expected return. If these arguments hold, then macroeconomic variables must have explanatory power on stock returns. Macroeconomic variables have explanatory power on stock returns (Liu and Shrestha, 2008).

Not only do macroeconomic variables have been found to have explanatory power on stock returns but their volatilities have also been found to impact stock market volatility (Morelli, 2002).

Findings from different studies had shown that the impact of the macroeconomic variables on stock returns and its volatilities on stock returns volatility vary from country to country and region to region. In certain jurisdictions a variable can have a significant relationship with stock return but in other jurisdictions the same variable will not. It is also discernible from literature that nature of relationship differs as well, some

relationships are positive whereas others are negative As an illustration, Alagidede and Panagiotidis (2012) found that a positive relationship exists between stock returns and inflation for G7 countries but Gathu *et al (*2015) found a negative relationship between inflation and stock returns in Kenya . Abugri (2008) found that the high volatility of macroeconomic variables of emerging market have resulted in stock returns of that region being highly volatile when contrasted with stock returns volatility of developed world, which happen to have low macroeconomic volatility.

The dissonance in the research findings about the subject matter brings to mind a question of 'what does finance theory say?' There are two finance theories that have largely been used by researchers in this area: The Arbitrage Pricing Theory (Ross, 1976) and Discount Cash flow model/ Present Value Model. Arbitrage Pricing Theory says that the asset returns are explained by multiple factors risk factors. Researchers like Fama, 1981, 1990; Fama and French, 1989; Schwert, 1990 and Ferson and Harvey, 1991 have used this theory to link macroeconomic variables as risk factors and as having explanatory power on stock returns. Discount Cash flow model relates the stock price to future expected cash flows and the future discount rate of these cash flows. Arguing that all macroeconomic factors that influence future expected cash flows or the discount rate by which these cash flows are discounted should impact stock price (Humpe and Macmillian, 2007).

All being posited, the critical question is what is Botswana's case? How is the relationship of macroeconomic variables and stock returns like? The issue of finding macroeconomic determinants of stock returns is of great relevance to investors' decisions making because, the former forms part of systematic risk, as argued by Bora and Adhikary (2015).

Sikalao-Lekobane and Lekobane (2014) used Johansen's co-integration technique to test the long term relationship of Botswana stock prices and selected macro-economic variables using quarterly data for the period 1998-2012. They found that macroeconomic variables are co-integrated with stock prices. However, this is not enough; there are still pertinent questions that are not answered. The questions relating to volatility transmission between macroeconomy and stock market. These questions include what the intention of this research will establish, which is the relationship between macroeconomic factors and stock returns in Botswana. Specifically the paper aims to address the following questions:

1. What are the macroeconomic determinant of stock returns in Botswana?
2. Is there a long run relationship between the Botswana stock markets and its macroeconomic determinants?
3. Are there any volatility spill overs between macroeconomic variables and stock market?

Finding answers for the above questions is very important especially given the fact that investors are risk-averse. Overall, the findings of this research will help settle the issue of whether the Botswana stock market compensates its investors for systematic risk.

4.0 OBJECTIVES

In line with the research questions, the main objective of this study is to find out the macroeconomic variables that have explanatory power on the Botswana stock returns. The specific objectives are:

1. To identify the macroeconomic determinant of stock returns in Botswana.
2. To investigate the long run relationship between the Botswana stock market and its macroeconomic determinants.
3. To investigate if there are any volatility spill over between macroeconomic variables and stock returns

5.0 SIGNIFICANCE OF STUDY

The relationship of macroeconomic variables and the stock informs the Investment Strategy. It gives a clear picture about the nature of the risk and return relationship. Depending on the nature of the relationship, portfolio managers can decide on whether to apply market timing strategy or buy and hold strategy, when and what to hedge e.g. a short term relationship of macroeconomic variables and the stock returns will make a market timing strategies more profitable than a buy and hold strategy (Shen, 2003). It is crucial to spell out how markets are linked over time to develop an effective hedging

strategy (Walid *et al*, 2011). This study will therefore provide insight to investors and portfolio managers on the dynamics between Botswana macroeconomic variables and stock returns. Lack of knowledge about the individual country's fundamentals may lead to investors treating these market as if they belong to a class and fail to take advantage of existing arbitrage opportunities (Aitken,1996; Abugri, 2008).

Additionally, the study will serve as a baseline for future research purposes by interested authorities. It can be expounded by other scholars to determine the predictive power of macroeconomic variables to stock market movements.

Furthermore, it will inform the policymakers on the volatility transmission between the macroeconomy and stock exchange, a factor very critical when assessing financial market stability. Macroeconomic volatilities have in the last decade played a major role in causing financial crises in Mexico and Argentina (Abugri, 2008).

6.0 BACKGROUND

Botswana Share Market was established in 1989 and became the Botswana Stock Exchange (BSE) in 1995 through the act of Parliament of Botswana (Morton *et al*, 2008). It is the sixth largest stock exchange in Africa in terms of market capitalisation (Africa strictly report, 2013). BSE is one of the representatives of an emerging market in terms of market capitalisation, trade volume and number of listed companies (Mollah, 2006). Its average weekly trading volume is 4,900,000 (African business central, 2014).

There are about 35 market listings and 3 stock listings indices: the Domestic Company Index (BSE DCI); the Foreign Company Index, incorporating companies which are dual listed on the BSE and another stock exchange; and the All Company Index, which is the weighted average of the DCI and FCI (BSE,2014). BSE has an equity market capitalization of P418 156.7m and debt market capitalization of P10.1bn, with private investors estimated to account for fewer than 10% of the total market capitalization and foreign based mining companies accounting for over 90% (BSE, 2014).

7.0 LITERATURE REVIEW.

The essence of an empirical research is to establish facts against a particular theory and/or model. As previously highlighted, the most used finance theories to establish the relationship of macroeconomic variables and stock returns are Arbitrage Pricing Theory (APT) and Discount Cash Flow or Present Value Model (PVM). APT is mainly used to test the short run relationship of macroeconomic variables and stock returns on first difference and assuming stationarity whereas PVM has the ability to establish a long run relationship of macroeconomic variables and stock returns (Humpe and Macmillian, 2007). On this basis, the latter is most preferred theory and it has been identified as the appropriate theory for this study.

PVM asserts that the stock prices are determined by the expected cash flows and the future discount rate of these cash flows. It further argues that these cash flows and discount rates are affected by macroeconomic variables therefore a change in the variables should influence stock prices.

The relationship between macroeconomic variables and stock returns has been investigated from different strands; scholars such as Fama (1981) and Ritter (2004) just investigated if the macroeconomic variables have explanatory power on stock returns. Whereas Chen (1991), Serfing and Milijkovic (2011) investigated if the macroeconomic

variables have predictive power on stock returns or stock returns do have predictive power on macroeconomic variables. Literature also show that certain scholars were interested in finding out shocks and volatility transmission between the macro economy and stock markets. These studies were conducted in different regions, using different econometric models and data of varying time horizons.

The commonly used macroeconomic variables are: interest rate spreads, money market rates, unemployment rates, production output and the exchange rates. In investigating the long term relationship of stock returns, inflation and industrial production, Fama (1981) concluded that the relationship of inflation and stock returns is negative whereas that of industrial production and stock returns is positive. Ritter (2004) used data from 1900-2002 to analyse the relationship between economic growth and equity returns for 16 countries that represented 90% of the world market capitalisation in 1900. He found that there is a negative correlation between per capita income growth and real equity returns. Dimson *et al* (2002) established that the long term relationship between geometric mean annual stocks is negatively correlated with arithmetic mean real per capita annual growth

Gay (2008) applied ARIMA model to test significance of stock market returns to macro-economic variables for four emerging market countries (Brazil, Russia, India and China).

The researcher noticed that the relationship is significance except in exchange rate and oil prices. It was also found that there is no significance of past and present stock returns. This suggests weak form of market efficiency. Murkherjee and Naka (1995) used the Johansen con-integration test in the Vector Error Correction Model to test co-integration of Japanese Stock Market prices to macroeconomic variables. They found that the stock market is co-integrated to exchange rate, money supply, inflation rate and industrial production, long term bond rate and short term call money rate.

Closer to Botswana , Gathu *et al (*2015), investigated the effects of macroeconomic environment on stock market returns of firms in the Agricultural sector in Kenya and, found that, exchange rate has a positive influence on the stock market returns whereas inflation has a negative effect. In Botswana, Sikalao-Lekobane and Lekobane (2014), used Johansen's co-integration technique to test the long term relationship of Botswana stock prices and selected macro-economic variables using quarterly data for the period 1998-2012.

Still on investigating the long term relationship of macroeconomy and stock market, some researchers have narrowed their studies to investigating a long term relationship of a particular macroeconomic variable with stock returns. Lin (2012) studied the comovement between exchange rates and stock prices in the Asian emerging markets.

The results suggested that the comovement between exchange rates and stock prices becomes stronger during crisis periods, consistent with contagion or spill over between asset prices, when compared with tranquil periods.

Gertler and Gilchrist (1994) argue that increasing interest rates (monetary tightening) negatively affects cash flow, this affect the firms' balance sheet and ultimately reduce the borrowing power of the firm. The impact is even more on small firms than on large firms because the former do not have enough collateral as opposed to the latter.

Wade and May (2005) decided to study both the short term and long term relationship of GDP growth and equity returns. They concluded that GDP growth and equity returns have a stable short term relationship but the relationship is unstable in the long term.

Researchers interested in investigating short term relationship only also came up with informative findings. Alagidede and Panagiotidis (2012) studied the short term relationship of inflation and stock returns for G7 countries using quantile regression framework. They found out that a positive relationship existed in most cases especially when moving to higher quantiles for the dependent variable the response increased as well. A conclusion that informs the portfolio managers that, stocks for G7 countries can act as an inflation hedge.

Jung and Kim (2016) used a definition of broad money M2 from Bank of Korea to breakdown aggregate money into an underlying and non-underlying part. According to the bank, underlying is the money held by households and non-financial corporations sectors necessary for basic purposes such as consumptions and normal business operations. Non-underlying is part of the money held by financial corporations and beneficiary certificates, this money was found to directly affect macro-liquidity which ultimately affect stock returns. In a nutshell, researchers state that unexpected changes in money growth can cause unfavourable shifts in the investment opportunities set.

As previously specified, another strand of research is on finding out the predictive power of either macroeconomic variables on stock returns or stock returns on macroeconomic variables. Chen (1991) states that lagged production growth rate, the default premium, term premium, short –term interest rate and the market dividend price ratio are indicators of recent and future economic growth.

Serfing and Milijkovic (2011) in their time series analysis of the relationships among (macro) economic variables , the dividend yield and the price level of the S&P 500 index, concluded that previous changes in the dividend yield ,interest rates, the money supply and the CPI predict current changes in the dividend yield. Furthermore, that previous changes in the dividend yield, interest rates, the S&P 500, the money supply the Industry

Production Index (IPI) and the CPI predict current changes in the yield on the 10 year Treasury note. They used the Vector Error Correction Model (VECM) to analyse monthly data from January 1959 to December 2009.

Gupta and Modise (2013) examined the predictability of South Africa stock returns using macroeconomic variables. Their analysis was based on a predictive regression framework, using monthly data covering the in-sample period between 1990:01 and 1996:12, and the out-of sample period commencing from 1997:01 to 2010:06. The in-sample revealed that different interest rate variables, world oil production growth and money supply have some predictive power at certain short-horizons. The out-of-sample showed that interest rates and money supply have short-horizon predictability. Inflation rate revealed a very strong out-of-sample predictive power from 6-month-ahead horizons.

In the shocks and volatility transmission stream, other eye opening findings were noted. Zhao (2010) investigated the case of China by analysing the dynamic relationship between Renminbi (RMB) real effective exchange rate and stock price using VAR and multivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models using monthly data from January 1991 to June 2009.The findings of the study were that there were no mean spillovers between the foreign exchange and stock markets. But there

were bidirectional volatility spillovers effects between the Foreign Exchange market and Stock Market.

Walid *et al* (2011) employed a Markov-Switching EGARCH model to investigate the dynamic linkage between stock price volatility and exchange rate changes for four emerging countries (Hong Kong, Singapore, Malaysia and Mexico) over the period 1994–2009. The exercise was in two regimes: conditional mean which is high mean –low variance and the conditional variance of stock returns which is low mean and a high variance. The results provided strong evidence that the relationship between stock and foreign exchange markets is regime dependent and stock price volatility responds asymmetrically to events in the foreign exchange market. An indication that foreign exchange rate changes have a significant impact on the probability of transition across regimes.

Tsai (2015) investigated how the United States (U.S.) stock returns responded to oil price shocks during the pre-crisis, within the financial crisis, and post-crisis by a long time series of daily data for 682 firms over a period of 12 years from January, 1990 to December, 2012. The results showed that U.S. stock returns responded positively to the changes in oil prices during and after such a crisis.

Generally, literature demonstrates that macroeconomic variables have explanatory power on the stock returns and vice versa. There is volatility and shock transmission between macroeconomic variables and stock market. It is worth noting that mostly, the extant literature focuses on the developed economies thereby creating a huge knowledge gap on the case of Africa despite it being an emerging market. Limited research in African space does not only disadvantage resident portfolio managers in crafting appropriate investment strategy but it also denies international investors a platform for broader portfolio diversification.

Even though it is acknowledged that Sikalao –Lekobane and Lekobane investigated the relationship of Botswana macroeconomy and stock returns but their study is only limited to the long term relationship without addressing volatility spillovers.

They used a small sample, quarterly data from 1998-2012. A small sample provides unreliable results. Verial (2010) argues that a small sample has a low statistical power. A statistical power is the ability of a statistical test based on a sample to show traits that truly exist on the population. He also argues that a small sample fails to detect significant details. This research will use monthly data from 1994-2014 a relatively large sample size.

Sikao –Lekobane and Lekobane (2014), used Johansen co-integration technique but our proposed methodology is AutoRegressive Distributed Lag (ARDL). The latter is more thorough and detailed than the former. ARDL is more robust for co-intergration analysis with small sample study (Pesaran *et al,* 2001). One of the advantages of using ARDL is that it is applicable regardless of the stationary properties or irrespective of whether the regressors are purely *I(0)* or *I(1),* or mutually integrated (Adu and Marbuah,2011). A better econometric model means results that are more reliable. The present study will therefore be a gap filler in this space.

8.0 DATA

There is no particular theory that spells out macroeconomic variables which are expected to have explanatory power on stock returns. Therefore objectivity in the selection of variables is always questionable. This is an unavoidable problem associated with this area of research (Fama, 1991). Researchers usually resort to using previous studies as a guide and this research intends to do the same. Chen *et* al. (1986), Murkherjee and Naka (1995) and Gathu *et al. (*2015) had used inflation, Gross Domestic Product, Interest and exchanges rates to test their explanatory power on stock returns.

The researcher intends to use Consumer Price Index as a proxy for inflation. USD/BWP exchange rate because the US Dollar is largely used in Botswana for international trade. Bank Rates as a proxy for interest rates and lastly M2 to proxy money supply. Gross Domestic Product is not included because of lack of its data for the desired period but its relevance is highly acknowledged. The Domestic Company Index (DCI) will be used to proxy the local stock. The researcher intends to use monthly data spanning from January 1994 to December 2014. Data on Macroeconomic variables was solicited from Bank of Botswana and data on Domestic Company Index is from Botswana Stock Exchange.

The researcher will use the returns for DCI because of their stationarity property over prices and they will be calculated as:

$$R_t = \ln(P_t) - \ln P_{t-1} \qquad (1)$$

Where R_t is the stock market return in month t, ln is the logarithm, and Pt is the DCI at the end of month t. Stationarity for stock returns will be tested using the Augmented Dickey-Fuller test.

The first differences in the log of macroeconomic variables will be taken. This is meant to ensure stationarity of the macroeconomic variables. The same Augmented Dickey-Fuller test will be conducted to also test for stationarity of the regressors. The data will also be tested for normality, skewness and Kurtosis (descriptive statistics).

9.0 METHODOLOGY

9.1 Baseline Model

This research uses the Ordinary Least Square (OLS) method to estimate parameters. The Classic Linear Regression Model will be applied. It is one basic econometric model that explains the linear relationship of a dependant variable and independent variable/s. The model can be applied to single or multiple explanatory variables and also categorical explanatory variables that have been appropriately coded (Hutcheson, 2011).

The model can be expressed mathematically using a straight line equation:

$$R_i = \alpha + \beta_1 r_{t-1} + \beta_2 i_{t-1} + \beta_3 e_t + \beta_4 m_{s-1} + \varepsilon_t \quad (2)$$

Where R_i is the stock return, r_{t-1} is interest rates for the previous month, i_{t-1} is the inflation rate for last month, e_t is the exchange rate for the current month , m_{s-1} is the money supply for previous and ε_t is the error term. $\beta_1 - \beta_4$ are coefficients to be estimated. A positive coefficient will mean a unit increase in the independent variable will result an increase of the dependant variable (stock returns) equivalent to coefficient value. The opposite is true for a negative coefficient; a unit increase in the independent variable will result in a decrease in dependant variable equivalent coefficient value

The model assumes that the mean of errors is zero, the variance is constant, that is homoscedasticity. It also assumes that covariance of the error terms is zero, which is no serial correlation, the regressors and error terms are non-stochastic, error terms are normally distributed and there is no multicollinearity among regressors.

The effect of unexpected economic news on stock prices is sometimes lagged because of the delay in the transmission and incorporation of information. Exchange rates are the only variables that have been seen to have an instantaneous effect because they are published every day (Bilson *et al*, 2001). The lagged effect of the variables will also be tested except exchange rates which will be tested for both instantaneous and lagged effect.

9.2 Testing long -run relationship

The co-integration method by Pesaran *et al* (2001) called Autoregressive –Distributed Lag (ARDL) will be applied. One of the advantages of using ARDL is that, it is applicable regardless of the stationary properties or irrespective of whether the regressors are purely *I(0)* or *I(1),* or mutually integrated (Adu and Marbuah, 2011). Moreover, the bounds test approach is robust for co-integration analyses with small sample study (Pesaran *et al*, 2001). With respect to equation (3), the ARDL framework for stock returns model is:

$$\Delta R = a + \sum_{i=0}^{m} b\,\Delta r_{t-1} + \sum_{i=0}^{m} b\,\Delta i_{t-1} + \sum_{i=0}^{m} b\,\Delta e_t + \sum_{i=0}^{m} b\,\Delta m_{s-1} + \lambda_0 r_{t-1} + \lambda_1 i_{t-1} + \lambda_2 e_t + \lambda_3 m_{s-1} + \varepsilon_t. \quad (3)$$

Where Δ is the difference in the operator and ε_t is the disturbance error term assumed to be white noise. The long run relationship between the concerned variables will be conducted based on the Wald test (*F*-statistic) by imposing the variables equal to zero, that is $H_0: \lambda_0=\lambda_1=\lambda_2=\lambda_3=0$ against $H_1: \lambda_0\neq\lambda_1\neq\lambda_2\neq\lambda_3\neq0$.

Incorporating the error correction model, then the formula is:

$\Delta R = a_0 + \sum_{i=0}^{m} b_1 \Delta r_{t-1} + \sum_{i=0}^{m} b_2 \Delta i_{t-1} + \sum_{i=0}^{m} b_3 \Delta e + \sum_{i=0}^{m} b_4 \Delta m_{s-1} + \gamma_t ECT_{t-1} + \varepsilon_t$ (4)

Where all the variables are as previously defined, γ_t is the coefficient of the error correction term (ECT_{t-1}) which measures the speed of adjustment to long–run equilibrium following a shock in the system.

9.3 Testing for Volatility spill overs

There is enough evidence that shows that linear models are not able to capture volatility clustering, leptokurtic and leverage effects evident on financial data. This therefore calls for the researcher to use an econometric model that is able to capture volatility.

The GARCH (1, 1) has been identified as an appropriate model because of its ability to capture volatility (Brooks, 2014). It was developed by Engle (1982) and Taylor (1986).The model allows the conditional variance to be dependent upon its previous lags.

The model states that the best predictor for the variance in the next period is the weighted average of the long run average variance with the most recent information carrying more weight. We follow the work of Engle (1982), where:

h_t *is* used to define variance of residuals of a regression $y_t = x_t + \sqrt{h_t\ \varepsilon_{t.}}$ According to the definition variance of $\varepsilon_{t.} = \infty$

The GARCH model can therefore be expressed as:

$$h_{t+1} = \omega + \alpha(y_t - x_t)^2 + \beta h_t = \omega + \alpha h_t \varepsilon_t^2 + \beta h_t \quad (5)$$

The econometricians must estimate the constants ω,α, β; updating simply requires knowing the previous forecast *h* and residual. The weights are (1- α- β, β, α) and the long run average variance is$\sqrt{\omega/(1-\alpha-\beta}$. It should be noted that this is a condition for GARCH (1, 1) if $\alpha + \beta < 1$, and only really makes sense if the weights are positive requiring $\alpha > 0, \beta > 0, \omega > 0$

MODEL SELECTION

Akaike Information Criterion (AIC) will be used to select a better model. The AIC statistic is discussed below:

$$AIC = \ln \frac{\sum_{i=1}^{T} \hat{\varepsilon}_i^2}{T-n} + \frac{2n}{T} \quad (6)$$

Where $\hat{\varepsilon}_i^2$ is the estimated squared residuals of the model, T is the number of observations in the sample and n is the number parameters estimated including the constant. A better model is the one with the lowest AIC.

10.0 RESULTS

Prior to running regressions, data was tested for stationarity under the null hypothesis: $H_{0:}$ θ= 0 (i.e. unit root is present) and alternative hypothesis $H_{1:}$ θ< 0 (i.e. unit is not present). Table 1 shows ADF unit root tests results; null hypothesis is rejected under all variables. This means data is stationary. It is appropriate to use stationary data because the shock gradually dies away but in a non-stationary data the shocks will always be infinite (Brooks, 2014).The author also argues that non stationary data causes spurious regressions and violates asymptotic analysis assumption.

TABLE 1: STATIONARITY TESTS

VARIABLE	CRITICAL VALUE (5%)	ADF STATISTIC	P VALUE
DCI	-3.44	-8.67	<0.0001
CPI	-3.43	-7.34	<0.0001
EXCHANGE RATES	-3.43	-11.22	<0.0001
INTEREST RATES	-3.43	-7.90	<0.0001
MONEY SUPPLY	-3.43	-18.82	<0.0001

Note :< 0.0001 indicates significance at 1%

Table 2 reports the summary statistics of the variables. DCI has a positive mean which implies that generally the stock returns have being positive over time. Standard Deviation is highest in DCPI (8.03) meaning that inflation is highly volatile when compared with

other variables. DMS has the second largest volatility and lastly is the DCI .This could mean that stock returns volatility is driven by inflation volatility and money supply volatility, however this will be confirmed by the results on volatility transmission.

The skewness results indicate that DCIRET (1.39) and DMS (1.76) are positively skewed. DCPI (-0.03), DER (-1.41) and DINTRATE (-2.56) are negatively skewed. In a normal distribution, the mean and the median are the same but in a skewed data they are different. A negatively skewed data will have a mean left of the median and a positively skewed data will have mean on the right of the median. Kurtosis measures the fatness of the tails of the data distribution and how the mean peaked is. Normally peaked mean has a kurtosis of 3 and excess kurtosis of 0. All variables have excess kurtosis of more than 0, which means they are leptokurtic and they have fat tails than those of a normal distribution.

Normality is being tested using Jarque –Bera tests (Brooks, 2014). The null hypothesis states that data is normally distributed but results prove it wrong so the null is rejected, that is data is not normally distributed. There are no missing observations in any variable.

TABLE 2: DESCRIPTIVE STATISTICS

	DCI	CPI	ER	INT	MS
MEAN	1.40	-0.44	-0.52	-0.23	1.27
MEDIAN	0.92	0.00	-0.39	0.00	0.83
STD	3.87	8.03	2.67	1.80	4.65
SKEWNESS	1.39	-0.03	-1.41	-2.56	1.76
KURTOSIS	9.38	7.06	9.43	16.47	12.80
JARQUE B	506.30	172.09	515.21	2172.53	1134.50
PROBABILITY	0.00	0.00	0.00	0.00	0.00

Note: DCI: Domestic company Index, CPI: Consumer Price Index, ER: Exchange Rate,INT: Interest rates MS; Money supply STD: Standard Deviation, Jarque Bera. Probability: 0.00 means significance at 1%

Table 3 reports correlation results. Correlation measures the relationship between variables. Its coefficients range between -1 and +1. -1 indicates that the variables are perfectly negatively correlated and +1 indicates that variables are perfectly positively correlated. A negative correlation means that as one variable increases, the other decreases whereas a positive correlation means that as one variable increases the other

one also increases. Results clearly show DCI RETURNS are weakly negatively correlated to inflation and exchange rate with correlation coefficients of -0.45 and -0.12 respectively. But weakly positively correlated to interest rates and money supply with correlation coefficients of 0.039 and 0.091 respectively.

TABLE 3: CORRELATION RESULTS

Correlation Probability	DCIRET	DCPI	DINTRATE	DER	DMS
DCIRET	1.000000 -----				
DCPI	-0.044547 (0.4823)	1.000000 -----			
DINTRATE	0.039220 (0.5362)	0.144923 (0.0216)	1.000000 -----		
DER	-0.123191 (0.0512)	-0.065883 (0.2985)	-0.095528 (0.1312)	1.000000 -----	
DMS	0.091135 (0.1500)	0.037156 (0.5579)	-0.014339 (0.8212)	0.001912 (0.9760)	1.000000 -----

Note: DCIRET is the DCI returns, DCPI is inflation, DER is the exchange rate , DINTRATE is the interest rate and DMS is the money supply . Figures in ( ) are p values.

Table 4 reports OLS regression results. Exchange rate and Money supply have a significant relationship at 10%, other variables do not have a significant relationship. A negative coefficient for exchange rates (DER) means that as exchange rates increases by 1 unit in the current month, DCI decreases by about 0.15 in the same month. A positive coefficient for money supply indicates that as money supply increases by 1 unit in the previous month, stock returns will increases by 0.06 in the current month.

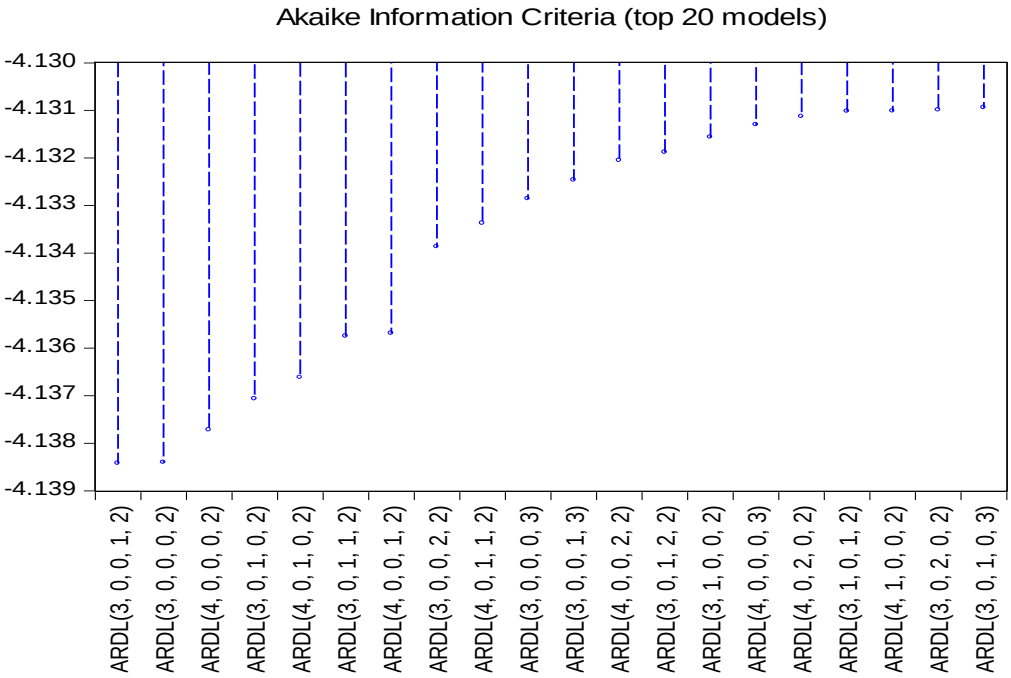
TABLE 4: OLS REGRESSION RESULTS

VARIABLE	COEFFICIENT	STD ERROR	T-STATISTIC
C	1.18***	0.40	2.94
DCPI(-1)	-0.01	0.02	-0.56
DINT(-1)	-0.04	0.08	-0.15
DER	-0.1*	0.08	-1.00
DER(-1)	-0.08	0.08	-1.00
DMS(-1)	0.06*	0.03	1.95
AR(1)	0.71***	0.06	11.26
AR(2)	-0.20***	0.06	-3.20

Note: DCPI (-1) is the 1 month lagged CPI, DINT (-1) is 1 month lagged interest rates, DER is the exchange rate for the current month, DER (-1) is 1 month lagged exchange rate, DMS (-1) is 1 month lagged money supply. * and *** are significance levels at 10% and 1% respectively.

In selecting the model for ARDL, the Akaike Information Criteria was used again. Results show that ARDL (3, 0, 0, 1, 2) is best model. Table 5 reports the results.

TABLE 5: ARDL MODEL SELECTION



NOTE: a model with lowest AIC value is the best model.

As stated in the methodology, ARDL is chosen model for testing long term relationship, results show that all the coefficients are significant. However, it should be noted that conclusions about the results will be made on the basis of bounds test (table 7).

TABLE 7: BOUNDS TEST RESULTS

Test Statistic	Value	k
F-statistic	2.084790	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Note: the F-statistic is lower than the lower (IO) this means there is no long run relationship between stock returns and macroeconomic variables.

Model selection for mean models is based on Akaike Information Criteria (AIC). A model with the lowest AIC is the most appropriate one. Table 8 shows results for best model based on AIC amongst possible all ARMA (p,q) for each variable.

TABLE 8: MODEL SELECTION FOR MEAN MODELS

Variable	ARMA(p,q)	AIC
DCI	(1,1)	5.08
CPI	(2,3)	6.92
Exchange Rates	(0,1)	4.69
Interest Rates	(2,3)	3.87
Money Supply	(2,3)	5.89

Note: AIC is the Akaike Information Criteria. ARMA (p,q) represents the appropriate Auto Regressive Moving Average model.

The mean values selected as shown in table 8 were subtracted from historical values, the difference were squared to get variance i.e. conditional volatility for each macroeconomic variable. Heteroscedasticity was present in Lag 15 of the CPI, autocorrelation also noted in the variables. This necessitated the use of GARCH model. We used each macroeconomic volatility as explanatory variable for DCI variable and the results are in table 9. DCI1 represents regression results for CPI vol and DCI, DCI2 is the regression

results for Exchange Rate(ER) and DCI. DCI 3 is regression results for Money supply volatility and DCI, lastly DCI4 is the results for Interest rates volatility and DCI. The results indicate that there is volatility transmission between macroeconomy and stock returns .They show that inflation volatility and money supply volatility drives stock returns volatility. These findings are consistent with what descriptive statistics is showing. Inflation, Stock returns have high standard which indicates high volatility because volatility is standard deviation squared. Heteroscedasticity was tested after applying GARCH and results revealed that there is no heteroscedasticity. Autocorrelation was also tested using a correlogram and the conclusion reached was that there is no autocorrelation (graphs in appendices).

TABLE 9: Estimation Results of ARMA (p,q)-GARCH(p,q) Models

	DCPI	DER	DMS	DINTRATE	DCI 1	DCI2	DCI3	DCI4
	Panel A: Conditional Mean Equation							
C	-1.0453	-0.3987**	0.9786	-0.1293	1.2186**	0.9423***	0.7345***	0.8570
	(0.7167)	(0.0176)	(0.1870)	(0.1968)	(0.5314)	(0.2986)	(0.1489)	(0.3014)
AR(1)	1.7059***		-0.7941***	1.6714***	0.1677*	0.4458***	0.4213***	0.4177***
	(0.0412)		(0.2115)	(0.1822)	(0.3030)	(0.0959)	(0.0947)	(0.0968)
AR(2)	-0.8401***		-0.6786***	-0.7346***				
	(0.0400)		(0.1507)	(0.1849)				
MA(1)	-1.6021***	0.345647***	0.5661**	-1.5786***	0.2019*	0.1997	0.2035	0.2269*
	(0.0821)	(0.0745)	(0.2292)	(0.2073)	(0.3497)	(0.1313)	(0.1279)	(0.1359)
MA(2)	0.6643***		0.5570***	0.6924				
	(0.1425)		(0.1599)					
MA(3)	0.1726**							
	(0.0786)							
	Panel B: Conditional Variance Equation							
Constant	14.0520***	0.7240**	0.2203*	0.3548***	11.7174*	0.3452	0.3895	0.0416

	(4.5956)	(0.3100)	(0.1328)	(0.0820)	(6.1673)	(0.2315)	(0.3223)	(0.2591)
ARCH	0.4370***	0.4218***	0.1313***	0.1068***	0.1085	0.4084***	0.5363***	0.4019***
	(0.1090)	(0.0909)	(0.0384)	(0.0362)	(0.1160)	(0.0794)	(0.1102)	(0.0783)
GARCH	0.4010***	0.5510***	0.8683***	0.7644***	0.5000*	0.6765	0.5063***	0.6676***
	(0.1028)	(0.0683)	(0.0295)	(0.0450)	(0.2900)	(0.0478)	(0.0722)	(0.0505)
MacroVol					-0.0307***	-0.0135	-0.1474***	0.1105
					(0.0050)	(0.0165)	(0.0285)	(0.1354)
Panel B: Diagnostics								
Ljung–Box Q-statistics Q(10)	0.382	0.307	0.544	0.001	0.000	0.401	0.618	0.341
ARCH LM test(5)	0.8891	0.1484	0.9979	0.5512	0.4663	0.8734	0.4082	0.2971

Notes: The table presents results for the relationship between macrovolatiliy and DCI. The top panel presents the parameter estimates for the conditional mean, modelled by an ARMA(p,q) model; the second panel presents parameter estimates from GARCH(1,1) models for the conditional variance. Values shown in parenthesis are the t-values. *, **and***indicates statistical significance at 10% , 5% and 1% respectively.

11.0 DISCUSSION

The Botswana case is very peculiar; most of results are in dissonance with what Present Value Model says. The theory asserts macroeconomic variables should impact stock returns because of their ability to affect the expected cash flows and discount rate. The researcher expected that all the macroeconomic variables will have explanatory power on stock returns and also a long run relationship between macroeconomic variables and stock returns.

The OLS regression results show that inflation does not have explanatory power on stock returns which implies that inflation does not affect Botswana stock returns. Theoretically, it is expected that inflation will have a significant negative relationship with the stock returns because inflation is a component of interest rates and interest rates are used as discount rates for fundamental stock valuation. Most empirical studies including the likes of Fama (1981) and Gathu *et al* (2015) do confirm that indeed inflation have a negative impact on the stock returns. The findings of this study are inconsistent with both theory and most of the literature.

International Trade and International Portfolio diversification have advanced discussions around exchange rate to be central to economic decision making. The issue of whether the exchange rate should have a negative or positive

impact on the stock returns is a function of the whether a country is import oriented or export oriented. In an import based economy, strengthening of the major trading foreign currency relative to a domestic currency will have a negative impact of stock returns but in an export oriented economy weakening of domestic currency relative to that of a foreign currency will have a positive impact. Botswana is an import based economy so it is expected that strengthening USD against BWP (domestic currency) will have a negative on domestic stock returns. The results are consistent with expectation, they showed that USD/BWP exchange rate have a significant negative relationship with stock returns. The results imply that, as the USD strengthens against BWP, the DCI returns declines. The situation calls for portfolio managers to identify a hedging strategy against the strengthening of the USD. If BWP strengthen against USD then DCI returns improves. All else being equal, strategic management of USD/BWP exchange rate can be used to improve Botswana stock returns.

Financial Economists have conflicting views when it comes to how money supply affects stock returns. The real activists economists hold the view that a positive shock in the money supply will increase stock prices .On the contrary, others like Sellin (2001) hold the view that an expansionary money policy will lead to expectation of contractionary monetary policy in the future, this will

result in increased interest rates which will ultimately result in low stock returns. The results of this study are consistent with the views of the real activists economists. The results show that money supply has a positive impact on stock returns, meaning that, an expansionary monetary policy will increase stock returns but a contractionary monetary policy will shrink DCI returns. The results are also in agreement with the findings of Jung and Kim (2016).

Interest rates by virtue of them being a cost of borrowing, are expected to have a negative impact on the stock returns but the findings of the study show that they have an insignificant relationship with stock returns. These findings are inconsistent with both theory and empirical research by Serfing and Milijkovic (2011).

The long run relationship of the macroeconomic variables and stock returns was tested using ARDL model. The results indicate that there is no long run relationship that exists between the macroeconomic variables and stock returns. These results were highly unexpected especially given that a similar study was carried out by Sikalao-Lekobane and Lekobane (2014), who realised that stock returns are co-integrated with macroeconomic variables. It is acknowledged that the duo used Johansen co-integration model but still, it was expected that the results will be the same more so that the period covered by both researches are close. These findings imply that investors are not

compensated for bearing systematic risk for a long time. In an environment like Botswana, a buy and hold strategy is inappropriate, portfolio managers should rather apply market timing strategy (Shen, 2003).

The third objective of this study was to establish if there is volatility spill over between macroeconomic volatilities and stock return volatilities. It was found out that inflation and money supply volatilities have a spill over effects on stock returns volatility. These results link very well with the results of the data description where it was found that inflation and money supply have the highest volatilities (measured by squaring standard deviation) amongst other macroeconomic variables.

Even though it is expected that macroeconomic volatilities will drive stock returns volatilities because previous studies like Abugri (2008) show that, this is a cause for concern because macroeconomic volatilities increases risk premia and hedging costs (Rother, 2004). However, investors should not be bothered much by both inflation and money supply volatilities because Botswana has a good Monetary Policy appropriate for managing the volatilities. Botswana monetary policy frame work makes inflation and monetary policy interventions very predictable (Bank of Botswana, 2016).

The results of this study justifies the essence of empirical research, they present the evidence that theory is not always correct and also that; what is the case in

one jurisdiction is not necessarily the case in another jurisdiction. The fact that some of the findings of this study are inconsistent with what theory says and also what literature show does not mean they are wrong, but they rather demonstrate the uniqueness of Botswana case. The difference between our findings and those of Sikalao-Lekobane and Lekobane (2014) is attributable to different econometric methods applied and also the varying sample size.

11.0 CONCLUSION

The purpose of this study is to find out the relationship of macroeconomy and stock returns in Botswana with specific objectives of: (a) identifying the macroeconomic determinant of stock returns in Botswana, (b) investigating the long run relationship between the Botswana stock market and its macroeconomic determinants and lastly investigating if there are any volatility spill over between macroeconomic volatilities and stock returns.

The OLS model used to find out the macroeconomic determinants of stock returns, ARDL model was used to investigate the long run relationship and GARCH method was used to test volatility spill overs. The objectives of this study have being met and the researchers confidently conclude by saying; money supply and exchange rates are macroeconomic determinants of stock returns in Botswana.

There is no long run relationship between stock returns and macroeconomy. Inflation volatility and Money supply volatility drives stock returns volatility, thanks to transparent monetary framework policy which makes it easy for investors to manage volatility.

We are pleased with the significance of this study to the investors, portfolio managers and policy makers. However, there are still certain questions that are

not answered. It is still not known how GDP affects stock returns in Botswana and also what the relationship of the macroeconomy and stock returns under extreme economic conditions is. Therefore it is recommended that, in future when there is enough sample data, a study be carried out to establish the relationship between GDP and stock returns. Once again, we recommend for a study that will establish the relationship of macroeconomy and stock returns under extreme economic climates which are recession and boom.

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13.0 APPENDICES

13.1 Correlogram for CPI volatility post GARCH

Sample: 1994M01 2014M12
Included observations: 249
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|* |	.|* |	1	0.104	0.104	2.7448	
.|. |	.|. |	2	0.045	0.034	3.2550	
.|. |	.|. |	3	0.046	0.038	3.7842	0.052
.|* |	.|* |	4	0.087	0.078	5.7033	0.058
.|. |	.|. |	5	0.053	0.034	6.4161	0.093
.|. |	.|. |	6	-0.000	-0.016	6.4161	0.170
.|* |	.|* |	7	0.126	0.121	10.513	0.062
.|. |	.|. |	8	0.010	-0.023	10.541	0.104
.|. |	.|. |	9	-0.005	-0.018	10.547	0.160
.|. |	*|. |	10	-0.065	-0.073	11.659	0.167
.|. |	.|. |	11	0.034	0.031	11.960	0.216
.|. |	.|. |	12	0.041	0.031	12.409	0.259
.|. |	.|. |	13	0.004	0.005	12.413	0.333
*|. |	*|. |	14	-0.129	-0.144	16.833	0.156
.|. |	.|. |	15	-0.006	0.022	16.842	0.207
.|. |	.|. |	16	-0.009	-0.010	16.865	0.263
.|. |	.|* |	17	0.056	0.087	17.702	0.279
.|. |	.|. |	18	-0.052	-0.060	18.422	0.300
*|. |	*|. |	19	-0.078	-0.076	20.082	0.270
.|. |	.|. |	20	0.040	0.047	20.515	0.305
*|. |	*|. |	21	-0.103	-0.074	23.428	0.219
*|. |	.|. |	22	-0.080	-0.063	25.191	0.194
.|. |	.|* |	23	0.044	0.083	25.726	0.217
.|* |	.|* |	24	0.147	0.114	31.701	0.083
.|. |	.|. |	25	-0.019	-0.017	31.805	0.104
*|. |	*|. |	26	-0.137	-0.119	37.102	0.043
*|. |	*|. |	27	-0.114	-0.120	40.778	0.024
.|* |	.|* |	28	0.121	0.151	44.911	0.012
.|. |	.|. |	29	0.019	0.025	45.017	0.016
.|. |	.|. |	30	-0.013	-0.016	45.066	0.022
.|. |	.|. |	31	-0.032	-0.060	45.367	0.027
.|. |	.|. |	32	0.005	-0.008	45.375	0.036
.|. |	.|. |	33	0.017	0.058	45.464	0.045
*|. |	.|. |	34	-0.067	-0.018	46.771	0.044
.|. |	.|. |	35	0.026	-0.048	46.968	0.054
.|. |	.|. |	36	0.037	0.021	47.373	0.063

*Probabilities may not be valid for this equation specification.

13.2 Correlogram for Exchange Rates post GARCH

Sample: 1994M01 2014M12
Included observations: 250
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|* |	.|* |	1	0.089	0.089	2.0211	
.|. |	.|. |	2	0.050	0.042	2.6588	
.|. |	.|. |	3	0.027	0.019	2.8407	0.092
.|. |	.|. |	4	0.059	0.054	3.7391	0.154
.|* |	.|. |	5	0.079	0.068	5.3368	0.149
.|. |	.|. |	6	0.032	0.015	5.6058	0.231
.|* |	.|. |	7	0.081	0.070	7.3081	0.199
.|. |	.|. |	8	0.019	-0.001	7.3981	0.286
.|. |	.|. |	9	0.050	0.035	8.0424	0.329
.|. |	.|. |	10	-0.034	-0.052	8.3412	0.401
.|. |	.|. |	11	0.043	0.037	8.8207	0.454
.|. |	.|. |	12	0.044	0.029	9.3421	0.500
.|. |	.|. |	13	-0.015	-0.032	9.4047	0.585
*|. |	*|. |	14	-0.113	-0.123	12.790	0.385
.|. |	.|. |	15	-0.000	0.020	12.790	0.464
.|. |	.|. |	16	-0.046	-0.054	13.366	0.498
.|. |	.|. |	17	0.052	0.068	14.108	0.517
.|. |	.|. |	18	-0.034	-0.037	14.415	0.568
.|. |	.|. |	19	-0.061	-0.045	15.422	0.565
.|. |	.|. |	20	0.038	0.055	15.826	0.605
*|. |	*|. |	21	-0.094	-0.081	18.237	0.507
*|. |	*|. |	22	-0.077	-0.067	19.884	0.465
.|. |	.|. |	23	0.008	0.050	19.903	0.527
.|* |	.|* |	24	0.151	0.148	26.287	0.240
.|. |	.|. |	25	-0.007	-0.008	26.299	0.287
*|. |	*|. |	26	-0.158	-0.162	33.287	0.098
*|. |	*|. |	27	-0.133	-0.115	38.304	0.043
.|* |	.|* |	28	0.099	0.141	41.074	0.031
.|. |	.|. |	29	0.062	0.057	42.183	0.032
.|. |	.|. |	30	0.010	0.003	42.213	0.041
.|. |	.|. |	31	-0.045	-0.053	42.803	0.047
.|. |	.|. |	32	0.009	0.008	42.824	0.061
.|. |	.|. |	33	-0.005	0.011	42.831	0.077
*|. |	*|. |	34	-0.089	-0.077	45.127	0.062
.|. |	.|. |	35	-0.022	-0.064	45.274	0.076
.|. |	.|. |	36	0.000	0.013	45.274	0.094

*Probabilities may not be valid for this equation specification.

13.3 Correlogram for Money Supply volatility post GARCH

Included observations: 247
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|* |	.|* |	1	0.093	0.093	2.1729	
.|. |	.|. |	2	0.032	0.024	2.4377	
.|. |	.|. |	3	0.006	0.000	2.4455	0.118
.|. |	.|. |	4	0.062	0.061	3.4205	0.181
.|. |	.|. |	5	0.038	0.027	3.7889	0.285
.|. |	.|. |	6	0.008	-0.002	3.8033	0.433
.|* |	.|* |	7	0.088	0.087	5.8018	0.326
.|. |	.|. |	8	0.015	-0.005	5.8581	0.439
.|. |	.|. |	9	0.025	0.016	6.0223	0.537
.|. |	.|. |	10	-0.030	-0.035	6.2614	0.618
.|. |	.|. |	11	0.045	0.041	6.7975	0.658
.|. |	.|. |	12	0.011	-0.001	6.8288	0.741
.|. |	.|. |	13	-0.014	-0.020	6.8799	0.809
*|. |	*|. |	14	-0.111	-0.116	10.144	0.603
.|. |	.|. |	15	0.000	0.019	10.144	0.682
.|. |	.|. |	16	-0.031	-0.036	10.396	0.733
.|. |	.|. |	17	0.031	0.045	10.647	0.777
.|. |	.|. |	18	-0.004	-0.005	10.652	0.830
.|. |	.|. |	19	-0.057	-0.053	11.525	0.828
.|. |	.|. |	20	0.054	0.069	12.303	0.831
*|. |	*|. |	21	-0.076	-0.067	13.884	0.790
*|. |	*|. |	22	-0.087	-0.084	15.957	0.719
.|. |	.|. |	23	0.029	0.069	16.188	0.759
.|* |	.|* |	24	0.141	0.126	21.693	0.478
.|. |	.|. |	25	-0.001	-0.014	21.693	0.539
*|. |	*|. |	26	-0.147	-0.144	27.707	0.273
*|. |	*|. |	27	-0.133	-0.127	32.679	0.139
.|* |	.|* |	28	0.111	0.144	36.145	0.089
.|. |	.|. |	29	0.038	0.039	36.548	0.104
.|. |	.|. |	30	0.015	0.007	36.611	0.128
.|. |	.|. |	31	-0.025	-0.042	36.782	0.152
.|. |	.|. |	32	0.031	0.027	37.054	0.176
.|. |	.|. |	33	0.005	0.023	37.063	0.209
*|. |	*|. |	34	-0.097	-0.078	39.804	0.162
.|. |	.|. |	35	0.005	-0.040	39.813	0.193
.|. |	.|. |	36	-0.002	0.002	39.814	0.227

*Probabilities may not be valid for this equation specification.

13.4 Correlogram Interest Rates volatility post GARCH

Sample: 1994M01 2014M12
Included observations: 249
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|* |	.|* |	1	0.099	0.099	2.4781	
.|. |	.|. |	2	0.059	0.050	3.3679	
.|. |	.|. |	3	0.029	0.018	3.5759	0.059
.|. |	.|. |	4	0.064	0.057	4.6069	0.100
.|* |	.|. |	5	0.077	0.064	6.1226	0.106
.|. |	.|. |	6	0.026	0.007	6.3006	0.178
.|* |	.|. |	7	0.077	0.066	7.8134	0.167
.|. |	.|. |	8	0.018	-0.002	7.8963	0.246
.|. |	.|. |	9	0.060	0.044	8.8190	0.266
.|. |	.|. |	10	-0.027	-0.047	9.0162	0.341
.|. |	.|. |	11	0.038	0.031	9.3880	0.402
.|. |	.|. |	12	0.041	0.027	9.8360	0.455
.|. |	.|. |	13	-0.009	-0.025	9.8567	0.543
*|. |	*|. |	14	-0.113	-0.125	13.227	0.353
.|. |	.|. |	15	0.019	0.042	13.320	0.423
.|. |	.|. |	16	-0.051	-0.062	14.009	0.449
.|. |	.|. |	17	0.046	0.061	14.585	0.482
.|. |	.|. |	18	-0.037	-0.040	14.952	0.528
.|. |	.|. |	19	-0.053	-0.037	15.710	0.544
.|. |	.|. |	20	0.040	0.053	16.143	0.583
*|. |	*|. |	21	-0.099	-0.091	18.839	0.467
*|. |	.|. |	22	-0.075	-0.065	20.389	0.434
.|. |	.|. |	23	0.005	0.055	20.396	0.496
.|* |	.|* |	24	0.156	0.151	27.181	0.204
.|. |	.|. |	25	-0.008	-0.013	27.200	0.248
*|. |	*|. |	26	-0.156	-0.165	34.061	0.084
*|. |	*|. |	27	-0.129	-0.108	38.764	0.039
.|* |	.|* |	28	0.102	0.151	41.728	0.026
.|. |	.|. |	29	0.051	0.046	42.472	0.030
.|. |	.|. |	30	0.010	-0.000	42.498	0.039
.|. |	.|. |	31	-0.042	-0.045	43.008	0.045
.|. |	.|. |	32	0.013	0.009	43.055	0.058
.|. |	.|. |	33	-0.008	0.001	43.071	0.073
*|. |	*|. |	34	-0.091	-0.078	45.468	0.058
.|. |	.|. |	35	-0.029	-0.065	45.708	0.070
.|. |	.|. |	36	-0.015	0.008	45.776	0.086

*Probabilities may not be valid for this equation specification.