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Dynamic Interaction between Saving, Investment and Economic Growth in Ethiopia

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Abstract: The purpose of this research is to investigate the dynamic interaction between savings, investment and economic growth in a case of Ethiopia by using quarterly time series data of National Bank of Ethiopia (NBE) from the periods 1992/93 to 2019/20. Consequently, the Vector Error Correction Model (VECM) results showed that there was a positive long run relationship between savings, investment and economic growth in Ethiopia. Granger causality from domestic investment and real GDP to domestic savings and domestic investment granger causes economic growth. The response of domestic investment to a positive shock of real GDP is positive. Investment and money supply reacts positively to shocks of domestic saving. Whereas, the exchange rate responds adversely to the shock of investment. In the short run the reaction of saving to shocks of real GDP and investment was positive and negative respectively. Whereas, shocks of saving generate a negative effect in the short run and insignificant effect on economic growth in the long run. Real GDP responds negatively to shocks of interest rate and exchange rate. Besides, the variance decomposition results show that the variation of economic growth is largely explained by shocks to itself and investment. The variation in saving emanates from the money supply, domestic savings, real GDP and investment. Investment deviation is also emanating from Real GDP and saving. Thus, the government and stakeholders are supposed to practice macroeconomic policies that will promote economic growth and gross domestic investment and thus saving will increase.

Keywords: Dynamic, Interaction, Saving, Investment, Economic, Growth, Ethiopia

1. Introduction

Economic growth and development to an excellent extent are determined by the speed of growth in domestic savings, investments and output of products and services which incorporates real GDP per capita, human development amongst others (Olanrewaju et al., 2015). According to Ilugbemi et al. (2019), the association between savings, investments and economic growth is clear since investment remains a catalyst for industrial and economic growth.

A study conducted by Omoregie & Ikpesu (2017) in Nigeria also distinguished that though there is a positive links between savings, investment and growth, which is well known in practical literature, the growth rate perceived in most less developed countries (Africa) compare to the rest of the world is a great concern for developmental economist.

Since savings and investment has been viewed as the two dynamic macroeconomic variables with microeconomic foundations to achieve price stability and promote employment opportunities for sustainable economic growth and it needs to have a detailed information of the dynamic interaction among savings, investment and economic growth is crucial as it will aid policy makers in designing and employing appropriate macroeconomic policies (Shimelis, 2014). Therefore, this research topic requires many investigators to distinguish which of the economic variables need attention so as to recognize macroeconomic goals and objectives as well as the different consequences of macroeconomics policies.

The incidence of additional investment than domestic savings generates a necessity of foreign financing. Most studies reveal that external debt in developing countries plays a vital role in filling a gap between savings and investment (Chenery, 1996, as cited from Mndeme, 2015). Nevertheless, the African Development Bank, (2019) report displayed that the result of low domestic saving and high essential investment are principal to persistent fiscal shortfalls and growing indebtedness.

With respect to Ethiopia, most researchers had conducted to observed the association between savings, investment and economic growth by commonly testing for bi-variate Cointegration and Granger causality distinctly between savings and economic growth, or between investment and economic growth (Getenet, 2017; Mohanty, 2017; Mohanty, 2018; Zelalem, 2018). Whereas only very limited studies were conducted to investigate the relationship concerning savings, investment and economic growth (Gebeyehu, 2010; Shimelis, 2014) but none of them has examined the dynamic interface between these variables Hence, the uniqueness of this study to investigate dynamic interaction of these macroeconomic variables by employing the Dynamic Vector AutoRegression (VAR) approach, because of the behavior of variables used in the economic growth study.

The other limitation of existing empirical studies in Ethiopia is they do not show the extent of sensitivity of Economic growth and investment to changes in saving of an economy and the transmission mechanisms to other macroeconomic variables. Even if there are different macroeconomics factors affecting savings, investment and economic growth , the research aimed to include only the monetary policy shocks like interest rate, exchange rate, money supply and inflation rate in the model related to saving, investment and growth in order to examine the dynamic interaction between this variable.

Thus, the main objective of the study is to investigate the dynamic interaction between savings, investment and economic growth in the case of Ethiopia by employing quarterly time series data of National Bank of Ethiopia (NBE) from the periods of 1992/93 to 2019/20. To the best of the knowledge of the researchers, no any study have employed the Vector Error Correction Model (VECM) and structural VAR models in Ethiopia on the research topic.

The remainder of the paper proceeds as follows: section two highlights literature review, in section three, research design, data and sources and methodology are discussed, section four presents results and discussion of the paper and the last section five provides the conclusions and recommendations of the study.

2. Literature Review

2.1. Concepts, definitions and Monetary Policy Transmission Mechanism

Todaro (2003) had defined "economic growth as a long-term rise in capacity to supply increasing diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands

Monetary policy, therefore, plays an important role in achieving the ultimate economic objectives of sustainable growth, full employment, price stability and a healthy balance of payments (Yabatfenta, 2019). Amongst macroeconomic variables, therefore, the exchange rate is one of the intermediate objectives through which monetary policy is transmitted to achieve the ultimate goals of monetary management and it is one of the primary transmission channels of monetary policy in open economies, especially in those with flexible exchange rate regimes. However, a monetary expansion would tend to reduce the real interest rate and lead to a depreciation of the currency, which would increase exports, reduce imports and finally leads to increase economy (Mohanty, 2014)

Interest rate means any bank lending rate or any rate at which a lender charges and it has a significant role in our everyday lives and can significantly affect our purchasing power. That is when there is a lower interest rate, which leads to the quantity of money in circulation increasing. Tendencies of east African real interest rate are fluctuating due to the discrepancy of inflation from year to year because real interest rate is the difference between nominal interest rate and inflation. However, the nominal interest rate is almost stable and its impact of variation of real interest rate is not that much significant. On the other hand variation of inflation is due to the change in the money supply because the main cause of inflation is money supply in the economies (Aslam & Awan, 2018).

Similarly, money supply is well-defined as the total stock of money available in the economy in a given period of time that comprises currency in circulation, demand deposits, small time denominations and longtime denominations, etc. But a broad money supply includes money that can be used for spending (M1) and items that can be quickly converted to M1.

2.2. Review Of Empirical Literatures

A study carried by Ngouhouo & Mouchili (2014) observed the nature of the connection between savings, investment and economic growth in Cameroon from 1980 to 2010 and verified by using the Vector Auto Regressive Model. The outcomes of the study illustrate that, there is a unidirectional causal relationship from investment in savings, from growth of savings, and lastly from growth to investment, while, there is no causal link from savings to investment, savings towards growth and investment to growth in Cameroon.

Another study conducted by Hishongwa (2015) analyzed the dynamic relationship between domestic savings, investment and economic growth in Namibia, by employing Vector Auto-regression. The result of the study found that; shocks to savings affect savings, investment and economic growth positively and significantly. Besides, shocks to investment significantly affected investment and savings in the short run, but they are insignificant in explaining economic growth. Likewise, shocks to economic growth significantly influenced savings, investment and economic growth. Second, the variance decomposition results show that the variation in savings is largely explained by shocks to savings, investment and economic growth, in that respective order of size.

Furthermore, though it can be noted that savings and economic growth are more important in explaining investment in the long run than investment, the variation in investment is explained significantly by shocks to all three variables. The variations in economic growth are not explained by investment shocks in both the short and long runs. In brief, saving shocks are more important in explaining variations in economic growth than economic growth in the long run (Ibid, 2015).

Sekantsi & Kalebe (2015) also studied the relationship between saving, investment and economic growth in Lesotho for the period 1970 to 2012. Hence, they used an Autoregressive Distributed Lag (ARDL) bounds testing method to Cointegration and

Granger causality test. The conclusion of the study displayed the presence of integration among the variables and short-run causal flow of economic growth to saving. The similar outcomes too designated the existence of short-term and long-term Granger causality from saving to investment and short-term and long-term causal flow from investment to economic growth.. Hence, the better-quality capital accumulation is likely to contribute to increasing sustainable economic growth in Lesoto.,

According to the study conducted by Omoregie & Ikpesu (2017)investigated the dynamic interaction between savings, investment and economic growth in Nigeria within the period 1981 to 2014 by employing the impulse response function (IRF) and the variance decomposition of VAR as well as the granger causality test. The result of the study shows positive influences between the variables. However, the causality test showed that only a unidirectional relationship running from GDP to GDS exists, which suggests that GDP granger causes GDS.

Taghavi & Pahlavani, (2018) analyzed the relationship between saving and investment with economic growth in terms of structural breaks using Iran's economic annual time-series data from 1960 to 2016. The ARDL method of the research showed the existence of a long-run equilibrium between savings, investment and economic growth in Iran in terms of structural failure. According to their ARDL method, gross national income and gross fixed capital formation have a meaningful and positive relationship with economic growth. Thus, a one percent increase in savings and investment will increase economic growth by 0.16 and 0.15 percent respectively.

Joshi et al. (2019) also employed identical ARDL methods and co-integration had been identified by means of the Johansen, Gregory–Hansen to study association between saving, growth and investment in the context of Nepal for yearly dataset regarding the period of 1975–2016. The empirical evidence indicated that there was a stable, long-run relationship between savings, investment, and economic growth in the presence of structural breaks but only when economic growth is the dependent variable. This indicates that the long-run relationship is running from savings and investment to economic growth in Nepal.

Shimelis (2014) carried out research on savings, investment and economic growth in Ethiopia. The researcher tried to examine the causal relationship between saving, investment and economic growth in Ethiopia by employing the annual time series data of 1969/70- 2010/11. Thus, the output of ARDL bounds testing indicated that there exists co- integration among gross domestic saving, gross domestic investment, real gross domestic product, labor force and human capital in Ethiopia.

Lately, Mohanty (2018) conducted research to examine the interaction among Gross domestic saving and economic growth in Ethiopia from the period of 1976 to 2017. The result of this study showed that ARDL bounds of the cointegration test concluded that Gross Domestic Savings and economic growth are cointegrated, and thereby it proved a long run relationship exists between them.

Zelalem (2018) also carried out research to Analyze the Nexus between Gross Domestic Savings and Economic Growth in Ethiopia with a reference period of 1976-2017. This study employed a more robust augmented granger causality test approach developed by Toda and Yamamoto (1995). The result showed that a steady long run relationship exists between savings and economic growth in Ethiopia. The same results also revealed that the growth rate of real GDP per capita Granger causes real gross domestic savings in Ethiopia. Thus the study concluded that the Ethiopian economy tends to have higher levels of income (RGDP) first in order to generate higher rates of domestic saving.

When we come to the case of Ethiopia, the general observation is that little empirical attention is given to the area and many studies were based on saving- economic growth nexus (Mohanty, 2018; Zelalem, 2018) and others, while Shimelis (2014) conducted the study of the relationship between savings, investment and economic growth.

Despite the abundance of studies on savings, investment and growth in other countries, their results cannot be generalized in the context of Ethiopia because of the difference between political systems, financial systems, policies and regulations, and other country specific factors affect this relationship. Due to this, this study analyzed this relationship in the context of Ethiopia by employing VECM to show short run and long run dynamic interaction between savings, investment and economic growth. Besides, Structural VAR will be employed for showing the transmission channel of macroeconomic monetary policy shocks like exchange rate policy, interest rate policy, and inflation and money supply policies from one to the other.

Further, this study differs from others in its methodological difference to show the dynamics and the transmission channel which has not been done by other studies. It will also provide information based on recent evidence on the relationship between savings, investment and growth in Ethiopia by adding a new thing that is more elaborating the nexus between these variables.

3. Data and Methods

3.1. Data Source

The main source of data to undertake the study was the secondary sources .The span of the study covers the periods between 1992/93 and 2019/20. Accordingly, money supply, exchange rate, inflation rates and interest rate were quarterly data collected from different publications of National Bank of Ethiopia (NBE) whereas Real Gross domestic saving, Gross domestic product (GDP) and Gross domestic Investment or Gross Capital formation (GDP) were annual data obtained from Ministry of Finance and Economic Development (MoFED), and National Bank of Ethiopia (NBE). The annual data had also been changed into quarterly data by using EViews 10.

3.2. Model Specification

To enlighten the possible dynamic interaction between savings, investment and economic growth and monetary policy transmission mechanism, this study postulated the specification with some modifications investigations (Omoregie & Ikpesu, 2017). Thus, in light of the existing literatures, the theoretical model used to examine the dynamic relationship between these variables of interest is stated as follows:

$$GDS = \beta_0 + \alpha_{\beta 1} \ln GDs_{t-i} + \beta_2 \ln GDI_t + \beta_3 ln\, GDP_t + \beta_4\, INF_t + \beta_5 ln\, MS_t + \beta_6\, IR_t + \beta_7\, Ex_t + \varepsilon 1_t \quad (3.1)$$

$GDI = \gamma_0 + \gamma_1 \ln GDI_{t-i} + \gamma_2 \ln GDP_t + \gamma_3 lnGDS_t + \gamma_4 INF_t + \gamma_5 ln MS_t + \gamma_6 IR_t + \gamma_7 Ex_t + \mathcal{E}2_t$ .... (3.2)

$GDP = \alpha_0 + \alpha_1 \ln GDP_{t-i} + \alpha_2 \ln GDI_t + \alpha_3 lnGDS_t + \alpha_4 INF_t + \alpha_5 ln MS_t + \alpha_6 IR_t + \alpha_7 Ex_t + \mathcal{E}3_t$ ....(3.3)

GDP stands for gross domestic product, GDS for gross domestic savings, GDI, for gross fixed capital formation or Investment, Ms_t for money supply, IRt is the real interest in period t; Ext is the exchange rate in year t; INFt is the inflation rate in year t; α0, β0 et γ0 are constant parameters. ε1t, ε2t and ε3t Are error terms (stochastic variables); and α, β and γ (1…7) are coefficients of variables. Monetary policies are used as control variables to capture the macroeconomic effect in the model.

3.3. Method of data analysis and Econometric estimation techniques

3.3.1. Vector autoregressive (VAR) model specification

VAR model is a general framework used to describe the dynamic behavior of the economy in time series analysis. If time series are not stationary, then the VAR framework needs to be modified to allow consistent estimation of the relationship between the series. It is a means of avoiding the limitation of the classical approach.

For a set of K time series variables$y_{t=(y_{1t,}} \dots \dots \dots, y_{kt)}$, a VAR model captures their dynamic interactions. The basic model of order $\rho(VAR(\rho))$ has the form:

$y_{t=} c + \pi_1 y_{t-1} + \pi_2 y_{t-2} + \cdots + \pi_p y_{t-p} + \varepsilon_{it}$ .... (3.4)

general equation of VAR model

Where $y_{t=(GDI,Ex,INF,MS,IR,GDS,GDP)}$; where C is a vector of $k \times 1$ constant matrix; $\pi_i\,(i = 1,2, \dots, p)$ is $(K \times K)$ coefficient matrices and the innovation vector ε_t is the linearly unpredictable component of y_t, given an information set consisting of the lagged values of all model variables. And $\varepsilon_t \sim iid(0, \Omega)$.

A lag length selection is the number of previous observations in a time series that will be used as a predictor in the VAR model, so that to choose the appropriate lag length in the model different method could be supplemented like Akaike information criterion (AIC) based on data concurrency based on some information, and Hannan-Quinn (HQ). In a standard time series Econometrics, the stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between two time periods depends only the gap between the two time periods rather than the actual time (Gujarati, 2004).

3.3.2. Tests of VAR model

i) Unit Root testing

Unit root test (stationarity) is vital before empirical estimation. Stationary is important for the development and assurance of estimation of the VAR model. Augmented Dickey Fuller test is the conventional method of unit root test whether the variable is stationary or not in the presence of a unit root in a series. Phillip-Peron tests also another method to test unit root test. ADF and Phillip Peron test are supplemented to determine a unit root test of stationarity based on the following general equation of ADF which contain constant and lagged difference.

$\Delta y_t = a + \mu_t + \beta - 1y_{t-1} + \sum_{i=1}^{p} \gamma_i \, \Delta y_{t-1} + \varepsilon_t$ ....(3.5)

From the equation at $-1 = 0$, there is non stationarity(unit root) in the null hypothesis and at $\beta - 1 < 0$. Thus, rejection of the null indicates that there is stationarity in time series.

Tests of autocorrelation, normality test and stability are also included in the model by using Breusch-Godfrey, Jarque -Berra, CUSUM square tests respectively which are supplemented in these diagnoses.

ii) Granger causality test

The VAR model is advantageous because it explains the past and the causal relationship among multiple variables over time and its prediction. The VAR model can also be analyzed through Granger causality test, impulse response function, and forecast error variance decomposition. Granger causality is a statistical concept of causality involving improved prediction of one time series by incorporating knowledge of a second time series, then the latter is said to have a causal inference on the first (Granger, 1969).

3.3.3. Structural vector autoregressive model (SVAR) framework

Structural Vector Autoregression (SVAR) model is an extensively employed means for the investigation of the monetary transmission mechanism (Christiano et al., 1999). In our case it is important to analyze the interaction between monetary policy shocks, that is, saving; Investment and economic growth dynamics. And also it is vital for examining the dynamics of a model by subjecting it to an unpredicted monetary policy shock and for figuring the structural impulse response.

Therefore, this study is based on the theory of the monetary transmission mechanism and draws from the model specification of the above VAR models for structural modeling of a structural shock. The reduced-form of VAR (*p*) model as representing data generated by the structural VAR (*p*) model;

$B_0 y_t = \alpha_{i,j} + B_1 A_i y_{t-1} + \cdots \cdots + B_p A_i y_{t-p} + w_{it}$ ... ... (3.6).

The reduced-form representation of the model (3.6) can be obtained by pre multiplying both sides by (3.5) by $B_0{}^{-1}$, results in the model , (Kilian & L¨utkepohl, 2016))

$y_t = \lambda + A_1 y_{t-1} \cdots \cdots + A_p y_{t-p} + u_t$ ... ... (3.7)

Where; $A_i = B_0{}^{-1} B_i$ and $u_t = B_0{}^{-1} w_t$, $\lambda = B_0{}^{-1} \alpha$ and it can be estimated by maximum likelihood (ML) estimation methods.

Estimation of the matrix B_0 requires additional restrictions on the data generating process (DGP) based on economic theory. If the matrix B_0 can be solved, given these restrictions and the data, we say that the structural VAR model parameters, $(B_0,\ B_1, \ldots, B_p,\ \Sigma w)$, are identified or, equivalently, that the structural shocks $wt = B_0 u_t$ are identified.

In compact form, an SVAR system relates to the following relations:

$$A_0 u_t = B w_t \ldots \qquad (3.8)$$

The equation (3.8) is known as the AB model (Amisano and Giannini 1997 and the structural innovations w_t can be derived from errors ut of the reduced form, but certain restrictions must be placed on the system. In details, $\frac{n(n-1)}{2}$ Where n is the number of variables in the model; restrictions must be imposed on $A0$ matrix to be able to identify the structural shocks (McCoy, 1997).

3.3.4. Recursively identified structural VAR model

According to (Kilian & L¨utkepohl, 2016) in estimating the response of economic variables to the temporary shocks, this paper employed a recursively identified structural model. This means current structural shocks cannot be simultaneously affected by the preceded ordering variables. We can assume that variables are affected by following a sequential chain of shocks, or the matrix A_0 is diagonal (that is, the structural shocks are orthogonal) and takes the form of a lower triangular matrix as follows:

$$\begin{pmatrix} u_t^{ex} \\ u_t^{ir} \\ u_t^{Ms} \\ u_t^{INf} \\ u_t^{GDS} \\ u_t^{GDI} \\ u_t^{Gdp} \end{pmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 & 0 & 0 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 & 0 & 0 & 0 \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & 1 & 0 & 0 \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & 1 & 1 \end{bmatrix} * \begin{pmatrix} w_t{}^{e}x \\ w_t^{ir} \\ w_t^{mS} \\ w_t^{Inf} \\ w_t^{GDS} \\ w_t^{GDI} \\ w_t^{GDP} \end{pmatrix}$$

Where, $(u_t^{ex}, u_t^{ir}, u_t^{GDS}, u_t^{GDI}, u_t^{ms}, u_t^{inf},\ and\ u_t^{rgdp})$, are the structural disturbance, that is, exchange rate shocks, interest rate shocks, domestic saving shocks, domestic investment shocks, money supply, the price shocks, and real GDP shocks respectively; and $(w_t^{ex}, w_t^{IR}, w_t^{GDS},\ w_t^{GDI},\ w_t^{ms},\ w_t^{inf}, and\ w_t^{rgdp})$, are the residuals in the reduced form equations, which represent unexpected movements (given information in the system) of each variable.

In our model, the data vector is $\{ex, ir, gds, gdi, ms, inf, rgdp\}$, where, Ex is nominal exchange rate to domestic currency ($/Birr); Ir indicates domestic interest rate; Gds is gross domestic saving, Gdi indicates domestic investment, Ms is money supply$(M_0 + M_1)$; Inf is a general inflation rate and rgdp indicates is output. The exchange rate is also contemporaneously being assumed to be unaffected by the shocks of other variables in the system.

The interest rate in the system is assumed to be affected by the contemporaneous shocks of exchange rate and its own lag.

On the other hand, we assumed money supply is contemporaneously affected by the positive innovations of exchange rate, interest rate and its own lag. Positive innovation shocks such as exchange rate, interest rate, money supply, and lagged of inflation rate are assumed to affect the current inflation rate in the system.

Finally, gross domestic savings in the fifth equation can be contemporaneously influenced by the positive innovations of exchange rate, interest rate, inflation, money supply and its own lag in the system.

Gross domestic investment equation can be contemporaneously influenced by the positive innovations of exchange rate, interest rate, inflation, money supply, gross domestic saving and its own lag in the system.

Finally, in the output equation, output is assumed to be contemporaneously influenced by all variables in the system.

3.3.5. Impulse response function

After identifying the structural shocks it is important analyzing and interpreting these macroeconomic shocks by using structural VAR tools in the structural model, that is, structural impulse responses and forecast error variance decompositions. Impulse response function shows how one variable might react to sudden changes in the other variable. It also traces out the responsiveness of the dependent variables in the VAR to shocks to each of the variables.

So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted The $(i,j)^{th}$ element of the matrix Φs, when treated as a function of s traces out the expected response of $y_{i,t+s}$ to a unit change in y_{jt} holding constant all past values of y_t since the change in y_{it} given $(y_{t-1}, y_{t-2}, \ldots)$ is measured by the innovation U_{it}, the elements of Φs represent the impulse response component of y_t with respect to the U_t innovations. The study has borrowed this equation from Kilian & L¨utkepohl, (2016) by considering VAR(1) representation of VAR(p) process and it is obtained from responses to VAR forecast errors can be indicated as the following.

$\Phi i = (\Phi_{jk,i}) = JA^iJ'$, where Φi is a forecast error of the model and a k×k matrix. And $J \equiv (I_k, 0_{k\times k,(p-1)})$ the response of the variable *j* = 1, . . . , *K* in the VAR(*p*) system to a unit shock U_{kt} , k = 1, . . ., K, i periods ago.

The response of an economic variable to a shock in period *t* at horizon *h* is obtained as the sum $\sum_{i=0}^{h} \theta_{mk,i}$ this is taken from L¨utkepohl (2005).

The impulse response is a method of examining interrelationship variables in the VAR. It indicates the time profile of the effects of a shock to one variable on the contemporaneous and future values of all endogenous variables.

An impulse response can be used to examine the dynamic behavior of the VAR or assess the policy impact of the variables that constitute the VAR. On the other hand, let y_t be m vector time series generated by the following p[th] order VAR model: $y_t = J(L)y_{t-1} + \varepsilon_t$, where $J(L) = \sum_{i=1}^{p} J_i L^{i-1}$, and t = 1,2,……..n

Impulse response describes the response of $y_{i,\ t+s}$ to a one time impulse in y_{it} with all other variables dated t. Hence

$$y_t = \mu + \varepsilon_t + \psi_1\varepsilon_{t-1} + \psi_2\varepsilon_{t-2} + \ldots\ldots + \psi_n\varepsilon_{t-n} \ldots \quad (3.9)$$

Where $\psi_s = \frac{\partial y_{t+s}}{\partial \varepsilon_t{}'}$

3.3.6. Forecast Error Variance Decomposition

Forecast Error Variance Decomposition - It provides information about the relative importance of each orthogonalized random innovation affecting the variability of the variables in each forecast error. It estimates how much of your forecast errors can be attributed to unpredictability in each variable in the VAR. Forecasting errors in a VARs period in to the future can be obtained as:

$$y_{t+s} - (y_{t+s/t})^{hat} = \varepsilon_{t+s} + \psi_1\ \varepsilon_{t+s-1} + \psi_2\ \varepsilon_{t+s-2} + \ \ldots\ldots + \psi_{x-1}\varepsilon_{t+1} \ \ldots \quad (3.10)$$

And the mean squared error $(\mathrm{MSE}(y_{t+s/t})^{hat} = \Omega + \psi_1\Omega\psi_1{}' + \psi_2\Omega\psi_2{}' + \ldots\ldots + \psi_{s-1}\Omega\psi_{s-1}{}'$

Where $\Omega = E(\varepsilon_t\ , \varepsilon_t{}')$

Forecast error variance decomposition is used in identifying the degree of one variable influence and the other variable in the system by breaking down. Variables in the system will have a forecast error and the error in forecasting can be attributed to the present and past values of the variable in question and the past and present values of all other variables in the system.

Consider a K×K VAR(p) model $y_t = \sum_{i=1}^{p} \Phi_i\, y_{t-i} + \varepsilon_t$,where ε_t is an independent and identically distributed error term with zero mean and covariance matrix Σ. Assuming weak stationarity, y_t obtains the infinite order moving average representation: $y_t = \sum_{j=0}^{\infty} AJ\varepsilon_{t-j}$

The limit of forecast variance decomposition, as h→ ∞, is the variance decomposition of y_t in a stationary model because it converges to the unconditional covariance matrix of y_t. Hence, for a stationary system one may construct forecast error variance decomposition for horizon infinity. In the integrated case the predicted mean squared error diverges when the forecast horizon goes to infinity, but the forecast error variance decomposing remains valid up to a finite maximum horizon of H. Therefore, the contribution shock J to the MSPE of y_{kt}, k= 1, 2,……., K at a horizon h is $MSPE = MSPE_J^K(h) = \sum_{J=0}^{K}(\theta^2{}_{kj,0} + \cdots, +\theta^2{}_{kj\,,h-1})$,where MSPE =Prediction mean squared error.

The ratio of the contribution shock J of the forecast error variance of the variable K will be in the structural variance decomposition:

$$\frac{MSPE^K{}_j\ (h)}{MSPE^K\ (h)}$$

By multiplying these fractions by 100 we obtain percentages.

3.3.7. Vector error correction model (VECM)

VECM is a special case of the VAR for variables that are stationary in their difference. It accounts for any co-integrating relationship among the variables. It also accounts for short run and long run effects and correct disequilibrium. According to Asteriou & Hall (2011) and Moriyama, (2008) , VECM is also a means of reconciling the short run behavior of the economic variable with its long run behavior. The VECM equation can be specified as in the following.

$$\Delta y = \emptyset(\mathrm{L})\,\Delta y_t + \lambda y_{t-1} + \varepsilon \ \ldots \quad (3.11)$$

The Δy represents the change in the vector of all variables in the system which includes , saving (lnGDS), economic growth(lnrGDP), investment(lnGDI), exchange rate (Ex), interest rate (IR), money supply(lnMS), inflation(INF).The lag operator is represented by $\emptyset$(L) and λ represents the long run relationship between the variable in the model.

The error correction of the variable in the long run can be obtained as:

$$ECM_{1,t-1} = Ex_{t-1} + \beta_0 + \beta_1\ \ln GDS_{t-1} + \beta_2\ \ln GDI_{t-1} + \ \beta_3\ INF_{t-1} + \beta_4\ \ln MS_{t-1} + \beta_5\ \ln GDP_{t-1} + \beta_6\ IR_{t-1} \ \ldots \quad (3.12)$$

$$ECM_{2,t-1} = IR_{t-1} + \beta_0 + \beta_1\ \ln GDS_{t-1} + \beta_2\ \ln GDI_{t-1} + \ \beta_3\ INF_{t-1} + \beta_4\ \ln MS_{t-1} + \beta_5\ \ln GDP_{t-1} + \beta_6\ Ex_{t-1} \ldots \quad (3.13)$$

$$ECM_{3,t-1} = GDP_{t-1} + \beta_0 + \beta_1\ \ln GDS_{t-1} + \beta_2\ \ln GDI_{t-1} + \ \beta_3\ INF_{t-1} + \beta_4\ \ln MS_{t-1} + \beta_5\ IR_{t-1} + \beta_6\ Ex_{t-1}\ \ldots \quad (3.14)$$

Therefore, in VECM the disequilibrium condition will be corrected in the long run and it is assumed to be zero so that the equation can be obtained as follows

$$Ex_{t-1} = \ -\beta_0 - \beta_1\ \ln GDS_{t-1} - \beta_2\ \ln GDI_{t-1} - \beta_3\ INF_{t-1} - \beta_4\ \ln MS_{t-1} - \beta_5\ \ln GDP_{t-1} - \beta_6\ IR_{t-1} \ \ldots \quad (3.15)$$

$$IR_{t-1} = -\beta_0 - \beta_1\ \ln GDS_{t-1} - \beta_2\ \ln GDI_{t-1} - \beta_3\ INF_{t-1} - \beta_4\ \ln MS_{t-1} - \beta_5\ \ln GDP_{t-1} \ - \beta_6\ Ex_{t-1} \ \ldots \quad (3.16)$$

$$GDP_{t-1} \ = -\beta_0 - \beta_1\ \ln GDS_{t-1} - \beta_2\ \ln GDI_{t-1} - \beta_3\ INF_{t-1} - \beta_4\ \ln MS_{t-1} - \beta_5\ IR_{t-1} - \beta_6\ Ex_{t-1} \ldots \quad (3.17)$$

Before directly going to the model specification first it is necessary to transform the variables under study into Log data to avoid biased coefficients and standard errors and then biased inference which gives a misleading result.

Depending on the above literature the functional form can take the following forms.

GDP= f (GDS, GDI, INF, Ms, Ex, IR)

To capture economic growth using GDP, use log of GDP, as log difference of GDP implies economic growth. Correspondingly, all the regressors are expressed in logarithms as follows.

$$GDP_t = B_0 + B_1 lnGDS_t + B_2 lnGDI_t + B_3 INF_t + B_4 lnMS_t + B_5 Ex_t + B_6 IR_t + e_t \ldots \ldots \quad (3.18)$$

IR =f(GDS, GDI, INF, MS,Ex,GDP).

The econometric model can be shown as:

$$IR_t = B_0 + B_1 lnGDS_t + B_2 lnGDI_t + B_3 INF_t + B_4 lnMS_t + B_5 E_t + B_6 lnGDP_t + e_t \ldots \ldots \quad (3.19)$$

Ex = f(GDS,GDI,INF,MS,GDP,IR).

It can also be shown as

$$Ex_t = B_0 + B_1 lnGDS_t + B_2 lnGDI_t + B_3 INF_t + B_4 lnMS_t + B_5 lnGDP_t + B_6 IR_t + e_t \ldots \ldots \quad (3.20)$$

All computations will be performed by using the widely used standard econometric software package for EViews 10 windows.

4. Discussion

4.1. Econometric Analysis

This part discusses the results of data analysis using econometric tools. The empirical assessment results are discussed in the following subsequent sub-units. Accordingly, the results and interpretations of unit root test of the data, the optimum lag length, Cointegration test result followed by estimation of VECM and their Granger causality results are provided. Moreover, the dynamic interaction and casual relationship between variables included in the model is investigated through SVAR model. Finally, the diagnostic test result that checks the accuracy of the model is presented.

4.1.1. Tests of VAR model

i) Unit Root Test Result

Various formal statistical tests could be employed like Augmented Dickey-Fuller Unit root test (ADF), Phillips Perron (PP), GLS transformed Dickey Fuller (DFGLS), Richardson and stock point optimal (ERS), and Ng and Peron (NP) to determine whether the series in the group are stationary. However, this study applied two types of widely recognized and the most popular unit root tests of the ADF and PP tests to ensure the stationary of our data.

The null hypothesis is that the variable under investigation has a unit root against the alternative that it does not. The decision rule for both the ADF and PP tests is that we reject the null hypothesis of stationary if the tau statistic value exceeds the critical (tabulated) value at a chosen level of significance (in absolute term). The results of ADF and a PP test of unit root both at level and first difference for each series are presented in Table 1 and Table 2 respectively.

The results obtained from the ADF test presented in Table 1 postulates that all variables are not stationary in the level series. Similar test was afterwards applied to their first differences and the outcomes are as well summarized in Table 1.

Table 1. ADF Unit Root Test Result.

Augmented Dickey Fuller test					
Variables	@ level		@ first difference		Order of integration
	t- statistics	Critical value	t- statistics	Critical value	
LrGDP	-0.867432	3.490772	-4.303939	-3.490772***	I(1)
LGDI	0.965958	-3.495677	-2.99262	-2.890037**	I(1)
LGDS	0.92256	-3.493129	-4.31041	-3.493129***	I(1)
Ex	3.306016	-3.49021	-9.366707	-3.490772***	I(1)
Inf	-1.898298	-3.495677	-7.86568	-3.495021***	I(1)
Ir	-3.065272	-3.490772	-6.443693	-3.490772***	I(1)
Lms	2.791562	-3.49021	-11.42363	-3.490772***	I(1)

Note: *, **, *** indicates significance at 10%, 5% and 1% level of significance respectively.

The result illustrates that they are stationary at the 1 percent significance level and investment (LGDI) becomes stationary at 5 percent significance level.

Table 2. Phillips-Perron Test Result.

Phillips-Perron test					
Variables	@ level		@ first difference		Order of integration
	t- statistics	Critical value	t- statistics	Critical value	
LrGDP	-0.397624	-3.49021	-4.303939	-3.490772***	I(1)
LGDI	1.288155	-2.887665	-6.046541	-3.4907723***	I(1)
LGDS	1.196312	-3.49021	-5.562803	-3.490772***	I(1)
Ex	3.50355	-3.49021	-9.468217	-3.490772***	I(1)
Inf	-3.258045	-3.49021	-6.219686	-3.490772***	I(1)
Ir	-3.49021	-3.999198	-6.247232	-3.490772***	I(1)
Lms	3.114704	-3.49021	-11.43842	-3.490772***	I(1)

Note: *, **, *** indicates significance at 10%, 5% and 1% level of significance respectively.

Both ADF and PP unit root test investigation results above verify that the same set of variables becomes stationary following the first difference, whereas the only interest rate (IR) becomes stationary at I (0) in the PP unit root test. In view of the fact that all the variables except Ex in PP test are non-stationary at levels and integrated of order one, this implies the possibility of the prevalence of co- integrating relations between economic variables.

ii) Optimal Lag Length

Following examining stationarity of the data, it is essential to recognize the optimal lag length to estimate the VAR/SVAR model. The most commonly used criteria for selecting the optimal lag length of Akaike information criteria (AIC), Schwarz information criteria (SIC), Hannan- Quinn Information Criterion (HQ), the sequential modified LR test statistic (LR), and Final prediction error (FPE) are used in this study. Table 3 demonstrates optimal lag selection criterion results.

Table 3. Appropriate lag length selection criterion results.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-789.7252	NA	0.006030	14.75417	14.92801	14.82466
1	338.5804	2089.455	1.26e-11	-5.232970	-3.842235	-4.669078
2	458.9156	207.2441*	3.40e-12*	-6.553993*	-3.946366*	-5.496695*
3	489.4119	48.56810	4.93e-12	-6.211331	-2.386811	-4.660627
4	515.1769	37.69331	8.00e-12	-5.781055	-0.739641	-3.736945

*indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

As shown in Table 3, AIC selects two optimal lag lengths. This information criterion is believed to be the most suitable criterion for this study based on the sample size. In addition the lag length is established by other two information criteria (HQ and SC). Two other measures (FPE and LR) also reveal the identical lag length.

To confirm whether the selected lag length is optimal or not, we employed Wald lag exclusion test. This test carried out the verification for appropriateness of each lag chosen by the above listed information criteria. For each lag the Chi-square (Wald statistic) of all series are reported separately and jointly below. The result of the test revealed that second lags of all the endogenous variables are significant both separately and jointly. This suggests that the uses of the first lags of the variables in the models are valid (Appendix A1).

iii) Co- Integration Test

The primary objective of the study is to show the dynamic interaction between savings, investment and economic growth. To capture this interdependence with monetary policy variables, the VAR model is a dynamic multivariate model and treats a set of variables equally. Hence, the VAR models are established in this study to indicate the dynamic interaction and the short-run dynamic disequilibrium among these macroeconomic variables.

Conventionally, there are two tests for cointegration commonly used; Engle and Granger approach and Johansen approach. However, the Johansen approach is stated to be superior over Engle and Granger especially if variables portray feedback relationship and if there is a possibility of more than one cointegrating vectors (Brooks, 2008, cited in Mndeme, 2015). Johansson's cointegration technique provides two test statistics which are trace test and maximum Eigenvalue statistics. The outcomes of both the trace and maximum Eigenvalue tests are used to confirm that the inferences drawn about the presence of a long-run relationship are shown in Table 4.

Table 4. Trace Test and Maximum Eigenvalue Test results.

Trace Test					Maximum Eigenvalue Test				
Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.	Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.
None*	0.320771	132.2393	125.6154	0.0185	None	0.320771	41.38734	46.23142	0.151
At most 1	0.236357	90.85192	95.75366	0.1037	At most 1	0.236357	28.85314	40.07757	0.5016
At most 2	0.215479	61.99878	69.81889	0.1792	At most 2	0.215479	25.96695	33.87687	0.3228
At most 3	0.134904	36.03183	47.85613	0.3947	At most 3	0.134904	15.50583	27.58434	0.7073
At most 4	0.0955	20.526	29.79707	0.3879	At most 4	0.0955	10.73994	21.13162	0.6732
At most 5	0.053584	9.786064	15.49471	0.2976	At most 5	0.053584	5.892779	14.2646	0.627
At most 6*	0.035732	3.893285	3.841466	0.0485	At most 6	0.035732	3.893285	3.841466	0.0485

* Indicates rejection of the hypothesis at the 0.05 level.

Table 4 shows cointegration test outcomes by means of Trace and Maximum Eigenvalue test. In order to test the result, the test statistics are contrasted with critical values. We reject the null hypothesis if the calculated test statistics are greater than the critical values and accepting the alternative hypothesis, there are more than zero or at least one cointegrating equation.

As shown from the table, three cointegrating equations are there by using the Trace test result, while no co-integrating equations by using the Maximum EigenValue test. Trace test is to be preferred or more powerful than maximum Eigenvalue (Hishongwa, 2015). Therefore, this implies that the study specifies and estimates VECM with one co-integrating equation and we can say that the existence of a long run relation between our macroeconomic variables.

4.1.2. Vector Error Correction Model (VECM) Estimation

The presence of cointegration points out the existence of long run equilibrium among variables of interest. In this regard the Johansen cointegration test as indicated above acknowledges that the included variables of time series data has three and two cointegrating vectors which implies a long-run economic relationship between the variables. This entailed that, VECM mechanism is suited for further investigation. It contains information on both the long run equilibrium and short run dynamic interaction between variables.

Therefore, let's present this interaction prior to the discussion of variance decomposition & impulse response and compare it with SVAR. VECM estimation output consists of two parts. The first component (Table 5) sets long run equilibrium equation (co-integration vector and the second part (Table 6) short run dynamic coefficients and error correction terms

i) The Long run model

The incidence of cointegration as indicated by Johnson, cointegration test (Table 5) reveals that we can estimate long run equilibrium relationships between economic variables. The coefficients of cointegrating equations signify the long run relationship in VEC model estimation. The result can be written as follows;

〖LRGDP〗_(t-1)=17.367+ 0.0567〖lnGDS〗_(t-1)+ 3.531〖lnGDI〗_(t-1)-3.133〖lnMs〗_(t-1)+0.022〖INF〗_(t-1) -0.483〖IR〗_(t-1)+0.101〖Ex〗_(t-1)---4.1

The above equation provides a long run relationship and shows a positive relationship between GDS, GDI and RGDP. This result is in line with the finding of (Namoloh, 2017; Yibeltal, 2019). In mechanical terms, a one percent increase in domestic savings and investment(GCF) leads to increased economic growth in our country by 0.057 percent and 3.53 percent respectively. Real GDP is thus relatively sensitive to domestic investment than saving in the long run. Positive correlation is also found between economic growth and exchange rate and inflation in the long run. Whereas negative relationships were found among economic growth and money supply & interest rate. Specifically, a one percent increase in INF and Ex leads real GDP to rise by 0.11 percent and 0.483 percent respectively.

Besides, a one percent increase in Ms and IR, leads to real GDP falling by 3.13 percent and 0.48 percent respectively. Consequently, a rise in interest rate (IR) leads to increased saving in the long run. This makes investment to decline and the shrink in investment leads to reduced real GDP in the long run.

Table 5. Long run equilibrium equation.

Co integrating Eq:	CointEq1
LRGDP(-1)	1.000000
LGDS(-1)	-0.056688
	(0.54881)
	[-0.10329]
LGDI(-1)	-3.530577
	(0.98421)
	[-3.58724]
IR(-1)	0.483329
	(0.07821)
	[6.18023]
INF(-1)	-0.021613
	(0.00713)
	[-3.03314]
LNMS(-1)	3.133023
	(0.71484)
	[4.38284]
EX(-1)	-0.109237
	(0.06893)
	[-1.58483]
C	-17.36712

ii) Short Run Dynamics and Vector Error Correction Model (VECM) Estimates

The association among savings, investment and economic growth can be shown using the VECM model (Table 5 and 6). The second part of the estimation result shown on above Table 5 holds error correction terms and short run coefficients. The error correction component (CointEq1) also known as adjustment coefficients in the VECM estimation result signifies the speed of adjustment to the equilibrium. A short run adjustment of the variation of the variables from their long run values is measured. Specifically, it should lie between 0 and 1 and should be negative in signs indicating a move back to equilibrium (Brooks, 2008, cited in Mndeme, 2015).

Thus, from the result, it can be seen that error correction term economic growth is -0.003176, which is significant with large t- statistics. This can be interpreted as the previous period deviation from the long run equilibrium is corrected in the current period as an adjustable speed of 0.32 percent.

In the short run the relation between economic growth and gross domestic saving is positive which is the same direction in the long run. That is, one percent in domestic savings leads real GDP to rise by 2.7 percent. On the other hand the impact of domestic investment in the short run is negatively and significantly on real GDP. Money supply and interest rate affect the economic growth negatively in the short run, whereas inflation and exchange rate affects economic growth positively. That is encouragement of the nation to devalue its currency leads to economic growth in the short run. In the short run the balance of payment is independent of explanatory variables. In other words, all variables in the model are insignificant in explaining the balance of payment variation in the short run. However, the adjustment coefficient of the error correction term is negative and statistically significant.

In the short run real GDP significantly affected by foreign exchange rate reserves. The estimated result from the short run model indicates that a one percent change in foreign exchange rate reserve led to an increase in real GDP by 0.001834 percent. However, in the short run other variables, including the exchange rate and balance of payment in our model have insignificant effect.

iii) Granger Causality (Block Exogeneity Wald Tests)

According to Kilian & L¨utkepohl (2016), an application for evaluating the dynamic link between several economic variables based on the VAR model was made by Granger (1969). Consequently, this study employed VAR Granger Causality/Block Exogeneity Wald Tests to investigate the causality between Ex, Inf, Ir, Ms, rRGDP, lnGDS, and lnGDI. Table 7 reports the VAR granger causality result between variables included in the system.

The result of the test indicated that, Money supply, gross domestic saving and investment Granger causes exchange rate in the short run. This means that the past value of the money supply, domestic saving and investment have projecting power in leading the current value of the exchange rate. In the short run inflation is Granger caused by money supply and gross domestic investment. The interest rate is also granger caused by inflation, money supply and real GDP in the short run. Gross domestic investment is granger caused by money supply unidirectional in the short run.

In addition money supply, gross domestic investment and real GDP granger cause gross domestic saving in the short run. This denotes that, the presence of unidirectional Granger causality among domestic investment and savings and this causality comes from gross domestic investment. This implies that the present change in domestic investment is affected by the past history (lagged value) of domestic savings.

Table 6. Short Run Dynamic Coefficients and Error Correction Terms.

Error Correction:	D(LRGDP)	D(LGDS)	D(LGDI)	D(IR)	D(INF)	D(LNMS)	D(EX)
CointEq1	-0.003176	0.028977	0.022500	-0.246589	2.552782	0.002072	0.117935
	(0.00258)	(0.01138)	(0.00791)	(0.05320)	(0.90081)	(0.00627)	(0.09818)
	[-1.23209]	[2.54561]	[2.84482]	[-4.63509]	[2.83388]	[0.33053]	[1.20116]
D(LRGDP(-1))	0.678784	0.095469	0.188713	-0.165106	28.59984	-0.213689	-0.178183
	(0.07394)	(0.32647)	(0.22684)	(1.52583)	(25.8358)	(0.17978)	(2.81600)
	[9.18073]	[0.29242]	[0.83192]	[-0.10821]	[1.10699]	[-1.18861]	[-0.06328]
D(LGDS(-1))	0.027184	0.496339	0.025498	0.633338	-3.827569	0.005438	0.283538
	(0.02371)	(0.10469)	(0.07274)	(0.48929)	(8.28481)	(0.05765)	(0.90301)
	[1.14655]	[4.74098]	[0.35052]	[1.29440]	[-0.46200]	[0.09432]	[0.31399]
D(LGDI(-1))	-0.067401	-0.074369	0.445889	0.256869	0.969999	0.168994	-0.901397
	(0.03473)	(0.15335)	(0.10655)	(0.71670)	(12.1353)	(0.08444)	(1.32270)
	[-1.94080]	[-0.48497]	[4.18481]	[0.35841]	[0.07993]	[2.00124]	[-0.68148]
D(IR(-1))	-0.007452	-0.013418	-0.011649	0.475497	0.510677	0.003633	0.202666
	(0.00342)	(0.01510)	(0.01049)	(0.07058)	(1.19509)	(0.00832)	(0.13026)
	[-2.17884]	[-0.88853]	[-1.11017]	[6.73693]	[0.42731]	[0.43688]	[1.55585]
D(INF(-1))	0.000263	-0.000586	0.000134	-0.018153	0.461125	-0.000459	0.007968
	(0.00026)	(0.00113)	(0.00078)	(0.00526)	(0.08911)	(0.00062)	(0.00971)
	[1.03042]	[-0.52026]	[0.17071]	[-3.44945]	[5.17489]	[-0.73995]	[0.82038]
D(LNMS(-1))	-0.061576	0.038415	0.096439	2.391584	1.957391	-0.113450	0.585440
	(0.04063)	(0.17941)	(0.12466)	(0.83851)	(14.1978)	(0.09880)	(1.54751)
	[-1.51552]	[0.21412]	[0.77363]	[2.85220]	[0.13787]	[-1.14832]	[0.37831]
D(EX(-1))	0.001834	0.002812	0.000180	0.083423	0.534207	-0.001321	0.035484
	(0.00271)	(0.01195)	(0.00830)	(0.05586)	(0.94576)	(0.00658)	(0.10308)
	[0.67751]	[0.23528]	[0.02173]	[1.49356]	[0.56485]	[-0.20072]	[0.34423]

Table 6. Continued.

Error Correction:	D(LRGDP)	D(LGDS)	D(LGDI)	D(IR)	D(INF)	D(LNMS)	D(EX)
C	0.011527	0.018288	0.009628	-0.133554	-0.714282	0.047722	0.261295
	(0.00303)	(0.01339)	(0.00930)	(0.06258)	(1.05962)	(0.00737)	(0.11549)
	[3.80139]	[1.36583]	[1.03486]	[-2.13413]	[-0.67409]	[6.47220]	[2.26240]
R-squared	0.566674	0.335381	0.362018	0.524020	0.267304	0.074637	0.060369
Adj. R-squared	0.532351	0.282738	0.311485	0.486319	0.209268	0.001341	-0.014057
Sum sq. resids	0.026920	0.524890	0.253403	11.46520	3287.101	0.159167	39.05127
S.E. equation	0.016326	0.072090	0.050089	0.336923	5.704871	0.039698	0.621809
F-statistic	16.51010	6.370849	7.163957	13.89924	4.605878	1.018299	0.811126
Log likelihood	301.2615	137.8943	177.9458	-31.71920	-342.9337	203.5223	-99.12497
Akaike AIC	-5.313845	-2.343533	-3.071741	0.740349	6.398794	-3.536769	1.965909
Schwarz SC	-5.092897	-2.122584	-2.850793	0.961297	6.619743	-3.315820	2.186857
Mean dependent	0.023899	0.037710	0.032224	0.049318	0.167769	0.043044	0.288915
S.D. dependent	0.023874	0.085121	0.060365	0.470092	6.415511	0.039724	0.617484

Furthermore, there is an existence of a unidirectional causality from real GDP to domestic saving. This implies that the past history of economic growth has predicted power in affecting the current value of gross domestic savings. This is the perspective of the Keynesian theory which believes that economic growth gives rise to savings and is in line with the works of Shimelis (2014), Yibeltal (2019), Zelalem (2018) and Mohanty (2017) in Ethiopia. In addition the result is also consistent with other studies conducted by Bolarinwa & Obembe (2017) for Ghana and Burkina Faso and by Omoregie & Ikpesu (2017) for Nigeria who found causality from economic growth in domestic savings.

A unidirectional relationship is also found among domestic investment and real GDP signifies that the lags of investment granger cause economic growth. This result supports the Harrod Domar model and new growth theories which give belief to the vital role of capital formulation promoting the economic growth of the nation. Similarly,the outcome of this study consistent with the finding of Ngouhouo & Mouchili, 2014, Omoregie & Ikpesu, 2017).for the case of Cameroon and Nigeria Lag of money supply and interest rate are as well identified to granger cause real GDP. Lags of exchange rate, interest rate, domestic investment and savings and real GDP granger caused by all variables in the system. This provides that these macroeconomic variables are affected to a great extent by jointly. To establish whether the causal association among variables is negative or positive as well as the magnitude of this interaction we employed impulse response and variance decomposition in the next subsection.

Table 7. Granger causality (Block Exogeneity Wald Test) results.

		DEPENDANT VARIABLES							
		D(Ex)	D(INF)	D(IR)	D(LNMS)	D(LGDI)	D(LGDS)	D(LRGDP)	Joint
D(Ex)	Chi sequre (c2)		1.528604	2.628377	5.75528**	7.8899**	5.7556**	2.903378	18.8438*
	Prob.		0.4657	0.2687	0.0563	0.0194	0.0563	0.2342	0.0924
D(INF)	(c2)	3.392582		0.104208	6.26865**	4.81074*	2.335877	0.797556	14.45554
	Prob.	0.1834		0.9492	0.0435	0.0902	0.311	0.6711	0.2726
D(IR)	(c2)	2.6155	10.31679***		5.688031*	4.307965	0.605782	4.968164*	36.30413***
	Prob.	0.2704	0.0058		0.0582	0.116	0.7387	0.0834	0.0003
D(LNMS)	(c2)	0.954843	0.200431	0.135077		2.278625	0.045122	1.807731	8.819189
	Prob.	0.6204	0.9046	0.9347		0.32	0.9777	0.405	0.7183
D(LGDI)	(c2)	1.866168	1.076574	0.460548	26.30661***		1.571107	3.947435	37.83807***
	Prob.	0.3933	0.5837	0.7943	0.0000		0.4559	0.1389	0.0002
D(LGDS)	(c2)	0.87081	2.831031	0.8105	17.7706***	5.134496*		8.531735**	36.48003***
	Prob.	0.647	0.2428	0.6668	0.0001	0.0767		0.014	0.0003
D(LRGDP)	(c2)	0.948556	0.8708	11.0842***	12.2254***	6.51367**	1.064184		27.24085***
	Prob.	0.6223	0.647	0.0039	0.0022	0.0385	0.5874		0.0071

4.1.3. The Response of Monetary Variables to the change in policy shocks

After that we employed a recursively identified SVARs model. Therefore, we intended to examine the interaction or the impulse responses of each variable in response to random innovation shocks in the SVAR model. This methodology signifies the dynamic interaction among the variables and identifies the reaction of each dependent variable in the model when a unit shock is applied to each variable. The impulse response function to savings, investment and economic growth to various shocks was calculated using EViews version 10. We intended to investigate the reaction of these variables to future changes of any of the seven variables.

i) The response of Exchange rate shocks

From Figure 1, it is observed that a positive innovation to the real GDP and gross domestic investment caused a negative impact on the exchange rate. The reaction of the exchange rate to shocks of interest rate, money supply and gross domestic saving noted to be positive. According to the Monetary theory of exchange determination the rate is determined based on the supply and demand of money. In theory, ceteris paribus, an increase in money supply in the international (foreign) exchange market leads to decrease (depreciation) of the currency. The higher interest rate also leads to lower demand for money, in relation to supply of money. This makes the domestic currency weaker. In addition, the decrease of the exchange rate tends to change aggregate demand left from traded non- traded goods, entailing a rise in the real interest rate to keep internal balance. A positive innovation to inflation caused a positive impact on exchange rate, but gradually declined. Positive shocks in exchange rate itself also influences highly.

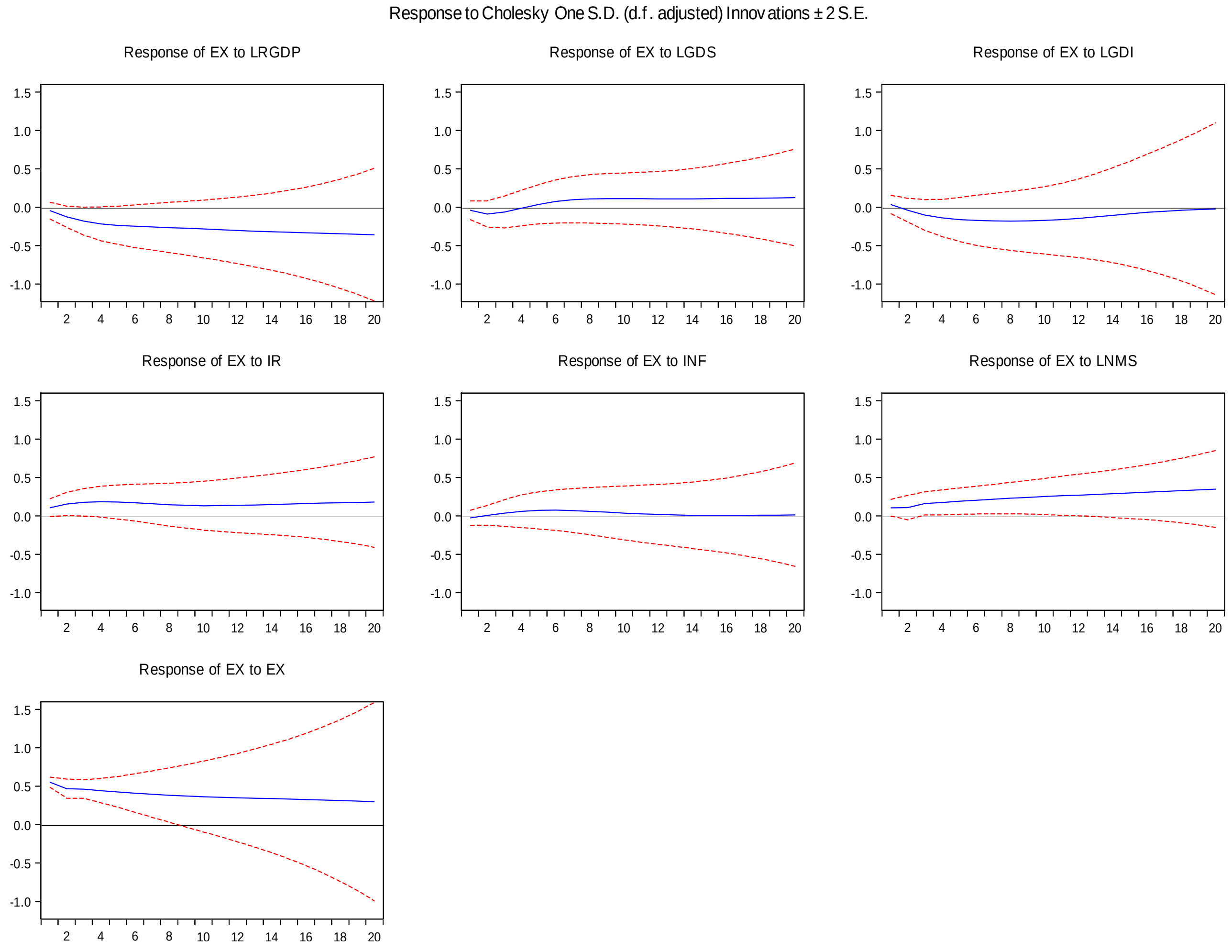

Figure 1. Contemporaneous response of exchange rate in shock of other variables.

ii) The response of Money supply to Shocks

Figure 2 plots the response of money supply to a random innovation of a positive shock. The response of money supply to the positive innovation of inflation is directly related. That is, positive association; a positive shock in inflation leads to the positive reaction of money supply. Then again the reaction of money supply on the interest rate shock was reported to be negative. This implied money supply and interest rate have inversely related, which is in line with economic theory. A positive shock in real GDP results in a negative response by money supply in the first ten quarters before it has a positive effect. In the long run money supply responds positively to economic growth, that is, a positive shock to the output leads to increase in money supply. Finally, the reaction of money supply to the shock of the exchange rate is noted to be positive with a long lasting effect.

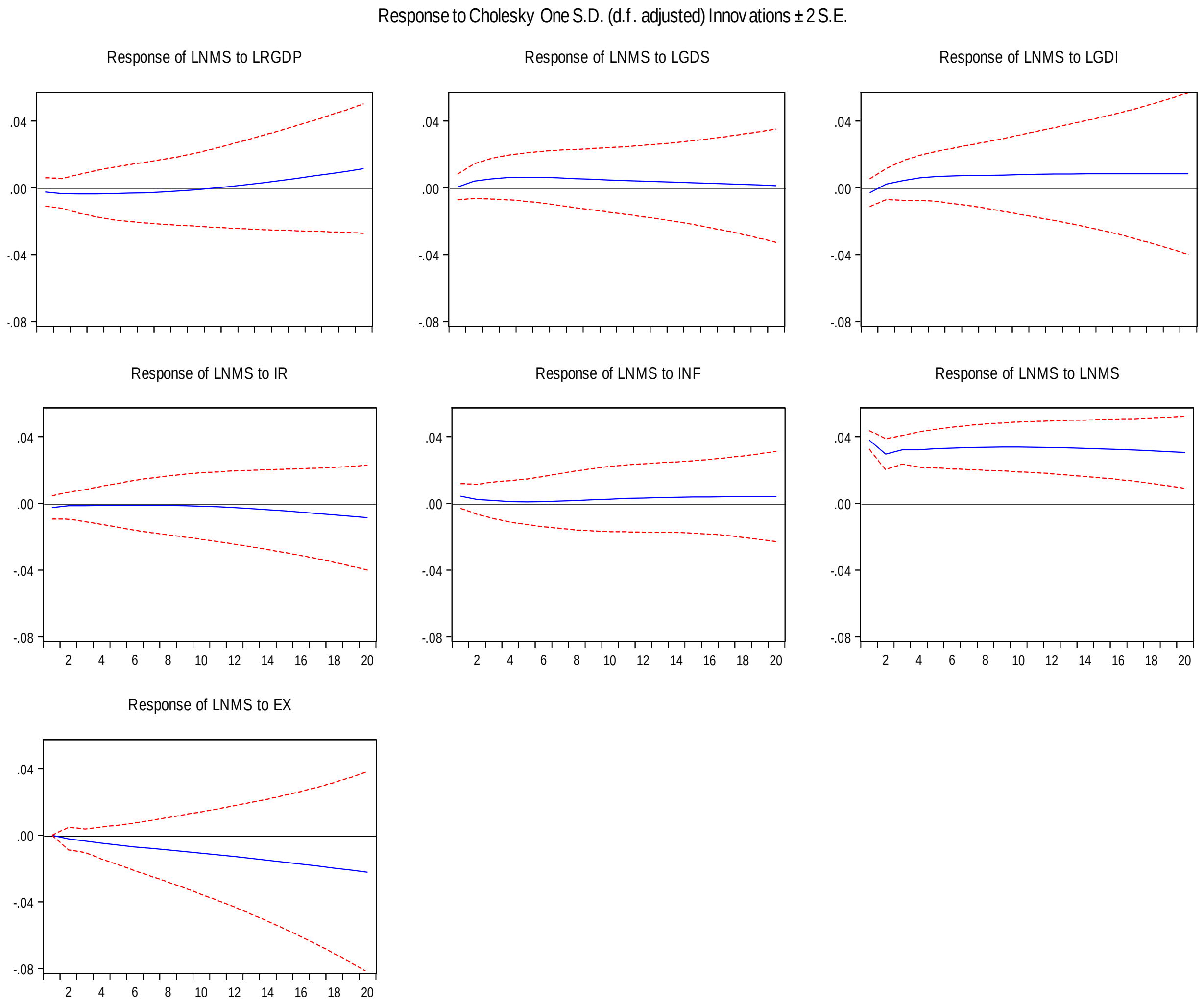

Figure 2. The response of money supply to a random innovation of a positive shock.

iii) The response of inflation to shocks

Figure 3 plots the response of inflation to a random innovation of a positive shock. In the beginning, the reaction of inflation to the shock of real GDP was noted to be negative. The response of inflation to positive innovations of the exchange rate is negative. A positive random shock in domestic savings leads to decrease in inflation. When savings increase, expenditure on goods and services would diminish. This means that more money is accumulating and a smaller amount is spent. As the resultant velocity of money circulation would diminish and therefore producers of goods and services, income reduces which would lead to reduce (inflation) the price level. An increase in domestic investment increases inflation. An increase in investment boosts the production of goods and services which in turn increases money income and saving. A raise in money income enhances effective demand and then raises inflation.

The reaction of inflation to a positive random shock of interest rate noted to be negative. A positive shock inflation results in a positive response by money supply in the first ten quarters before it declines. This is for the reason that, surplus supply of money in the market leads to raising the demand for goods and services which in turn has a positive impact on inflation.

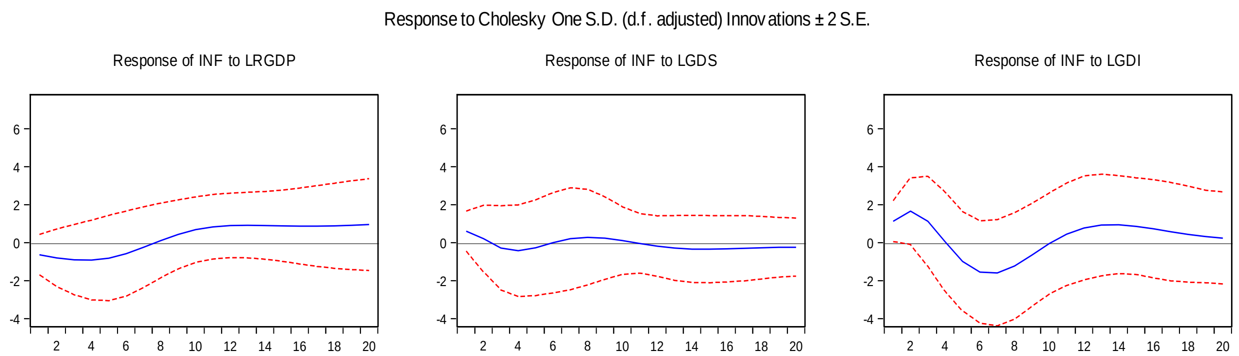

Figure 3. The response inflation to a random shock of other variables in the system.

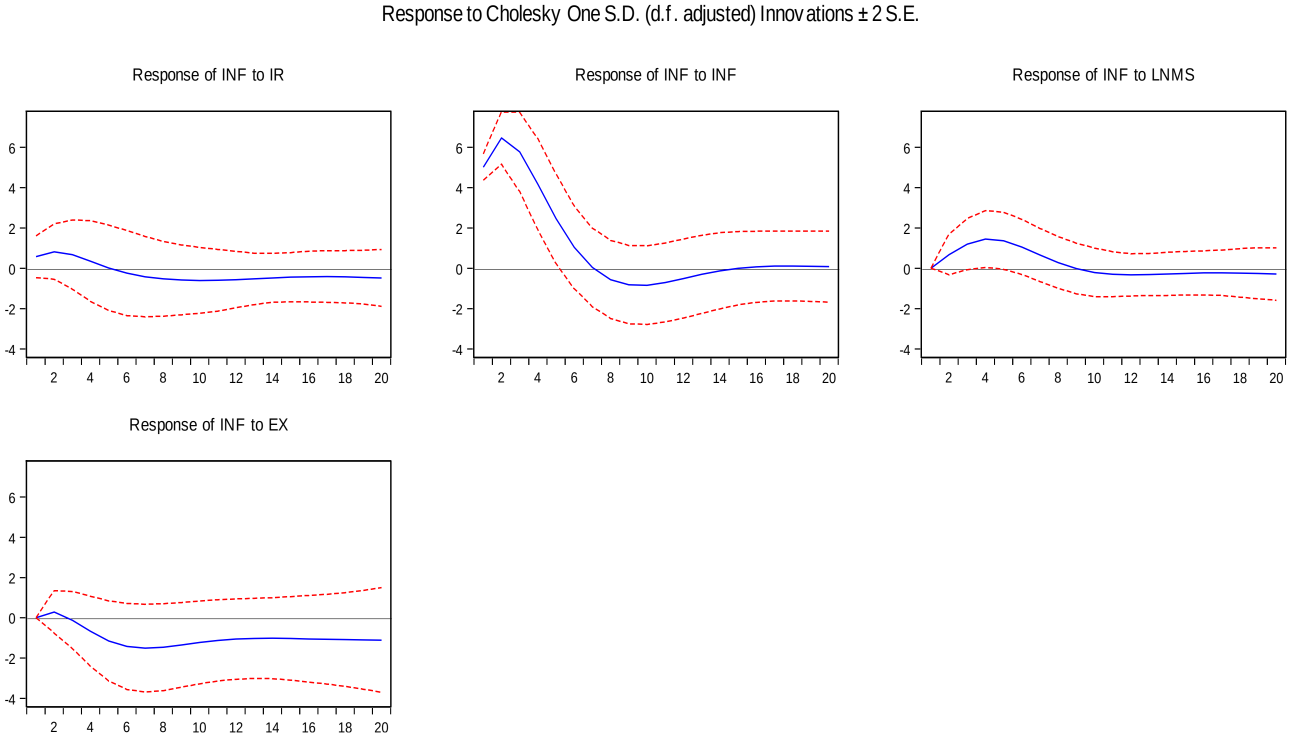

Figure 3. Continued.

iv) The response of interest rate to shocks

Figure 4 plots the response of interest rate to a positive shock of other macroeconomic variables in the system. The reaction of interest rate to shock of domestic saving and investment, money supply and exchange rate noted to be positive. This result coincides with McKinnon's (1973) view that high interest rate raises the amount of domestic funds (credits), which in turn raises investment by encouraging savings. Whereas, the response of interest rate of economic growth is negative. Initially the reaction of interest rate to the shocks of inflation is positive but declines. After the 6th quarter the effect becomes negative, but dies away from the 14th quarter.

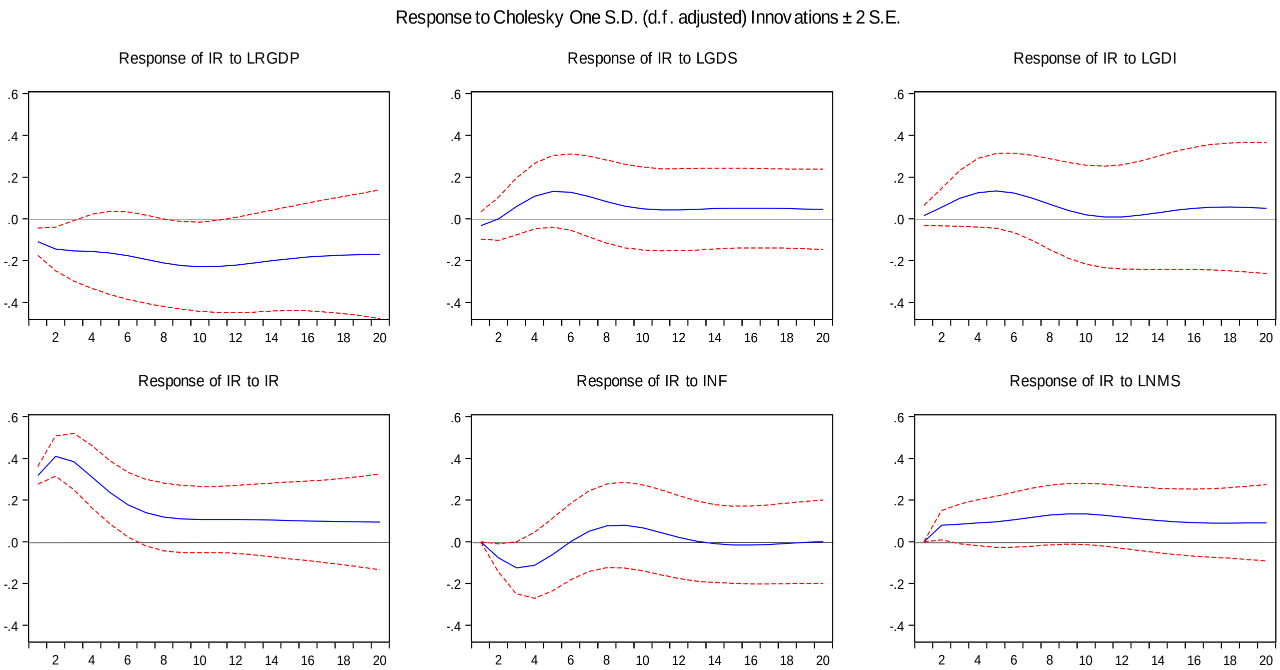

Figure 4. The response interest rate to a positive random shock of other macroeconomic variables.

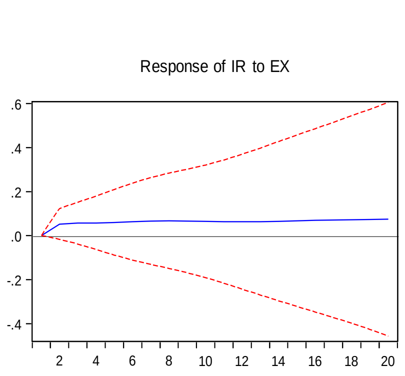

Figure 4. Continued.

v) The response of Investment to shocks

Figure 5 illustrates how domestic investment responds to a shock to other macroeconomic variables. The response of domestic investment to a positive innovation of real GDP is directly related in the first five quarters. However, after 6th quarter the effect is negative, but becomes positive starting from 18th quarter, which is in line with the finding of Mndeme (2015) in Tanzania, Namoloh (2017) in Namibia, (Omoregie & Ikpesu, 2017) in Nigeria and Shimelis (2014) and Yibeltal (2019) in Ethiopia.

A positive Shocks of domestic saving leads to the positive response of domestic investment, but gradually decreasing. This result is in agreement with prior anticipations and has the theoretical and practical sense that increased savings entails that availability of funds increased, making it possible to convert to investment. According to Harrod- Domar and the MacKinnon models a rise in savings in the economy led to a rise in investment. Empirically, this positive relationship is also demonstrated in the study of Omoregie & Ikpesu (2017) in Nigeria, Shimelis (2014) and Yibeltal (2019) in Ethiopia.

The response of interest rate (lending rate) to a sudden increase in investment is positive in the beginning, but the effect becomes positive in the middle period before it becomes negative in later periods. Economic theory suggested a negative relationship between investment and lending rates. The direction of investment response to inflation innovation is negative, but weak in the beginning and becomes positive during later periods. The reaction of investment on the money supply shock was reported to be positive.

When money supply increased, savings increased and in turn increased investment flow. In the theory of Keynes (1936), it had been enlightened that with the supply of money raises, interest rate declines, investment and real GDP boosts. Finally, the response of exchange rate shock on investment results in a negative impact that is transitory and lasts throughout for 20 quarters.

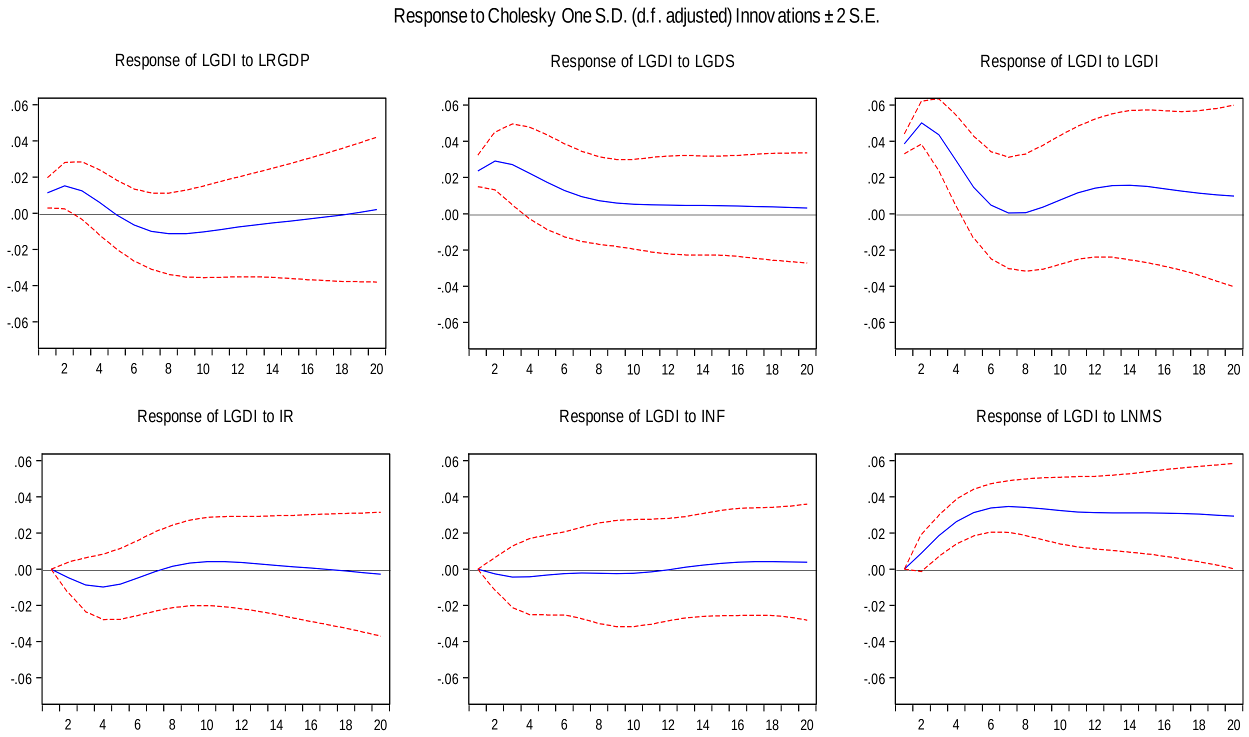

Figure 4. The response investment to a random shock of other variables in the system.

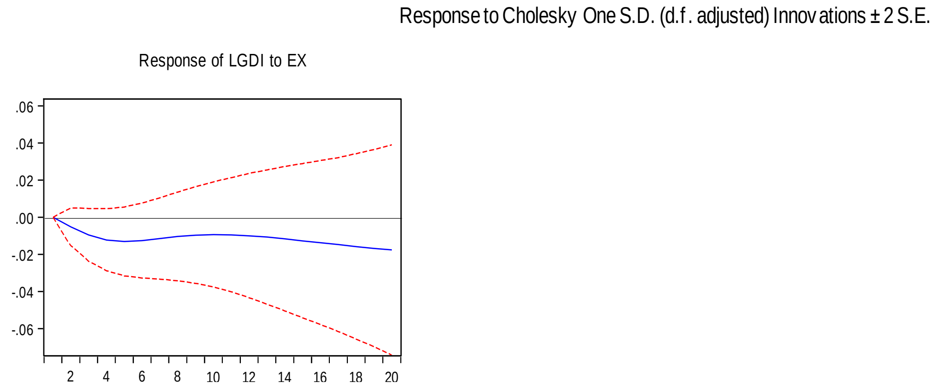

Figure 5. Continued.

vi) The response of Savings to shocks

Figure 6 uncovers the impact of shock of other macroeconomic variables on domestic savings. The reaction of saving to shocks of real GDP was noted to be positive in the beginning. Hypothetically, this supports the Keynesian theory that economic growth leads to increased savings. While after six quarters the effect is negative. The response of saving to a shock of investment is negative in the beginning, while the effect is positive after the 8th quarter. This result is consistent with the common perception that domestic saving boosts investment. Empirically, this positive relationship is also demonstrated in the study of Omoregie & Ikpesu (2017) in Nigeria, Shimelis (2014) and Yibeltal (2019) in Ethiopia..

Initially, a rise in interest rate led to fall in domestic savings, whereas the effect becomes positive after six quarters. Increases in interest rates encourage economic agents to postpone present consumption in order to yield future interest income from the savings. It is also manifested from Figure 6 that money supply and exchange rate generate a positive effect on savings, which is revealed by the positive reaction of saving to a shock to supply of money and exchange rate during the entire period. While inflationary pressure affects saving negatively.

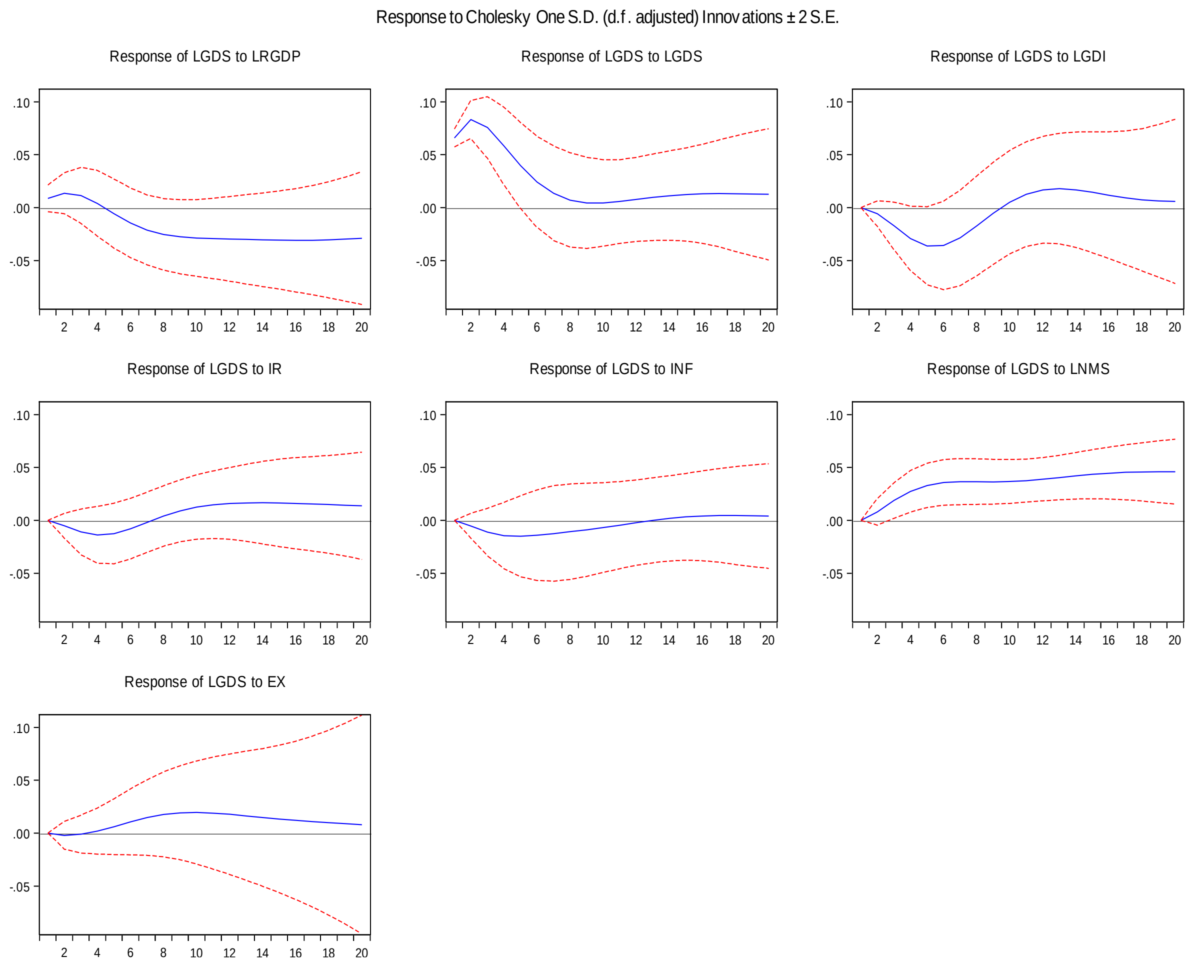

Figure 6. The response of domestic saving to positive innovations.

vii) The response economic growth to shocks

Figure 7 below provides an assessment of the response of economic growth to other macroeconomic shocks. It is evident that the shocks of domestic savings generate a negative effect in the beginning and a constant (insignificant) effect on economic growth is noted from quarter six, while investment affects economic growth negatively, but declining. This result is consistent with the finding of Hishongwa (2015) in Namibia, Nwanne (2016) in Nigeria and Joshi et al. (2019) in Nepal. But the result contradicts with the finding of Omoregie & Ikpesu (2017) in Nigeria, Yibeltal 2(019) in Ethiopia.

Real GDP responds negatively to shocks of interest rate. Empirically, this result is also demonstrated in the study of Ahmed et al. (2016) in Pakistan, Yigermal (2018) in Ethiopia. The reaction of real GDP to shocks of inflation was noted to be positive in the beginning, but declined. This result corresponds to the suggestion made by Lupu (2016) that inflation exerts a positive impact on economic growth in Romania. However, money supply shock generates a weak effect on economic growth and it is an insignificant monetary policy instrument that drives growth.

A positive exchange rate leads to a negative effect on real GDP throughout the whole period. This indicates that a positive random innovation on exchange rate has a contractionary effect on real GDP. Empirically, this negative relationship between real GDP and exchange rate is also demonstrated in the study of Aslam (2016) in Sri Lanka and Yigermal (2018) in Ethiopia.

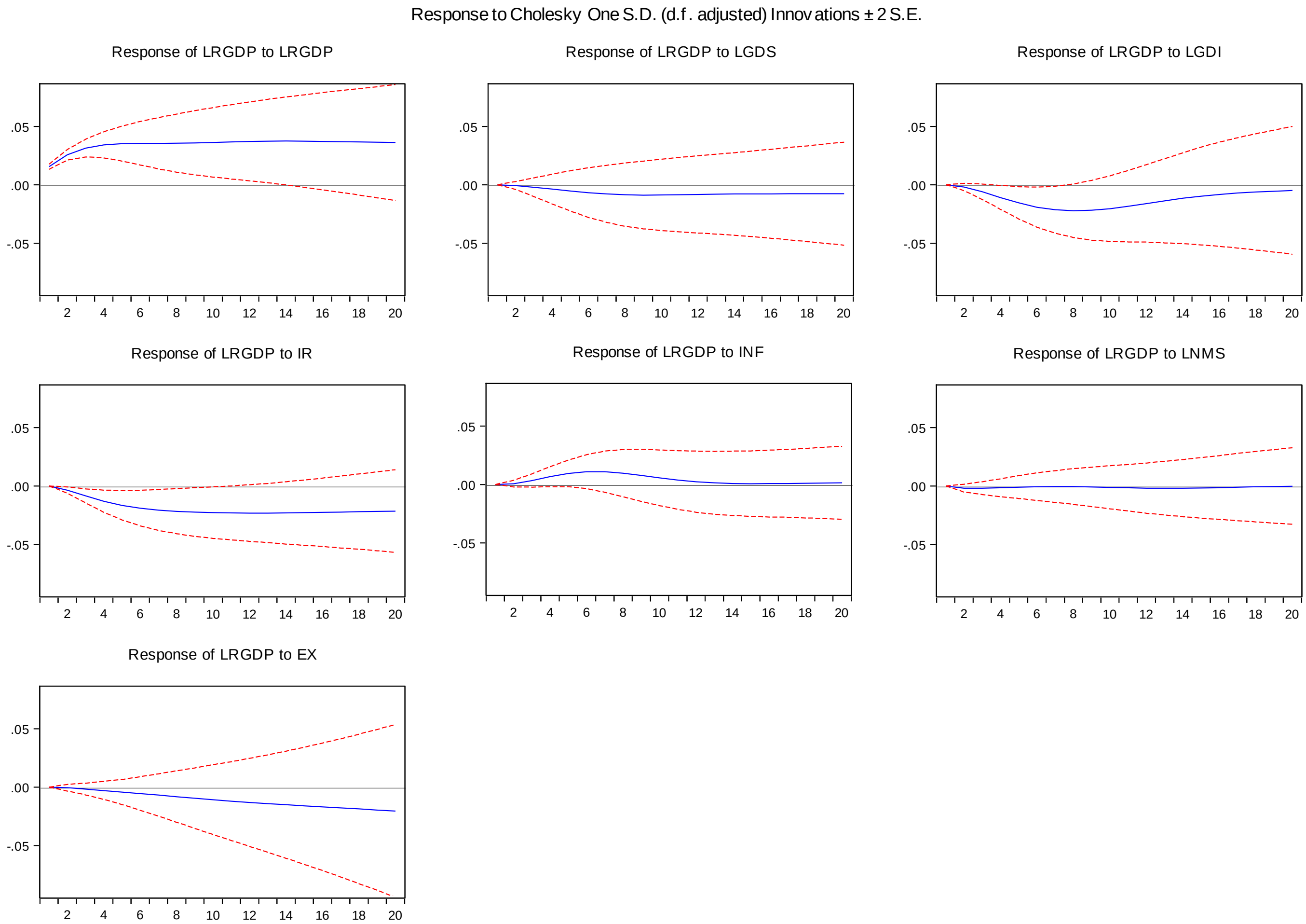

Figure 7. The response of economic growth to other macroeconomic shocks.

4.1.4. Impulse Response function for VECM

To investigate the dynamic interaction among variables, the impulse response function of the vector error correction model is compared with the SVAR model in Appendix C1. The response of real GDP to positive shocks of investment, saving, money supply, and interest rate is negative in the VECM model, while the response of exchange rate and inflation is positive. This result supports the outcome in the SVAR model.

Shocks of domestic investment generate a positive effect on real GDP, money supply, saving and interest rate, while the effect is noted to be negative on exchange rate and inflation. That is, the result more or less supports the outcome in the SVAR model.

The contemporaneous effect of positive shocks in real GDP, money supply and interest rate led to a positive response by domestic savings. The response of saving to the positive shock in investment, inflation and exchange rate is negative. The finding VECM model opposes the outcome of the SVAR model in the shocks of investment and exchange rate which savings respond.

4.1.5. Variance Decomposition

To trace the effect of a random shock to one endogenous variable on the other variable Impulse response is used, while variance decomposition separates the variation and demonstrates how much of the forecast error variance of each variable is explained by the shocks of other variables.

The result of the variance decomposition over a 20 –quarter time period is selected to represent the short run and the long run effect on Appendix Table B2.

As can be seen from Table B2, variation in real GDP is largely explained by its own shock which accounts for more than 97.7 percent in the first period, but this then fluctuates over time. The effect finally reached approximately 59.74 percent in the last quarter. Subsequently, interest rate, investment and exchange rate are the second, third and 4th major contributors explaining real GDP's variation. During the first year, they accounted for around 1.4%, 0.4%, and 0.37%, and they increased to 19.3%, 9.3%, and 7.6% respectively in the long run. On the other hand inflation, money supply and savings do not have any significant effect on growth variation.

Forecast errors in domestic saving are caused by deviations in the money supply, domestic savings, real GDP and investment. Moreover, with the 20th quarter period forecast error, it can be seen that money supply, real GDP and investment have more impact with 35.06 percent, 17.79 percent and 8.34 percent respectively whereas the remnant is accounted for by the other macroeconomic variables. The suggestion of this result is that in the long run, money supply, investment and economic growth begin to impact more on the domestic savings.

The variance decomposition contribution of domestic investment in itself decreases with time from 68.61% in the short run to 25.69 % in the long run. In addition real GDP and savings explain around 6.08% and 25.5% in the short run and decreased to 3.8% and 10.18% in the long run respectively. While variance contributions of money supply and exchange rate to investment increases with time from 1.37% and 0.44% in the short run to 50.37% and 8.31% in the long run respectively. From this, we can understand that long term money supply seems to have a higher contribution than in the long run. Inflation and interest rate contributes low variation both in the short run and long run.

Variations in the interest rate are due to variations in real GDP, saving, investment, exchange rate, money supply and inflation. All the variables in the model contribute to its forecast error, but the great deviation comes from real GDP and money supply followed by its owner.

At the beginning of the forecasting time horizon a high variation of inflation comes from the variations of its own real GDP, saving and investment. While the variation in exchange rate rises when the forecasting horizon increases and becomes the second largest part of the forecast error variance. But the variations in savings are very small in explaining the variations of the inflation rate. This is less than one percent in all other forecasting time periods.

The deviation in money supply is highly explained by its own innovations followed by the variations in the exchange rate and investment during the end of the forecast horizon. Table B2 also shows that deviations in the exchange rate are due to deviations in money supply, real GDP, interest rate and interest rate. Real GDP and money supply contributes significantly to its variations in the last time horizon by accounting for 23.3 percent and 19.13 percent, respectively, following the exchange rate itself by a great portion of 42.66 percent. The remnant is accounted for by the other macroeconomic variables.

4.1.6. Monetary policy transmission channels

In this section different channels of monetary transmission mechanisms with some information about Ethiopian economy structure and monetary policy are discussed. The empirical outcomes indicated that the exchange rate, channel played a vital role in the monetary transmission channel. This is no longer a stunning finding. A recursively identified restriction on all macro-economic variables included in the model plays a role as discussed above.

The exchange rate, channel connects the economy via real GDP, money supply, interest rate, domestic investment and saving. Within this exchange rate, channel real GDP, money supply and investment have leading functions in determining the exchange rate. It is additionally one of the most necessary policy variables, which determines capital and trade flow inflation, international reserve and remittance of an economy. The commencing of floating exchange rate has directed renewed interest to the consequences of devaluation on the change of stability of each developed and less developed nations (Yigermal, 2018). As a result, it is necessary for the central bank to control the exchange rate deviation.

Monetary policy factors like the money supply, inflation and interest rate had a larger impact on economic growth of the country. Mainly, these monetary factors were found to have an impact on output level as shown in the impulse response and variance decomposition results. The possibility that the money supply could be the cause of inflation following and the existence of a price puzzle can recommend the inadequate capability of the central bank to use monetary policy to control inflation.

In the investment channel, devaluation reduces investment flows. Thus, devaluation raises interest rate; an increase in interest rate decreases the money supply and causes return on investment to fall. This situation restricts the capacity of firms to finance their activities as the cost of capital rises because of an increase in interest rate and an increase in the cost of investment. Therefore, a decrease in domestic investment is possible to happen and cause economic growth to fall.

4.1.7. Model Stability and Diagnostic Tests

Residual vector LM test for autocorrelation, normality test, Heteroscedasticity test of residuals and stability tests are carried out examining the adequacy of the model prior to use for associated tests. To show the stability of the model both CUSUM tests are commonly practiced (Appendix A2).

5. Conclusion and Recommendation

5.1. Conclusion

Interaction between savings, investment and economic growth has been a crucial concern to the development economists and there exists considerable debate both theoretically and empirically over the nature of the long run relationship between them. Therefore, the study aimed at investigating theoretically and empirically the dynamic interaction between domestic saving, investment and economic growth in Ethiopia. Quarterly data from the period ranging from 1992/1993Q1 to 2019/20Q4 were utilized to estimate. Co-integration analysis, SVAR, VECM, Granger causality and the variance decomposition response were used to examine not only correlation and causality but also dynamic behavior on the interaction between these variables.

ADF and PP unit root tests show that all variables are non- stationary at level and ,on the other hand, stationary at first difference which reveals that all the variables included in the model are integrated at first order, that is, I(1). Johansen co- integration test shows the existence of cointegration between variables which is an indication of long run economic association between the variables. The VECM result indicates the existence of a long–run positive relationship between savings, investment and economic growth in Ethiopia.

Short run relationships also exist among variables. The long run analysis is followed by a causal analysis. To find causal relationship, this study employed the widely used granger causality, which indicates that there is the presence of unidirectional Granger causality from domestic investment and real GDP to domestic savings and domestic investment granger causes economic growth. This means the past history of economic growth has predicted power in affecting the current value of gross domestic savings. This is the perspective of the Keynesian theory which believes that economic growth give rise to savings

Causality also exists from Money supply, gross domestic saving and investment to exchange rate in the short run. Inflation is Granger caused by money supply and gross domestic investment. The interest rate is also granger caused by inflation, money supply and real GDP. Gross domestic investment is granger caused by money supply unidirectional. Money supply granger causes gross domestic saving Lag of money supply and interest rate are as well identified to granger cause real GDP. Recursive identification decomposition is used in the SVAR model to validate the result.

The response of the exchange rate to a random positive innovation of real GDP and gross domestic investment is reported to have a negative impact. Whereas, the reaction of the exchange rate to shocks of interest rate, money supply, inflation and gross domestic saving was noted to be positive. A positive shock in real GDP results in a negative response by money supply in the short run before it has a positive effect. In the long run money supply responds positively to shocks of economic growth, saving, investment and inflation. While the reaction of money supply to the shock of exchange rate and interest rate was noted to be negative. The response of inflation to positive innovations of saving, money supply, interest rate and exchange rate are negative in the long run. While the reaction of inflation to the shock of real GDP and investment is noted to be negative. The reaction of interest rate to shock of saving, investment, money supply and exchange rate noted to be positive. Whereas, the response of interest rate of economic growth and inflation is negative.

The response of domestic investment to a positive innovation of real GDP is positive in the first five quarters. However, after the 6th quarter the effect is negative, but becomes positive in the long run. A positive Shock of domestic savings leads to the positive response of investment and money supply. According to Harrod- Domar and the MacKinnon models a rise in savings in the economy led to a rise in investment. The response of interest rate (lending rate) to a sudden increase in investment is positive in the beginning, but the effect becomes positive in the middle period before it becomes negative in later periods. In theory (Keynes, 1936) had enlightened that with the supply of money rises will cause interest rate to decline, investment and real GDP to boost. The response of exchange rate shock to investment results in a negative impact.

In the short run the reaction of saving to shocks of real GDP and investment noted to be positive and negative respectively. Hypothetically, this supports the Keynesian theory that economic growth leads to increased savings. While in the long run the effect becomes vice versa. An increase in interest rate led to an increase in domestic savings in the long run. A rise in interest rates encourages economic agents to postpone present consumption in order to yield future interest income from the savings. Positive reaction of saving to a shock to supply of money and the exchange rate is also reported in the same period.

Shocks of domestic savings generate a negative effect in the short run and a constant (insignificant) effect on economic growth is noted in the long run, while investment affects economic growth negatively, but declining. Real GDP responds negatively to shocks of interest rate and exchange rate. Money supply shock generates a weak effect on economic growth. The reaction of real GDP to shocks of inflation was noted to be positive in the beginning, but declined.

From the variance decomposition representation of the economic growth equation, a great variation in real GDP emanates from itself and investment along with an interest rate and exchange rate. The variation in saving comes from the money supply, domestic savings, real GDP and investment. Investment deviation is also emanating from Real GDP and saving in the short run and decreased in the long run. Therefore, there is a linkage between domestic savings, investment and economic growth.

5.2. Recommendations

Based on the results obtained from the previous chapter and the conclusion, the following study recommendations are drawn. Granger causality results revealed that domestic investment Granger causes economic growth and also that domestic investment and real GDP collectively Granger causes domestic savings. In connection with this the result also finds evidence of response to shocks and variations of saving emanating from real GDP and investment. This means that policies that increase investment and real GDP led to a rise in saving. The variation and response to shocks of investment comes from economic growth and savings as indicated by causality result, impulse response and variance decomposition. Thus, the government and stakeholders are supposed to practice macroeconomic policies that will promote economic growth of our country, and gross domestic savings and thus investment will increase.

This result is as well in line with the Keynesian school of thought view which hypothesized that a raise in saving is a result of economic growth. To this perspective, to increase gross domestic saving, the government must attain economic growth. We, consequently, recommend that the governments of Ethiopia be supposed to practice policies that bring about economic growth, for instance increase in government expenditure on infrastructural facilities, industry parks, education, health, research and development, among others. This will automatically increase gross domestic savings. As a result, a rise in domestic savings increases the amount of funds available for investment as well lead to enhanced capital formation and investment. This will in the end improve the general welfare of the people.

The result further revealed that the exchange rate, channel connects the economy via real GDP, money supply, interest rate, domestic investment and saving. So, the government should consider a policy that promotes productivity, expansion of import substituting industries and diversify export promoting investments which are alternative policies for devaluation prior to devaluing its currency. The country is planned to become a manufacturing hub in Africa so that, first it needs to promote import substituting investments; the alert on to export oriented investments based on production planning. Therefore devaluation will be effective. So that the National Bank of Ethiopia should take measures in controlling devaluation and inflationary pressures in the country.

The third policy implication is that, in view of the fact that inflation has unfavorable consequences, the National Bank of Ethiopia should be kept at the level that cannot source unfavorable effects on saving and investment behaviors. The government also recommended influencing commercial banks in the country to reduce lending rates as a result potential investors can raise their investment and increase production capacity of the nation.

Generally, proactive policies which would promote investment and promote growth are suggested. Accordingly, over the long run domestic savings will eventually rise and lead to sustainable growth of the economy. It is to be noted that monetary policy could be used to influence savings in the economy through their effects on investment and economic growth.

Conflicts of Interest: The authors declare no conflict of interest.

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Appendix

A1. Lag exclusion Wald test

VAR Lag Exclusion Wald Tests
Date: 04/11/21 Time: 06:25
Sample: 1992Q1 2019Q4
Included observations: 110

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	LRGDP	LNMS	LGDS	LGDI	IR	INF	EX	Joint
Lag 1	611.6279 [0.0000]	66.48726 [0.0000]	231.0715 [0.0000]	268.5433 [0.0000]	317.6948 [0.0000]	237.4369 [0.0000]	94.66622 [0.0000]	1831.500 [0.0000]
Lag 2	104.3201 [0.0000]	6.519036 [0.4806]	42.20089 [0.0000]	57.56751 [0.0000]	74.58551 [0.0000]	46.49216 [0.0000]	8.883201 [0.2612]	330.0447 [0.0000]
df	7	7	7	7	7	7	7	49

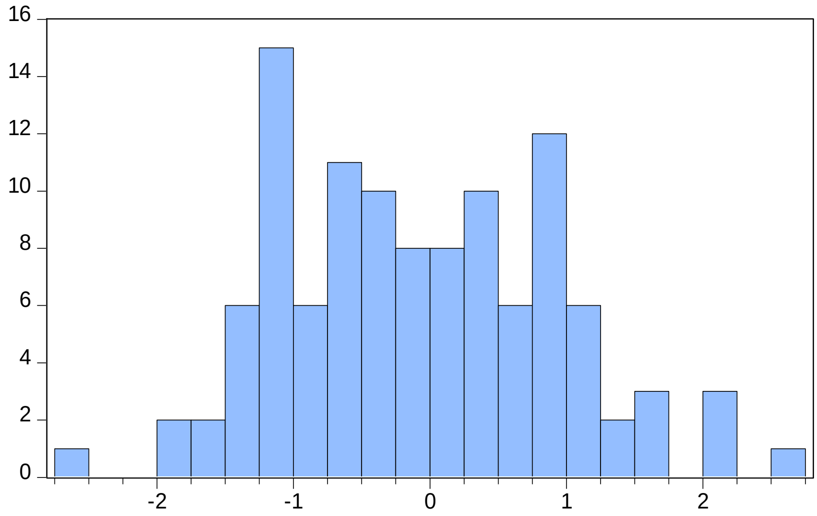
A2. VAR Residual Serial Correlation LM Tests

VAR Residual Serial Correlation LM Tests
Date: 04/11/21 Time: 06:39
Sample: 1992Q1 2019Q4
Included observations: 110 s

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	58.13111	49	0.1744	1.200421	(49, 420.7)	0.1758
2	31.37302	49	0.9764	0.628321	(49, 420.7)	0.9766
3	52.81351	49	0.3290	1.083968	(49, 420.7)	0.3309

B1.



Series: Standardized Residuals
Sample 1992Q1 2019Q4
Observations 112

Mean	-0.098552
Median	-0.132324
Maximum	2.638073
Minimum	-2.707114
Std. Dev.	0.999685
Skewness	0.231042
Kurtosis	2.698646
Jarque-Bera	1.420232
Probability	0.491587

B2. Variance decomposition in the Structural VAR model.

Table B2. Variance decomposition in the Structural VAR model.

				Variance Decomposition of LRGDP:				
Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.015547	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.030336	97.71420	0.055658	0.368883	1.406953	0.060245	0.368825	0.025233
3	0.045103	92.60697	0.229525	1.906950	4.204587	0.583967	0.329963	0.138039
4	0.059647	85.76483	0.496473	4.395827	7.191636	1.591653	0.251007	0.308577
5	0.073814	78.79193	0.829550	7.258340	9.728943	2.694799	0.181547	0.514894
6	0.087348	72.78516	1.185593	9.954133	11.68159	3.504551	0.134084	0.754882
7	0.100004	68.15478	1.519769	12.15085	13.16073	3.874295	0.104004	1.035574
8	0.111653	64.86458	1.799675	13.70223	14.31821	3.866643	0.085488	1.363166
9	0.122299	62.68412	2.011825	14.59432	15.26654	3.629226	0.075535	1.738430
10	0.132041	61.33867	2.159296	14.90273	16.07009	3.299593	0.072923	2.156703
11	0.141011	60.57664	2.254836	14.75597	16.75975	2.966297	0.076183	2.610313
12	0.149337	60.19337	2.313935	14.29971	17.34883	2.669842	0.082793	3.091522
13	0.157125	60.03480	2.350292	13.66670	17.84402	2.419835	0.089778	3.594576
14	0.164455	59.99257	2.373892	12.95923	18.25122	2.211963	0.094769	4.116365
15	0.171392	59.99556	2.390876	12.24488	18.57768	2.038409	0.096651	4.655948
16	0.177987	60.00069	2.404307	11.56162	18.83220	1.892099	0.095522	5.213553
17	0.184291	59.98454	2.415233	10.92638	19.02456	1.767515	0.092216	5.789562
18	0.190349	59.93647	2.423681	10.34328	19.16465	1.660349	0.087754	6.383812
19	0.196206	59.85365	2.429398	9.809725	19.26186	1.567117	0.082978	6.995271
20	0.201905	59.73747	2.432278	9.320323	19.32452	1.484969	0.078405	7.622034

				Variance Decomposition of LGDS:				
Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.066439	1.721955	98.27804	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.108113	2.253367	96.43063	0.271275	0.221869	0.232011	0.553168	0.037683
3	0.135830	2.148930	92.19075	1.774768	0.781285	0.808032	2.267848	0.028392
4	0.154513	1.725978	85.50308	4.936921	1.388394	1.494922	4.912798	0.037909
5	0.168246	1.568984	77.70993	8.777886	1.714441	2.061187	8.003889	0.163682
6	0.178983	2.042990	70.51867	11.73011	1.709106	2.436182	11.06424	0.498706
7	0.187590	3.129638	64.71275	12.99667	1.565620	2.655261	13.87248	1.067580
8	0.194840	4.593566	60.12079	12.84813	1.495959	2.761176	16.37252	1.807861
9	0.201569	6.170123	56.22327	12.07544	1.599221	2.772743	18.56088	2.598320
10	0.208411	7.667466	52.63632	11.35706	1.860329	2.701215	20.46420	3.313414
11	0.215626	8.997778	49.24395	10.95717	2.209383	2.568579	22.15076	3.872368
12	0.223166	10.15627	46.09204	10.79916	2.577666	2.407714	23.71339	4.253760
13	0.230857	11.17623	43.24671	10.69622	2.921792	2.249959	25.23117	4.477918
14	0.238538	12.09180	40.72890	10.51723	3.222308	2.114313	26.74406	4.581390
15	0.246097	12.92189	38.51749	10.22748	3.474130	2.005476	28.25330	4.600233

16	0.253464	13.67062	36.57419	9.855897	3.678881	1.918798	29.73803	4.563592
17	0.260584	14.33436	34.86148	9.450193	3.840858	1.846799	31.17343	4.492873
18	0.267409	14.90862	33.34831	9.049559	3.965240	1.783469	32.54201	4.402797
19	0.273904	15.39174	32.00889	8.677175	4.057288	1.725534	33.83661	4.302769
20	0.280052	15.78582	30.82030	8.343390	4.121929	1.671855	35.05844	4.198253

Variance Decomposition of LGDI:

Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.046686	5.881484	25.50532	68.61320	0.000000	0.000000	0.000000	0.000000
2	0.076965	6.087805	23.72097	67.89863	0.358193	0.112551	1.377279	0.444571
3	0.096169	5.587798	23.16124	64.09496	1.037413	0.271114	4.591058	1.256414
4	0.107638	4.781023	22.82160	58.46335	1.662428	0.365600	9.620264	2.285743
5	0.115457	4.161371	22.08033	52.42690	1.944610	0.392503	15.73523	3.259061
6	0.122061	4.007003	20.86766	47.05857	1.898015	0.387970	21.81057	3.970208
7	0.128167	4.237489	19.47678	42.68205	1.731498	0.379317	27.09439	4.398477
8	0.133777	4.610409	18.17075	39.17958	1.603587	0.377914	31.42165	4.636118
9	0.138893	4.933592	17.03705	36.41334	1.547431	0.381746	34.90929	4.777553
10	0.143670	5.123094	16.05441	34.31803	1.529946	0.380234	37.71134	4.882942
11	0.148286	5.174330	15.17959	32.81215	1.514039	0.366279	39.96569	4.987924
12	0.152842	5.119390	14.38523	31.74480	1.482087	0.345065	41.80597	5.117452
13	0.157349	4.996660	13.66121	30.92950	1.433207	0.330225	43.35796	5.291229
14	0.161767	4.836364	13.00470	30.20798	1.373684	0.333046	44.72049	5.523739
15	0.166053	4.657714	12.41282	29.48679	1.310446	0.355692	45.95303	5.823511
16	0.170178	4.471841	11.88030	28.73476	1.248858	0.392194	47.07859	6.193462
17	0.174136	4.286106	11.39982	27.95938	1.192879	0.433617	48.09599	6.632206
18	0.177934	4.107507	10.96317	27.18227	1.145830	0.472620	48.99295	7.135655
19	0.181596	3.944379	10.56206	26.42361	1.110924	0.505303	49.75530	7.698431
20	0.185150	3.806529	10.18883	25.69598	1.091399	0.530826	50.37155	8.314892

Variance Decomposition of IR:

Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.338524	10.39271	0.900265	0.230296	88.47672	0.000000	0.000000	0.000000
2	0.567464	10.16821	0.320692	1.070721	83.77846	1.847053	1.963381	0.851490
3	0.729867	10.54995	0.858463	2.464461	78.41952	4.041757	2.544406	1.121440
4	0.840439	11.40288	2.328911	4.064977	72.94090	4.843046	3.098677	1.320601
5	0.917019	12.73656	4.030237	5.546592	67.95039	4.507531	3.692404	1.536285
6	0.975102	14.53435	5.293209	6.534953	63.43002	3.986684	4.439674	1.781108
7	1.024843	16.72930	5.895228	6.880669	59.27417	3.851895	5.340066	2.028672
8	1.071068	19.18540	5.990709	6.725661	55.48926	4.038996	6.320931	2.249040
9	1.114903	21.71623	5.833789	6.340134	52.17127	4.240404	7.269077	2.429099
10	1.155809	24.13423	5.605334	5.927456	49.39541	4.274885	8.088237	2.574450
11	1.193083	26.29822	5.393723	5.568859	47.15651	4.150895	8.731967	2.699822
12	1.226530	28.13472	5.230971	5.275526	45.37766	3.958824	9.202422	2.819880
13	1.256509	29.63344	5.121118	5.046971	43.95007	3.772724	9.530708	2.944968
14	1.283678	30.82903	5.054238	4.889186	42.76983	3.619975	9.757209	3.080535
15	1.308722	31.77965	5.014838	4.804772	41.75738	3.495872	9.919468	3.228016
16	1.332205	32.54871	4.988268	4.782202	40.86064	3.387015	10.04715	3.386014
17	1.354527	33.19240	4.964461	4.797121	40.04893	3.284587	10.16104	3.551459
18	1.375952	33.75345	4.938632	4.822191	39.30495	3.186287	10.27381	3.720682
19	1.396638	34.26001	4.909978	4.836600	38.61844	3.093109	10.39155	3.890310
20	1.416672	34.72792	4.879845	4.830024	37.98251	3.006265	10.51558	4.057851

Variance Decomposition of INF:

Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	5.256670	1.458339	1.348531	4.639948	1.180125	91.37306	0.000000	0.000000
2	8.610753	1.420498	0.564870	5.435415	1.348681	90.49675	0.625742	0.108045
3	10.56177	1.665489	0.444263	4.750851	1.311969	90.04801	1.694855	0.084562
4	11.51979	2.035202	0.511230	3.994543	1.195486	88.83637	3.010753	0.416416
5	11.98663	2.345093	0.524021	4.361427	1.104348	86.28557	4.073045	1.306497
6	12.27690	2.458429	0.499569	5.759040	1.092149	82.97557	4.618824	2.596416
7	12.50006	2.409715	0.508527	7.180138	1.165280	80.04019	4.730132	3.966020
8	12.67494	2.352270	0.544933	7.915867	1.305215	78.04291	4.648709	5.190092
9	12.81281	2.420145	0.567519	8.000743	1.485664	76.78483	4.549349	6.191745
10	12.93367	2.654482	0.563953	7.853243	1.678621	75.77971	4.490162	6.979831
11	13.05397	3.014975	0.554932	7.825744	1.859125	74.68545	4.461706	7.598066
12	13.17868	3.431299	0.564473	8.022063	2.011141	73.42884	4.440393	8.101796

13	13.30383	3.847211	0.599467	8.359247	2.130193	72.10586	4.413250	8.544770
14	13.42325	4.236303	0.650879	8.705339	2.220926	70.83771	4.379247	8.969601
15	13.53320	4.596327	0.705023	8.969557	2.292254	69.69127	4.342471	9.403094
16	13.63365	4.937475	0.752214	9.122187	2.353462	68.67117	4.306934	9.856555
17	13.72713	5.273548	0.789022	9.175301	2.412455	67.74527	4.275077	10.32933
18	13.81716	5.617410	0.816507	9.156803	2.475504	66.87193	4.248348	10.81350
19	13.90696	5.979152	0.837646	9.093295	2.547402	66.01613	4.228053	11.29832
20	13.99893	6.365473	0.855674	9.003587	2.631448	65.15466	4.215682	11.77348

Variance Decomposition of LNMS:

Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.038653	0.423787	0.013260	0.586478	0.399812	1.313793	97.26287	0.000000
2	0.049100	0.740729	0.655428	0.555660	0.327566	1.049393	96.48310	0.188128
3	0.059357	0.877564	1.265888	0.911792	0.275723	0.812315	95.39033	0.466383
4	0.068364	0.933534	1.770671	1.455420	0.240270	0.641545	94.11485	0.843709
5	0.076742	0.939963	2.094695	1.939230	0.215384	0.524442	93.01474	1.271543
6	0.084541	0.919081	2.270450	2.320509	0.196959	0.447153	92.11327	1.732580
7	0.091861	0.878448	2.337571	2.610375	0.183246	0.400270	91.37357	2.216524
8	0.098765	0.822031	2.333679	2.838431	0.174051	0.378311	90.72968	2.723819
9	0.105315	0.754335	2.286757	3.028582	0.170209	0.376759	90.12305	3.260310
10	0.111562	0.682224	2.215751	3.195305	0.173379	0.390937	89.50818	3.834227
11	0.117555	0.614812	2.132392	3.345038	0.185992	0.416208	88.85195	4.453610
12	0.123335	0.562584	2.043377	3.479256	0.211076	0.448423	88.13042	5.124860
13	0.128941	0.536393	1.952215	3.597214	0.251911	0.484171	87.32602	5.852076
14	0.134408	0.546684	1.860600	3.697861	0.311625	0.520808	86.42546	6.636957
15	0.139769	0.603019	1.769326	3.780830	0.392886	0.556383	85.41853	7.479031
16	0.145054	0.713826	1.678849	3.846697	0.497733	0.589529	84.29736	8.376006
17	0.150293	0.886281	1.589572	3.896794	0.627532	0.619378	83.05628	9.324159
18	0.155513	1.126243	1.501969	3.932851	0.783018	0.645463	81.69179	10.31867
19	0.160741	1.438190	1.416600	3.956631	0.964363	0.667630	80.20268	11.35390
20	0.166004	1.825170	1.334084	3.969677	1.171252	0.685945	78.59023	12.42365

Variance Decomposition of EX:

Period	S.E.	LRGDP	LGDS	LGDI	IR	INF	LNMS	EX
1	0.576425	0.583907	0.468858	0.375744	3.369452	0.222315	3.257713	91.72201
2	0.780787	2.882150	1.580345	0.453787	5.719374	0.129853	3.664107	85.57038
3	0.962792	5.456245	1.463764	1.428951	7.099592	0.235140	5.234882	79.08143
4	1.120667	7.789763	1.091669	2.612252	7.938628	0.447686	6.297097	73.82291
5	1.262216	9.670927	0.946830	3.678108	8.300064	0.670918	7.239459	69.49370
6	1.390045	11.16909	1.064086	4.547975	8.334695	0.834544	8.102215	65.94740
7	1.506862	12.40982	1.320070	5.250613	8.171605	0.919685	8.952770	62.97544
8	1.614924	13.50133	1.602565	5.811385	7.916777	0.937658	9.804068	60.42621
9	1.716061	14.51275	1.851489	6.231508	7.643019	0.910511	10.65200	58.19873
10	1.811591	15.48043	2.048889	6.499789	7.394395	0.859079	11.48705	56.23037
11	1.902462	16.41872	2.199183	6.610943	7.193472	0.798624	12.30297	54.47609
12	1.989435	17.32946	2.314586	6.576029	7.048216	0.738409	13.09851	52.89479
13	2.073215	18.20893	2.407450	6.422006	6.957254	0.682898	13.87621	51.44525
14	2.154486	19.05228	2.487378	6.184219	6.913840	0.633417	14.64052	50.08835
15	2.233875	19.85580	2.560776	5.897611	6.908808	0.589708	15.39617	48.79113
16	2.311907	20.61765	2.631355	5.590657	6.932629	0.551042	16.14711	47.52955
17	2.388968	21.33748	2.700873	5.283177	6.976636	0.516780	16.89591	46.28915
18	2.465299	22.01577	2.769821	4.987069	7.033574	0.486501	17.64352	45.06375
19	2.541011	22.65317	2.837979	4.708384	7.097704	0.459901	18.38948	43.85338
20	2.616103	23.25017	2.904808	4.449482	7.164660	0.436673	19.13228	42.66192

Cholesky Ordering: LRGDP LGDS LGDI IR INF LNMS EX