DOES MONETARY POLICY AFFECT REAL OUTPUT IN A SUPPLY-CONSTRAINED ECONOMY: CASE OF MALAWI

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DECLARATION

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2. This work has not been previously submitted in whole, or in part, for the award of any degree in this or any other university. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works of other people has been attributed, and has been cited and referenced.

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ABSTRACT

This paper explores the impact of monetary policy on economic growth with respect to a low-income developing economy, with relatively undeveloped financial sector. In particular, economies that may be relatively supply constrained or suffer from sticky prices may not respond to monetary movements as anticipated, owing to a lack of flexibility in the system from economic and institutional constraints. In this case, monetary policies that might otherwise affect the creation of capital for investment and a robust environment for businesses to thrive may not occur.

We consider the case of Malawi, which is acknowledged to have a number of supply-side constraints including those related to electricity production and water for agricultural production. We begin with a Cobb-Douglas type production function for the country, which includes droughts, owing to its effect on both electricity production and agriculture. This underlying production function provides an estimate of the long-run supply capacity as it measures potential output based on capital, labour and water constraints. The goal is to determine if the changes in real Gross Domestic Product (GDP) that are not explained by supply factors, can be explained by monetary aggregates.

In a second stage of the model, we use the Engle-Granger approach to estimate a modified Error Correction Model (ECM) for a short-run growth equation, where we include the movements in monetary variables to test the impact of monetary policy on real GDP growth. We estimate our models for the period 1980 to 2014.

Our estimated long-run production function shows that drought depresses real output, and capital and labour have roughly equal importance as factors of production. We then estimate a short-run growth equation using the ECM methodology and find that real exchange rate and real interest rate do not have a significant impact on growth although they have the anticipated sign. We also find that net credit to government and net credit to private sector negatively affect to the growth in real output.

Our econometric results indicate the primacy of supply factors for economic growth and a secondary rate for monetary factors-mainly the money growth. We note that Malawi has had a history of volatile inflation, which appears to be driven by monetary policy and has a negative impact on real output. Our results highlight the importance of more stable management of the money supply, as the monetarism school of thought would propose. Money growth appears to fuel inflation and dampen growth. Thus greater coordination of fiscal and monetary policies are needed to create smoother growth and inflation paths.

Keywords: Supply constraint; monetary variables; Capital; ECM; Cointegration

1.0. INTRODUCTION

In recent decades, the nature and impact of monetary policy has become more complex. The importance of monetary policy has increased with the liberalization of financial markets and development of new financial instruments. The gap between countries has become wider, and the Less Developed Countries (LDCs) are unsuccessfully (for the most part) in trying to catch up with the industrialized economies (Buteau, 2011). Some economists have attributed this to the negative effects of globalisation[1]. The environment in which monetary policy operates has changed and there is need for a stylized approach to policy in order to control the inefficiency in low-income countries.

The goal of the study is to determine if the changes in real GDP that are not explained by supply factors, are explained by monetary variables. This is done by assessing whether monetary policy variables have a statistically significant relationship with the changes in real GDP growth rate after running a supply model.

To realize this goal, the study will:

- Determine the long run relationship between supply factors i.e. labor, capital, and drought (proxy for water constraints) on real GDP.

- Econometrically investigate the short run relationship between monetary variables (real interest rate, real exchange rate, real net credit to government and real net credit to private sector) and the changes in real GDP growth rate.

- Discuss the policy recommendations based on the results from the models.

The study will investigate whether there exists a short run relationship between monetary variables and the growth rate of real output in a supply constrained-economy. We consider the case of Malawi. This will be done by using a modified Error Correction Model (ECM).

[1] L. Paramo (2007), speech delivered at the conference *Globalisation and Monetary Policy,* Finlands Bank Helsinki, 15 March 2007.

The ECM is conducted in a two-step equation procedure. Our first regression models the supply side potential output using a Cobb-Douglas style model equation to ascertain the long run relationship between supply factors and the real output. The subsequent error correction equation will include the changes in the monetary variables of: real interest rate, real exchange rate, real net credit to government (NCG) and real net credit to private sector (NCP). We want to determine if these monetary variables have a statistically significant impact on the output growth in the short run, hence establishing the relevance of monetary policy to economic growth in Malawi. This will ultimately give us a platform to draw conclusions on whether monetary policy has significant influence on real output in a supply-constrained economy.

To attain these objectives, section two shows the background on monetary policy framework and sources of growth in Malawi, section three provides the theoretical framework and empirical literature on the supply side studies using Cobb-Douglas function model, literature on how monetary policy affects real output and monetary channels. Section four presents the methodology and applied time series econometric techniques employed in the study. Section five presents the empirical results for the study. Finally, Section six provides the conclusions and policy recommendations from the results obtained

1.1. Motivation

In LDCs, in the context of development, monetary policy has an active role and is considered quite relevant (Buteau, 2011). Underdeveloped markets, extensive non-monetized sector, shortage of entrepreneurial abilities, and deficit financing have been cited as some of the reasons for the fundamental failure of many African countries to attain growth and development. According to Tobin (1965), inflation promotes capital formation in advanced economies while Reed and Ghossoub (2012) find that higher inflation rates in poor countries are associated with a reverse-Tobin effect and increased inequality.

Various scholars have laid much of the blame for the failure of monetary policies to transform the growth rate of the economy as a result of poor implementation and insincerity on the part of policy executors (Onakoya et al, 2012).

Fischer (2015: 11-12) describes this as:

> **In the advanced economies and some emerging market economies, financial systems are relatively well developed, deep, and diversified, which facilitates the conduct of monetary policy through open market operations. In many of the developing countries, however, although financial systems are developing rapidly, they remain small and not**

well diversified, hindering the ability of central banks to conduct open market operations. Indeed, in many countries, interbank markets are still underdeveloped, and, even though some central banks use policy rates, changes to these policy rates have only limited effect on other interest rates and on the economy more generally. Thus, the ambitions of developing countries to modernize their monetary policy frameworks have to proceed in parallel with further efforts to develop the market institutions necessary to conduct monetary policy in a conventional way.

Due to the importance of economic growth among the macroeconomic objectives of developed and developing countries, persistent concern has always been given among monetary economists to the relationship between monetary variables and the real output (Olusegun, 2016). The monetary variables might counter each other but the overall purpose is to achieve a smoother growth and inflation path. This calls for a critical analysis in the nature of monetary policy and the desired impact with regards to low-income economies.

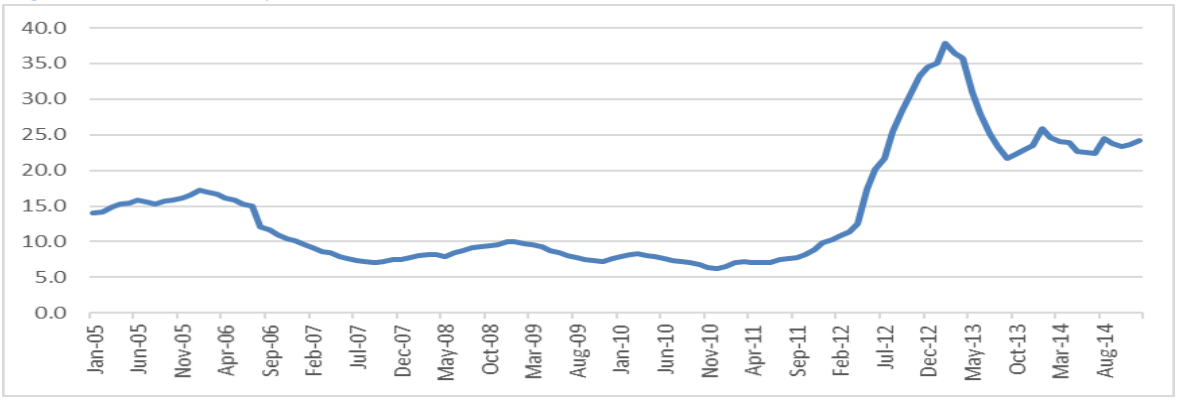
2.0. MACRO-PERFOMANCE AND MONETARY POLICY

2.1. Macroeconomic Performance

The economy of Malawi is characterized by severe macroeconomic imbalances, including volatile GDP, unstable prices, high government domestic debt, low private sector credit, high unemployment and low capacity utilization from the internal sustainability perspective (Lungu, 2015). Monetary financing of large fiscal deficits is singled out as an important source of internal imbalances causing inflation and sometimes slowing down growth particularly in most developing countries. The paper uncovered that over-expenditure in the economy partly leads to a build-up of inflationary pressures and these cause persistent depreciation of the Malawi Kwacha thereby destabilizing the economy. High levels of public debt hinder the government to engage in fiscal expansion during a crisis. These inflationary pressures go way back in the development history of Malawi.

The inflationary environment is largely unchanged and inflation remains volatile, averaging around 18 percent since 1990. Inflation is largely driven by the food prices with agriculture dependent on the unpredictable weather conditions. The growth in Real GDP has taken a similar volatile pattern. This has raised questions on whether the monetary framework and its instruments are capable of yielding on the central bank's price stability directive (Chiumia, 2015). The evidence of volatile inflation pattern can be seen in the inflation cycle Figure 1. Inflation tends to stabilize during the maize harvest season and the Tobacco trading season as there is an inflow of foreign exchange. This appears to calm the rising inflation for only a moment. The big jump in **2012** was due to a **33 percent devaluation** of the kwacha, adoption of a floating exchange rate regime and adoption of an automatic fuel price adjustment mechanism. This was in response to the acute forex shortages and aid withdrawal from donors.

Figure 1. Inflation Cycle.

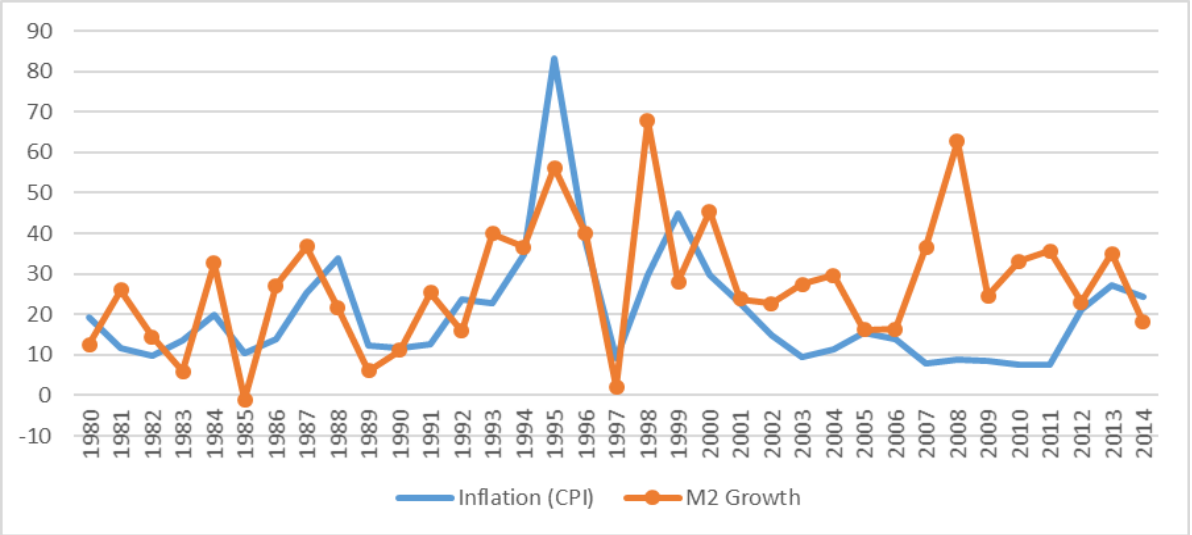


Source: Reserve Bank of Malawi, 2005-2014.

Consumer price response to monetary impulses is weak, giving us an indication that inflation might be largely driven by factors other than monetary in the economy (Ngalawa, 2009). He also noted that food costs have a preponderant weight (58.1 percent) in the all items national composite consumer price index. This reveals presence of structural rigidities in food production may be more important determinants of inflation than monetary considerations, further undermining the impact of monetary policy.

A break down in the relationship between inflation and money growth from 2001, presented in Figure 2, shows that there is no symmetry in the movements of these variables even in the later years (Simwaka et al., 2012). This could suggest that these movements are due to factors outside the control of monetary authorities. Further substantiating that while monetary policy tightening in the face of unsupportive fiscal policy remains key in lowering inflation, we need to look critically into structural rigidities that can be the underlying constraint to sustainable economic growth.

Figure 2. Movements in Inflation and Money (M2).

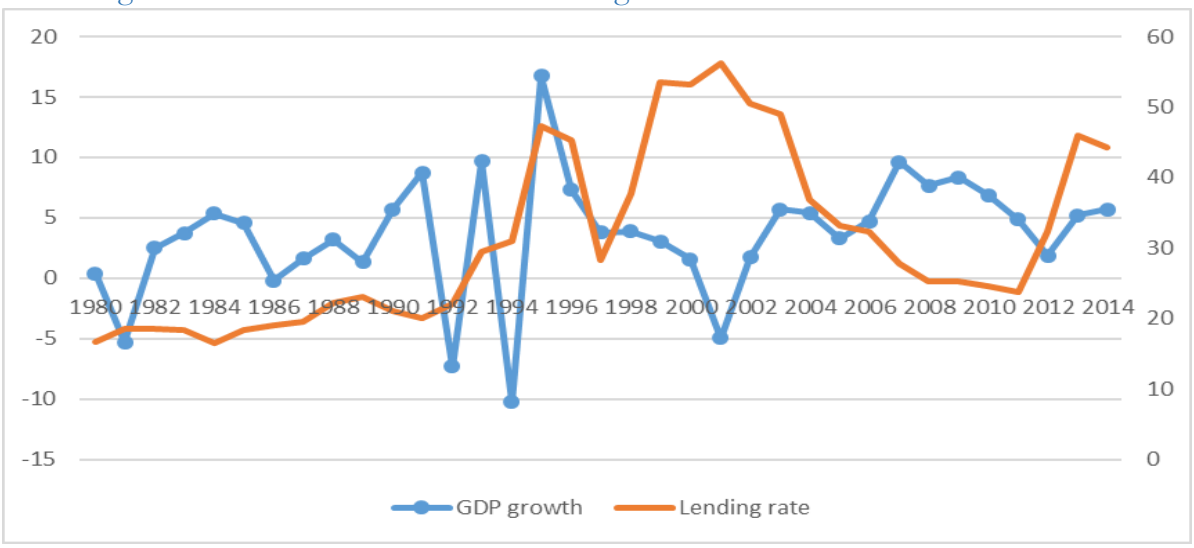


Source: World Bank Development Indicators, 1980 - 2014.

The surprising results of an unexpected tightening of *monetary policy* being followed by an increase rather than a decrease in the *price level* are a consequence of faulty methodological issues arising from imperfectly controlling for some factors (Sims, 1992). There are specific factors that pertain to the type of economy under observation with specific factors pertaining to low income countries being agricultural dependence, fiscal dominance and policy reversals among others. This explains why economists find contradictory results with Mangani (2012) finding evidence of this puzzle, while Mwabutwa et al (2013) found contradicting results. This leaves a knowledge and policy gap for African central banks which results in ineffective engagements with fiscal authorities, general public and the International Monetary Fund (Chiumia 2015). As a low income country, the agricultural dependence in Malawi shapes the face of output production. It is one of several African countries severely affected by *El Nino* having had dry spells during the 2015/2016 growing season. Agriculture production was massively affected with over 39% of the population estimated to not be able to meet their annual food requirements and likely to be food insecure in the consumption period 2016/2017 Food Security Assessment (2016).

GDP growth has been volatile and averaging around 3.6 percent since the early 80's. We see a mismatch in the movements of inflation and interest rates by the declining inflation trend during the 2000-2004 period (Figure 2), while that of interest rates averaged 46.4. The bank rate hit a record 50.23 percent in 2000, resulting in pressures to the base lending rate that rose to 52 percent (Figure 3).

Figure 3. Real GDP Growth and Lending rate.



Source: World Bank Development Indicators, 2015.

Note: Lending rate is read from the secondary x-axis. 1980 – 2014.

Since 2005, interest rates and inflation plummeted. Inflation and interest rates were low owing to the productive agricultural season that led to Malawi exporting some of the maize crops and the fixed peg exchange rate which controlled for imported inflation. Chavula (2016) notes that "Real GDP growth reached an average of 6.3%, with a relatively lower money supply growth rate of 1.93% over the same period". There was a decline in money supply growth during the 2003-2011 period as seen in Figure 2. There was considerable economic growth over this period and tight fiscal management led to discipline in government conduct (Mangani, 2011). The GDP growth fell since 2009, and though it has had a positive growth sign, this has not really translated into real growth in terms of development of infrastructure, the human capital development and status of the nation.

The Reserve Bank of Malawi (RBM) recently cut the policy rate from twenty four to twenty two percent (The Nation Newspaper, 24th March 2017). This has received mixed responses among economists in Malawi with most arguing that the core issues are more structural and infrastructure related than monetary policy.

This brings us to the contention of whether monetary policy is really necessary to effect the much needed economic growth or major focus has to be directed to the productive capacity and the supply issues of energy and water as well as infrastructure.

The study will add to the existing literature by empirically investigating whether the monetary variables have an impact on the short run changes in the real GDP growth rate. This is to determine if the changes in real GDP growth rate that are not explained by supply factors can be explained by the monetary variables. For this we find the long run impact of supply side factors on the potential output and then proceed to the short-run analysis including the monetary variables to ascertain the existence of a statistically significant relationship.

2.2. Monetary Policy Framework

RBM was established by an Act of Parliament that was passed in July 1964 after getting independence from the Britain and it became operational in 1965. The Act was later repealed in 1989 (Sato, 2001). The Revised Reserve Bank Act provided a basis for the RBM to increase its functions as a central bank by establishing a framework for open market operations, adjusting reserve requirements to meet policy goals, enhancing its supervisory powers, and strengthening its role as lender of last resort (IMF Staff Report, 1996). This granted the Bank some form of independence in its monetary policy operations and

exchange rate management topping up to the responsibility of issuing the Malawi currency. The Act stipulates that monetary policy should aim at promoting economic growth, employment, stability in prices, and maintenance of a sustainable balance of payments position (RBM).

Monetary policy framework shifted towards the use of Monetary Aggregate Targeting in the early 1990s. Following the full commissioning of a flexible exchange rate system after the 1994 general elections and the implementation of structural and political adjustments, this seemed to be a welcome development. But overtime, this role has evolved and it has been understood as that of maintaining price stability while promoting overall financial system soundness and monetary stability in the long-term interest of the national economy (Chiumia, 2015). Operationally, the Reserve Bank seeks to influence the broad money supply (M2) aggregate and domestic interest rates to attain its objective. The main instruments available to the Bank include statutory liquidity reserve requirement (LRR), open market operations (OMO), and the Bank rate (Sato, 2001). As reiterated in the Reserve Bank monetary policy statement (MPS) published in July 2016, the main objective of monetary policy is to achieve low and stable prices, that preserve the value of the Kwacha, and encourages investment needed to achieve sustainable economic growth and employment creation. The Bank also aims at building official foreign exchange reserves in order to manage exchange rate movements in a more credible manner and better cushion the market from shocks and ultimately anchor inflationary expectations that cause market distortions in the economy (Monetary Policy Statement, 2016).

Malawi uses an interest rate-based monetary policy framework where a change in the policy position is communicated by adjustments to the policy rate. It has to be noted that, regardless of this, monetary aggregates are still discussed and agreed in the context of the Extended Credit Facility (ECF) program with the International Monetary Fund (IMF). The set money supply target growth is achieved by setting an intermediate target on the growth of reserve money, which is directly linked to broad money supply through a money multiplier. The Bank conducts monetary policy objectives using an array of instruments comprising of; open market operations (OMO), the liquidity reserve requirement (LRR), the Policy Rate, foreign exchange market operations and Communication. The **Policy rate** is the main monetary policy instrument in Malawi. The Monetary Policy Committee (MPC) reviews and announces the policy rate, with its movements signalling the monetary policy stance of the Reserve Bank at that point (RBM, 2015). A reduction in the rate signals an

easing of monetary policy and a desire for market interest rates to move downwards while an increase signals tightening of monetary policy with desire to mop up excess liquidity.

3.0. LITERATURE REVIEW

3.1. Growth Models

"**The LDCs have neither the surplus of exportable products nor the production capacity to take immediate advantage of new trade opportunities. They will need substantial investment and technical assistance in order to expand their production**."

(Kofi Annan, 2001, as cited in Stiglitz and Charlton, 2006, p. 13)

Broader definitions of supply side economics focus on the determinants of aggregate supply. In this light, 'production or supply is the key to economic prosperity'. Supply-side economics is concerned with the determinants of potential output, or productive capacity, and changes in it over time (Krueger, 2010). He notes that it is quite possible to recognise that output is the outcome of the interaction of aggregate supply and aggregate demand from the set definition. Krueger further explains that not only do the shortfalls in aggregate demand lead to production below the potential level, but they also cripple investment and this impacts negatively on future potential output. Therefore, supply-side analysis focuses on the root of increases in the supply of factors of production as well as the total factor productivity.

A 2007 study by the United Nations Industrial Development Organization (UNIDO) noted that the reasons for developing countries' failure to benefit from the opportunities offered by rapidly evolving global markets are not only related to market access issues but also to lack of supply capacity with which to enter market. Lack of or poor export capacity in many sectors in Africa can be traced back to a plethora of problems that inhibit industrial and trade development such as high physical infrastructure costs (energy, water, communication, transport), low skill base, low level of technology adoption, absence/weakness of institutions to support private sector development. They pointed out one of the areas of special concern to be lack of effective industrial productive capacity to ensure optimisation of production and product diversification. This cripples the economic growth of the nations and leaves them on a constant struggle to catch up.

The standard approach to modelling the supply side of an economy is the Solow growth model (Eq. 1). Farida & Asfahani (2006) extended the Solow growth model to include

corruption as a determinant of the multifactor productivity. In addition to the classical components of a growth model, (labor and capital), they incorporate corruption as a determinant of government expenditure, investment and foreign aid. The functional form of the production function is represented by a revised Cobb-Douglas function (Eq. 2):

$$Yt = K_t^{a} L_{\beta_t} \quad where\ L^{1-a} \qquad (1)$$

$$Yt = K_t^{a} H_t[G_t(\rho)L_t].^{1-a-\beta} \qquad (2)$$

where $\mathbf{Y_t}$ is the aggregate level of real income, K_t is the level of physical capital, H_t is the level of human capital, L_t is the amount of labor employed, G_t is the level of government expenditure, and ϱ is the level of corruption in the country, where $G'(\varrho) < 0$. They let $0 < \alpha < 1$, $0 < \beta < 1$ and $\alpha + \beta \leq 1$. These conditions are defined to ensure that the production function exhibits constant returns to scale and diminishing return to each point. With the omission of the corruption term, the model yields standard neoclassical results. We get some empirical motivation from this approach in our potential output phase.

Hájková and Hurník (2007) discuss the use of the production function method for the measurement of potential output growth and they take into account different sources of an economy's productive capacity. These included the contributions of labour, capital and total factor productivity (TFP), with TFP containing information about technological and allocative efficiency and hence about the supply-side functioning. We will use a stylized production function model as it suits our supply side purposes.

Malawi Constraints Analysis (2010) found the issues of: power, international corridors, human capital, water and irrigation and finance to represent the binding constraints for Malawi's economic growth. The study notes that the poor state of the power infrastructure is clearly a major constraint on returns to investment within the private sector for both existing and new investors. As a result, the risk of lower returns limits diversification into non-traditional exports and particularly undermines manufacturing output and investment. On water and irrigation, beside frequent droughts and flooding as well as low levels of irrigation, one of the other challenges in this sector is the degradation of water resources through deforestation and sedimentation that negatively impacts businesses and individuals as well as other sectors such as health, power generation and the transport network. The

study shows that droughts affect agricultural productivity which is main export conduit for Malawi. It is these supply constraint values that make up for our research variables. We take into account rainfall because it the catalyst variable for economic growth. In Figure 4, we see the percentage contribution of hydroelectricity to the total power generated in Malawi from 1990 to 2014.

Figure 4. Power Generation Share of Hydro-electricity

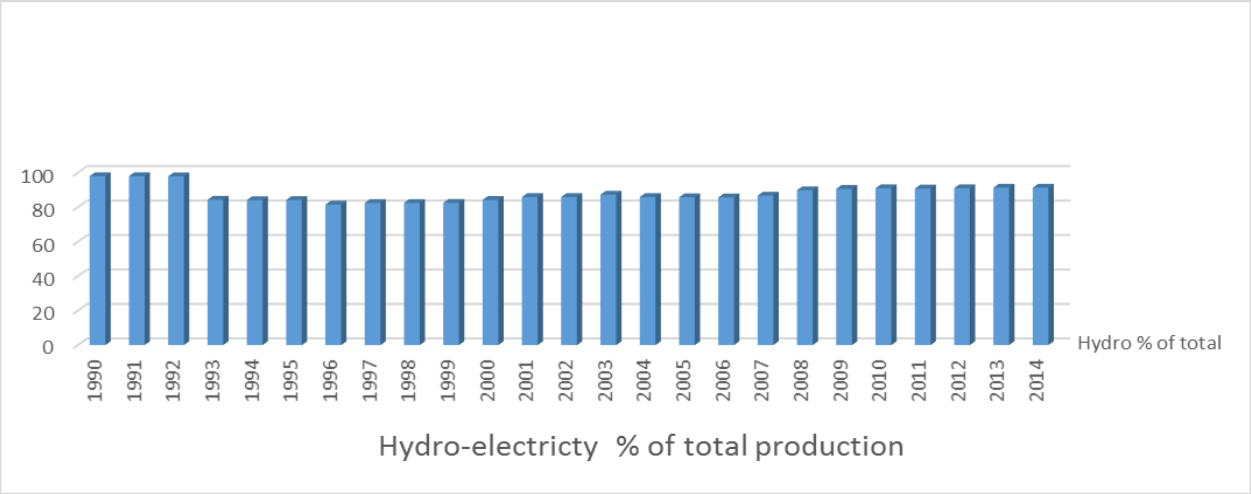


Figure 3. Source of data: World Development Indicators

This contribution has been well over 80 percent which tells us the importance of rainfall. If we include the variable of electricity, there will be high autocorrelation with rainfall as well as the variable of capital which has an element of electricity as part of working capital. Therefore, we will consider the variable of rainfall over the time period under study to control for this.

The quality of the infrastructure with regards to transportation is handpicked as one of the key factors that affect investment decisions (Duc Thanh & Van Dai, 2016). The Vietnam Chamber of Commerce and Industry (VCCI) conducted a survey in 2013 on more than 85 investors and it showed that the transportation infrastructure is the first and foremost element to be considered in selecting an investment destination. They noted that investment in the transportation sector has massive positive spillover effects in addition to boosting the economic growth. Earlier research had shown that improving roads in rural areas helps increase the number of the working hours by rural employees and this substantiated these

findings (Cuong, 2011). The performance of the supply side of an economy is often identified with the growth rate of potential output (Hájková & Hurník, 2007).

Kasekende & Brownbridge (2011) highlight the issues that arise from the nature of major macroeconomic shocks in Africa, which are more likely to emanate from the supply side than from the demand side. Supply-side shocks create a policy dilemma for central banks because they entail a trade-off between growth and inflation targets. They noted that a monetary policy with too strong an emphasis on meeting an inflation target in the short term could intensify volatility in output which, in turn, could translate into lower long-run growth.

A weakness of the monetarist orientation of monetary policy is that it ignores the effects of contractionary monetary policy on the supply side of the economy. A shortage of credit constitutes a constraint on capacity utilization, investment, and employment in the business sector. Therefore, as Blinder (1987, p. 336) puts it, 'credit restrictions, which reduce the supply of credit for either working capital or investment, are a major channel through which financial policies have real effects.' If these supply effects are quantitatively important, there may not be a trade-off between price stability and output growth (Olweny & Chiluwe; 2012).

Malawi is failing to meet its local demand for the textile and garments exports due to lack of equipment and raw materials. There is a need to get equipment which could boost productive capacity for the small and medium enterprises by over 50 percent from the current annual level of production (COMESA[2], 2017). As of September 2016, Malawi exported goods worth K10.8 billion to COMESA and imported K97.6 billion worth of products, creating a massive negative trade balance of K86.8 billion (NSO,[3] 2017). There is a huge need a boost in the productive capacity. In addition to this, Malawi is failing to meet the huge rice demand from the SADC region including its neighbouring countries, Zambia and Zimbabwe, with Zimbabwe importing most of its rice from Thailand which accounts for 35 percent of their imports and Zambia having a production capacity of around 15,000 tonnes every year (The Nation newspaper, 2017). Our trade balance has been in recurrent deficit and the lack of supply response to demand is a huge problem.

The empirical literature on the supply side studies shows the existence of diverse views among researchers on the supply factors impact on the economic growth but generally notes supply constraint which stifles economic growth. We will consider the two variables of

[2] Common Market for East and Central Africa
[3] National Statistics Office

agricultural rainfall and power generation in the Malawi Constraints Analysis (2010) study for investigation in our Cobb Douglas style supply function.

3.2. Monetary Channels

Holtrop (1963) coins monetary policy as the art of managing money. He argues that its very use poses a potential threat to economic stability as it enables the creation of time lags between the acts of supplying and purchasing goods and services from the market. The ultimate aim of monetary policy should be to cancel out such disturbances if and when they occur, thus assuring a steady flow of total demand that will continually absorb the steady flow of total supply. This shows monetary policy as a correction mechanism for market distortion due to time lags in transactions.

Monetary policy influences the level of nominal interest rates, the currency and the average rate of inflation in the economy. The relationship between inflation and interest rates is an example of a policy rule (Stiglitz & Walsh, 2005). They describe a monetary policy rule as the way in which the Central Bank adjusts the policy as a reaction to economic circumstances. Inflation is one of the main factors that determine the reaction of the Central Bank, but it reacts to changes of unemployment rate and GDP, too. To be able to stabilize the economy, the Central Bank should manipulate the nominal interest rate with far greater caution that it also curtails inflation. Thus, monetary policy is the main factor determined by inflation.

Monetary policy performs through its impact on aggregate demand components, and such effects influence real economy and inflation (Khasawneh, 2015). The channels of monetary policy which affect economy can be divided into the following:

(a) Credit Channel

The credit channel is based on interest rate and the internal changes it causes in the **External Finance Premium** (EFP). The EFP is the difference between external assets (shares issued or debt) and internal assets which including retained profits (Bernanke & Gertler, 1995). Problems faced due to information asymmetry in the financial markets that make it hard to access finance as well as the general market defects are captured in the external finance and the interests it incurs (Khasawneh, 2015). The credit channel can be categorized into the; Bank lending channel and Balance sheet channel.

Aban (2013) defines the bank lending channel as having to do with the issues arising from information asymmetry between commercial banks and depositors that propel banks to restrict accessibility to funds available for lending by using various mechanisms i.e. sufficient

equity. This makes lending more difficult and expensive, thus unaffordable to the small commercial banks with insufficient capital, in effect giving undue advantage to larger banks. He notes that following a stringent monetary policy by monetary authorities as well as the small banks' inability to provide alternative sources of funds available for lending, it will put pressure upon such banks to reduce their lending activities. From this, it is evident that bank capital sufficiency is a primary factor to its lending abilities particularly in light of reverse movements in monetary policy. And banks with bigger capital and sufficient liquidity have a cushion that minimizes the effects of tightening monetary policy. Aban also found that another source of loan supply for the banks might be over-liquidity as this can be regarded as an alternative to capital or foreign debts that can be earned.

The Balance Sheet Channel also known as the Broad Credit Channel has to do with the possible effect of monetary policy changes on the balance sheet (Khasawneh, 2015). From the perspective of the firm, monetary policy effects on private sector can be observed through the balance sheet, the cost of capital, its effect on investment decisions and the internal rate of return (Gaiotti and Generale, 2001). Thus monetary policy that facilitates credit to private sector investment encourages the growth of private investment whilst tight monetary policy that restricts credit to businesses discourages private sector growth.

As in Boivin et al. (2010), we find that the interest channel is by far the most important transmitter of monetary policy shock. It is followed by the exchange rate. The bank lending rate of the credit channel comes in the third position. Monetary policy shock affects bank deposits, the total equity of banks, and claims on the domestic private sector alike. This means that monetary policy shock affects both the assets and liabilities of banks.

In the credit channel, a percentage increase in the repo rate decreases mortgage advances, total loans and advances, the credit extended to private sector, and the money supply (M3) (Gumata et al, 2013). A rise in repo rate is translated directly into an increase in short-term rates, which in turn aspect the cost of capital and cause a drop in investment spending by corporates and households. They further discovered that the decline in total loans and advances becomes significant four quarters after the shock and lasts until the tenth quarter. Similarly, total credit to private sector declines between six and ten quarters (Gumata et al, 2013: 25). Bank balance sheets are impaired. Equity and liability of banks increase shortly after the impact and then decrease and reach the minimum two years after the shock and then the effects die out gradually. It is evident that contractionary monetary policy to some extent affects the ability of the financial intermediary to supply loans to both corporates and

households. It is even clear when we consider the separately equity and deposits. They noted that the bank lending channel affects the demand for loans more. Total claims on the private sector decrease gradually and attain a minimum of 0.12 percent five quarters after the shock.

Bayangos (2010) found that there is a bi-directional causality between the private sector credit and real GDP, between private sector credit and consumer price index, between money supply and private sector credit in the Philippines. These findings so far confirm findings from other literature.

(b) Interest rate channel

The Interest rate channel takes into account short and long-term interest rates for business and household sectors. Increases in short-term interest rates lead to an increase in long term interest rates and this drives up the cost of capital combined with reduced demand for capital assets and final goods (Boivin et al, 2010; Clarida et al, 2000). This causes a reduction in aggregate expenditure. Therefore, the increase of stock from such assets includes a cost related to the changes in the interest rate which affect investment and expenditure decisions (Khasawneh, 2015). He noted that the expected age of the asset, which is usually long termed, determines the real interest rate and the expected real capital asset value.

Khasawneh also noted that interest rates are also relevant to the investment decisions made by household and business sectors through the Tobin's q channel (Tobin, 1969). Tobin defined '**q**' as the market value of firms divided by the cost of capital replacement. The higher the value of (q), the higher the facility value – higher than the cost of capital replacement – and the higher the investment expenditure (Boivin et al, 2010). This is one of the most important channels in industrial countries as direct and indirect interest rate gaps interpret about 80% of investment movements which influence the GDP (Khasawneh, 2015). He says there are many obstacles which prevent the interest rate channel from performing effectively

i.e. underdeveloped financial and debt markets, especially in the countries which have state-owned commercial banks. This limits the bank' ability of providing loans in accordance with commercial standards and measures (Horvath & Maino, 2006; European Central Bank, 2002). Price stickiness for those who follow a stringent monetary policy might increase nominal and real interest rates which might increase the cost of capital and decrease the investment expenditure, so that the aggregate demand and real GDP could be reduced (Kuttner & Mosser, 2002). An expansionary monetary policy reduces nominal interest rates

which reduce real interest rates, and this decreases the price of capital which increases investment and real GDP (Khasawneh, 2015).

(c) Exchange Rate Channel

The exchange rate channel is an international trade-based channel as the exchange rate movements affect the current account balance. It is especially important for emerging economies due to the vulnerability of their exchange rate to the shocks that occur in international exchange markets. The strength of the exchange rate channel in the monetary policy transmission depends on the exchange rate sensitive to changes in interest rate and that it seems larger in open economies (Boivin et al, 2010). They noted that the exchange rate channel is potent when the exchange rate is very sensitive to interest rate movements, as in the case of uncovered interest rate parity. The important role played by the exchange rate can be attributed to the fact that in a floating exchange rate regime the domestic currency becomes a shock absorber.

Higher interest rates mean stronger currency, and this depresses net export demand and output while lower interest rates weaken the domestic currency, with currency depreciation resulting in a rise in export and GDP. Interest rate changes also affect prices of imported goods and services leading to a direct price hikes (Boone and Maurel, 1998).

3.3. Monetary Policy and Growth

Monetary policy affects business investment through the interest rate channel as the movements in nominal interest rates change the cost of capital and the movements also have an effect on the net cash flow[4] available to an organization that in turn affects investment (Chatelain et al, 2001). This is the broad credit channel. They concluded that, from the results, the interest rate channel is operative when market interest fluctuations change the user cost of capital and hence investment and the broad credit channel is operative when market interest fluctuations change the balance sheet condition and the available cash flow of firms, and through this it affects investment.

Credit plays a significant role in the relationship between monetary policy and output (Olweny & Chiluwe (2012). Conventional change in short-term interest rates brought about by the central bank changes the cost of capital, which then changes the rate of fixed investment, (housing expenditures, and inventories). The change in aggregate demand then leads to a change in GDP (Kahn, 2010). He, however, posits that empirical evidence to

[4] Cash flow after interest payments

support the conventional view of the effects of monetary policy on GDP is weak and this led to the development of the credit channel theory of monetary policy.

Ncube & Ndou (2011) note that a proportion of consumption declines due to the combined effect of house wealth and credit changes following monetary policy. The findings show that the direct effects of high interest rates on consumption appear to be more important in transmitting monetary policy to the economy than through the indirect effects. Hence, monetary policy tightening can marginally weaken inflationary pressures rising from excessive consumption operating through house wealth and the credit channel.

Monetary variables remains one of the most common monetary policy instruments used by developing countries. "It is especially important for countries such as Malawi where monetary authorities continue to put emphasis on the role of money demand on their monetary policy operators" (Lungu et al., 2012). They noted that some economists have made an argument for the money demand function as being an alternative mechanism for monetary policy, apart from the interest rate channel, as it provides useful information about portfolio allocations. The RBM targets money supply by focusing on monetary aggregates as intermediate targets
(Chavula, 2016). He argues that money demand function is based on the belief that demand for money in a country makes aggregate money supply traditionally believed to be driven by the level of income, consumer prices and interest rates.

A reduction in the policy rate leads to a fall in the lending rate, but with an increase in money supply, and with an insignificant impact on output growth. Monetary authorities in Malawi have to make a choice between the objectives of maintaining lower money supply and lowering the lending rate. Despite the Reserve Bank of Malawi Act of 1989 stipulating that monetary authorities should pursue both price and high growth and employment objectives, price stability is the principal objective of monetary policy in the country. Suggesting that monetary authorities in the country should not only place more emphasis on the objective of stabilization and achieving low inflation, but also focus on supporting strong, sustained and shared growth. To some extent further suggesting that emphasis should be placed on policies and strategies aimed at structurally transforming the Malawian economy so that the monetary policies' impact should translate into an increase in the country's output and growth. Further suggesting enhanced effective coordination between fiscal and monetary policies (Chavula, 2016).

4.0. METHODOLOGY

This study provides a country case study for Malawi over the period 1980 and 2014 for the short run impact of monetary policy variables on changes in output after identifying a long run production function. We adopt an error correction model approach according to the work of Binh (2013) and apply an innovative approach by integrating monetary variables in the error correction equation to account for the contribution of monetary policy. The time period selection is motivated by the availability of data for the variables in this study.

4.1 Model Specification

The first part of this research design follows the production function work of Mansouri (2004) which included additional variables to capital and labor in Morocco. He used the supply side approach by including drought and other variables, as Morocco is an agricultural economy, to a Cobb Douglas model. He noted that drought plays a major role in reducing private consumption and investment. After examining the factors outlined in the Malawi Constraint Analysis (2010), we incorporate drought into our model. We create a drought variable to represent the fluctuations of rain in our model, which affects both agriculture production and hydro energy production.

The second part of this research design uses the Error Correction Model (ECM) following the work of Binh (2013). The ECM determines the short run relationship and we factor in the monetary variables so that we can empirically investigate their impact on the changes in economic growth given the long run production function. We conduct the necessary tests to determine if the model is stable.

4.1.1. Potential Output using the Cobb Douglas model

We specify a long run supply side production function in equation (3) below. The aim is to find deviations from the potential output, which are the residuals not explained by the factors of production.

$$Y = A.\ K^{\alpha}.\ L^{(1-\alpha)} \qquad (3)$$

Where Y is real GDP, A is total factor productivity, and L and K stand for the growth of labor and capital inputs respectively.

In this model A captures the total factor productivity (TFP) of growth in output not accounted for increases in factor inputs (K and L). Following the new growth theory, A may be endogenously determined by economic factors (Mansouri, 2004:5). The fundamental assumption made in this model is that total factor productivity is constant and there are constant returns to scale.

According to the Malawi Constraint Analysis (2010), the issues of Power, international corridors, human capital, water and irrigation, and finance are singled out to be the binding constraints with regards to economic growth Malawi. To account for some of these additional constraints on economic growth, we introduce a drought variable (as a proxy for rainfall), to capture some of the variations in hydroelectricity production as well as agriculture production. The specificities of the Malawian economy, being an agricultural economy, make for a case to put rainfall into consideration. Then we modify the standard Solow growth model to account for the supply constraints.

Furthermore, we want to relax the assumption on constant returns to scale[5]. Therefore we do not constrain the sum of the coefficients of the factors for the supply variables.

$$Y_t = A_t * K_t^{\alpha} * L_t^{\beta} * Dr_t^{\gamma} \qquad (4)$$

Where:

- Y is measured as GDP in constant prices, that is nominal GDP deflated by the GDP deflator
- L is measured as the volume of the total labor force
- K is approximated through the capital
- Dr is the drought

The final selected form of the model may be presented in logs:

$$\text{Log}(Y_t) = \alpha_0 + \alpha_1 \text{Log}(k_t) + \alpha_2 \text{Log}(L_t) + \alpha_3 \text{Log}(Dr_t) + \eta_t \qquad (5)$$

[5] We also tested a Cobb Douglas model but it did not work well.

Where the α_i ($i \in \{0, 1, 2 \ldots 3\}$) are the elasticities to be estimated, η is a residual variable.

4.1.2. Error Correction Model

Malawi is a small-open economy, so the aggregate demand function may include the real interest rates and the exchange rate (Chavula, 2016). We are particularly concerned about the impact of monetary policy in Malawi, so we will also test monetary variables in the ECM growth equation (6). The modified ECM goes as follows:

$$\Delta Y_t = B_0 \Delta X_t - \pi ECT_{t-1} + B_1 \Delta Z_t + u_t \quad (6)$$

Output (Y) and, capital and labor (X) are assumed to be in long-run equilibrium. We also take the impact of monetary variables (Z_t.). If Y_{t-1} deviates from its equilibrium, the error correction mechanism returns it to equilibrium with the speed of adjustment given by $\pi = (1A_1)$, which is between 0 and -1.

Our final model will resemble a growth model and is written as follows:

$$\mathbf{dLog}Y_{t-1} = B_0 - \pi ECT_{t-1} + B_1 \mathbf{dlog}(K_t) + B_2 \mathbf{dlog}(L_t) + B_3 \mathbf{dlog}(Dr_t) + B_4 \mathbf{d}(RIR_t) + B_5 \mathbf{dlog}(RER_t) + B_6 \mathbf{dlog}(1+NCG_t) + B_7 \mathbf{dlog}(NCP_t) + u_t \quad (7)$$

Where $\mathbf{dlog}(Y) = \mathbf{log}(Y_t) - \mathbf{log}(Y_{t-1})$ $\mathbf{d}(RIR_t) = \{RIR - (RIR(-1)\}$

In our model above, the full variable description below:

- πECT_{t-1} is the deviation from potential output in the long-run equation.
- Y_t is the growth rate of real gdp in the economy
- RIR is the real interest rate
- RER is the real exchange rate
- NCG is the net credit to government
- NCP is the net credit to private sector

4.2. Data Sources and Variables

The descriptive statistics can be found in Appendix 1. The macroeconomic time series data are collected from the World Bank's *World Development Indicators* (WDI), World Bank group

climate change knowledge portal, the Reserve Bank of Malawi (RBM), National statistics office (NSO) Malawi and the Federal Reserve Bank of St. Louis Economics Database (FRED).

The variables are defined below:

(a) Real gdp

This is the dependent variable. We use the Malawi GDP (constant 2010 US$) obtained from the IMF database.

(b) Capital

This is the capital stock in constant national prices for Malawi. This is obtained from the Federal Reserve Bank of St. Louis Economic Data (FRED).

We expect capital to positively affect real GDP as is typical of a production function.

(c) Labor

This is the number of people employed in the population in millions. The data is taken from Federal Reserve Bank of St. Louis Economic Data (FRED).

We expect this to positively affect real GDP as in all production functions.

(d) Drought

We created a drought variable based on annual rainfall (mm rain), taken from the World Bank Climate Knowledge Portal and National Statistics Office (NSO) Malawi. Drought is the shortfall of actual annual rainfall from the calculated average over 1980 to 2014 which is 1057.66mm, and we establish a cut-off point for drought and flood based on this. Any point below 100mm from **1057.66 mm** is a **Drought**. We will measure the drought variable as the difference between our actual cut-off point, (**1057.66-100) = 957.66mm,** and the actual amount of rainfall in the drought year. This will capture the magnitude or severity of the drought.

We expect this variable to negatively impact real GDP, because Malawi is an agricultural economy with rain-fed growth and having a hydroelectric mode of power generation.

(e) Real Net Credit to Government (NCG)

This is one of the key elements of money supply. We use the real net credit to the government obtained through dividing the nominal NCG by the average annual consumer

price index (CPI). We obtain the nominal NCG from the Reserve Bank of Malawi (RBM) data and the CPI from the IMF economic indicators. This allows us to capture the real individual sector contribution.

Real increases in credit to government is more likely to create high government debt and crowd out other investments, thus have a negative impact on real GDP growth.

We use (1+NCG) for this variable in our equation because we have periods where the NCG was negative.

(f) Real Net Credit to Private Sector (NCP)

This is the second key component of money supply. We use the real net credit to the private sector calculated through diving the nominal NCP by the average annual CPI. The nominal NCP data is obtained from the RBM and CPI from the IMF economic indicators.

It is not clear whether positively or negatively impact real GDP growth. A real increase in NCP may be inflationary or cause an increase in the nominal interest rate and this depresses GDP. However, a real increase in NCP may also mean more credit for investment and this creates employment, boosts businesses and drives up the real GDP growth. Therefore, the impact is not readily certain.

(g) Real interest rate (RIR)

The real interest is measured as the lending rate less the average annual CPI. We use the World Bank Development Indicators for the data.

We expect the real interest increases to negatively impact real GDP.

(h) Real exchange rate (RER)

We calculated real exchange rate using the formula: RER=NER*(CPI_US/CPI_Malawi) where NER=nominal exchange rate for Malawi, CPI_US is consumer price index for USA and CPI_Malawi is the consumer price index for Malawi. The Malawi data is taken from the Reserve Bank of Malawi and FRED website for US CPI. In this formulation, an increase represents a depreciation.

We expect this variable to have a positive relationship with real GDP if the Marshall-Lerner conditions hold. A depreciation of the RER makes domestic goods cheaper than the partner trade nation and this positively affects the export revenue while slowing down imports hence boosting trade balance.

5.0. EMPIRICAL RESULTS AND DISCUSSION

5.1. Data Analysis

The descriptive statistics of each individual variable in our model and the results are shown in **Appendix 1**. We examine the stationarity of the data through testing for unit roots using the ADF test. After conducting the ECM test, we will check for the robustness of our models by testing for autocorrelation, heteroscedasticity and the normality of residuals.

(a) Unit Root Test

Empirical literature suggests that models estimated using trended or non-stationary macroeconomic time series due to the presence of a unit root in the data may result in a "spurious regression" (Mbewe & Ellyne, 2015). Series that are nonstationary may still be cointegrated but must be tested for cointegration. Typically, it is advantageous to identify nonstationary series for long-run relationships.

We use Augmented Dickey-Fuller (ADF) test for unit roots. We examine the data to determine if the variables are non-stationary and to which order they are integrated (Asteriou & Hall, 2011: 338). For variables that are stationary, we expect them to have a constant variance guaranteeing no heteroscedasticity.

Table 1 shows the ADF test summary for all the long-run production function. The results indicate that all variables are nonstationary in level specification, but become stationary with first difference, except drought which is already stationary in levels.

Table 1: Unit Root Test of Long-run Variables Using the ADF Test

H_0: The variable has a unit root

Variable	ADF Test		Order of Integration
	Level	Differenced	
Rgdp	1.327108	-7.634***	I (1)
Capital	-0.200035	-3.571***	I (1)
Labor	0.154891	-3.1951***	I (1)
Drought	-4.9549***	-6.1306***	I (0)

Notes: *****[**][***] indicate rejection of the null hypothesis at 10% [5%] (1%) level of significance.

Table 2 shows the ADF test summary for the monetary variables, and shows that the variables are stationary in first difference, except for **NCG** and **RIR** which are already stationary in levels. The ADF test is performed in EViews and the t–statistics presented in Tables 1 and 2 are compared against the MacKinnon (1990) critical values.

Table 2: Unit Root Test for Monetary Variables Using the ADF Test

H_0: The variable has a unit root

Variable	**ADF Test**		**Order of Integration**
	Levels	**Differenced**	
Rer	-1.963604	-5.7479***	I (1)
Ncg	-3.2905***	-5.4048***	I (0)
Ncp	0.219344	-4.55839***	I (1)
Rir	-2.8229***	-6.7521***	I (0)

Notes: *****[**][***] indicate rejection of the null hypothesis at 10% [5%] (1%) level of significance.

We will use the non-stationary levels to test for the existence of a cointegrating relationship. The results of the ADF test give us the much needed impetus to go ahead with our analysis.

5.2. Long Run Relationship

Cointegration is used to determine a long run relationship between our supply side variables, including the exogenous rainfall variable. Variables X_t and Y_t are said to be cointegrated if they follow a common stochastic trend and the linear combination of which yields a stationary process (Engle & Granger, 1987). We can make use of both the Johansen (1988) and Engle and Granger (1987) cointegration techniques. Using OLS on stationary series may change the nature of the underlying relationship being studied if it employs differenced series. Using cointegration methods on non-stationary level data preserves more of the original information in the data, which can be particularly beneficial for establishing long-run relationships (Mbewe and Ellyne, 2015).

We prefer the (Engle & Granger, 1987) approach and have used it in our cointegration analysis. To affirm the existence of a cointegrating equation (see Appendix for a Johansen Cointegration EViews result of our test).

The Engle Granger is done in two steps. We first estimate a long-run production function, then test its residuals for stationarity.

We see the summary of first step results below. The full equation is in appendix 2, table b1.

Table 3: Long Run Production Function Results

Dependent variable = log (RGDP)

Variable	Coefficient	Standard Error	t-Statistic	P-Value
C	-6.9970	4.8536	-1.442	0.1594
Log(Capital)	0.891802	0.3178	2.8057	0.01***
Log(Labor)	0.878247	0.1555	5.647	0.0000***
Ln_Drought	-0.0045	0.0051	-0.887	0.3820
R2	0.975011			

Notes: ***** (***) indicate significance of the parameter at [5%] level of significance

With Engle-Granger cointegration, we see the summary of first step results above. The full equation result is in appendix 2, table B1. We can see that the Durbin Watson statistic is less than our Adjusted R-squared which might present misgivings for our model being spurious but if the residuals from this equation are stationary in levels then the equation is justified and more importantly, it means there is a cointegration relationship in the model.

Table 4: Unit Root Test of Residuals of Long Run Equation

H_0: The residuals are nonstationary

Variable	**ADF t-Statistic**	**Standard Error**	**P-Value**
ECT	-3.241173	4.576877	0.0936
Engle Granger Critical Values		5% ~ 3.34	10% ~ 3.04

We see the summary of second step results in the table above. **ECT** is the residual of the long run equation. The absolute ADF test statistic, **3.241173,** is greater than the Engle Granger critical value as stipulated by MacKinnon (1991) at 10% level of significance which is **3.04**. Therefore, this gives us justification of rejecting the null of the presence of a unit root.

In summary, we find that there is one cointegrating relationship between real output, capital, labor and drought variables in Malawi.

Interpretation

From the table of summarized results in **Table 4**, it is important to note that all the estimated coefficients of the long run equation conform to our *a priori* expectations as capital has more and positive effect on real output than labor, and drought has an inverse effect. The P-values indicate that all the estimated coefficients are statistically significant at the 5% level except the constant and the drought. Moreover, our log-log model indicates the likelihood of increasing returns to scale.

A strong relationship exists between real gross domestic output and capital, labor and drought over the period of 1980-2014 in Malawi. The regression model is not spurious as tested using the unit root of its residuals and this makes the parameters credible. The time series data of these variables are not stationary and they become stationary after first difference. There exists a long run relationship as indicated by Johansen co-integration test.

The statistically significant elasticity coefficients of OLS estimation at level expresses that, ceteris paribus, a percentage increase in capital usage will increase the real gdp output by approximately **0.89%** in the long run. This exhibits that capital is a valuable resource as it almost gives an equal return on its investment. This assertion is consistent with the studies of Lea and Hanmer (2009). The elasticity coefficient of labor expresses that a 1% increase in labor usage will increase the real gdp output by approximately **0.88%** in the long run holding all other factors equal. We can notice that the sum of capital and labor is greater than one in our equation. What we have here is an evidence of increasing returns to scale. A percentage increase in the factors of production will translate to an over 1% increase in the real output displaying increasing returns to scale.

The elasticity coefficient of drought expresses that, ceteris paribus, a percentage increase in drought occurrence will decrease the real gdp output by approximately **0.01%** in the long run. The IFPRI[6] (2009) found that droughts and floods cost the Malawian economy about

[6] International Food Policy Research

1.7 percent of its GDP every year. This is equivalent to almost US$22 million (measured in 2005 prices). They noted that, compared to droughts, the flood scenarios have similar but smaller macroeconomic effects. This research is highly consistent with our results in this study. The research noted that droughts exacerbate poverty incidence, both directly through its impact on household incomes and indirectly through its impact on consumer prices. At the national level, a low scale drought causes a 0.7 percentage point increase in the poverty rate. This rises to as much as 16.9 percentage points during a severe drought. This is according to our expectation.

Lastly, the constant coefficient of 0.0009 calculated from the getting the exponent of the constant is our total factor productivity (TFP). This shows that there is a small but constant increase in the TFP of our economy.

5.3. Short Run Dynamics

(a) Error Correction Model

After estimating the long run cointegrating equation (Eq.3), we estimate the short run equation with an ECM (Eq.4). The ECM includes errors from the long run relationship, which must have a coefficient with a value less than -1. If a long-run cointegration is valid, then the ECM will exist, according to Engle and Granger (1987). We have established a long run production function, now we want to examine short run impact of monetary variables by including them in ECM. Find below a summary of the short run dynamics.

Table 5: ECM Test Results

Dependent variable = Dlog (RGDP)

Variable	Coefficient	Standard Error	P-Value
ECT (-1)	-0.374056	0.138945	0.0123***
Dlog(Capital)	0.775576	1.606389	0.1203*
Dlog(Labor)	1.253695	0.356458	0.0016***
Dlog(Drought)	-0.003830	0.003583	0.2949
Dlog(ncp)	-0.076775	0.034293	0.03 ***
Dlog(1+ncg)	-0.004975	0.003076	0.079 [**]
Dlog(Rer)	-0.028098	0.029804	0.3545
(Rir-(rir(-1)))	0.000102	0.000713	0.8869
R^2	0.467861		

Notes: *****[**](***) indicate rejection of the null hypothesis at 10% [5%] (1%) level of significance.

The summary results for the coefficient on the error correction terms, ECT (-1), has negative sign less than 1, which confirms that the system is stable and converges back to the long-run equilibrium. The rate of convergence has a magnitude of -0.374, which means that 37% of the disequilibrium in real output caused by changes in the independent variables (the supply factors) is corrected each year. This suggests it would take close to 2.7 years to return to equilibrium.

Labor, net credit to government and net credit to private sector are significant at 5 and 10 % levels in the short-run but capital, real exchange rate and real interest rate are not significant contrary to our expectations. All of these have the right signs but for RIR.

The coefficients for these variables tell us about the rate at which the real output growth changes in response to a percentage increase in the growth rate of the variables (Dhungel, 2014).

The coefficient on capital means that a percentage growth rate increase in this variable will lead to a **0.78%** change in growth rate of real output which tells us that capital is valuable in the short-run as also discovered in the long-run. A percentage growth rate in labor will lead to a **1.3%** change in growth rate of real output while the same growth rate in drought will decrease the real output growth rate by **0.004%** in the short run. The message these bring across is that capital and labor are still more important even in the short run. The supply factors are primary to economic growth while the monetary variables are secondary.

Two of our monetary variables are significant which shows that monetary policy seem to affect real output even though we do not have strong results. We expected real interest rate to be negative but it is giving us a positive sign, however, for the real exchange rate we have the sign according to our expectations even though it is not significant. With Real interest and real exchange rate not being significant, it goes away from the Keynesian school of thought that advocates that short-term real interest rates changes are more effective in policy, and substantiates the monetarist's view that changes in money supply are more potent (Chiumia, 2015).

The problem with central bank using bank rates to direct interest rates was that the major banks, until of late, would collude and reduce their rates by identical magnitudes, reflecting structural rigidities (RBM, 2000). This perhaps could be ascribed to the fact that with only two major banks, competition would not be expected to emerge from the deregulation in the

short-run. Another problem is that the spreads have not narrowed at all. Literature converges on the fact that long-run effects of monetary policy fall almost entirely on prices, with no discernible impact on the real variables but nominal rigidities help to exploit the dividends in the short-run (Walsh, 2010).

The negative sign on the rate of growth of real NCP was counter to our expectations but this gives us a fresh perspective as to what else this captures in the mix of monetary policy. The statistically significant rate coefficient of NCP tells us that a percentage increase in the rate of this variable will lead to a **0.08%** declining change in the rate of real output. We believe this might be capturing the policy reaction, with the inflation going up due to increased money circulation in the economy. This captures the inflationary effect that influences the central bank to raise the nominal interest rate by more than one percent point which is intended to foster price stability and full employment by systematically reducing uncertainty and increasing the credibility of future actions by the central bank (Taylor, 1993).
Despite that
Private sector credit expanded overtime, it did not hit the threshold level of 15.0 percent of GDP. This threshold level seems to be too high for developing countries like Malawi where the private sector is not vibrant and high degree of consumption in the economy is done by government. Nevertheless, private sector credit is mostly used for consumption of nondurables most of which are imported. This development also poses a challenge of debt repayment under prevailing circumstances of macroeconomic instability hence posing a risk of financial system instability due to loan defaults (Lungu, 2015). Private sector credit spurs private sector demand for imports which contributes to worsening the current account deficit.

The negative sign on growth of real NCG tells us that a percentage increase in the rate of this variable will lead to a **0.01%** declining change in the rate of real output. From 2000 to 2005 general government debt was very high averaging 150.0 percent to GDP. The bulk of the debt was external. A record high of 204.0 percent was registered in 2000 (Lungu, 2015). After debt relief, debt levels dropped substantially from 135.0 percent in 2005 to 32.3 percent in 2006. Since debt relief, the structure of debt has been dominated by domestic debt. However, from 2006 to 2014 debt levels have been below the threshold levels of 60.0 percent.

5.4. Diagnostic Checks

We performed several post-estimation diagnostic tests to ensure that our models are not spurious and yield robust estimates (See Appendix 5). We tested for the normality of residuals by using the Jarque-Bera test, which suggest that all our models have normally distributed residuals at the 5% significance level. We tested for heteroscedasticity of residuals by using the BreuschPagan-Godfrey Lagrange Multiplier (LM) and the results suggest that all our models are homoscedastic at the 5% level of significance. The last test was for autocorrelation using Breusch-Godfrey LM test which suggests that the models are free from autocorrelation. Based on the diagnostic tests, we can make statistical inference with greater certainty and have credible analysis.

5.5. Does Monetary Policy Affect Output In a Supply-Constrained Economy?

The long run production function above suggests that capital and labour are very valuable as they give an increasing return to scale. Surprisingly, the supply factors are still primary to economic growth in the short run while money seems to matter less. Therefore, the supply factors are the driving forces of economic growth while monetary factors are secondary.

6.0. CONCLUSION AND POLICY RECOMMENDATIONS

The goal of the study was to examine the impact of monetary policy in a supply-constrained economy using Malawi as a case study. The results should give us a framework on what to expect and how to go about monetary policy in economies that are supply-constrained.

6.1. Conclusions

The study has tried to show whether monetary policy affects real output in a supply constrained economy. The empirical investigation of macroeconomic issues shows the importance of including remedies to structural rigidities in policy formulation.

The results show evidence of a long run relationship between real GDP and supply factors; capital, labor and drought. Real GDP tends to increase by 0.891802 percent with an additional unit of capital and by 0.878247 percent with labor, but drought tends to decrease the level of real GDP by 0.004481 percent.

After estimating the long run relationship we used the ECM methodology to identify a dynamic short run growth model in which we added monetary variables

The results show that Capital and labor impact great changes to the growth of real out by effecting a 0.78% and 1.1%, respectively, in the growth rate of GDP for every percentage increase. The monetary variables exhibited the importance of money supply. A real exchange rate appreciation depresses real gdp. A real appreciation will make imports cheaper and exports less competitive. This only has a price effect and no quantity effect. Prior to 2011, Malawi was using a fixed exchange rate regime which led to overvaluation of the currency. This led to acute forex shortages and a high presence on the parallel market. After the exchange rate regime change to a flexible regime and an almost 55 percent devaluation mid2011, the real gdp growth picked up and forex restrictions were eased. Further study has to look into the different exchange regimes during this period to eliminate structural breaks in the data sample.

NCG and NCP were shown to depress real growth rate. This can be through the inflationary effect of money supply on the economy or a short run Phillips curve trade off. An increase in inflation will lead to a decline in investment by providing a disincentive for lending/borrowing or creating future uncertainty to investor and also alternatively might

increase the cost of exports as the real exchange rate appreciates which negatively impacts the balance of payments. This cumulatively gives us the negative and significant relationship in the model.

The real interest rate was positively related with real GDP. This is contrary to our expectations but the model could be capturing a policy response to increased money supply. An increase in money supply will trigger response a strong growth in GDP triggering a tightening of monetary policy. This could justify the positive relationship between real interest rate and real GDP.

The short run dynamics of our growth model indicate that monetary policy indeed affects the changes in the real output particularly through the impact of real net credit to government and real net credit to private sector. We also note that the disequilibria in real output caused by the various determinants are corrected within a space of 2.7 years in Malawi.

6.2. Policy Recommendations

The findings of this study give us a basis to a corroborative effort between prudent macroeconomic management and supply-side policies to ensure economic development.

(a) Macroeconomic Stability

A stable macroeconomic environment is fundamental for any economy's growth. The macroeconomic instability has led to reduced levels of investment which could mean the capital is being invested outside. Most of the fiscal and monetary policies that have been undertaken have generated unsustainable budget deficits and inflationary pressure thus raising local production costs, generating exchange rate instability and making the country a risky location for long term investment. The fiscal authorities should ensure that real exchange rate movements are stable and this can also be complemented by closely observing the general rise in the price level.

The fiscal authorities should make a stern effort to implement policies that promote macroeconomic stability by also considering the necessary fiscal adjustments. Though it has been shown that there is lack of capital, the government should focus on channelling the available foreign direct investment into human development platforms which would rather encourage domestic investment and make necessary import curfews to avoid the superfluous importing tendencies.

(b) Improved Irrigation Technology

Due to the regressive effect of droughts from the unpredictable weather pattern and high dependence on rainfall, Malawi must put in place a mechanism to harness from its water bodies in terms of irrigation to ensure sustained agricultural yields that could act as buffer for adverse economic consequences of droughts.

The Malawi Growth and Development Strategies (MGDS) II (2011) made reference to Green Belt Irrigation and Water Development as one of the key priority areas but this has not taken off. There must be enhanced coordination with regards to this priority area to ensure the natural water bodies are harnessed.

6.3. Limitations of Research

One of the setbacks in our methodology was the availability of data. There is no consistent long run data for all variables in the research hence we make use of annual time series data for the period 1980 to 2014. Another setback was the structural breaks in the dataset that makes the data unstable. These might potentially create a degrees of freedom problem but our tests prove the statistical credibility of the model results.

6.4. Directions for Further Research

Further research could consider a much longer time period of observation depending on the availability of the data. Due to the data instability, categorizing the structural breaks or the different exchange rate regimes and analysing the effects during each of these periods could be another direction for further. And also using the quality of education proxy for labor can help expound more on the human capital contribution. Therefore, there is still further need for research in this realm.

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APPENDICES

Appendix 1: Descriptive Statistics and Data

Table A1: Variable Definitions and Summary Statistics

Variable	Definition	Descriptive statistics				
		Obs	Mean	Std Dev	Min	Max
1. RGDP	Real GDP Output	35	6.48E+11	2.55E+11	3.58E+11	1.24E+12
2. CAPITAL	Capital Stock	35	6.86E+09	9.50E+09	5.33E+09	8.75E+09
3. LABOR	Quantity of Laborforce	35	8.14E+06	2.29E+06	5.00E+06	1.28E+07
4. DROUGHT	Rainfall Shortage	35	43.08	82.24	0	302.13
5.RER	Real exchange rate	35	55.5198	19.4167	24.612	91.786
6.RIR	Real interest rate	35	10.72	14.07	-35.99	39.34
7.NCG	Real net credit to Gvt.	35	405562	362966	-27059.9	1307281
8. NCP	Real net credit to Pvt.	35	483086	478076	115521	1676938

Notes: Obs means observations; Std. Dev means Standard Deviation

Sources: Author's own calculations EViews.

Table A2: Supply Variables Data

Year	RGDP	CAPITAL	LABOR	DROUGHT
1980	377633807.01	5328502.42	5002664.11	0
1981	357656528.43	5472198.63	5104759.30	164.69
1982	366610294.40	5612202.98	5362638.45	23.94
1983	380243464.63	5746730.03	5370039.24	197.37
1984	400625670.58	5866064.05	5593790.87	9.91
1985	418938199.06	5976527.91	5766794.71	0
1986	418038309.26	5968853.13	6007077.83	0
1987	424832431.74	5993393.86	6192863.74	269.64
1988	438330595.50	6074130.15	6384395.61	88.61
1989	444244781.89	6205856.21	6650412.09	0
1990	469511364.73	6272334.96	6786134.79	0
1991	510500795.58	6552111.29	6924627.33	2.04
1992	473065883.57	6683823.90	6952335.42	0
1993	518914673.42	6779115.51	6972599.71	0
1994	465776867.85	6748571.05	6953812.58	302.13
1995	543695830.36	6730383.17	7042955.90	180.8
1996	583476322.66	6699032.84	7174851.63	0
1997	605604190.17	6712853.82	7356721.54	0
1998	629194009.39	6696222.67	7584632.09	0
1999	648335840.92	6749232.02	7889843.68	0
2000	658554118.38	6792478.51	8193444.02	119.99
2001	625791289.12	6843907.29	8480966.46	0
2002	636429741.07	6813119.49	8782604.60	0
2003	672742127.39	6819027.82	9079947.29	0
2004	709208098.85	6900587.12	9392566.45	55.76
2005	732390167.18	7078224.94	9713858.26	77.32
2006	766812505.04	7363485.88	10044085.2	0
2007	840426505.50	7633970.16	10299262.1	0
2008	904632878.30	7910634.23	10720501.1	0
2009	979971702.00	8070312.89	11033373.1	0
2010	1009173847.2	8227297.51	11343225.3	0
2011	1098173847.2	8677092.51	11694192.9	15.56
2012	1118883204.2	8628099.10	12042233.9	0
2013	1177065130.8	8685711.36	12417826.2	0
2014	1244157843.3	874726252	12821954.1	0

Source: World Development Indicators, National Statistics Office (NSO) Malawi, Federal Reserve Bank of St. Louis Economics Database (FRED)

Table A3: Monetary Variables Data

Year	RER	RIR	NCP	NCG
1980	60.28	-2.523	386.8	176.86
1981	67.46	6.685	363.76	317.11
1982	75.65	8.679	378.2	364.91
1983	73.12	4.831	387.51	384.49
1984	80.20	-3.526	289.53	343.53
1985	91.76	7.856	243.85	376.9
1986	89.50	4.953	237.65	460.12
1987	81.25	-5.655	165.06	394.48
1988	77.66	-11.66	157.4	195.99
1989	88.36	10.55	204.45	183.84
1990	24.99	9.176	246.73	106.52
1991	24.61	7.731	279.06	90.26
1992	26.56	-1.751	302.85	245.53
1993	27.25	6.727	213.35	262.47
1994	41.57	-3.65	244.04	278.63
1995	40.44	-35.99	141.54	145.49
1996	30.18	7.73	115.52	90.66
1997	30.70	19.11	120.63	92.94
1998	42.72	7.92	184.77	-24.66
1999	45.18	8.78	134.77	-27.06
2000	48.76	23.54	155.88	3.63
2001	47.78	33.47	162.56	146.82
2002	44.93	35.7	227.44	347.85
2003	53.29	39.34	245.5	411.79
2004	54.87	25.4	306.07	490.78
2005	53.46	17.67	375.93	411.38
2006	55.61	18.28	508.27	277.98
2007	54.53	19.76	598.42	267.28
2008	52.29	16.57	793.58	976.56
2009	48.27	16.83	1020.9	1218.6
2010	48.69	17.21	1448.4	950.3
2011	48.55	16.13	1621.9	1307.3
2012	65.03	11.73	1676.9	1077.3
2013	75.22	18.73	1507.58	1108.3
2014	72.47	19.86	1461.28	739.8

Source: *World Development Indicators, Reserve Bank of Malawi (RBM) database*

Appendix 2: Tests

(a) Unit Root

Table B1: Level Form Variables

Null Hypothesis: Unit root (individual unit root process)
Series: LN_RGDP, LN_CAP, LN_DR, LN_LAB, LN_NCG, LN_NCP, LN_RER, RIR
Date: 07/11/17 Time: 04:02
Sample: 1980 2014
Exogenous variables: None
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Total number of observations: 270
Cross-sections included: 8

Method	Statistic	Prob.**
ADF - Fisher Chi-square	22.0063	0.1430
ADF - Choi Z-stat	2.15936	0.9846

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Intermediate ADF test results UNTITLED

Series	Prob.	Lag	Max Lag	Obs
LN_RGDP	1.0000	0	8	34
LN_CAP	0.9940	1	8	33
LN_DR	0.0012	0	8	34
LN_LAB	0.9961	1	8	33
LN_NCG	0.4937	0	8	34
LN_NCP	0.9137	0	8	34
LN_RER	0.6568	0	8	34
RIR	0.0476	0	8	34

Real interest rate and drought are stationary at level form.

Tables B2: First Differenced Variables

Null Hypothesis: Unit root (individual unit root process)
Series: LN_RGDP, LN_CAP, LN_DR, LN_LAB, LN_NCG, LN_NCP, LN_RER, RIR
Date: 07/11/17 Time: 04:16
Sample: 1980 2014
Exogenous variables: None
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Total number of observations: 259
Cross-sections included: 8

Method	Statistic	Prob.**
ADF - Fisher Chi-square	150.342	0.0000
ADF - Choi Z-stat	-9.43101	0.0000

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Intermediate ADF test results D(UNTITLED)

Series	Prob.	Lag	Max Lag	Obs
D(LN_RGDP)	0.0576	1	8	32
D(LN_CAP)	0.0124	0	8	33
D(LN_DR)	0.0000	1	8	32
D(LN_LAB)	0.4218	0	8	33
D(LN_NCG)	0.0000	1	8	32
D(LN_NCP)	0.0120	1	8	32
D(LN_RER)	0.0000	0	8	33
D(RIR)	0.0000	1	8	32

Null Hypothesis: D(LN_LAB) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.240215	0.0960
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_LAB,2)
Method: Least Squares
Date: 07/11/17 Time: 04:25
Sample (adjusted): 1985 2014
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_LAB(-1))	-0.461204	0.142338	-3.240215	0.0035
D(LN_LAB(-1),2)	-0.020476	0.171326	-0.119517	0.9059
D(LN_LAB(-2),2)	0.528002	0.169616	3.112920	0.0047
D(LN_LAB(-3),2)	0.322687	0.169550	1.903198	0.0691
C	0.008577	0.004511	1.901195	0.0693
@TREND("1980")	0.000202	0.000146	1.381412	0.1799

R-squared	0.458061	Mean dependent var	-0.000293
Adjusted R-squared	0.345157	S.D. dependent var	0.008356
S.E. of regression	0.006762	Akaike info criterion	-6.978182
Sum squared resid	0.001097	Schwarz criterion	-6.697942
Log likelihood	110.6727	Hannan-Quinn criter.	-6.888531
F-statistic	4.057083	Durbin-Watson stat	2.117375
Prob(F-statistic)	0.008241		

The labor variables indicates stationarity after differencing with intercept and trend

(b) Diagnostic Tests

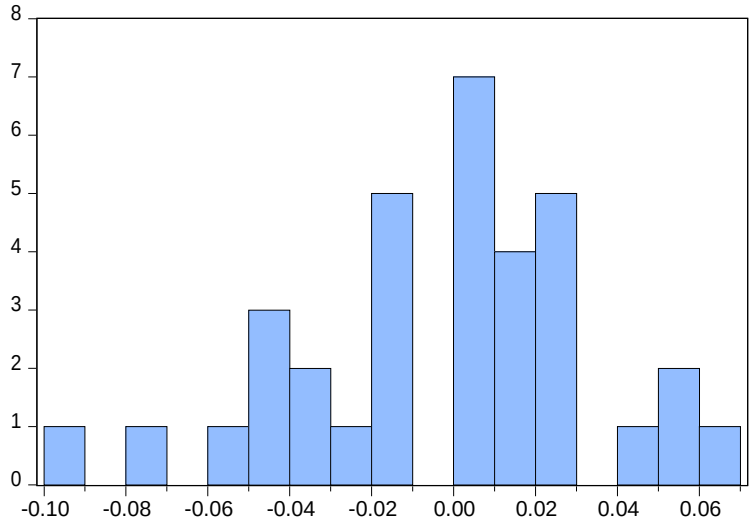
The ECM is likely to yield inefficient estimates if the equations are wrongly specified, or whether the data has outliers and with large variation. We therefore ensure that our estimates are robust by observing that our parameters are BLUE (Best Linear Unbiased Estimator). As such, we test for heteroscedasticity, serial correlation and the normality of residuals.

Normality of Residuals

We test the assumption of normality of residuals of the ECM by employing the Jarque Berra residual tests by testing whether the residuals of the ECM are normally distributed through

estimating a chi-square statistic which is eventually compared to the Jarque Berra tabulated statistic. This test is performed against a null of not normally distributed residuals.

Table C1: Jarque Berra Results



Autocorrelation

Table C2: Autocorrelation Results

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	3.367189	Prob. F(2,24)	0.0514
Obs*R-squared	7.449927	Prob. Chi-Square(2)	0.0241

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 07/11/17 Time: 03:23
Sample: 1981 2014
Included observations: 34
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.267958	0.188607	-1.420720	0.1683
C(2)	0.003955	0.027458	0.144040	0.8867
C(3)	-0.000719	0.002849	-0.252343	0.8029
C(4)	-0.108987	0.449210	-0.242619	0.8104
C(5)	-0.198977	0.338391	-0.588010	0.5620
C(6)	0.005649	0.003994	1.414458	0.1701
C(7)	0.000788	0.000725	1.086024	0.2883
C(8)	0.000710	0.032482	0.021871	0.9827
RESID(-1)	0.277642	0.274985	1.009662	0.3227
RESID(-2)	0.620305	0.239067	2.594698	0.0159

R-squared	0.216037	Mean dependent var	-0.002259
Adjusted R-squared	-0.077950	S.D. dependent var	0.036515
S.E. of regression	0.037911	Akaike info criterion	-3.467198
Sum squared resid	0.034495	Schwarz criterion	-3.018269
Log likelihood	68.94237	Hannan-Quinn criter.	-3.314100
Durbin-Watson stat	2.100963		

Homoscedasticity

Homoscedasticity relates to when the errors in the model have a constant variance. When errors are heteroskedastic (non-homoscedastic or without a constant error variance), our parameters become inefficient and we this using the Breusch-Godfrey LM Test which regresses the squared OLS residuals on the model's explanatory variables (Wooldridge, 2009). We perform this test based on the null hypothesis of the presence of heteroscedasticity (non-constant error variance).

Table C3: Homoscedasticity Results

Appendix 3: Engel-Granger and Johansen Results

Table D1: Summary of Engle-Granger Residual Cointegration Test

Null Hypothesis: ECT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.238726	0.0263
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECT)
Method: Least Squares
Date: 07/11/17 Time: 03:38
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT(-1)	-0.414046	0.127842	-3.238726	0.0028
C	-0.002945	0.007355	-0.400404	0.6915

R-squared	0.246870	Mean dependent var	-0.002245
Adjusted R-squared	0.223335	S.D. dependent var	0.048643
S.E. of regression	0.042868	Akaike info criterion	-3.404341
Sum squared resid	0.058806	Schwarz criterion	-3.314556
Log likelihood	59.87380	Hannan-Quinn criter.	-3.373722
F-statistic	10.48934	Durbin-Watson stat	2.058561
Prob(F-statistic)	0.002797		

Table D2: Johansen Cointegration Test

Date: 07/11/17 Time: 03:40
Sample (adjusted): 1982 2014
Included observations: 33 after adjustments
Trend assumption: Linear deterministic trend
Series: LN_RGDP LN_CAP LN_LAB
Exogenous series: LN_DR
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.484379	30.70421	29.79707	0.0392
At most 1	0.202299	8.845586	15.49471	0.3799
At most 2	0.041156	1.386897	3.841466	0.2389

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.484379	21.85862	21.13162	0.0395
At most 1	0.202299	7.458689	14.26460	0.4364
At most 2	0.041156	1.386897	3.841466	0.2389

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LN_RGDP	LN_CAP	LN_LAB
-20.81817	50.23567	3.818160
9.926866	17.10453	-22.39485
-6.613617	0.496171	4.357149

Unrestricted Adjustment Coefficients (alpha):

D(LN_RGDP)	0.006940	-0.012422	-0.006797
D(LN_CAP)	-0.004324	-0.005324	0.000216
D(LN_LAB)	-0.004121	0.000549	-0.001003

1 Cointegrating Equation(s): Log likelihood 279.0498

Normalized cointegrating coefficients (standard error in parentheses)

LN_RGDP	LN_CAP	LN_LAB
1.000000	-2.413068	-0.183405
	(0.36610)	(0.17721)

Adjustment coefficients (standard error in parentheses)

D(LN_RGDP)	-0.144481

	(0.17630)	
D(LN_CAP)	0.090017	
	(0.05086)	
D(LN_LAB)	0.085792	
	(0.02657)	

2 Cointegrating Equation(s): Log likelihood 282.7792

Normalized cointegrating coefficients (standard error in parentheses)

LN_RGDP	LN_CAP	LN_LAB
1.000000	0.000000	-1.392575
		(0.09747)
0.000000	1.000000	-0.501092
		(0.04098)

Adjustment coefficients (standard error in parentheses)

D(LN_RGDP)	-0.267794	0.136167
	(0.18738)	(0.43114)
D(LN_CAP)	0.037169	-0.308278
	(0.05115)	(0.11769)
D(LN_LAB)	0.091247	-0.197624
	(0.02934)	(0.06751)

Appendix 4: Regression Results

- Supply Regression

Dependent Variable: LOG(RGDP)
Method: Least Squares
Date: 07/07/17 Time: 03:21
Sample: 1980 2014
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.997074	4.853625	-1.441618	0.1594
LOG(CAP)	0.891802	0.317849	2.805740	0.0086
LOG(LAB)	0.878247	0.155525	5.646986	0.0000
LN_DR	-0.004481	0.005053	-0.886831	0.3820

R-squared	0.975011	Mean dependent var	27.12871
Adjusted R-squared	0.972593	S.D. dependent var	0.369243
S.E. of regression	0.061129	Akaike info criterion	-2.644466
Sum squared resid	0.115838	Schwarz criterion	-2.466712
Log likelihood	50.27815	Hannan-Quinn criter.	-2.583105
F-statistic	403.1839	Durbin-Watson stat	0.675550
Prob(F-statistic)	0.000000		

- Error Correction Model

Dependent Variable: D(LN_RGDP)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 07/07/17 Time: 23:34
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments
D(LN_RGDP)=C(1)*ECT(-1)+C(2)*D(LN_RER)+C(3)*D(LN_NCG)+C(4)
*D(LN_CAP) +C(5)*D(LN_LAB)+C(6)*LN_DR+C(7)*(RIR-(RIR(-1)))
+C(8)*D(LN_NCP)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.374056	0.138945	-2.692118	0.0123
C(2)	-0.028098	0.029804	-0.942752	0.3545
C(3)	-0.004975	0.003076	-1.617262	0.0179
C(4)	0.775576	0.482807	1.606389	0.1203
C(5)	1.253695	0.356458	3.517088	0.0016
C(6)	-0.003830	0.003583	-1.068961	0.2949
C(7)	0.000102	0.000713	0.143685	0.8869
C(8)	-0.076775	0.034293	-2.238775	0.0339

R-squared	0.467861	Mean dependent var	0.035067
Adjusted R-squared	0.324593	S.D. dependent var	0.050155
S.E. of regression	0.041219	Akaike info criterion	-3.337517
Sum squared resid	0.044174	Schwarz criterion	-2.978374
Log likelihood	64.73779	Hannan-Quinn criter.	-3.215039
Durbin-Watson stat	1.960778		

Appendix 5: Variable Graphs

Figure 5. Real Gdp

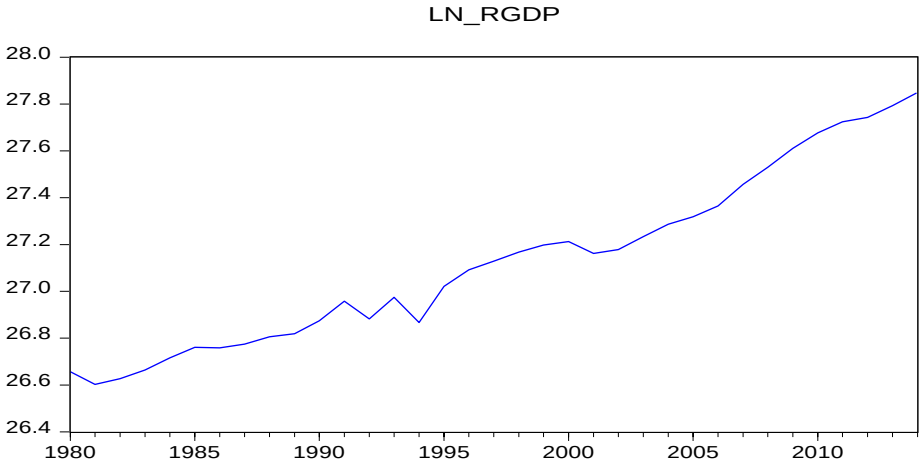


Figure 6. Capital

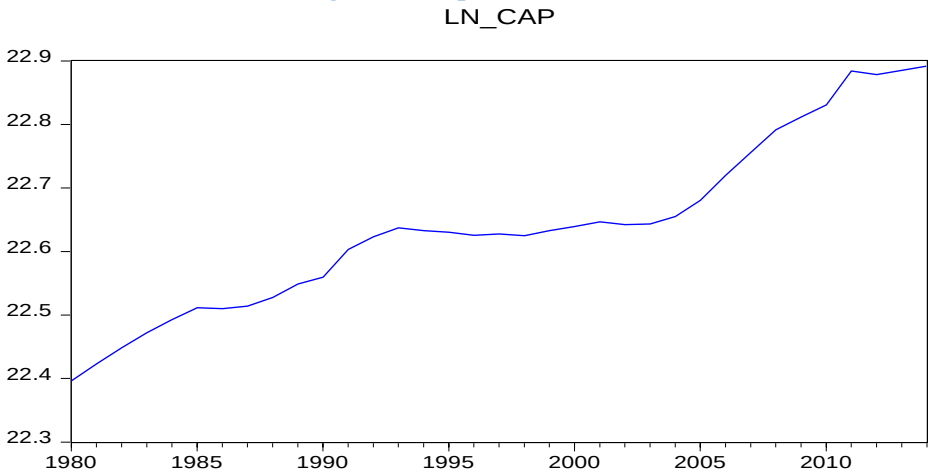


Figure 7. Drought

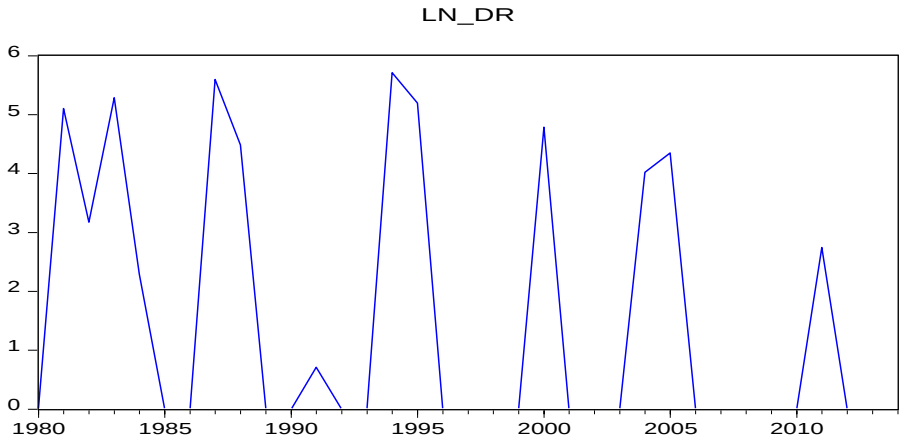


Figure 8. Labor

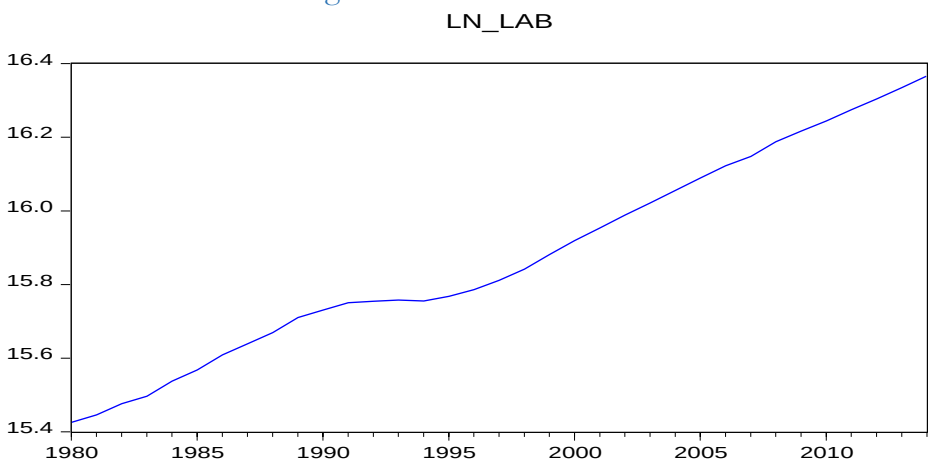


Figure 9. Real NCG

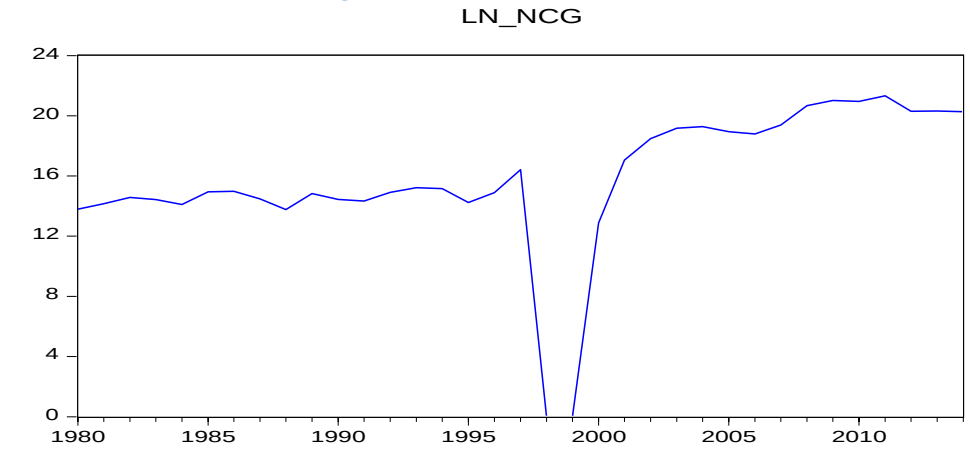


Figure 10. Real NCP

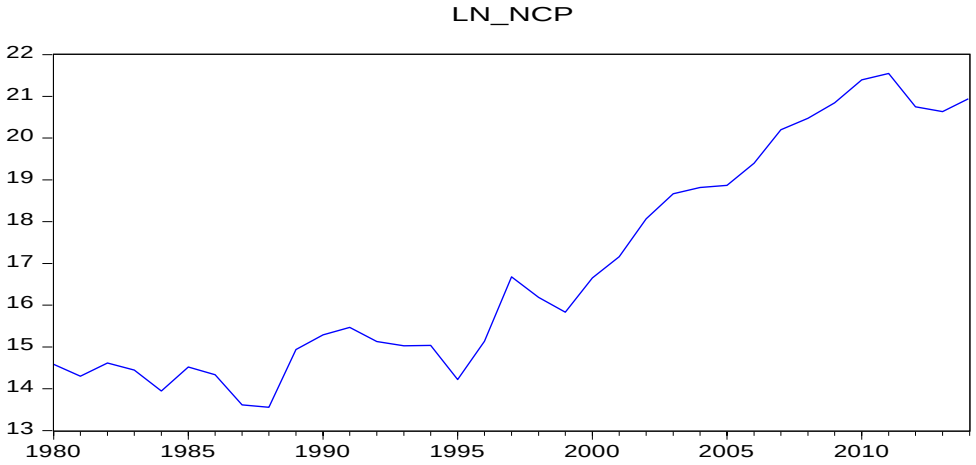


Figure 11. Real Interest Rate

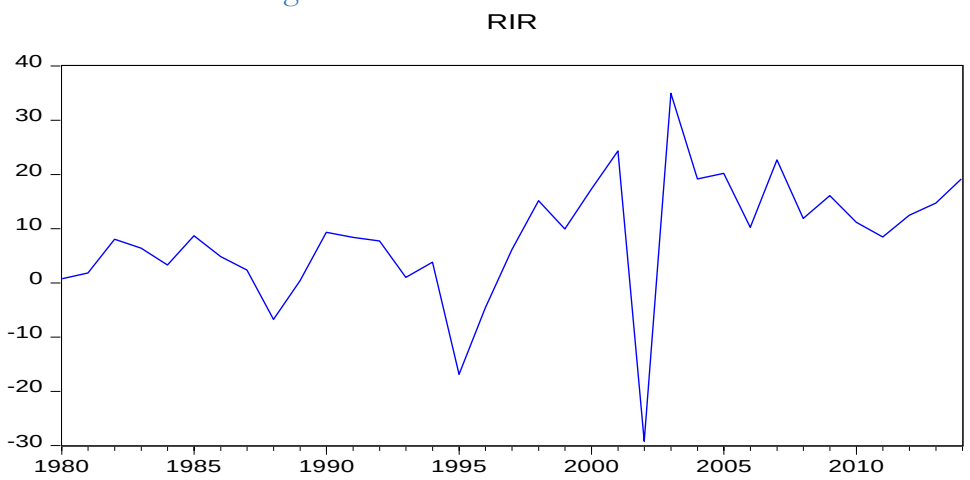


Figure 12. Real Exchange Rate