EMPIRICAL ANALYSIS ON THE IMPACT OF MONETARY POLICY ON THE GROWTH OF KENYA'S MANUFACTURING SECTOR

MBURU BYRON GICHUHI

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Strathmore Institute of Mathematical Sciences

Strathmore University

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

..……..... [*Name of Candidate*]
……..... [*Signature*]
……..... [*Date*]

This Research Project has been submitted for examination with my approval as the Supervisor.

..……..... [*Name of Supervisor*]
……..... [*Signature*]
……..... [*Date*]

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ABSTRACT

The purpose of this study was to find out the impact of monetary policy in boosting manufacturing sector growth in Kenya. This paper uses the Vector Autoregression (VAR) Model to measure the impact of monetary policy on the growth of Kenya's manufacturing sector through analysis of four variables; interest rates which are used as the proxy for monetary policy, exchange rates, real GDP and manufacturing sector GDP. Quarterly time series data was used was for the period 1980-2015. The study finds a significant positive relationship between monetary policy and growth of Kenya's manufacturing sector in the short-run and long-run. Analysis shows that Kenyan exchange rates and lending rates are insignificant as they do not cause a major difference in the manufacturing sector mainly due to fiscal dominance and also due to deregulation in Kenya's financial sector and this is evidenced by figures obtained after running the VAR model. On the other hand, real GDP has significant and positive effect on the growth of Kenya's manufacturing sector. However, when an impulse response function is carried out on the variables, exchange rates are observed to have a positive impact on the growth of the manufacturing sector while interest rates have a negative effect on the growth of the manufacturing sector. In conclusion, stringent policies and information asymmetry need to be put in place when accessing credit facility in favour of firms in the manufacturing sector.

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List of Abbreviations

AIC	-	Akaike Information Criterion
ADF	-	Augmented Dickey Fuller
CBK	-	Central Bank of Kenya
CBR	-	Central Bank Rate
GDP	-	Gross Domestic Product
KNBS	-	Kenya National Bureau of Statistics
OLS	-	Ordinary Least Squares
REER	-	Real effective exchange rate
SBIC	-	Schwarz' Bayesian Information Criterion
SINT	-	Short term interest rate
SIP	-	Sectoral industrial production
VAR	-	Vector Autoregression
VECM	-	Vector Error Correction Model
IRF	-	Impulse Response Function

1 INTRODUCTION

1.1 Background of the Study

Manufacturing in Kenya has been an anchor of the economy for decades and has gone through a lot of obstacles from stringent policies to calamities to counterfeited products from foreign countries. The growth of Kenya's manufacturing sector since independence has been notable; its share of GDP noted to have increased from 10% percent in 1964 to 13.6% in 1992 (World Bank, 1993); having seen rapid expansion with textiles and garments, food, beverages, and tobacco as the leading sectors in the 1960s. The importance of manufacturing is derived from the fact that it promotes creativity and innovation, promotes research and development activities eventually also increasing productivity of other sectors of the economy.

Among the most important influencers of manufacturing growth in Kenya beside fluctuations in business cycles, foreign investment from investors, taxes, government expenditure and relative prices; lays monetary policy, which is one of the key determinants of the of the growth experienced in the manufacturing sector. Monetary policy mainly refers to the process by which a country's central bank controls the money supply by targeting a rate of interest that would eventually lead to stability in prices offered and general confidence in the country's currency. The main tools used by the Central Bank of Kenya (CBK) to put monetary policy into action are; Open Market Operations, Discount Window Operations and Reserve requirements (Central Bank of Kenya, 2010).

With the foregoing, the effectiveness of monetary policy has been of particular interest to many scholars in the recent past. Friedman (1968) noted that positive and negative changes in lending rates leads to variations in the demand for goods in the country mostly by varying costs of borrowing, availability of long-term and short-term loans and exchange rates. Mishkin (1981) is also of the opinion that low interest rates and a stable economy prompt an increase in lenders willingness and ability to lend to businesses hence increasing a country’s Gross Domestic Product (GDP) in the long run.

With regard to the effect of monetary policy on growth of the manufacturing sector, Kimanja (2011) finds that monetary policy has a large impact on sectoral growth in a

country as high interest rates lead to less money circulating around the economy hence lack of purchasing power by individuals. In contrast however, Gang and Khan (1991) found out that high interest rates lead to less money circulating in the economy and therefore low rate of inflation which is good for a country.

Kenya National Bureau of Statistics (2015) affirms that the manufacturing sector in Kenya has made a tremendous amount of growth having grown by 9% in 2015 as compared to other years as shown in figure 1 below. Credit from banks also increased by 19.3% just in the 2014-2015 period. Kenya National Bureau of Statistics (2015) also goes further to mention that this growth was attributed to the loosening of the monetary policy where interest rates had decreased for the better part of the year.

Figure 1- Share of Kenyan GDP from manufacturing sector

Largely, the impact of monetary policy on Kenya's manufacturing sector is still a very important issue in Kenya and as such warrants more research using disaggregated statistics in order to prove how CBK's interest rates affects Kenya's manufacturing sector.

1.2 Problem Statement

Kenya has witnessed several forms of manufacturing distress and drawbacks such as high rates of inflation, high interest and exchange rates in the last 30 years all of which are determined by monetary policy set to regulate and ensure price stability in the country. In 1991 to 1993 for instance, Kenya witnessed the worst economic performance

with the rate of inflation increasing abnormally to a record of 100% in August 1993 hence abnormally increasing interest and exchange rates.

The manufacturing sector has for decades served as an avenue for increasing replacement of imports with domestically manufactured products and expanding the quantity of exports, increasing foreign exchange earning capacity by stabilizing exchange rates as well as targeting full employment. As such, the Kenyan government has embarked on various policies to protect it being the second largest sector in Kenya (Trading Economics, 2016). Some of the policies used by the government involve the use of monetary and fiscal policy.

Anderson (1968) postulated that monetary policy in the USA has greater and faster impact on economic activity thus suggesting that greater reliance be placed on monetary measures than fiscal measures in the conduct of stabilization policy. Uniamikogbo (2001) asserted that monetary variables in the Nigerian republic are more effective and dependable than fiscal variables when it comes to affecting changes in economic activities such as in the manufacturing sector.

The foregoing implies that there is a need for a closer look at Kenya's monetary policy and how it particularly affects the manufacturing sector which is the second largest team player when it comes to contribution to the country's GDP. This study is also informed by the fact that most studies done here in Kenya; (Corazon, 2014) (Tobias, 2012), focus on impact of monetary policy on Kenya's economic growth as a whole as opposed to how monetary policy specifically affects the performance of a specific sector, which in this study is the manufacturing sector.

1.3 Research Objective

The overall objective of this study is to establish the effect of monetary policy on the growth of Kenya's manufacturing sector.

1.4 Research Question

The research question in this study is:

- Does monetary policy have any impact on the growth of Kenya's manufacturing sector?

1.5 Significance of the Research

The significance of this study is to inform academicians and researchers on how monetary policy can affect a country's economic growth on a sectorial basis and also to contribute to the existing literature on the effects of monetary policy when it comes to growth of a country's economy. This contribution is achieved by focusing on how interest rates affect only a certain sector as a section of the country's GDP. This study is therefore significant as it could inform the Central Bank of Kenya on the significance of controlling money supply by targeting a rate of inflation that would eventually lead to stability in prices offered and instil general confidence in the country's currency. The study may also prove significant to foreign investors as they make decisions on whether to invest in our manufacturing sector or other sectors that are less affected by our monetary policies particularly interest rates.

2 LITERATURE REVIEW

2.1 Introduction

There has been a lot of literature in the field of knowledge concerning monetary policy and its impact on different macroeconomic factors such as national output, investment, inflation, savings and unemployment. In this respect, chapter two reviews the theoretical framework including models used to explain the effect of monetary policy in relation to manufacturing sector growth, empirical literature from a number of authors on the same, the research gap being filled and the conceptual framework.

2.2 Theoretical literature

This section provides a review of some of the theories that have been brought forward to explain how monetary policy affects sectoral performance and eventual growth of the economy.

2.2.1 New Keynesian Model

Rotemberg and Woodford (1997) together with Goodfriend and King (1997) developed the New Keynesian model and Woodford (2003) later developed this model in detail and it is what is mainly used by researchers when it comes to monetary analysis. New Keynesian model uses the assumption that firms in the country regardless of the industry they fall in and households make choices based on information available in the market, past economic experiences and their rational outlook assuming that their economical expectations will be more or less the same as how the future state of the economy will look like. New Keynesian model also states that there exists imperfect competition between determining both prices and wages hence the reason why prices and wages do not instantaneously adjust in the presence of economic shocks.

Presence of viscous wages and prices and other market failures hint that the economy may not attain full production capacity. As a result of this, new Keynesians argue that macroeconomic stabilization by the central bank through the use of monetary policy can lead to a more increased macroeconomic output in terms of full employment and increased output in terms of production through the manufacturing sector.

Bekaert and Moreno (2010) assessed New Keynesian models and discovered three equations that are a representation of these models. They include the IS curve, the Phillips curve and the monetary policy rule as described below:

2.2.1.1 IS curve

The IS curve used in New Keynesian models is similar to the one in traditional Keynesian models except that the new IS curve takes into account future expected output and it has the following representation;

$$x_t = -\phi\,[i_t - E_t\pi_{t+1}] + E_t x_{t+1} + \nu_t$$

Where the variables are defined as;

- $x_t = y_t - \tau_t \equiv$ output gap
- $y_t \equiv$ output
- $\tau_t \equiv$ potential output
- $i_t \equiv$ nominal interest rate
- $\pi_t \equiv$ inflation
- $i_t - E_t\pi_{t+1} \equiv$ real interest rate
- $\nu_t \equiv$ demand shock.
- $E_t\pi_{t+1} \equiv$ expected future inflation
- $E_t x_{t+1} \equiv$ expected output gap

From the foregoing equation, x_t which is the output gap, has a negative relationship with the real interest rate such that the lower the interest rates offered by the central bank, the higher the output since it stimulates investments. In the manufacturing sector context, low interest rates encourage investments since manufacturers can easily access funding hence increasing output and the sector's total contribution to GDP.

2.2.1.2 Phillips curve

The New Keynesian Phillips curve takes the form;

$$\pi_t = \lambda x_t + \gamma E_t \pi_{t+1} + \mu_t$$

Although inflation is positively related to the output gap or inversely related to unemployment, it also depends on expected future inflation ($E_t\pi_{t+1}$) and a cost-push shock (μ_t). It simply states that decreased unemployment in an economy will correlate with higher rates of inflation, which then leads to increased interest rates leading to low output in sectors like the manufacturing sector since money supply in the economy would be lower.

2.2.1.3 Monetary rule

This rule stipulates the nominal interest rate determined by the central bank should have already incorporated current and expected inflation rates, output and other economic conditions hence the nominal interest rate should change in response to any changes in the foregoing. More specifically, the monetary rule suggests an increase in inflation by 1% should by countered by an increase of more than 1% to the nominal interest rate.

This rule takes the following form;

$$i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t).$$

In the above equation, i_t refers to the short-term nominal interest rate, π_t is inflation rate, π^*_t is the targeted inflation rate, r^*_t refers to the real interest rate, y_t shows logarithmic form of real GDP while $\bar{y}_t$ represents the logarithmic form of potential output which is determined by a linear trend.

This rule generally suggests a relatively high interest rate i.e. a tight monetary policy when inflation is above its target in order to reduce inflationary pressure. It also recommends a relatively low interest rate i.e. a loose monetary policy when rate of inflation is low in order to stimulate output of sectors in an economy.

2.2.2 Friedman monetary rule

Friedman (1974) suggests that whenever there is a positive increase in the nominal rates, individuals take it as an opportunity cost to holding money. Hence Friedman

recommends a nominal interest rate of zero in order to obtain optimality. Theoretically, Friedman's rule has been thought to be quite effective in monopolistic monetary economies such as Ireland. However, this rule does not sit well with what actually transpires in the actual economy. In actual reality, economies that have set their nominal interest rates to be zero or near zero have experienced difficult economic times such as the United States of America (USA) during the Great Depression in 1929 to 1939 and Japan during their 1991 to 2000 financial crisis hence concluding that extremely low nominal rates of interest are more likely to lead to severe and long-lasting recessions.

Banks and lenders view zero nominal interest rates as an opportunity to hold large amounts of money and give out few loans since outside money is considered a very important and powerful asset. With the foregoing, low nominal interest rates will lead to low rates of investment and hence low growth rates. As a matter of fact, researchers investigating USA's Great Depression and the Japanese financial crisis associated both to low lending rates for investment purposes.

Friedman (1968) also suggests that inflation rate equals the difference between the money supply growth rate and physical volume of production growth rate. In other words, if the money supply growth rate increases in the same quantity as the physical volume of production growth rate then no price increase would be perceived. Price increase occurs only when money supply increases at a faster rate than physical volume of production. Friedman (1968) suggests that the central bank should be make decisions based on the demand for money and the proportional growth of the country's output i.e. real GDP. Friedman (1968) also suggested that central banks ought to aim at offering constant long-term rate of monetary growth as this will eventually lead to long-term economic growth since key sectors such as the manufacturing sector would be growing at high rates.

2.3 Empirical literature

Over the years, there have been a number of schools of thoughts on the monetary policy debate and how it stimulates national output in terms of Gross Domestic Product (GDP). The Keynesian school of thought implies that changes in the supply of money influences the real GDP of an economy by reducing the interest rate that banks use to offer loans

hence stimulating investment and output growth (Wrightsman, 1976). In contrast McKinnon (1973) and Shaw (1973) in their thesis advocated that higher interest rates induced by market forces, would increase investments by channeling savings to investments that are deemed productive hence motivating growth in real output in sectors such as the manufacturing sector.

Monetary policy over decades has been one of the main drivers of economic management used by governments to shape sectoral and general economic performance of a country. When monetary policy is compared to fiscal policy and their effectiveness measured, monetary policy as discovered by Uniamikogbo (2001) tends to be faster in rectifying economic shocks. Kahn (2010) did a study to find out how growth of the private sector is impacted by monetary policy and observed that monetary policy aims are mainly concerned with attaining stability of prices, attaining full employment in the country, stabilizing exchange rates and the long-term interest rates in order to prevent financial crises. According to Khan (2010), a lot of emphasis should be placed on ensuring prices are stable and interest rates are maintained at low levels in order to enhance lending to private sectors, which then results to increased national output.

In Africa as a whole, research carried out to investigate effect of monetary policy on sectoral growth has led to Abdulrahman (2010) mention that for the time frame of 1990 to 2004 in Sudan, monetary policy's impact on Sudan's economic activity was quite minimal.

Nigeria's manufacturing sector was also examined to see how monetary policy impacted its growth and Nneka (2013) noted that from 1986 to 2009 the aim of monetary policy has been the stimulation of output, attainment of full employment in the country and stabilizing exchange rates and the long-term interest to promote both domestic and external economic stability. Nneka (2013) used the Vector Error Correction Model (VECM) and Ordinary Least Squares (OLS) estimation model. The author’s research findings showed that money supply in Nigeria led to growth of the manufacturing sector's output. Nneka (2013) also found out that the high lending rates, rate of inflation, income tax rate to companies and exchange rates all have an inverse impact on the growth of Nigeria's manufacturing sector during the 23 years. Nneka (2013) then

proposed that expansionary monetary policy whereby interest rates are cut and money supply increase should be implemented as it will lead to growth of the manufacturing sector in Nigeria which in turn would lead to economic growth.

In Nigeria again, Odior (2013) investigated on how macroeconomic factors impacted productivity of Nigeria's manufacturing sector in the 1975 to 2011 time frame. Odior (2013) used the Vector Error Correction Model (VECM) and came to a conclusion that loans to manufacturing companies and investment from foreign investors have the capability to increase Nigeria's manufacturing productivity and this goal would be reached only by low interest rates and low inflationary rates from the central bank. Odior (2013) was also of the opinion that money supply has less impact when it comes to growth of Nigeria's manufacturing sector and proposed that expansionary monetary policy would be the best strategy to use as it will lead to growth of the manufacturing sector in Nigeria.

In Malawi, Mangani (2011) researched on how monetary policy affects sectoral growth using the Vector Autoregressive (VAR) model to analyze the relationships among monetary policy, financial variables, prices and sectoral output and established when it comes to price prediction and stability in sectors of the economy, the exchange rate proved to be the most important variable despite having market imperfections, dominance from fiscal policies and vulnerability to external shocks.

In the Kenyan context, Benjamin (2012) studies the relationship between the growth of the Kenyan private sector and monetary policy for the 1996 to 2009 time frame by tracing how different sectors responded to changes in monetary policy. By use of the Vector Error Correction Model, Benjamin (2012) noted that increased money supply in the country and increased domestic saving both have a positive effect on private sector investment while monetary policy variables of domestically borrowed money by the government and Treasury bill rate have an inverse relationship with private sector investment. This study noted that a measure to tighten Kenya's monetary policy by 1 % would reduce investment in the country by 2.63% and vice versa.

In other countries outside Africa, studies conducted on how monetary policy affects growth of sectors show little variations from studies conducted in Africa. Alam (2006)

examined the impact of monetary policies across six sectors in Pakistan; manufacturing, building and construction sector, insurance, agricultural, mining and wholesale and retail sectors, and found out that shocks on Pakistan's interest rates mainly affected the manufacturing, wholesale and retail sector and insurance sector while the remaining three sectors; agricultural, mining and building and construction sectors proved to be insensitive or slightly sensitive to increasing or decreasing interest rates.

In the only such study done in Turkey, Saygin and Evren (2010) evaluated how the Turkish manufacturing industry is affected by Turkey's monetary policy and Turkey's sectoral growth cycles. Saygin and Evren's analysis was through the Vector Autoregression (VAR) model and their aim was to investigate the extent to which monetary policy shocks cause variations in output levels of Turkey's manufacturing industries. Results showed output reduced significantly when tight monetary policy measures were implemented. However, the degree of reduction in output varied throughout the different manufacturing sub-sectors in Turkey. Sub-sectors such as the steel manufacturing sector were severely affected whereas others such as the packaging sector were not severely affected. Saygin and Evren (2010) finally concluded that a contractionary monetary policy measure has limited impact on Turkey's manufacturing industries.

Vizek (2006) in his article 'Econometric Analysis of Monetary Transmission Channels in Croatia' uses the Vector Error Correction Model (VECM) and the Granger causality test to analyze Croatia's monetary transmission and comes to a conclusion that interest rate changes does not affect industrial output while variations in exchange rates and money supply have a greater impact on Croatia's monetary transmission.

Lastly, Lukytawati (2010) used the computable general equilibrium (CGE) model to research the extent to which both the fiscal and monetary policies influenced Indonesia's industrial and economic growth. Lukytawati (2010) came to a conclusion that Indonesia’s macroeconomic performance in terms of changes in the country's GDP, foreign and domestic investment, consumption patterns and capital rate of return were positively impacted by favorable fiscal and monetary policies.

2.3.1 Performance of manufacturing sector in Kenya

The manufacturing sector in Kenya is the second largest by sectoral contribution to GDP (10.3 per cent) after agriculture and forestry (23.4 per cent) with GDP from manufacturing in Kenya averaging 96,825 KES Million from 2009 until 2015 (KNBS, 2015).

Kenya's manufacturing sector is a key anchor in positive transformation of Kenya's economy in that it is an opportune avenue for increasing output related to replacing imports while at the same time increasing exports to other countries, increasing foreign exchange earning capacity by increasing ties with foreign investors and raising employment rate and per capita income, which then increases the citizen's standards of living.

It is due to this that the government is trying to rejuvenate the manufacturing sector by increasing monetary and fiscal incentives in order to increase domestic sourcing of raw materials which will then reduce the cost of production while at the same time increasing output. For instance, recently, the Kenyan ministry of Industrialization and Enterprise Development signed a Memorandum of Understanding with the manufacturing sector stakeholders; and the World Bank launched the first ever priority manufacturing sector which is estimated to stimulate Kenya’s economy in leaps and bounds. Also, in June 2016, the Kenyan president, H. E. Mr. Uhuru Muigai Kenyatta pitched Kenyan manufacturing strategies to Belgium investors all in a bid to boost Kenya's manufacturing sector.

Ndung'u (2010) investigated Kenya's manufacturing sector as a whole and concluded that its growth despite having great potential has been limited due to inadequate credit from Kenyan banks. Ndung'u (2010) links this limited funding to either inefficient capital market or the culture of Kenyan banks to give preference to short term investment and finance them first. Kenya's banking sector has stringent credit guidelines hence making it difficult for manufacturing companies to access long term funds.

2.4 Research Gap

There exist a number of important gaps in the literature regarding the relationship between monetary policy, the manufacturing sector and the real economy. Evidence on

the direct role of monetary policy to the growth of the manufacturing sector remains scarce and hence why this study ought to bridge that gap.

In addition, from the studies methodological point of view, there has been a gap when it comes to how most VECM models incorporate two variables making it quite difficult to incorporate more than two variables. This study bridges that gap and shows how multiple variables could be incorporated.

In conclusion, more work should be done when it comes to effect of monetary policy on the growth of sectors in Kenya as no such study has been done. This study bridges that research gap by showing how models can incorporate sectors and showing how sectors directly contribute to Kenya's GDP.

2.5 Conceptual Framework

To investigate the link between monetary policy and growth of the manufacturing sector, four variables will play a crucial role in this study. They include interest rates, real GDP, real effective exchange rate and industrial output. A conceptual framework generally shows the relationship between the dependent variable and independent variables of a study.

Industrial output from the manufacturing sector will be the dependent variable as its value depends on real GDP, interest and exchange rates. The link between the dependent and independent variables will be measured and analyzed using the Vector Autoregression (VAR) model or the Vector Error Correction Model (VECM) model in case the variables exhibit cointegration. The relationship between monetary policy and manufacturing sector growth will be established by establishing interest and exchange rates that are determined by monetary policies which then result in maximum industrial production.

The conceptual framework as brought out from the review of theoretical literature is illustrated as follows:

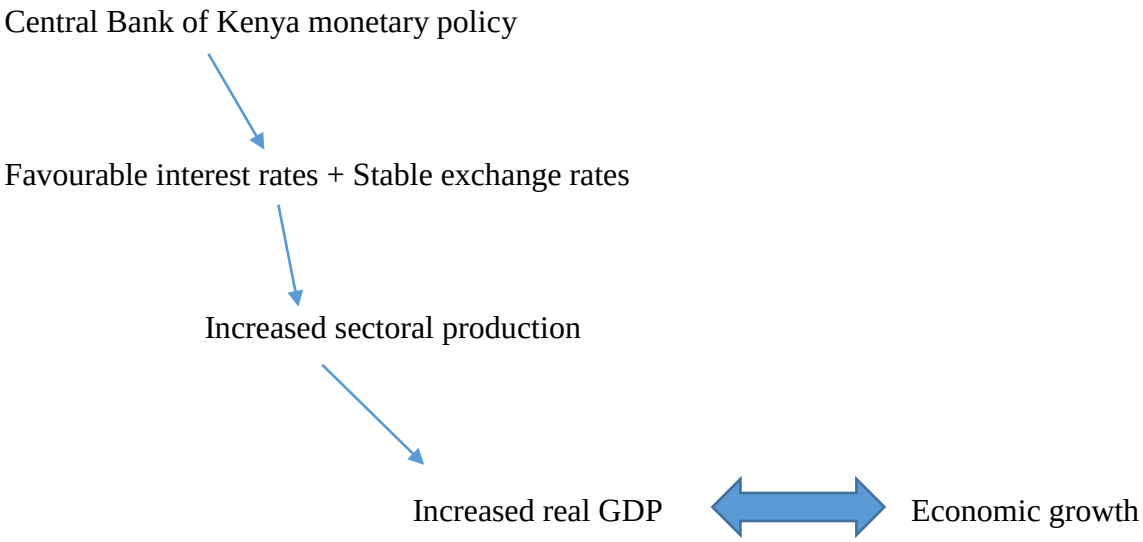


Figure 2 - Diagrammatic representation of the conceptual framework

3 METHODOLOGY

3.1 Introduction

This chapter presents the methodology for this study. The purpose of this study is to find out the impact of monetary policy on the growth of the manufacturing sector as a share of GDP and this will be done by running the VAR or VECM models after conducting the stationarity test and Johansen cointegration test.

3.2 Research design

This research employs a quantitative research design to test the research hypotheses of whether or not monetary policy has an impact on the growth of Kenya's manufacturing sector. For this study, the quantitative research design can be broken down to a descriptive research design where this study attempts to explore and provide more information about the research topic hence filling in the missing parts and expanding the readers understanding.

The quantitative research design focuses on numeric data and statistics hence gives high reliability and credibility to the reader of this study. Also, it establishes associations only between variables hence assuring accuracy when it comes to implementing the research model.

3.3 Population and sampling.

3.3.1 Population

This study uses quarterly time series data covering the period between 1980 and 2015 and the population being analysed for this study is data from the output of the manufacturing sector as a whole more so as a share to GDP.

3.3.2 Sampling

The sampling technique employed in this study is cluster sampling whereby certain groups are randomly sampled and all subjects in them are observed. Samples being used for study are simply data from the manufacturing sector as a whole all for years 1980 to 2015.

3.4 Data collection

This study made use of secondary sources of data for the analysis covering the period 1980 – 2015.

The data on real GDP was retrieved from the World Bank, Africa Development Indicators database. Data on the aforementioned variable was taken from the World Bank, Africa Development Indicators database because it includes data on all these different variables for the specified time period. This reduced the probability of estimation errors that come with acquiring data from many different sources. The World Bank can also be seen as a relatively reliable source.

Data on the lending rates was retrieved from the World Bank database. This is because the site gives actual interest rates commercial banks charge on loans to firms over long periods of time hence it can be seen as a credible source. Lending rates are used as a proxy for monetary policy in this study.

The study also made use of the Economic Surveys which are annual publications of the Kenya National Bureau of Statistics (KNBS). Data on manufacturing sector growth was retrieved from this source.

Finally, exchange rate data was acquired from the Central Bank of Kenya database since it is a reliable source that arrays this data on a daily basis and it being what is actually used in the market, it becomes very helpful for the purpose of this study due to accuracy purposes.

3.5 Data analysis

This study takes into account the following four fundamental variables: Interest rates, Real GDP, real effective exchange rate and sectoral output. The Vector Auto Regression (VAR) model was employed to test the long run and short run impact of monetary policy on the growth of manufacturing sector.

Before carrying out the VAR analysis, a unit root test needs to be carried out on the data in order to establish the order of integration of the data i.e. to test whether or not the data is stationary. This will be achieved using the Augmented Dickey Fuller (ADF) test. A

cointegration test then needs to be carried out to examine if there is a long run relationship between the dependent and independent variables. This is an integration technique used to test for the presence of long-run relationships among non-stationary variables and will be carried out using the Johansen Multivariate approach.

3.5.1 Stationary test

Augmented Dickey Fuller (ADF) test

In order to conduct the stationary test, Augmented Dickey Fuller (ADF) is conducted to establish the order of integration. A stationary variable is mean reverting while a non-stationary variable diverts from its mean with time. A stationary variable does not contain a unit root while a non-stationary variable on the other hand contains a unit root in the autoregressive process.

$$y_t = \phi y_{t-1} + \varepsilon_t \quad \text{where } \phi = 1 \text{ and } y_t \text{ is the time invariant variable.}$$

The basic objective of the test is to test the null hypothesis that $\phi = 1$. The hypothesis tested is:

H_0: Variable has a unit root.

H_1: Variable does not have a unit root i.e. are stationary

Therefore if the ADF test statistic is less than the critical value then you fail to reject the null hypothesis.

3.5.2 Cointegration test

Johansen Multivariate approach

Given that our cointegration function has many explanatory variables, Johansen multivariate approach is best suited for this in determining the long-run relationship between these variables. Considering other estimation techniques such as Engle-Granger two step technique that comes along with several disadvantages such as only being suitable for bivariate testing and that it only identifies only a single cointegrating relation, the Johansen multivariate approach proves to be the best fit to test for cointegration.

The test will be conducted on the basis of the following hypotheses; reject the null hypothesis or accept the alternative.

$$H0: \pi = 0\ (No\ cointergration)$$

$$H1: \pi < 0\ (Cointergration)$$

It should be noted that VAR is carried out with variables that do not exhibit cointegration. If our variables exhibit cointegration, then VAR would not be applicable and will have to use the Vector Error Correction Model (VECM) model.

3.6 Model specification and estimation

3.6.1 Vector Autoregression (VAR) model

In this study, VAR model is the model used as it allows for identification of monetary policy shocks. Here, the VAR for the Kenyan manufacturing sector is obtained in order to compare its reaction to monetary policy shocks over time. Over the years, there have been several studies that have examined the effects of monetary policy in Kenya by using a VAR model. However, to the best of my knowledge this study is the first attempt to identify the reactions of different sectors in Kenyan manufacturing to monetary policy shocks over time.

The benchmark VAR model used for analysis has the following representation:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t$$

Where;

y_t is the (n ×1) vector of endogenous Kenyan variables which has as the i^{th} element, $y_{i,t}$ which can be read as the observation at time t of the i^{th} variable. For instance if the i^{th} variable is sectoral industrial production, then $y_{i,t}$ is the value of sectoral production at time t. c is a k × 1 vector of constants ε_t is a vector of white noise processes or (n ×1) vector of structural disturbances while A_1 is a time invariant (n × n) matrix.

The VAR model will be modified to take into account all the variables and will have the following representation;

$$y_t = [MGDP_{it}\ \ GDP_t\ \ SINT_t\ \ REER_t]$$

Where;

y_t is a vector of the following variables: Interest rates, Real GDP, real effective exchange rate and manufacturing sector output.

$MGDP_{it}$ represents the sectoral industrial production. GDP_t represents the Kenyan real GDP; $SINT_t$ is the short term interest rate while $REER_t$ refers to the real effective exchange rate at time t.

The matrix form of the VAR consisting of the four variables has the following representation;

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \\ y_{3,t} \\ y_{4,t} \end{bmatrix} == \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \begin{bmatrix} A_{1,1} & A_{1,2} \\ A_{2,1} & A_{2,2} \\ A_{3,1} & A_{3,2} \\ A_{4,1} & A_{4,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \\ y_{4,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \end{bmatrix}$$

Where each variable in the model has one equation.

With the VAR model, the assumption is that the sectoral production will respond to any change to all the other variables i.e. Real GDP, short term interest rate and the real effective exchange rate.

Real GDP, real effective exchange rate and industrial output are in logarithmic form while short term interest rate is in percentage terms and within the time frame of 1980 to 2015. A lag length of one is then set in order to enable the comparison of the results across sectoral VARs. This lag length is decided to be one and this can be calculated using the Akaike Information Criterion (AIC) or the Schwarz' Bayesian Information Criterion (SBIC)

Impulse response function of the VAR model

Impulse response function (IRF) of the VAR model is its output when presented with a brief input signal, called an impulse. Generally, the impulse response describes the

reaction of the VAR model as a function of the independent variable that parameterizes the dynamic behaviour of the model.

In this study, we assume the non-recursive structural VAR model which has the following restrictions:

$$\begin{bmatrix} \varepsilon^{GDP}{}_t \\ \varepsilon^{MGDP}{}_t \\ \varepsilon^{SINT}{}_t \\ \varepsilon^{REER}{}_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ f_{21} & 1 & 0 & 0 \\ 0 & 0 & 1 & f_{34} \\ f_{41} & f_{42} & f_{43} & 1 \end{bmatrix} \begin{bmatrix} \mu^{GDP}{}_t \\ \mu^{MGDP}{}_t \\ \mu^{SINT}{}_t \\ \mu^{REER}{}_t \end{bmatrix}$$

Where;

μ_t is a vector of reduced-form disturbances, with var $(\mu_t) = \Sigma$

After carrying out an impulse response function on the above matrix, the first equation is expected to show the slow response of real GDP with respect to shocks to the short-term interest rates and the real effective exchange rate although this might differ after analysis. The second equation can also be interpreted that the sectoral industrial production has slow response to shocks to the short-term interest rates and the real effective exchange rate although again this might differ after analysis is conducted. The third equation shows that the short term interest rate responds contemporaneously to the real effective exchange rate but does not respond immediately to contemporaneous real GDP and sectoral industrial production shocks because data on real GDP and sectoral industrial production is usually only available with a lag. The fourth equation suggests that the real effective exchange rate responds immediately to all other variables when subjected to shocks. The assumptions on the third and fourth equations as well may differ after the actual analysis is conducted.

Justification of the VAR approach

The VAR model was chosen for this study for a number of reasons. First, the VAR model has an impulse-response function which is an important use of VAR as it

quantifies the effects of the monetary policy over time. It answers the questions of when, for how long and how much does the interest rates shock impact manufacturing sector output. An impulse-response function describes the response over time of each variable in the VAR to a one-time shock in any given variable while keeping all others constant. Finally, the VAR model allowed us to use different optimal lags that could be used with limited data, making it quite suitable for this study as well.

3.6.2 Vector Error Correction Model (VECM) model

Where cointegration among variables is evident, VECM would be fit to the first differences of the non-stationary variables, but a lagged error-correction term would need to be added to the relationship. In this case where variables are more than two, i.e. multiple variables, there is a vector of error-correction terms of length equal to the number of cointegrating relationships or cointegrating vectors among the series.

Recall that the real GDP, real effective exchange rate (REER) and manufacturing sector output (MGDP) are in logarithmic form while short term interest rate (SINT) is in percentage terms form hence the Vector Error Correction model pertaining to the four variables incorporated in this study follows the following representation:

$$\Delta L\mathrm{MGDP}_t = \Delta\delta_0 + \sum_{i=0}^{n} \delta 1\mathrm{i}\ \Delta L\mathrm{GDP}_{t-i} + \sum_{i=0}^{n} \delta 2\mathrm{i}\ \Delta L\mathrm{REER}_{t-i} + \sum_{i=0}^{n} \delta 3\mathrm{i}\ \Delta\mathrm{SINT}_{t-i} + \lambda_1 E\mathrm{CM}_{t-1} + \varepsilon_t$$

Where $E\mathrm{CM}_{t-1}$ is the error correction term and ε_t is the mutually uncorrelated white noise residual. The coefficient of the ECM variable contains information about whether the past values of variables affect the current values of the dependent variable under study hence statistically implying the Granger-exogeneity or the endogeneity of the dependent variable. The non-significance of the error-correction term is referred to as long – run non causality, which is equivalent to saying that the variable is weakly exogenous with respect to the long – run parameters.

The size and statistical significance of the coefficient of the error correction term in the model measures the tendency of each variable to return to the equilibrium. A significant

coefficient implies that past equilibrium errors play a role in determining the current outcomes.

The short run dynamics are captured through the individual coefficients of the difference terms. The absence of short – run causality is established from the non-significance of the sums of the lags of each explanatory variable.

The non-significance of all explanatory variables including the error-correction term in the Vector Error Correction model indicates the econometric strong-exogeneity of the dependent variable and therefore the absence of Granger-causality. Hence if all $\delta_s = 0$ and $\lambda_1 = 0$ then we can establish that there is no relationship between monetary policy and manufacturing sector growth in Kenya.

4 RESULTS AND ANALYSIS

4.1 Introduction

This chapter presents the empirical findings of this study. The sections in this chapter have been divided based on the different empirical tests and models that were carried out towards achieving the research objective of this study. This section begins with the stationarity test followed by the Johansen cointegration test and finally the VAR model is run in order to obtain the final results.

4.2 Stationary test

In order to examine the existence of stochastic non-stationary in the series, the study establishes the order of integration of individual time series through the unit root test. All variables in the model were subjected to a stationary test. Granger and Newbold (1974) have demonstrated that if time series variables are non -stationary, all regression results with these time series will differ from the conventional theory of regression with stationary series. That is the regression coefficients with non-stationary variables will be spurious and misleading.

To get over this problem, we test for stationarity of the time series. Augmented Dickey Fuller (ADF) test will be used to investigate whether the variables used in the study have unit root or not. The results of the unit root test are presented in table 1 below;

Table 1-ADF Test for stationarity

Variable	**Level t-statistic**	**First Difference t-statistic**	**Order of Integration**	**5% critical value**
Log Real GDP	-1.2586	-11.9169	I (1)	-2.9434
Log Real Exchange Rates	-0.3629	-4.9547	I (1)	-2.9411
Log Manufacturing Sector Output	-2.0629	-8.1731	I (1)	-2.9434
Short Term Interest Rates	-1.4026	-4.5593	I (1)	-2.9411

In the table above, time series of the variables i.e. LRGDP, LRER, LMGDP and SINT were non-stationary in levels I (0) since the ADF t-statistic of each variable at level is

less than the 5% critical values but become stationary after first differencing, or integrated of order one, I (1) since the ADF t-statistic of each variable at first difference is greater than the 5% critical values.

4.3 Cointegration test

Having confirmed that the variables are not stationary at levels, it became crucial that the data series are tested for to determine whether there exist long-run equilibrium relationships among the variables under study. In this study, the Johansen multivariate approach is employed. The trace statistic tests the null hypothesis that there is at most r cointegrating equations. The trace test rejects the null hypothesis if the trace statistic exceeds the critical values; otherwise, it fails to reject the null hypothesis that there is no cointegrating equation.

Table 2-Johansen multivariate test for cointegration

Sample: 1980 - 2015
Included observations: 120
Series: SINT LRER LMGDP LRGDP

Hypothesized No. of CE(s)	**Eigen Value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None	0.626474	50.65646	57.36413	0.0028
At most 1	0.318454	20.36866	28.75607	0.3124
At most 2	0.159819	8.196543	16.65471	0.5646
At most 3	0.078078	0.756581	3.765466	0.4295

From the results above, the trace statistic of 50.65646 is less than the critical value of 57.36413 at 5 % confidence interval showing that there is no cointegration among the variables (SINT, LER, LRGDP and LMGDP).The Johansen co-integration shows that there is no presence of full cointegration rank given that subtraction of the number of co-integrating equations and the variables under study is not equal to zero, therefore implying that the model is good and is in functional form. There is no presence of multi

co-linearity as the value of the log likelihood is positive. Based on this, vector Autoregression model (VAR) is used to estimate the parameters of the model.

4.4 VAR result

Table 3-VAR result

Vector Autoregression Estimates
Date: 10/27/16 Time: 16:12
Sample (adjusted): 1980Q1 2015Q4
Included observations: 120 after Adjustments
Standard errors in ( ) & t-statistics in [ ]

	LMGDP
LMGDP(-1)	0.420761 (0.12049) [3.49207]
LMGDP(-2)	-0.245952 (0.11993) [-2.05078]
SINT	-0.036864 (0.34643) [-0.10641]
LRGDP	0.647153 (0.10355) [6.24977]
LER	0.018852 (0.09574) [0.19690]
C	-0.190352 (0.31778) [-0.59900]
R-squared	0.908520
Adj. R-squared	0.894227
Sum sq. resids	0.036955
S.E. equation	0.033983
F-statistic	63.56094
Log likelihood	77.85734
Akaike AIC	-3.781965
Schwarz SC	-3.523399
Mean dependent	4.529537
S.D. dependent	0.104490

$LMGDP = 0.421LMGDP_{t-1} - 0.246LMGDP_{t-2} - 0.03686SINT + 0.647LRGDP + 0.0189LER - 0.190352$

The above Vector Autoregression (VAR) model shows that the R-square is 0.90852 showing that the explanatory variables explained 91% of changes in the dependent variable. It remains strong after adjusting for degrees of freedom to 89% (Adjusted R-square). This reveals high goodness of fit meaning that the variable chosen are strong in explaining the growth of manufacturing output (LMGDP) in the Kenyan economy.

To explain the significance of the variables used in this study to conclude whether they are significant in contributing to growth in Kenya's manufacturing sector, the following table was used.

Table 4-VAR result on significance of variables

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.420761	0.118252	3.495816	0.0014
C(2)	-0.245952	0.117521	-2.160651	0.0381
C(3)	0.018852	0.093483	0.282448	0.7794
C(4)	-0.036864	0.037474	0.400222	0.6916
C(5)	0.647153	0.092128	6.783567	0.0000
Determinant residual covariance		0.000980		

Equation: LMGDP = C(1)*LMGDP(-1) + C(2)*LMGDP(-2) + C(3)*LER + C(4) *LLR + C(5)*LRGDP

Observations: 38

R-squared	0.907829	Mean dependent var	4.529537
Adjusted R-squared	0.896657	S.D. dependent var	0.104490
S.E. of regression	0.033590	Sum squared resid	0.037234
Durbin-Watson stat	2.154177		

In order to determine whether an independent variable is significant or not in determining the dependent variable, the p-values of the independent variables coefficients are examined. If any of the p-values of the independent variables coefficients are above 5%, then that variable is said to be insignificant in determining the dependent variable.

The p-values of the coefficient of individual variables are examined to determine the nature of the relationship between monetary policy and the growth of Kenyan manufacturing sector output. Real GDP is arguably the most important indicator on the health of any economy and hence if real GDP is high, it proves that the economy and its sectors like the manufacturing sector are thriving. In the research conducted, the co-efficient of real GDP being 0.647 was observed to be positive and significant and its significance was because its p-value was less than 5% i.e. it was 0.0%. It can therefore be concluded that real GDP is quite important in determining the growth of the manufacturing sector and should always be maintained at high levels. In the period of study, significance of real GDP can mainly be attributed to lower interest rates, increased government investments, an increase in the working population, political stability and also an increase in labour productivity through better education and training or improved technology.

The coefficient of lending rates and exchange rates i.e. -0.03686 and 0.0189 respectively were observed to be insignificant with their p-values being 67.16% and 77.94% respectively. Both the p-values of lending rates and exchange rates are above 5% and hence can be concluded that for the time of study, these variables were insignificant in determining the growth of Kenya's manufacturing sector. This shows that monetary policy as a policy option had been inactive in influencing these macroeconomic variables to induce the performance of the manufacturing sector. This could be as a result of dominance of fiscal measures especially government expenditures in stimulating such macroeconomic variables.

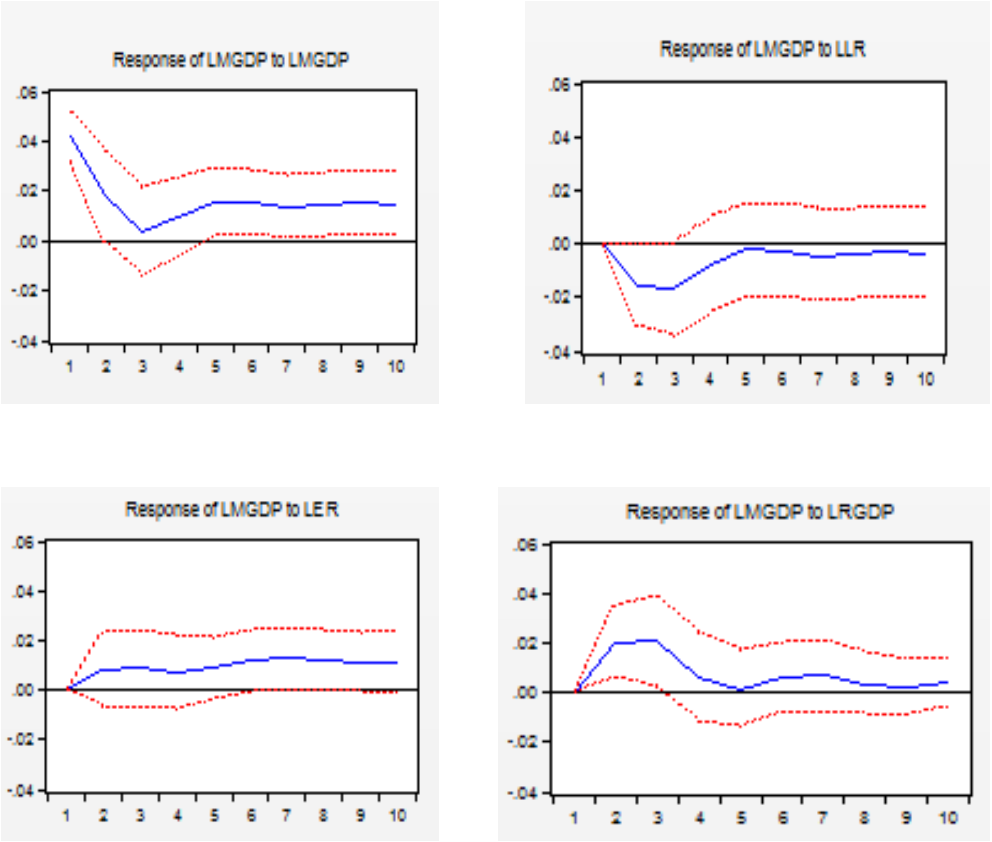
More so, the insignificant relationship that interest rates and exchange rates have with the manufacturing sector growth could be explained by the under developed nature of the financial institutions in transmitting monetary policy to the ultimate variables in the economy which is usually to stimulate the growth of the real sector of the economy such as the manufacturing sector. The insignificant effect of interest rates; as shown by the 67.16% p-value which is above 5%, on the output of Kenya's manufacturing sector can be as a consequence of lack of proper financial regulation, interest rate and exchange rate deregulation from the body that is granted monetary authority in Kenya. This also

points out to the fact of the stringent policies and information asymmetry in accessing credit facility in the manufacturing sector.

4.5 Impulse response function

Impulse response function (IRF) of the VAR model is its output when presented with a brief input signal, called an impulse. Generally, the impulse response describes the reaction of the VAR model as a function of the independent variable that parameterizes the dynamic behaviour of the model.

Figure 3- Impulse Response Function



From figure 3 above, the numbers on the x-axis refer to the quarterly periods that were used in the research. If one standard deviation positive shock is given to lending rates, its effect on the output of the manufacturing sector is that it will cause output of the manufacturing sector to be negative in the first ten quarters as shown by the blue line and this may be due to instability in the financial sector, fiscal policy dominance or lack of stringent policies to curb the financial sector such as banks' lending money to manufacturing firms. However if monetary policy in Kenya is regulated in a better way

to favour Kenya's manufacturing sector then a positive shock to lending rates would cause positive effects on the manufacturing sector's growth.

One standard deviation positive shock on exchange rates causes a positive effect on the output of the manufacturing sector and this is evidenced by the blue line being on the positive scale of the graph. It causes output from the manufacturing sector to increase steadily for the first two quarters then decrease slowly for the next two quarters and increase slowly till it becomes steady for the remaining six quarters.

One standard deviation positive shock on real GDP causes a positive effect on the output of the manufacturing sector and the blue line as observed increases for the first two quarters then becomes steady for one quarter and decreases for the next three quarters then gradually becomes steady for the remaining six quarters showing that real GDP should always be maintained at high levels in order to transmit positive growth to Kenya's manufacturing sector.

5 DISCUSSIONS

5.1 Summary

The purpose of this study was to examine the impact of monetary policy on the growth of Kenya's manufacturing sector and to address the foregoing objective, quarterly time series data was collected for the period 1980 to 2015.

Due to lack of cointegration between the given variables, a VAR model was used to find out the actual effect that each variable had on the growth of Kenya's manufacturing sector. The study factored in the macroeconomic variables; short term lending rates, real GDP, exchange rates and manufacturing sector output.

Overall, the study found that monetary policy had a positive effect on growth of Kenya's manufacturing sector in the long run but insignificant mainly due to dominance of fiscal policy and under developed nature of Kenya's financial institutions. This study is different from previous research conducted in Kenya as they deal with impact of monetary policy on the Kenyan economy as a whole unlike this paper which focuses on the impact of monetary policy on the growth of one sector of the economy which is the manufacturing sector.

5.2 Conclusion and recommendations

The main objective of this study has been to investigate the impact of monetary policy and Kenya’s manufacturing sector growth. This study covers a 1980–2015 time frame using the Vector Autoregressive Model and Johansen co-integration test procedure. The findings of this study show that growth in Kenya’s manufacturing sector would be quite high if monetary policy measures were improved such as proper financial regulation, proper interest rate and exchange rate regulation and stringent policies in conjunction with information asymmetry when accessing credit facility in the manufacturing sector.

From the impulse response function carried out on this study, it is evident that real GDP has a positive impact on growth of the manufacturing sector when one standard deviation positive shock is given to real GDP and the country's authority should always strive to maintain it at high levels. When subjected to a one standard deviation positive

shock, exchange rates are observed to cause a positive effect on the manufacturing sector growth but this is not the case with lending rates which produce a negative effect on the growth of the manufacturing sector and this may be due to unstable financial regulation by monetary regulators.

From this study it is clear that the variables have the potential to transmit effects of monetary policy to the manufacturing sector in the Kenyan economy as evidenced by how lack of proper financial regulation in the country causes interest and exchange rates to have an insignificant effect on Kenya's manufacturing sector; as shown by their p-values of 67.17% and 77.94% respectively being above the required 5%, which shows that if proper financial regulation was done then interest rates and exchange rates would have a high positive effect on Kenya's manufacturing sector (Mabiru, 2015).

The paper also found that monetary policies should not be fully relied to induce growth in the manufacturing sector as their contribution is insignificant. It therefore suggests that monetary policy makers should use this policy instrument to complement other macro-economic policies. More so, policies should be put in place to increase domestic manufacturing production of export commodities to enhance stability in Kenyan external reserves and contribute positively to the sector output and economic growth.

Furthermore, monetary authority should create and implement monetary policies that provide a more efficient investment climate by facilitating the emergence of market based interest rate and exchange rate regimes that attract both domestic and foreign investment to the manufacturing sub-sectors that are currently operating below expected capacity such as the assembly of motor-vehicles, processing of maize meal and manufacture of bread (KNBS, 2015).

In order to maintain and exploit the current investment climate, the Central Bank of Kenya should introduce more monetary instruments such as special interest rates for manufacturing firms that are flexible enough to meet the demands of the manufacturing sector. This will allow for the existence of different measures that will deal with different situations. The Central Bank should make more stringent punishments for non-compliance to the monetary policies by financial institutions especially in the provision

of credit facility to the manufacturing sector such as having a higher maximum loan limit that can be given to manufacturing firms.

5.3 Limitations of the study

One shortcoming of this study is the poor data quality. The lack of high frequency and reliable data because some years did not have complete data points renders econometric analysis difficult. Data available was limited hence quarterly data had to be used in order to get more data points.

Another shortcoming of this study was the fact that the lags could have eaten up degrees of freedom thereby reducing the statistical power of the models run.

A potential area for further research could be to carry out a panel analysis based on the manufacturing sub-sectoral data and to therefore analyse the effectiveness of monetary policy in each of the sub-sectors. This may yield more robust results because a panel analysis would take into account the commonalities in the sectors as well as take care of any unobserved heterogeneity in these sub-sectors.

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