EFFECT OF SELECTED MACROECONOMIC VARIABLES ON NON-PERFORMING LOANS IN KENYAN COMMERCIAL BANKS

By

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MASTER OF COMMERCE (FINANCE AND INVESTMENT)

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DECLARATION

I declare that this dissertation is my own original work and has not been previously published or submitted elsewhere for award of a degree. I also declare that this dissertation contains no material written or published by other people except where due reference is made and author duly acknowledged.

Student Name: **Ruth Wanjiru Mathina** Reg. No. **11/00704**

Sign: …… Date:…….....

I do here declare that I have examined the master's dissertation of

Ruth Wanjiru Mathina

And have certified that all revisions that the dissertation panel and examiners recommended have been adequately addressed.

Sign: …… Date:…….....

Dr. Renson Muchiri
Dissertation Supervisor

ABSTRACT

Non-performing loans can be defined as credit facilities, which for a long time do not generate returns. The role played by non-performing loans in triggering banking and financial crises in both most developed and least developed countries widely acknowledged. The aim of the study was to examine the effect of selected macro-economic variables on non-performing loans in Kenyan commercial banks. The study used time series data to model the relationship between non-performing loans and selected number of macro-economic variables.The use of time series analysis was deemed advantageous due to the dynamic nature of time series model. The time series were found to be non-stationary but stationarity was attained after taking the first difference. Further, cointegration test indicated that the study variables were not cointegrated. The study used vector autoregression (VAR) models. Vector error correction (VEC) models were found inappropriate as the study variables' were not cointegrated.

The study found out that there was no long run relation between inflation rate, interest rate, foreign exchange rate and non-performing loans. Further, the one month lagged effects on inflation rate, non-performing loans and three months lagged effects on non-performing loans were found to be significant in determining the non-performing loans. The Granger causality test indicated that only inflation rate Granger causes non-performing loans.

In conclusion, in long run interest rate, inflation and foreign exchange rate did not influence non-performing loans while in the short run only inflation rate influenced non-performing loans.

Key words: Non-performing loans; Macroeconomic variables; Cointegration; Vector Autoregression Model (VAR); Impulse Response Functions (IRFs).

ACKNOWLEDGEMENT

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DEDICATION

I dedicate this work to my spouse Anthony, mum Naomi and sons Brian and James for their love, support, encouragement and understanding which has brought me this far.

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ACRONYMS

CBK	Central bank of Kenya
KNBS	Kenya national bureau of statistics
NPLS	Non-performing loans
INF	Inflation rate
INT	Nominal interest rate
FX	Nominal exchange rate
fdNPLS	First difference of non-performing loans
fdINF	First difference of inflation rate
fdINT	First difference of interest rate
fdFX	First difference of foreign exchange rate
VAR	Vector Autoregressive models
VEC-M	Vector Error Correction Models
OIRFs	Orthogonalized Impulse Response Functions

TERMS AND DEFINITIONS

Non-performing loans – They are loans where either principal or interest or both have remained unpaid for at least 90 days.

Inflation – inflation refers to rapid increase of the prices of goods and services.

Nominal interest rate –This refer to the market lending rate.

Nominal exchange rate – The exchange rate between US dollar to Kshs.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Commercial banks play an important role of mobilizing savings and aiding capital flows in various sectors in the economy, thus, encouraging investment and production (Richard, 2011). In most economies commercial banks are largely the source of credit for most of households and businesses firms (Ross, 1997). A well-operating banking sector is a necessary factor of economic growth, while poorly functioning one tends to hinder economic progress (Rajaraman and Vasishtha, 2002).

Non-performing loans can be defined as credit facilities, which for a long time do not generate returns (Caprio and Klingebiel, 2002). The role played by non-performing loans in triggering banking and financial crises in both most developed and least developed countries has been the subject of many different studies (see for example Brownbridge, 1998; Fofack, 2005; Khemraj and Pasha, 2009). The relationship between the macroeconomic variables and non-performing loans has also attracted attention in literature (see for example Hoque and Hossain, 2004; Siddiqui, Malik and Shah, 2011). Some of macroeconomic variables that have received much attention include inflation rate, GDP, index of production, unemployment rate, real effective exchange rate and lending rates (Adebola, Yusoff and Dahalan, 2011; Asari et al, 2011; Rinaldi and Sanchis-Arellano, 2006, Salas and Saurina, 2002; Sinkey and Greenwalt, 1991). These macroeconomic variables affect economic conditions on households and firms and influence their ability to repay the loans.

When the economy is expanding, there is a relatively few number of non-performing loans, as both consumers and firms have enough returns to repay their debts. However as boom time continues, granting of loans is extended to less credit worthiness borrowers and later, when the recession time start, the level of non-performing loans increase (Quagliarello, 2007). For example, a rise in the unemployment rate would be expected during periods of recession, which may negatively influence the cash flow streams of consumers and compromising their ability to honor debt obligations. For firms, unemployment means increased layoffs leading to reduced output. Such an occurrence may imply that few households retain sufficient capacity to repay loans and that firm revenues decrease thus, increasing the probability of default.

Moreover, increase in interest rates can influence the accumulation of non-performing loans due to increased cost of borrowing resulting higher likelihood of default. Recession periods are normally associated with low Gross Domestic Product (GDP). When the GDP shrinks, households and firms end up having reduced streams of income and consequently higher levels of non- performing loans. Literature has shown real effective exchange rate and non-performing loans are positively related. Real effective exchange rate and non-performing loans were noted to have a positive relationship (Fofack, 2005). He claimed that the result was due to the large amounts of loans granted to the exporters of agricultural products which were negatively influenced by the increase in value of the currency of those countries during the 1980s and early 1990s. Literature reviewed has proved that inflation rate and non-performing loans are positively related. For example, Fofack, (2005) showed that inflation contributed to the

increase of bad loans in most of African countries. Further, he showed that inflation contributed to the rapid erosion of commercial banks' equity and thus higher non-performing loans in commercial banks of those African countries. The study expected inflation rate and non-performing loans to be positively related.

The choice of inflation rate, nominal interest rate and nominal exchange rate as the primary determinants of non-performing loans has also been justified through empirical studies. For example, Lawrence (1995) while examining the probability of default reportedly found that borrowers with little incomes had higher probabilities of default. He ascribed the enhanced default probability to higher rate of unemployment and consequently diminished ability to pay. This, he reported, was exacerbated by the tendency of banks and financial institutions to charge higher interest rates on such clients who are viewed as high risk. Rinaldi and Sanchis-Arellano (2006) extended Lawrence's model by including the possibility that customers can also borrow in order to invest in real or financial assets and reported that the chances of non-payment was dependent on the present earnings, the unemployment rate and the lending rate. Cifter et al (2009) while using neural network based wavelet decomposition models found lagged effects of industrial production could be used to explain changes in non-performing loans in the Turkish financial system. Salas and Saurina (2002) also reported GDP and the non-performing loans to have a negative relation. A positive relation between non-performing loans and inflation rate in the banking sector of Sub-Saharan African countries was reported (Fofack, 2005).

1.2 Non-performing loans in Kenya

Challenges in the Kenyan commercial banks came to be noticeable in the late 1980s persisting into 1990s decade and extending to 2003. This period saw the collapse of many banks due to poor lending decisions. For example, in 2002, there was a 4.5 per cent decrease in the profit before tax in the banking sector while the level of non-performing loans in 1998 was estimated at 30% of advances, up from 27% in1997 as compared to 33.4% of total loans in November 2001 (CBK, 2003; CBK, 1999). The Kenyan levels of non-performing loans can be related with levels of non-performing loans in other countries. For example, the non-performing loans ratio of commercial banks in Taiwan was estimated at 7.7 percent by the end of year 2001, by year 2001, the ratio of non-performing loans to the total loans in Philippine's commercial banks was estimated to be 16.81 percent (Waweru and Kalani, 2009). Kenyan banks'non-performing loans ratio in the year 2000 was 33% which was much higher as compared to similar African economies in the same year. For example, the non-performing loans ratio of Zimbabwe was (24%), Nigeria (11%) and South Africa (3%) (CBK, 2001).

1.3 Statement of Problem

One of the main products of commercial banks is lending, and their main source of risk is default risk. Thus, understanding the types of risks banks are exposed to has numerous effects, since reduced size of non-performing loans proposes a relatively more stable financial system while high size of non-performing loans indicates the existence of financial fragility (Greenidge and Grosvenor, 2010). Therefore, the size of non-performing loans (NPLs) is a fundamental component in the start and advancement of

financial crises. proof shows that the global financial crisis of 2007-2009 which originated in United States of America was caused by default of borrowers from sub-standard loans/mortgages and in fact, there was evidence to show that the size of non-performing loans started to escalate meanifully in early 2006 (Khemraj and Pasha, 2009). Different studies have linked the financial crisis both in developed and developing countries to high levels of non-performing loans which start to build-up before the beginning of the crisis (Ahmad, 2002; Brownbridge, 1998; Fofack, 2005;Khemraj and Pasha, 2009;). For instance, Kenya has experienced banking problems since 1986 and as at 1998 about 40 banks had collapsed which was probably due to high levels of non-performing loans. (Kithinji and Waweru, 2007).

Despite the intensified interest on the causes of non-performing loans, the solution to this problem remains elusive. In Kenya, several studies on non-performing loans have been carried out. For example, Waweru and Kalani (2009) studied on the determinants of non-performing loans in Kenyan commercial banks. They reported national economic downturn as a key factor causing non-performing loans. Njeri (2011) investigated on the factors that contribute to non-performing loans in Kenyan commercial banks. She reported risk assessment methods as a major cause of non-performing loans. Ng'etich and Wanjau (2011) studied on the impact of interest rates spread on the size of non-performing loans in Kenyan commercial banks. They reported that a significant relationship existed between interest rates spread and non-performing loans. Daumont *et al* (2004) studied on the factors causing non-performing loans in Kenyan commercial banks and attributed accumulation of non-performing loans to economic downturns and

high interest rates.

Most of the Kenyan studies have concentrated on economic downturn (as measured by performance of the GDP) and interest rate spread yet there are other macroeconomic factors that affect non-performing loans. Moreover, majority of these studies have relied on cross-sectional data. This study sought to expand knowledge on the relationship between a select number of macro-economic variables and non-performing loans. The study used time series analysis to model the relationship between non-performing loans and a select number of macroeconomic variables. The use of time series analysis was deemed advantageous due its dynamic nature and accommodation of time related variation like seasonal fluctuations and trends.

1.4 Purpose and objectives of the study

The purpose of this study was to determine the effect of selected macroeconomic variables on non-performing loans in Kenyan commercial banks. Specifically the objectives of the study were;

1. To determine the short run impact of inflation rate, nominal interest rate, nominal exchange rate on non-performing loans.
2. To determine the long run impact of inflation rate, nominal interest rate, nominal exchange rate on non-performing loans.

The study thus sought to answer the following questions;

1. What is the short run impact of inflation rate, nominal interest rate and nominal exchange rateon non-performing loans?
2. What is the long run impact of inflation rate, nominal interest rate and nominal exchange

rateon non-performing loans?

1.5 Scope of the Study

The study focused on the effect of inflation rate (INF), nominal interest rate (INT) and nominal exchange rate (FX) on non-performing loans in Kenyan commercial banks. The study was confined to all commercial banks in Kenya and involved monthly data from Central Bank of Kenya and Kenya National Bureau of Statistics (KNBS).

1.6 Significance of the Study

- Banks -The findings will provide the banks with increased knowledge, understanding and control of non-performing loans.
- Policy makers – The findings will assist in development of policies that could aid banks during recession period and reducing risk-taking during boom period.
- Literature – The study on the effect of macroeconomic variables on non-performing loans will add to the existing literature information on non-performing loans analysis in commercial banks.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

A number of studies have been carried out on the variables leading non-performing loans in developed and developing countries. The interest may be linked to the fact that non-performing loans has been related with commercial banks financial crunches both in most developed and least developed countries (Fofack, 2005; Khemraj and Pasha, 2009). In this chapter reviewed literature on non-performing loans. The section below reviews literature on determinants of non-performing loans leading to the development of the conceptual framework in the section that follows.

2.2 Determinants of Non-performing loans

Khemraj and Pasha (2009) while examining the factors causing non-performing loans in Guyana commercial banks used a dynamic model to model data spanning from period 1994 to 2004. They reported that the growth in real GDP, real effective exchange rate, and real interest rate significantly impacted the non-performing loans. Dash and Kabra (2010) used regression analysis and data from 1998 to 2009 to investigate the association between non- performing loans and bank specific variables and macroeconomic variables in India. They reported that the real effective exchange rate, the real interest rate, the bank size and the real GDP related with non-performing loans while the annual inflation rate was found not to be useful in the study. Using a pseudo panel-based model Fofack (2005) showed that GDP, real exchange rate, the real interest rate, were factors causing non-performing loans in many African countries.

Using a dynamic model and data from 1985 to 1997 to determine the factors leading to non-performing loans in Spanish banking sector, Salas and Saurina (2002) revealed that GDP, rapid growth in loans, bank size, capital ratio and market power explained changes in non-performing loans. Louzis, Vouldis and Metaxas (2010) used a dynamic model to study the factors causing non-performing loans in the Greek's commercial banks for the period 2003 to 2009. They noted that the growth of real GDP, the unemployment rate and lending rate influenced non-performing loans. Vogiazas and Nikolaidou (2011) used multivariate regression analysis and secondary data from Bank of Romanian and European Central Bank to study the factors leading to non- performing loans in the Romanian commercial banks for the period 2001 to 2010. They reported that gross fixed capital formation, unemployment, total consumption, interest rates, influenced the level of non-performing loans.

Using multiple regression analysis and sample of eighty-nine industrial firms in Bangladesh financed by Bangladesh Shilpa Bank from 1985 to 2005 period, Hoque and Hossain (2004) examined impact of higher interest rates on industrial loan defaults. They showed that higher interest rates were positively correlated to high industrial loan default. Siddiqui, Malik and Shah (2011) carried out a study in Pakistan to determine the effects of interest rate changes on non- performing loans by using Generalized Autoregressive Conditional Heteroskedastic (GARCH) techniques and secondary data for the period 1996 to 2011. They reported that interest rate changes influenced non-performing loans. Asari *et al*. (2011) used Vector Error Correction Model (VECM) and a forty eight monthly data for the period 2006 to 2009 to investigate the relationship between interest

rate, the inflation rate and non- performing loans in Malaysia. They showed that in short term both the interest rate and the inflation rate didn't associate with the non- performing loans but in the long term only the interest rate influenced non- performing loans.

Greenidge and Grosvenor (2010) used a sample of six commercial banks and univariate Autoregressive Integrated Moving Average (ARIMA) models and multivariate Autoregressive Distributed Lag (ARDL) models to predictthe non–performing loans in Barbados for the period 1996 to 2002. They reported that the macroeconomic factors i.e. the GDP, the inflation rate, and the Treasury bill rate impacted on the level of non-performing loans. Jimenez and Saurina (2005) examined the Spanish commercial banks from 1984 to 2003 period and showed that non-performing loans were caused by GDP, interest rates and relaxed loans terms. Adebola, Yusoff and Dahalan (2011) used multivariate Autoregressive Distributed Lag (ARDL) of Pesaran and Shin (1999) and Pesaran et al. (2001) and monthly data for the period 2001 to 2009 to examine the effects of interest rate, the industrial production index and the producer price index on non-performing loans in Islamic banks in Malaysia. They reported that in the long run the interest rate, the industrial production index and the producer price index influenced the level of non- performing loans while in the short term only the interest rate influenced the level non- performing loans. Espinoza and Prasad (2010) investigated the factors causing non-performing loans in Gulf Cooperative Council (GCC) banking sector by using a dynamic model and data spanning from 1995 to 2008. They reported that economic growth, interest rate, risk-taking, efficiency and risk aversion could be used to determine the non-performing loans in GCC. Keeton and Morris (1987) examined the causes of loan

losses in United States of America using 2,470 insured commercial banks over the 1979 to 1985 period. They reported that local economic conditions, high risk-taking by some banks and poor performance of agricultural and energy sectors explained the changes in non-performing loans recorded by the banks.

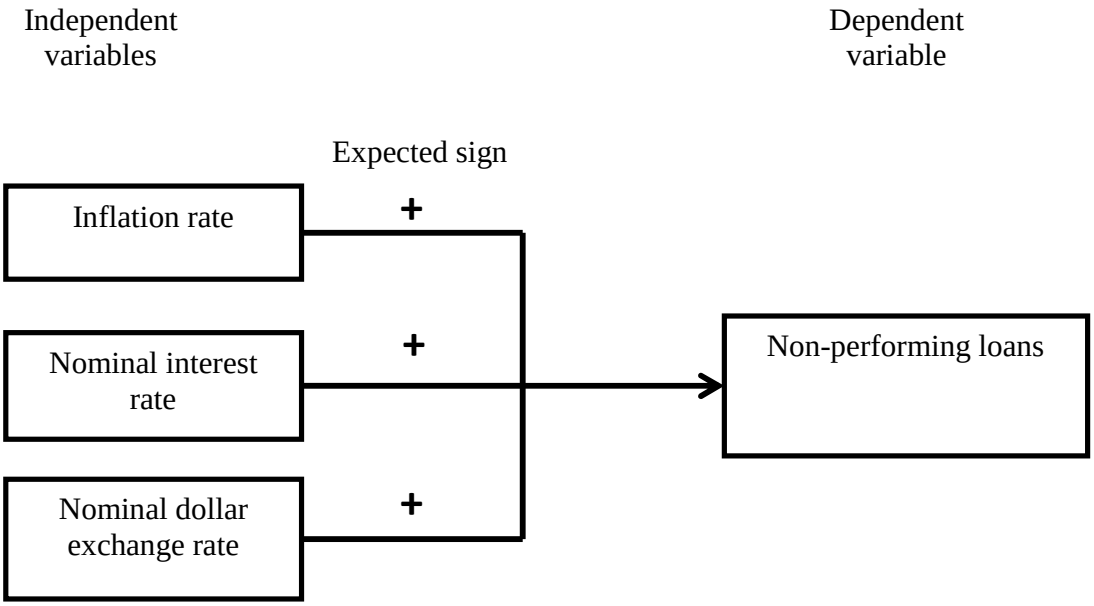
Most of the studies above used similar variables; the real GDP, real interest rate, the real effective exchange rate, bank size but were carried out in different countries. The GDP and the non-performing loans were negatively related while the interest rate and effective exchange rate were positively related with non-performing loans. Some studies found bank size a relevant variable causing non-performing loans, while others found bank size as an irrelevant factor in their study. A number of the studies used regression analysis to model the relationships under investigation. Given that the studies were dealing with time series data, the use of regression analysis method may be disadvantageous as there is likelihood to reach the conclusions of significant links when in reality there are none i.e. spurious regression. Additionally, parameter estimates may not be efficient or reliable due to possible existence of autocorrelation and heteroscedasticity in the errors.

2.3 Conceptual framework

In light of the highlighted literature above we hypothesized a positive relationship between inflation rate, nominal interest rate, nominal exchange rate and non-performing loans.

FIGURE 1

Conceptual framework



CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology applied in this study. In the first section, there is a discussion on the methods used to model the data, and description of the study variables.

3.2 Data analysis

The study adopted an econometric model similar to Asari et al. (2011) to investigate the impact of macroeconomic variables on non-performing loans in Kenyan commercial banks. The study built on the model by adding the variable nominal exchange rate (FX). Specifically, the study modeled non-performing loans as a function of nominal interest rate (INT), nominal exchange rate (FX) and inflation rate (INF).

$$NPL = f(INF, INT, FX) + \varepsilon \quad (1)$$

The specific model used in this study was a Vector Autoregression model (VAR) while lag length was determined through Johansen Trace and Eigen value Tests. The following equation was used.

$$\Delta Y_t = \beta_0 + \beta_1(\Delta Y_{t-1}) + \beta_2(\Delta Y_{t-2}) + \beta_3(\Delta Y_{t-3}) + \beta_4 ect_{t-1} + \varepsilon_t \quad (2)$$

Where $\Delta Y_t = \begin{pmatrix} \Delta NPL_t \\ \Delta INF_t \\ \Delta INT_t \\ \Delta FX_t \end{pmatrix}$

ΔNPL_t is first difference of non-performing loans at time t.

ΔINF_t is first difference of inflation rate at time t.

ΔINT_t is first difference of interest rate at time t.

ΔFX is the first difference of foreign exchange rate at time t.

$\beta_0, \beta_1, \beta_2, \beta_3$ are matrices of coefficients.

ect is the error correction term which means correction for short term variations from the equilibrium.

To examine if there exist a causal relationship between macroeconomic variables and NPLS. To achieve this objective, the study used Granger causality equations below.

$$Y_t = a_0 + a_1 Y_{t-1} + ... + a_p Y_{t-p} + b_1 X_{t-1} + ... + b_p X_{t-p} + b_p ect_{t-1} + \mu_t \quad (3)$$

$$X_t = c_0 + c_1 X_{t-1} + ... + a_p X_{t-p} + d_1 Y_{t-1} + ... + d_p Y_{t-p} + b_p ect_{t-1} + v_t \quad (4)$$

Then, we tested $H_0 : b_1 = b_2 = ... = b_p = 0$, against H_A, which is a test that X does not Granger causes Y. Similarly, we tested $H_0 : d_1 = d_2 = ... = d_p = 0$, against H_A, which is a test that Y does not Granger causes X.

Our study used monthly secondary data for all commercial banks spanning from January 2005 to December 2010 which was obtained from the Central Bank of Kenya Banking Supervision Reports and Kenya National Bureau of Statistics (KNBS).

3.3 Description and Measurement of variables

The study considered the relation between non-performing loans (NPLS) and nominal interest rate (INT), nominal exchange rate (FX), annual inflation rate (INF).

Interest rate

Interest rate was taken to be the market lending rate.

Nominal exchange rate

The nominal exchange rate was used to determine an individual country's currency value relative

to the other major currencies in the index. The study used the exchange rate between US dollar to Kshs. because most of foreign transactions are denominated in US dollar.

Inflation rate

According to Melicher and David, (1973) inflation refers to rapid increase of the prices of goods and services. Inflation was measured by changes in consumer price index. Inflation was calculated by using the following formular.

$$INF_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} x100\%$$

Where $CPIt$ and $CPIt_{-1}$ refer to the consumer price index at time t and t_{-1} respectively.

Non-performing loans

According to Caprio and Klingebiel, (2002)Non-performing loans can be defined as credit facilities, which for a long time do not generate returns. Non-performing loan ratio was calculated by using the following formular.

$$NPLA_t = \frac{NPL_t}{TL_t} x100\%$$

Where $NPLA_t$ refer to the non-performing loans ratio

NPL_t refer to the non-performing loans at time t

TL_t refer to the total gross loans of commercial banks at time t

CHAPTER FOUR: FINDINGS AND DISCUSSION

This chapter presents and discusses the results of the data analysis exercise. Previously, some scholars have used multiple linear regression models to investigate the relation between non-performing loans and selected macro-economic variables (see for example Vogiazas and Nikolaidou, 2011). Consequently, in the section below we fitted multiple linear regression models to the study variables and report on the aptness of fitting such models. However, before that the study reports on the distributional characteristics of the variables under study. Investigating the distributional properties was useful in determining whether it was necessary to transform some of the variables. Thereafter, the study used time series models, specifically, VAR and VEC models to provide a detailed analysis of the relationship between NPLS and the selected macro-economic variables.

4.1 Distributional properties of study variables

The descriptive statistics for the data are presented in table 1 below. From these statistics, a significant deviation from normality of the NPL ratio was noted, an observation supported by the histograms presented in figure 2. While for the rest of the variables, it appeared reasonable to assume normal distribution (see appendix 2).

NPL_ ratio was transformed to investigate if a better distributional fit could be obtained. Figure 2 below shows the histograms for various transformations considered. The results indicated none of the transformations provided a better distribution that was close to normality than the identity. Hence, the study opted to use the non-transformed NPLS series.

FIGURE 2

NPL _ratio Histograms

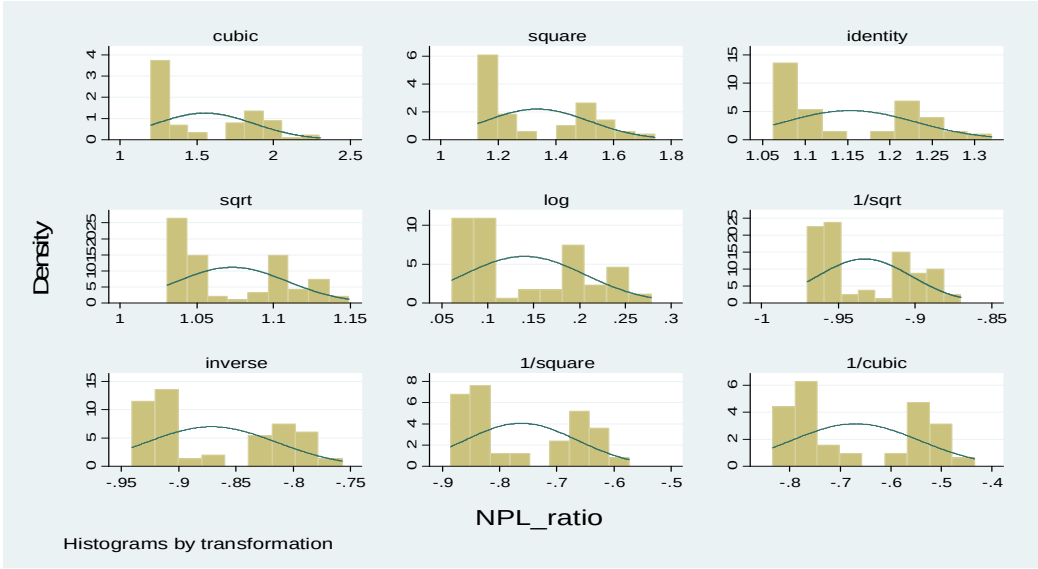


TABLE 1

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	P value
NPL_ratio	72	1.1527	0.0775	1.0625	1.3204	0.0999	0.0000	0.0000
INF_rate	72	1.1393	0.0825	0.9884	1.3156	0.2672	0.1238	0.1535
INT_rate	72	1.1384	0.0071	1.1212	1.1503	0.9790	0.0698	0.1807
FX_rate	72	73.4565	5.1307	61.8993	81.4262	0.1233	0.0867	0.0747

4.2 Regression models

In this section, multiple linear regression models were fitted and carried out statistical tests for heteroskedasticity and autocorrelation to examine how well regression models could fit our data. In the past some studies have used multiple regression models to model non-performing loans (See for example Vogiazas and Nikolaidou, 2011)). It was thus important for us to examine how well regression models fitted our data. For a start, multiple linear regression models were fitted

by using forced entry method. The regression results obtained were shown in table 3 below which were used to carry out the following diagnostic analysis. The results indicated only the INT rate was a significant predictor of NPL_ratio. The VIF values were less than 4 indicating no multi-collinearity problem in INF rate, INT rate and FX rate.

TABLE 2

Forced Entry Regression Results

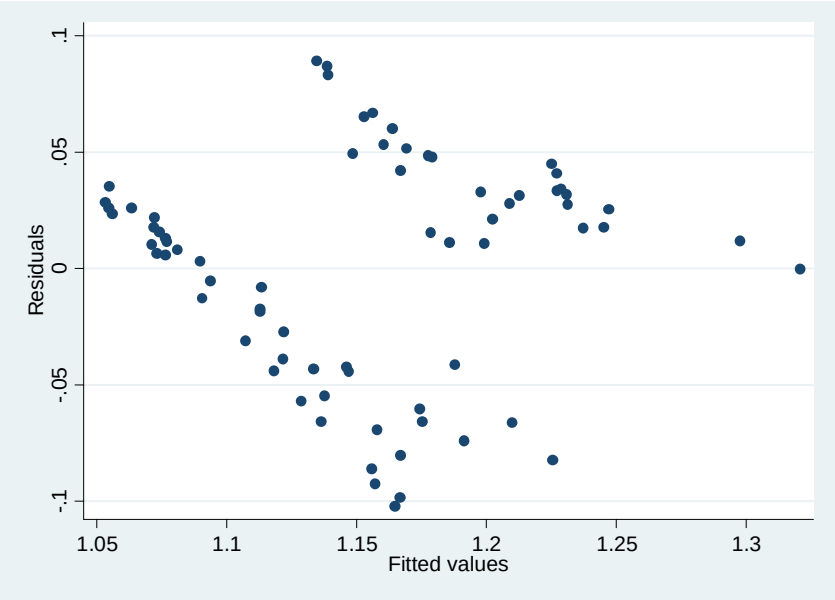
	coefficient	standard error	t	p	VIF values
INF rate	0.021	0.078	0.260	0.792	1.22
INT rate	-9.158	0.940	-9.740	0.000***	1.30
FX rate	0.002	0.001	1.820	0.073	1.34
constant	11.378	1.007	11.300	0.000***	
R-squared	**0.616**				

Note *, ** and *** indicate significance at 5% level, 10% level and 1% level respectively.

Regression analysis based on time series data indirectly assumes that the underlying series are stationary. However, in practice time series are non-stationary. Regression of a time series variable on one or more time series variables may consequently lead to spurious results. Further, regression models are known to be biased if data is heteroskedastic or autocorrelated. To evaluate the goodness of fit of the fitted regression model, the study performed residual analysis using the residual plot results of which are shown in figure 3 below.

FIGURE 3

Residuals Analysis



The above residual plot shows that regression model may not be a good fit as the residuals form a pattern. Further, the fitted model was examined by carrying out heteroscedasticity and autocorrelation tests shown in table 3 below.

TABLE 3

Heteroscedasticity and autocorrelation

White's test for Heteroscedasticity H_0 = *Data homoscedastic*	Breusch-Godfrey LM test for Autocorrelation H_A = *No Autocorrelation*
Chi-square = 28.04 Probability = 0.00	Chi-square = 63.36 Probability = 0.00

The results in table 3 indicate that the residuals are heteroscedastic and autocorrelated. These results indicate that fitting regression models to the data may be appropriate. Consequently, in the sections that followed, time series was used to model our variables.

4.3 Time series models

Initially the study variables were tested for stationarity, a necessary step to avoid spurious results before applying multivariate time series models to the data.

4.3.1 Unit root tests

In this sub-section, the Phillips Peron (PP) unit root tests were used to determine if the series were stationary or not. If the series were non-stationary, we investigate if the series were co-integrated or not. The results of unit root test were shown in table 4 below.

TABLE 4

Results of the unit root test

Unit root test at levels				
	With Constant		Trend	
	Statistic	p-value	Statistic	p-value
NPLS	-2.257	0.186	-1.584	0.678
INF	-1.585	0.491	-1.569	0.804
INT	-2.520	0.111	-2.115	0.538
FX	-1.366	0.598	-1.859	0.676

TABLE 5

Results of the unit root test for differenced series

	With Constant		Trend	
	Statistic	p-value	Statistic	p-value
D.NPLS	-9.833	0.000	-10.160	0.000
D.INF	-5.533	0.000	-5.509	0.000
D.INT	-7.462	0.000	-7.655	0.000
D.FX	-5.823	0.000	-5.891	0.000

From the table 4 above, it was observed that all the variables were non-stationary indicating they were integrated. Each series was differenced once and table 5 revealed the results of the unit root test for differenced series. The results indicate that after the first difference the series were

stationary and thus integrated.

4.3.2 Test for Co-integration

Since the series were integrated, I (1), the analysis proceeded to examine if the variables were co-integrated. If the variables are co-integrated then it would mean that their movements in long run were similar. However, to correct for the short-term variations that cause the series depart from the equilibrium, application of the Vector Error Correction (VEC) would be necessary. Nevertheless, the use of VEC models was conditional on the series being co-integrated otherwise, the VAR models were applied.

Determining the lag order

To determine if the series were cointegrated, we first determined the lag order of series then applied the Johansen maximum Eigen value and trace test to determine the co-integration rank. The specification of vector autoregressive model starts by determining a suitable lag length (Lutkepohl, 2005). Lag length can be chosen by using the sequence of likelihood ratio test (LR), Final Prediction Error Criterion (FPE) and information criterion which include; Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Hannan Quinn Information Criterion (HQIC) and Schwarz Bayesian Information Criterion (SBIC). LR compares a VAR with p lags with the one with p-1 lags. The information criterion selects a lag with the smallest value to be the optimal order. FPE selects a lag with the lowest value to minimize the prediction error. From the results obtained in table 5below HQIC and SBIC show a lag of one, FPE and AIC show a lag of three while LR show a lag of six. To resolve the discrepancy, the correlograms for each of the lags from lags one to lag six. The optimal lag was the one with the minimum lag and having residuals correlograms falling within the 95% confidence band. We

chose an optimal lag of three since most of the autocorrelations of residuals are within the 95% confidence interval. (See Figure 4 below).

FIGURE 4

Correlograms for Residuals for Var (3)

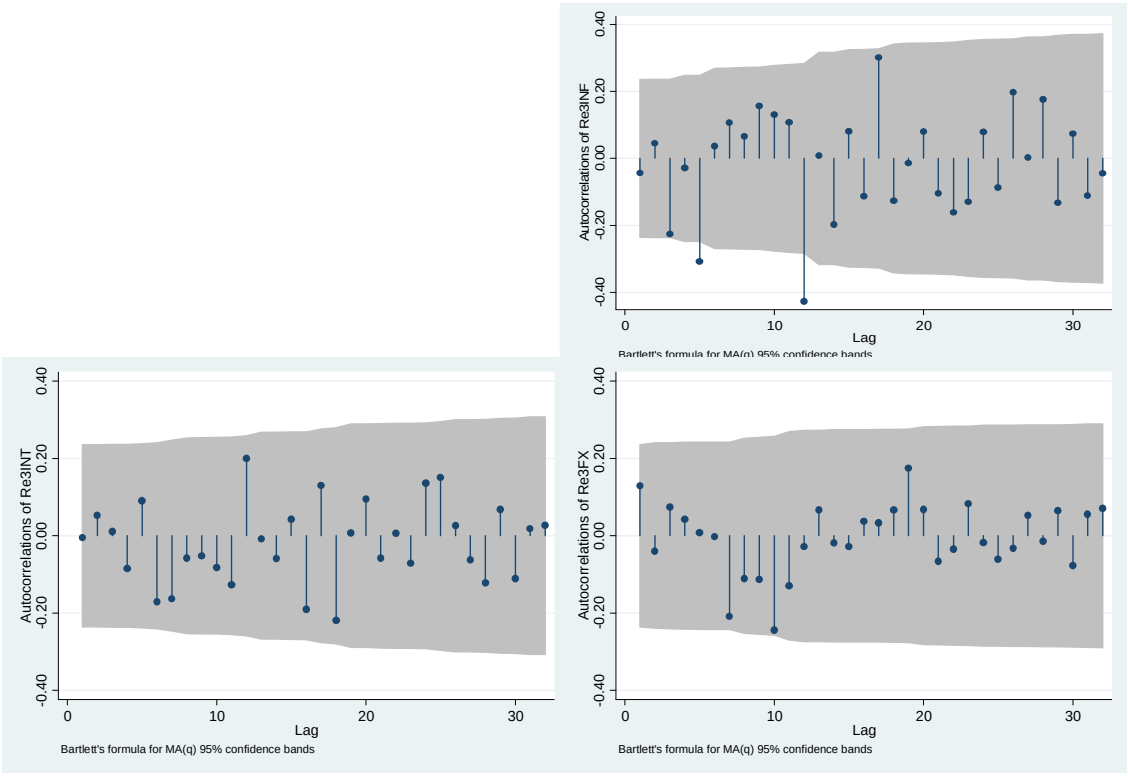


TABLE 6

Cointegration test results

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	232.771				1.100E-08	-6.932	-6.880	-6.800
1	569.183	672.82	16	0.000	7.000E-13	-16.642	-16.380*	-15.978*
2	585.585	32.803	16	0.008	6.900E-13	-16.654	-16.182	-15.460
3	602.362	33.555	16	0.006	6.900E-13*	-16.678*	-15.996	-14.953
4	614.402	24.080	16	0.088	7.900E-13	-16.558	-15.666	-14.302
5	626.062	23.319	16	0.105	9.500E-13	-16.426	-15.325	-13.639
6	642.753	33.383*	16	0.007	9.900E-13	-16.447	-15.136	-13.129

*Indicates lag with minimum criterion value

Determining the Rank of co-integration

The number of cointegrating equations could be determined by using the following three methods. First, Johansen Trace statistical method, second is Johansen Maximum eigenvalues and third is Information criterion. The study used Johansen and Juselius (1988) maximum Eigen values and trace statistical method to identify the number of cointegrating equations in the analysis. Based on results from Johansen trace statistical method, table 7below; revealed we had a rank of zero meaning the study had no independent cointegrating equations.

TABLE 7

Johansen tests for Co-integration

Max rank	Parms	LL	Eigenvalue	Trace Statistic	5% critical value	1% critical value
0	36	605.5071	0	45.1547*	47.21	54.46
1	43	616.6938	0.27693	22.7812	29.68	35.65
2	48	625.0568	0.21526	6.0552	15.41	20.04
3	51	627.5178	0.06885	1.1333	3.76	6.65
4	52	628.0845	0.01629			

The critical values were insignificant at all lags except zero indicating that our maximum rank

was zero. Further, a maximum rank of zero meant that the study variables were not cointegrated and therefore they had no long-term relationship. Therefore, the best models to fit were VAR models to the differenced series.

4.3.3 Fitting VAR models

From the results on lag order we identified an optimal lag order of 3 hence we fitted a VAR (3) whose general formula was

$$\Delta \mathrm{Y}_t = \beta_0 + \beta_1(\Delta \mathrm{Y}_{t-1}) + \beta_2(\Delta \mathrm{Y}_{t-2}) + \beta_3(\Delta \mathrm{Y}_{t-3}) + \varepsilon_t$$

Where $\Delta \mathrm{Y}_t = \begin{pmatrix} \Delta NPL_t \\ \Delta \mathrm{INF}_t \\ \Delta \mathrm{INT}_t \\ \Delta FX_t \end{pmatrix}$

$\beta_0, \beta_1, \beta_2, \beta_3$ are matrices of coefficients.

The results obtained from our VAR analysis were shown in table 8 below. Considering fdNPL regression, it was observed that individually, only fdNPL at lags 1and 3, fdINF at lag 1 were statistically significant at 5% level. Turning to the fdINF regression, it was seen that fdINF at lags 1 and 3 were individually significant at 5% and 10% respectively. Using the fdINT rate regression, it was observed that fdNPL at lag 3, fdINF at lag 1 were individually significant at 5% and 10% level respectively. Finally, from the fdFX rate regression, all the lagged terms for fdFX and only the 2and 3 periods for fdINT rate were statistically significant at 5% level. Therefore, it was concluded that; lagged values of fdNPL and fdINF were significant in explaining the changes in fdNPL, while lagged values of fdINF and fdFX were significant in explaining changes in fdINF rates. Finally, changes in fdINT rates could be explained by lagged

values of fdNPL and fdINF but lagged values of fdINT and fdFX were significant in explaining fdFX rates changes. This meant that a shock in change in fdINT rates to fdFX rates was significantly felt in the second month but dies down to zero.

TABLE 8

Vector autoregression estimates based On 3 Lags

	fdNPL			fdINF			fdINT			fdFX		
	Coef.	t-value	p-value	Coef.	t-value	p-value	Coef.	t-value	p-value	Coef.	t-value	p-value
fdNPL-1	-0.24	-2.12	0.03*	-0.25	-0.73	0.47	0.03	1.26	0.21	16.92	0.95	0.34
fdNPL-2	-0.12	-1.14	0.26	-0.07	-0.22	0.82	0.02	0.78	0.44	-13.43	-0.80	0.42
fdNPL-3	0.30	3.02	0.00**	-0.09	-0.29	0.77	-0.04	-1.98	0.05*	-10.35	-0.66	0.51
fdINF-1	-0.12	-3.12	0.00**	0.39	3.38	0.00**	0.02	1.78	0.08*	-3.02	-0.49	0.62
fdINF-2	0.06	1.35	0.18	0.03	0.26	0.79	0.01	0.57	0.57	1.26	0.18	0.86
fdINF-3	-0.04	-0.97	0.33	-0.23	-1.89	0.06*	0.00	0.44	0.66	-1.99	-0.31	0.75
fdINT-1	0.57	1.07	0.28	-1.15	-0.71	0.48	-0.02	-0.13	0.90	-54.73	-0.65	0.52
fdINT-2	-0.02	-0.03	0.97	0.94	0.61	0.55	0.04	0.32	0.75	-226.77	-2.79	0.01**
fdINT-3	0.55	1.07	0.29	-1.58	-1.01	0.32	-0.02	-0.15	0.88	213.11	2.59	0.01**
fdFX-1	0.00	0.91	0.36	0.00	-1.58	0.11	0.00	0.85	0.40	0.57	5.11	0.00**
fdFX-2	0.00	0.36	0.72	0.00	0.41	0.68	0.00	0.63	0.53	-0.37	-3.35	0.00**
fdFX-3	0.00	0.55	0.58	0.00	0.97	0.33	0.00	0.26	0.79	0.24	2.24	0.03**
cons.	0.00	-2.88	0.00	0.00	-0.58	0.56	0.00	0.48	0.63	-0.01	-0.06	0.95

FdNPL refer to the first difference in non-performing loans
FdINF refer to the first difference in inflation rate
FdINT refer to the first difference in interest rate
FdFX refer to the first difference in foreign exchange rate

Testing the model robustness

The robustness of the VAR models fitted above was tested by using the Lagrange-multiplier test and obtained the results in table 9 below. From the results, we accepted the null hypothesis of no autocorrelation at lag order 3 since the p-value >0.05. Hence the VAR models fitted are not misspecified.

TABLE 9

Lagrange-multiplier test

Lag	Chi2	df	Prob
1	13.046	16	0.669
2	11.441	16	0.782
3	16.780	16	0.400

4.3.4 Impulse Response Function

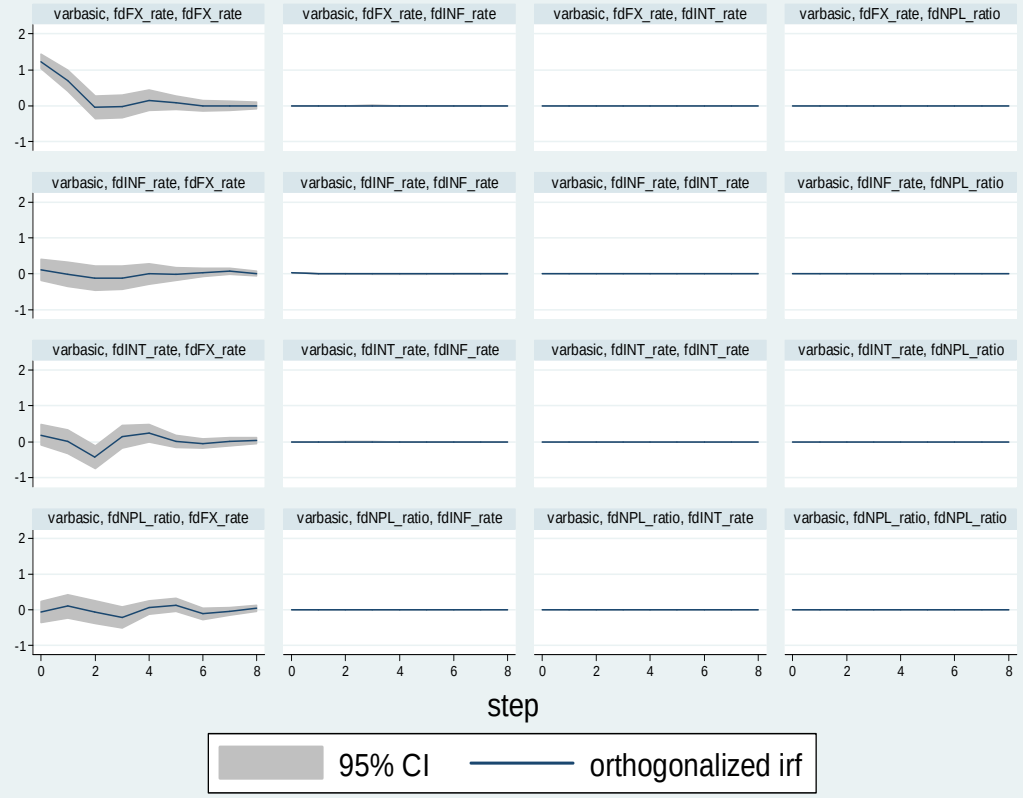
In this section the dynamic variables relationships were summarized through the analysis of orthogonalized impulse response functions (OIRFs). An OIRFs traces out the response of a variable of interest to an exogenous shock. The ith impulse function of variable b on variable c measures the effect on variable c in period t+i in response to a one unit shock to variable b in period t holding everything else constant.

The graph plots of the impulse responses of each variable, which were interpreted as their reactions to unexpected shocks. For each variable, the horizontal axis covered the number of months after the impulse had been initialized. The vertical axis measured the response of relevant variables. Figure 5 below showed how each macroeconomic variable responded to unexpected change in itself and other variables. For example, a shock in change in fdFX rates to fdFX rates had an immediate significant impact on the change in the fdFX rates. The effect was significantly felt in the second month but the fdFX shocks only persisted for two months then died down to zero. A shock in change in fdFX rates had no effect on the changes in fdINF rates, fdINT rates and fdNPL ratio. A shock in change in fdINF rates to fdFX rates had a slight change in fdFX rates though not significant while no impact on the changes in fdINF rates, fdINT rates and fdNPL ratio. A shock in change in fdINT rates to fdFX rates had a significant impact on the fdFX rates. The fdINT rate shock was not felt immediately until the second month after which its

effect died out to zero but had no effect to fdINF rates, fdINT rates and NPL ratio. A shock in change in fdNPL ratio to fdFX has a change in fdFX rates though not significant but had no effect to fdINF rates, fdINT rates and fdNPL ratio (see figure 5 and table 10 below). From the figure 5 below it was observed that only fdFX rate responded to changes in fdFX, fdINF, fdINT and fdNPL. Therefore, ORIF tables for this part were extracted for further analysis. Table 10 below showed that changes in fdNPL ratio and fdINF rate did not have significant change in fdFX rate while change in fdINT rate had a significant change in fdFX rate and the effects were felt significantly in the second month. Further, change in fdFX rate had a contemporaneous effect on fdFX rate (see table 10 below).

FIGURE 5

Impulse Response Functions



Graphs by irfname, impulse variable, and response variable

TABLE 10

Impulse response function for change in FOREX rate

	Response to ΔNPL ratio shocks			Response to ΔINF rate shocks		
step	oirf	lower	Upper	oirf	lower	upper
0	-0.059	-0.357	0.239	0.109	-0.188	0.407
1	0.101	-0.222	0.423	-0.012	-0.343	0.319
2	-0.068	-0.382	0.246	-0.121	-0.463	0.222
3	-0.203	-0.498	0.092	-0.118	-0.447	0.211
4	0.065	-0.131	0.260	-0.004	-0.294	0.286
5	0.137	-0.036	0.311	-0.010	-0.189	0.169
6	-0.113	-0.266	0.041	0.027	-0.088	0.143
7	-0.036	-0.142	0.070	0.071	-0.014	0.155
8	0.050	-0.037	0.138	0.005	-0.058	0.068
	Response to ΔINT rate shocks			Response to ΔFX rate shocks		
step	oirf	lower	Upper	oirf	lower	upper
0	0.193	-0.102	0.488	1.233	1.026	1.440
1	0.014	-0.314	0.343	0.700	0.407	0.993
2	-0.432	-0.751	-0.113	-0.046	-0.359	0.266
3	0.146	-0.169	0.460	-0.020	-0.336	0.297
4	0.237	-0.002	0.476	0.151	-0.137	0.439
5	0.010	-0.164	0.185	0.082	-0.113	0.277
6	-0.050	-0.182	0.083	-0.001	-0.155	0.152
7	0.009	-0.103	0.121	-0.003	-0.128	0.122
8	0.035	-0.051	0.121	0.004	-0.092	0.100

95% lower and upper bounds reported

4.3.5 Granger Causality

The third objective was to examine if there exist a causal relationship between INF, INT, FX and NPLS. Granger causality was applied to investigate that relationship. Using the Granger causality method was better than regression models since it captured the lagged relationships of the series. We proceeded in testing Granger causality by using the following equations.

$$Y_t = a_0 + a_1 Y_{t-1} + ... + a_p Y_{t-p} + b_1 X_{t-1} + ... + b_p X_{t-p} + \mu_t \quad (5)$$

$$X_t = c_0 + c_1 X_{t-1} + ... + a_p X_{t-p} + d_1 Y_{t-1} + ... + d_p Y_{t-p} + \nu_t \quad (6)$$

Then, we tested $H_0 : b_1 = b_2 = ... = b_p = 0$, against H_A, which was a test that X doesn't Granger cause Y. Similarly, we tested $H_0 : d_1 = d_2 = ... = d_p = 0$, against H_A, which was a test that Y doesn't Granger cause X. If the coefficients were significant at 5%, 1% or 10% level we reject the null hypothesis, otherwise, we accept the null hypothesis.

The results in table 11 below showed that, from fdNPL ratio equation, we observed that fdINF rate Granger causes fdNPL ratio while from the fdFX rate equation, fdINT rate Granger causes fdFX rate. This means that change in fdFX rates causes change in fdNPLS ratio while change in fdINT rates causes change in fdFX rates.

TABLE 11

Granger causality

Equation	Excluded	df	Prob	Equation	Excluded	df	Prob
fdNPL_ratio	fdINF_rate	3	0.015*	fdINT_rate	fdNPL_ratio	3	0.069
fdNPL_ratio	fdINT_rate	3	0.454	fdINT_rate	fdINF_rate	3	0.136
fdNPL_ratio	fdFX_rate	3	0.629	fdINT_rate	fdFX_rate	3	0.587
fdNPL_ratio	ALL	9	0.074	fdINT_rate	ALL	9	0.120
fdINF_rate	fdNPL_ratio	3	0.903	fdFX_rate	fdNPL_ratio	3	0.495
fdINF_rate	fdINT_rate	3	0.597	fdFX_rate	fdINF_rate	3	0.953
fdINF_rate	fdFX_rate	3	0.189	fdFX_rate	fdINT_rate	3	0.005**
fdINF_rate	ALL	9	0.705	fdFX_rate	ALL	9	0.057

H_0: No Granger-causality

*and** shows significance at 5% and 1% level respectively

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The first objective was to determine the short run impact of inflation rate (INF), nominal interest rate (INT), nominal exchange rate (FX) on non-performing loans (NPLS). The second objective was to determine the long run impact of inflation rate (INF), nominal interest rate (INT), nominal exchange rate (FX) on non-performing loans (NPLS).

From co-integration test it was noted that the study variables weren't cointegrated, meaning that our co-integration rank was zero implying in long-run the study variables and non-performing loans were not related. From the impulse response functions plots, non-performing loans did not respond significantly to shocks of any of the studied macro-economic variables. However, we found that changes in inflation rate Granger causes non-performing loans. This effect of inflation rate was specifically one month after the adjustment occurs. This means that, when the cost of living goes up, default of loans can be expected at least one month later. Therefore, only inflation rate had an influence on non-performing loans in the short run but all the study variables had no impact on non-performing loans in the long run.

Our results disagreed with the results of Asari *et al* (2011) that both inflation rate and interest rate did not influence non-performing loans in the short run but interest rate had a significant influence on NPLS in the long run. Although Asari *et al* (2011) reported that their variables were co-integrated, the results obtained did indicate that variables were not co-integrated. A result that was similar to our study. Further, they used transformed data; base lending rate was taken to mean interest rate while we used untransformed data and market

interest rate. Finally, we found that changes in interest rate Granger causes foreign exchange rate. This effect of interest rate was specifically expected in the second and the third months after the adjustment occurs, meaning that higher interest rate attracted foreign capital and caused an increase in foreign exchange rate. The influence of high interest rate could be expected two or three months later after the change in interest rate occurred. According to Khemraj and Pasha (2009), growth of real GDP, real effective exchange rate (REER) and real interest rate (INT) impacted significantly the non-performing loans in Guyanese. These results are contrary to our findings, a fact attributed to the use of non-transformed data and VAR models in our case as opposed to transformed data and regression models applied by Kemraj and Pasha. According to Siddiqui, Malik and Shah (2011) interest rate changes impacted the non-performing loans in Pakistan. Their results differed from our results that could be attributed to the fact that they used Generalized Autoregressive Conditional Heteroscedasticity (GARCH) techniques and in our study we used VAR model. Greenidge and Grosvenor (2010) in their study in forecasting non-performing loans in Pakistan reported that, growth of real GDP, inflation rate and Treasury bill rate influenced non-performing loans. These results agreed with our results that inflation rate influenced non-performing loans in the short run but disagreed with our results that interest rate did not influence non-performing loans in the short run. This disagreement could be explained by Greenidge and Grosvenor (2010) used Autoregressive Distributed Lag models (ARDL) and Treasury bill rate while we used VAR models and market interest rate. We hypothesized that inflation rate, interest rate, foreign exchange rate and non-performing loans were positively related. From the findings, inflation rate and foreign exchange rate had positive signs as expected except interest rate with negative sign. Normally, we expect if interest rate had any effect on the

borrower's ability to pay loans, such an effect cannot be contemporaneous since there would be a lag for the effect in the interest rates to be felt. But the lagged effects on interest rate were insignificant. Further, regression analysis assumes that the data is stationary but time series are usually non-stationary, therefore, the results from regression analysis were spurious, meaning that the relationship detected by regression analysis was spurious.

The research on the effect of selected macroeconomic variables on non-performing loans could be extended to include Gross Domestic Product (GDP) and proxy variable for political instability.

5.2 Recommendations

The study had important implications for commercial banks, banks regulators and professionals. In an effort to control the size of non-performing loans in Kenya, commercial banks need to pay attention to inflation rate in the country while providing loans. Commercial banks regulators should expand their checking framework to include macroeconomic factors such as inflation rate when assessing the firmness sand soundness of the commercial banks.

REFERENCES

Adebola, S, Yusoff, B and Dahalan, J., (2011) "An ARDL approach to the determinants of non- performing loans in islamic banking system in Malaysia" Kuwait chapter of Arabic *journal of business and management review. 1 No. 2.*

Ahmad, N.H.,(2002)"Financial crisis and Non- performing loans: The Malaysian Banks' Experience" *International Journal of Finance, 14:2, pp 2257- 2278.*

Asari, F, Muhamad N, Ahmad W, Abdullah N. and Jusoff, K., (2011) "An analysis of non- performing loans, interest rate and inflation rate in Malaysia using Stata software."*World Applied Sciences Journal 12 pp 41-48.*

Brownbridge M., (1998). "Financial Distress in Local Banks in Kenya, Nigeria, Uganda and Zambia: Causes and Implications for Regulatory Policy". *Development Policy Review Vol. 16, 173-188.*

Caprio, J &Klingebiel, D., (2002)."Episodes of Systemic and Borderline Financial Crises.In Daniela Klingebiel and Luc Laeven (Eds.) Managing the real and fiscal effect of banking crisis". Washington, DC: *World Bank Discussion Paper No. 428, 132-45.*

Central Bank of Kenya, (2003), Inflation, *Monthly Economic Review, Nairobi.*

Central Bank of Kenya, (2001), Bank Supervision Annual Reports, The Central Bank of Kenya. Credit Suisse.

Cifter, A, Yilmazer, S, Cifter E.,(2009) "Analysis of Sectoral Credit Default Cycle Dependency with Wavelet Networks" Evidence from Turkey. *Economic Modeling 26,1382-1388.*

Dash, M and Kabra, G., (2010) "The determinants of non- performing assets in India commercial bank" An Econometric study*". Journal of Finance and Economics issue 7 (2010).*

Daumont, R, Gall, F &Leroux, F., (2004) "Banking in Sub- Saharan Africa: What went wrong?" *IMF Working Paper,WP/04/55, 156 – 67.*

Espinoza, R and Prasad A., (2010) "Nonperforming Loans in the GCC Banking System and their Macroeconomic Effects*". IMF working paper WP/10/224.*

Fofack, H., (2005) "Non-Performing Loans in sub-Saharan Africa: Causal Analysis and Macroeconomic Implications".*World Bank Policy Research Working Paper No.*

3769, 134- 154.

Greenidge, K and Grosvenor, T., (2010). "Forecasting Non-performing loans in Barbados". Business Finance and Economics in Emerging Economies, 5 (1): 79-108.

Hoque, M and Hossain Z., (2004) "*International Review of Business researchPapersVol.4No.5 October –November 2008 Pp. 235-246*" Flawed Rate Policy and Loan Default: Experience from a developing country".

Johansen S., (1988): "Statistical Analysis of Cointegration Vectors". *Journal of Economic Dynamics and Control, Vol. 12 pp 231 – 254.*

Jimenez, G and Saurina, J., (2005). "Credit cycles, credit risk, and prudential regulation." Banco de Espana, January.

Keeton, W, and Morris, S., (1987) "why do banks loan losses differ? Federal Reserve Bank of Kansas City, *Economic Review, 3-21."*

Khemraj, T and Pasha, S., (2009) "The Determinants of Non-performing Loans: An Econometric Case Study of Guyana presented at the Caribbean Centre for Banking and Finance Bi-annual Conference on Banking and Finance, St. Augustine, Trinidad."

KithinJi, A and Waweru. N., (2007) "Merger Restructuring and Financial Performance of Commercial banks in Kenya."*Economic, Management and Financial Markets Journal, 2 (4), 9-39.*

Lawrence, E. C., (1995). "Consumer default and the life cycle model".*Journal of Money Credit and Banking. 27, 939-954.*

Louzis, D, Vouldis,A and Metaxas V., (2010) "Macroeconomic and bank-specific determinants of non-performing loans in Greece: a comparative study of mortgage, business and consumer loan portfolios," *Bank of Greece Working Paper, no. 110, pp. 1–41.*

Lutkepohl,J H.(2005) New Introduction to Multiple Time Series Analysis. New York Springer.

Melicher, R and David, F., (1973) "The performance of conglomerate firms, Recent Risk and Return Experience". *Journal of finance. 28 (2) 381-388.*

Nge'tich, J and Wanjau,K., (2011) "The effects of interest rate spread on the level of

Non- Performing Assets of commercial banks in Kenya". *International Journal of Business and Public Management (ISSN: 2223-6244) Vol. 1(1): 58-65.*

Njeri, E., (2011) "An investigation of the factors contributing to non- performing loans. A case of commercial banks in Kenya."

Pesaran, M. Hashem and Yongcheol Shin (1999) "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis". In Strom S. (ed.) *Econometrics and IJRSS Volume 2, Issue 3 ISSN: 2249-2496.*

Pesaran, H., Shin, Y. and Smith, R. (2001) 'Bounds testing approaches to the analysis of level relationships', Journal of Applied Econometrics, 16(3), 289-326

Quagliarello, M., (2007) "Banks' riskiness over the business cycle: a panel analysis on Italian intermediaries".Applied Financial Economics 17, 119–138.

Rajaraman, I and Vasishtha,G., (2002). "Non Performing Loans of PSU Banks: Some Panel Results".*Economic and Political Weekly, 429 – 435.*

Richard, E., (2011) "Factors that cause non-performing loans in commercial banks in Tanzania and strategies to resolve them".*Journal of management and practice vol. 12(7).*

Rinaldi, L and Arellano, A., (2006) "Household debt sustainability: what explains household non-performing loans? *Working paper series No. 570 / 2006 An empirical analysis"*.

Ross,P. S., (1997). Money and Capital Markets: Financial Institutions and Instruments in a Global Marketplace. 6th ed. McGraw – Hill International Edition.

Salas,V and Saurina, J., (2002). "Credit Risk in Two Institutional Regimes:Spanish Commercial and Savings Banks."*Journal of Financial Services Research, 22:3, pp. 203-224.*

Siddiqui, S, Malik, K and Shah, Z., (2011) "Impact of interest rate volatility on non-performing loans in Pakistan". *International research journal of Finance and Economics ISSN 1450- 2887 issue 84.*

Sinkey, F and Greenwalt, B., (1991). "Loan-Loss Experience and Risk-Taking Behvior at Large Commercial Banks."*Journal of Financial Services Research, 5, pp.43-59.*

Vogiazas, D and Nikolaidou, E., (2011) "Investigating the Determinants of NonperformingLoans in the Romanian Banking System: An Empirical Study

with Reference to the Greek Crisis," *Economics Research International, vol. 2011, Article ID 214689, 13 pages, 2011.*

Waweru, N. M and Kalani, V. M., (2009). "Commercial Banking Crises in Kenya: Causes and Remedies." *African Journal of accounting, Economics, Finance and Banking Research, 4 (4), 12 – 33.*

APPENDIX I

Raw data

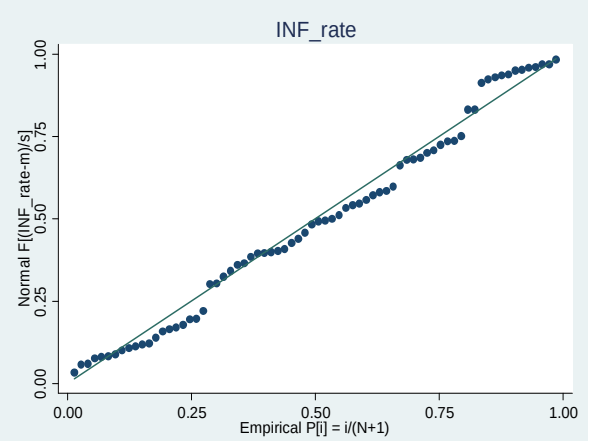
The following was data for our variables of interest which was collected from Kenya Bureau of Statistics and Central Bank of Kenya. The variables were used to develop time series models which were more robust even in the presence of heteroscedasticity and autocorrelation errors. The data was transformed so as to do away with negative values.

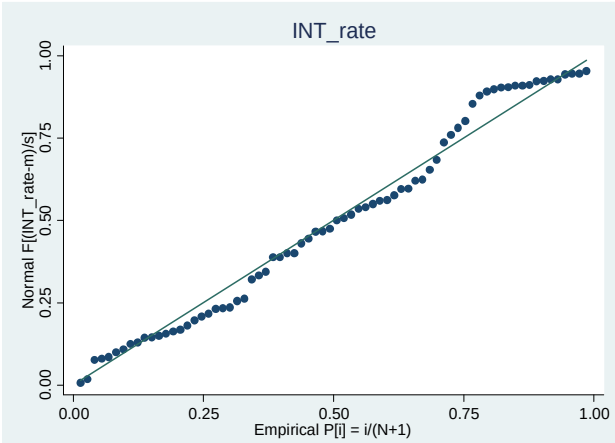
PERIOD	NPL_ratio	INF_rate	INT_rate	FX_rate
1	1.3204	1.126615	1.1211977	77.929895
2	1.3094	1.1390686	1.1234755	76.938105
3	1.2724	1.1414329	1.1284413	74.80281
4	1.2699	1.1598786	1.1312482	76.146424
5	1.2678	1.1478878	1.1310695	76.396619
6	1.2628	1.1189454	1.1308883	76.680671
7	1.2607	1.1172116	1.1309466	76.233648
8	1.2588	1.0688019	1.1302676	75.808552
9	1.2627	1.0430233	1.1282588	74.103335
10	1.2627	1.0369089	1.1296884	73.708538
11	1.2547	1.0606061	1.1293059	74.737632
12	1.244	1.0754936	1.1316072	73.106698
13	1.2368	1.1542431	1.1319606	72.214339
14	1.2234	1.1885292	1.1326641	71.803556
15	1.2306	1.1914894	1.1332783	72.281473
16	1.2262	1.148855	1.1351289	71.303529
17	1.2257	1.1306233	1.1394599	71.763563
18	1.2229	1.109589	1.137934	73.405269
19	1.224	1.1016013	1.1371521	73.656933
20	1.2206	1.1148724	1.136387	72.869899
21	1.2271	1.1382386	1.1353505	72.866108
22	1.2238	1.1568409	1.1400936	72.289065
23	1.2222	1.1461538	1.1392831	71.126512
24	1.2182	1.1560475	1.1374013	69.626759
25	1.1981	1.0963736	1.1378051	69.884522
26	1.2137	1.068323	1.1363795	69.615946
27	1.2089	1.0587406	1.1355706	69.292854
28	1.197	1.0565259	1.1333096	68.57708
29	1.1939	1.063279	1.1337657	67.191285
30	1.21	1.1106173	1.1314445	66.574832
31	1.1465	1.1358396	1.1328577	67.067729

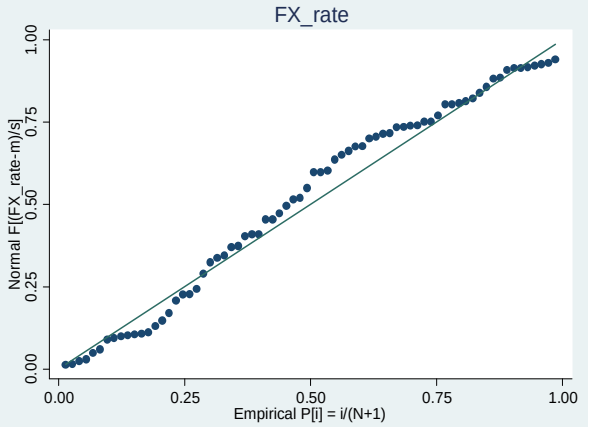
32	1.1435	1.1239423	1.1304097	66.946184
33	1.143	1.1175318	1.1287055	67.024278
34	1.1172	1.1057212	1.1323631	66.845456
35	1.1138	1.1183126	1.1339074	65.489945
36	1.1094	1.1200841	1.133223	63.30282
37	1.1038	1.182329	1.1378086	68.081224
38	1.1028	1.1912791	1.13839	70.624254
39	1.1052	1.2185974	1.1406191	64.924157
40	1.0946	1.2662504	1.1391085	62.255836
41	1.0954	1.3155546	1.1401212	61.899263
42	1.0943	1.2927968	1.1405505	63.782778
43	1.0902	1.264872	1.1390132	66.703962
44	1.0886	1.2757307	1.1366107	67.678993
45	1.0866	1.2820771	1.1366233	71.408537
46	1.083	1.2843167	1.1411908	76.657144
47	1.0829	1.2936814	1.1433599	78.175845
48	1.0896	1.2771778	1.1487271	78.039722
49	1.089	1.2187476	1.147832	78.949605
50	1.0883	1.2509292	1.1466748	79.532722
51	1.0885	1.2578037	1.1487162	80.26149
52	1.093	1.2606783	1.147139	79.625806
53	1.094	1.1952432	1.1484768	77.861361
54	1.0901	1.1775752	1.1503136	77.851164
55	1.0898	1.1778662	1.147921	76.751329
56	1.0893	1.1844407	1.14759	76.371861
57	1.0823	1.1793075	1.1473742	75.604881
58	1.0816	1.1739454	1.1478367	75.243571
59	1.0893	1.1511979	1.1485129	74.739233
60	1.0794	1.1377171	1.1476055	75.431148
61	1.0817	1.0968178	1.1497628	75.786194
62	1.0807	1.0499685	1.1497575	76.730486
63	1.0795	1.0110908	1.1495668	76.946751
64	1.0776	.98843426	1.1458359	77.254359
65	1.0763	1.0091467	1.1443791	78.541384
66	1.0742	1.0238332	1.143876	81.018082
67	1.0717	1.0414396	1.1428661	81.426174
68	1.0704	1.033559	1.1417709	80.439764
69	1.0696	1.0251282	1.1397553	80.911932
70	1.0681	1.0213404	1.1385045	80.714306
71	1.0646	1.0279489	1.1394899	80.46024
72	1.0625	1.0393445	1.1387184	80.568005

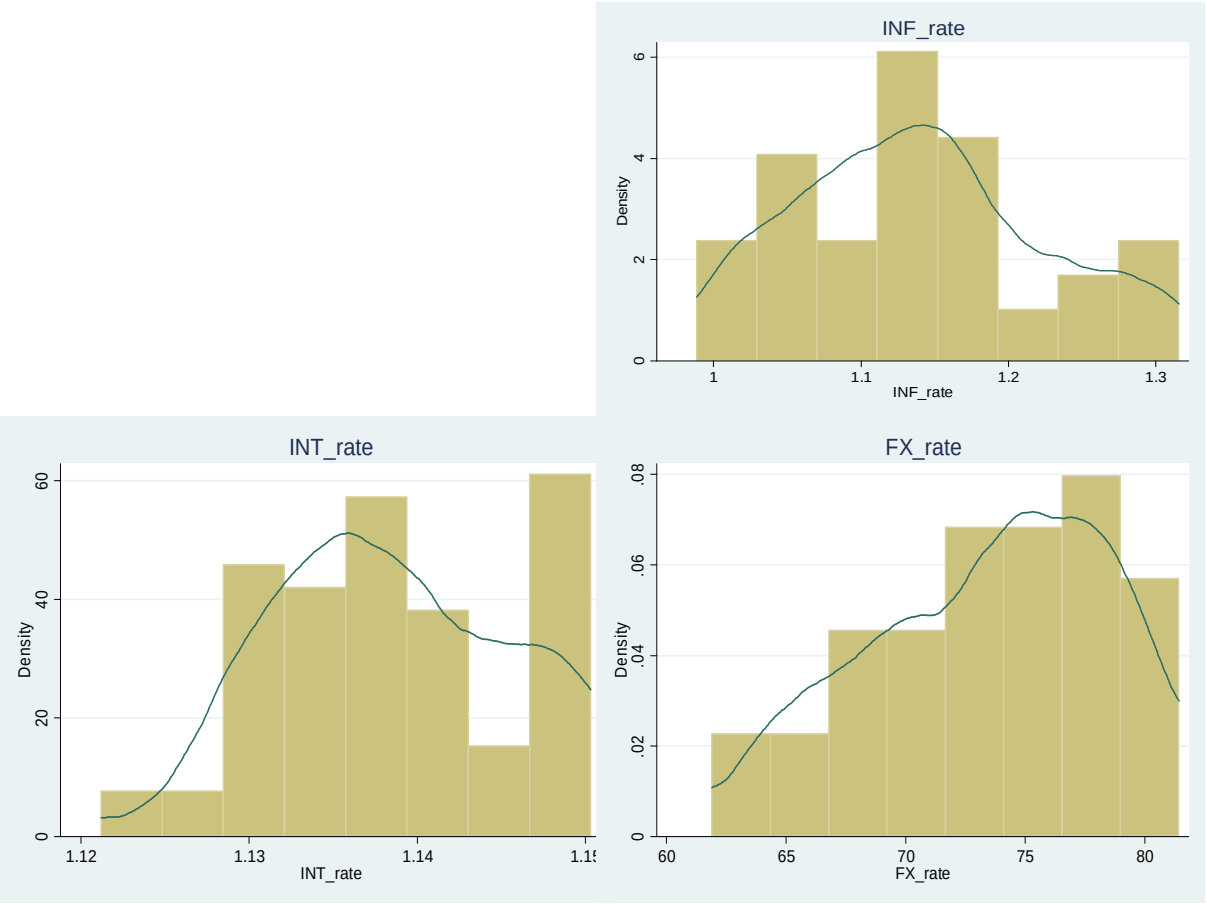
APPENDIX II

Normal probability and Histogram plots.





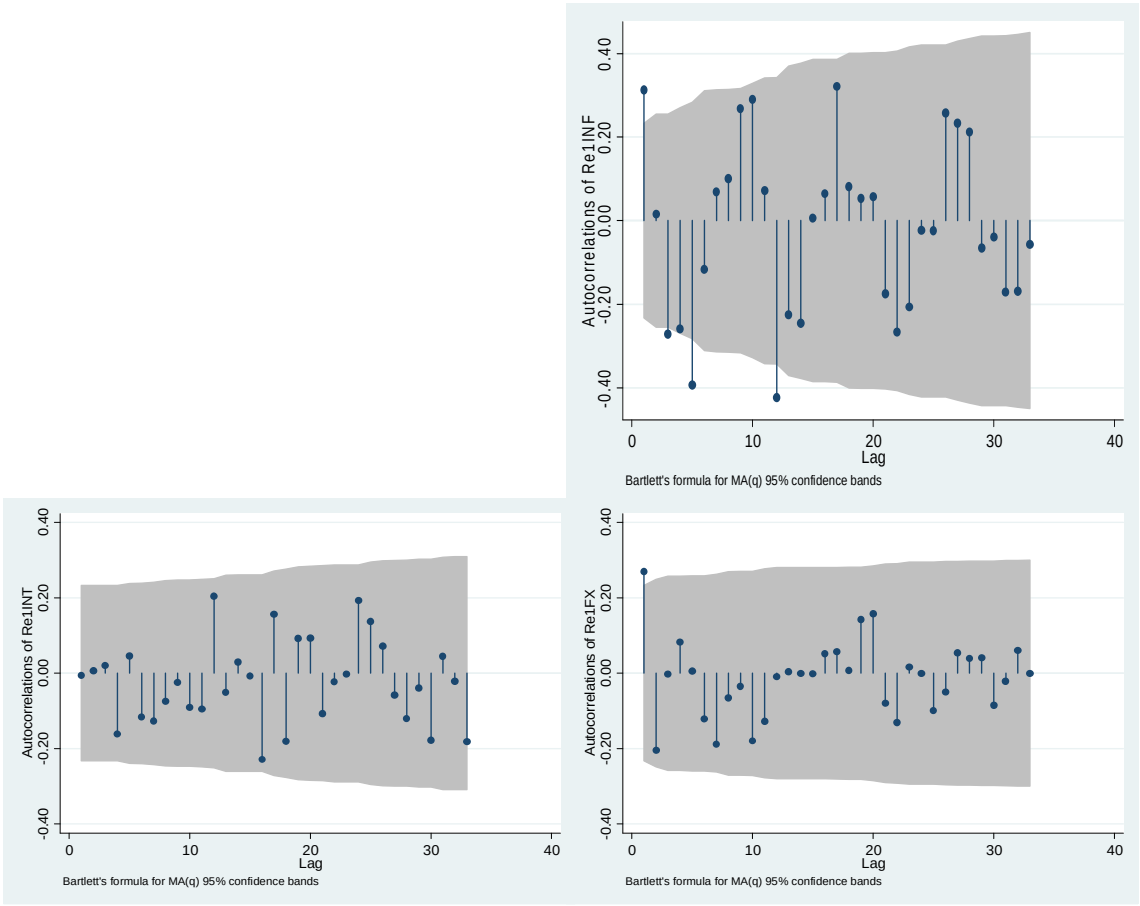




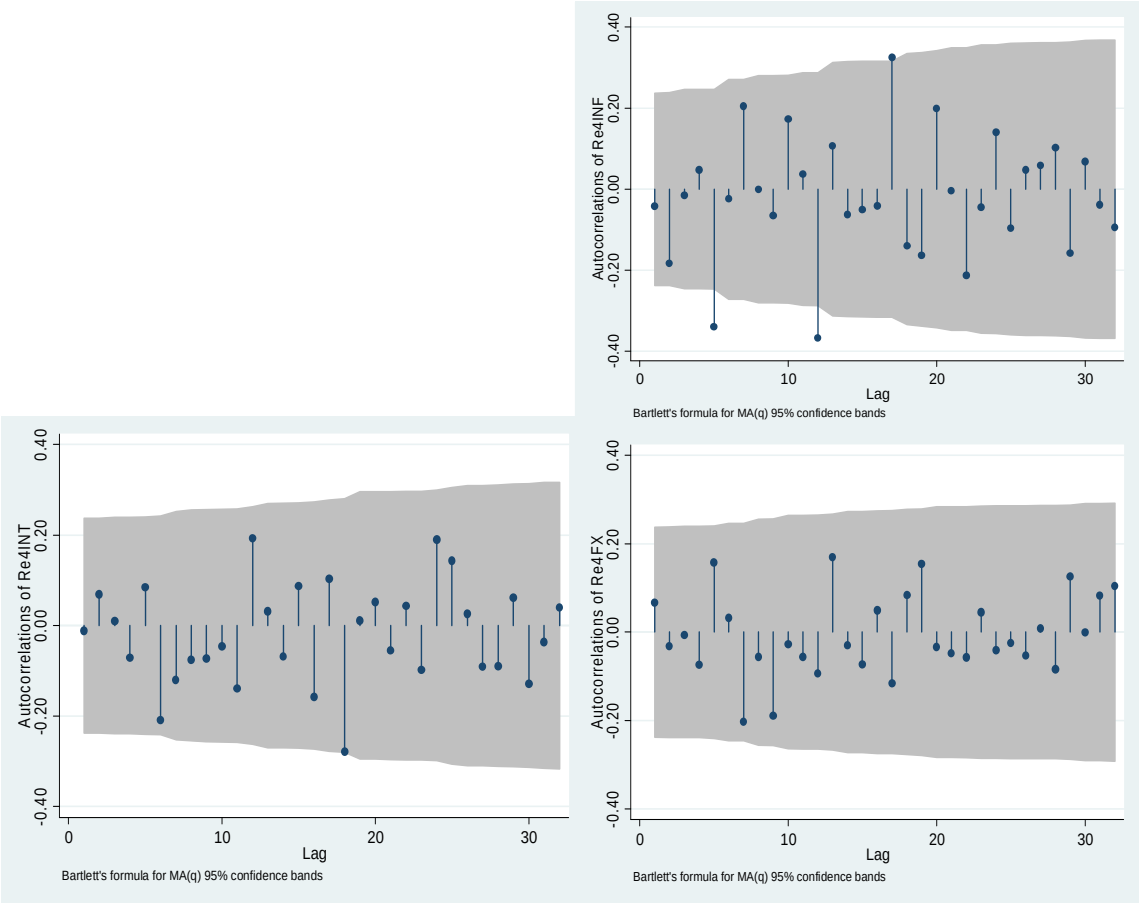
Both normal probability and histogram plots confirmed that our variables were normally distributed except for NPL_ratio.

APPENDIX III

Correlograms for Residuals for Var (1)



Correlograms for Residuals for Var (4)



We had a minimum of 1 lag and a maximum of 6 lags but from the correlograms for residuals above the study chose an optimal lag of 3 since most of the autocorrelations for residuals of the study variables were within the area of 0.95.