Assessment of Monetary Policy Transmission Mechanism in Tanzania

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Abstract

This study aims at assessing the effectiveness of alternative monetary policy transmission channels in Tanzania. Theoretically, the monetary policy transmission is expected to differ between developed and developing countries due to varied structural and institutional features. The empirical work undertaken by this study suggests that the sensitivity of output and prices to changes in monetary policy are generally weak and slow. Moreover, the study found a significant contribution of monetary policy in explaining dynamics of supply of credit to private sector which matters in fostering the growth of the economy. And lastly, it appears that inflation and exchange rate dynamics in Tanzania are highly influenced by developments in the international oil prices. There are potentially three policy implications, the first one being sustaining financial sector reforms geared towards eliminating the remaining structural impediments that hinder financial deepening, the Bank may choose to switch to an alternative monetary policy framework that has proved to be successful in attaining price stability, the Bank of Tanzania should continue with close monitoring of the global developments especially the movements in the international oil prices and react appropriately in order to safeguard the domestic macroeconomic stability.

Keywords: Monetary Policy, Central Banks and Their Policies

JEL: E52, E58

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[1] Authors are staff of the Bank of Tanzania. The views expressed in this paper are solely those of the author(s) and do not necessarily represent the opinion of the Bank of Tanzania.

1.0 Introduction

1.1 Dynamics of Macroeconomic Variables in Tanzania

The concern about the impact of monetary policy on the economy has received enormous attention in macroeconomic theory and among central banks in the world. It is generally agreed that the monetary policy affects output and prices through influencing key financial variables such as interest rates, exchange rate and monetary aggregates (Mishkin, F. (1996)). Changes in monetary policy are "proliferated" through the economy by means of a transmission mechanism, normally referred to as the monetary transmission mechanism.

Since 1995, the Bank of Tanzania implements a monetary policy framework that is directed towards attaining low[2] and stable inflation (price stability) conducive to balanced and sustainable growth of the economy (BOT Act, 2006). In the current framework, the Bank targets monetary aggregates (the extended broad money-M3) as a nominal anchor[3] in attaining the policy objectives. However, the Bank is currently contemplating to move into the inflation-targeting framework [4]as part of commitment to the implementation of the East Africa Monetary Union (EAMU) Protocol (BOT, 2018).

It is widely acknowledged that changes in the structure of the economy tend to alter the effectiveness of a given monetary policy transmission mechanism (Carranza et al., 2010; Mishra et al., 2012; Ma and Lin, 2016). There have been enormous developments in the financial sector in Tanzania especially since the 2000s that were brought about by financial innovations mainly related to developments in payments systems and financial markets developments such as introduction of new financial instruments. All these have enhanced the financial inclusion that involves increase in access and usage of financial services (FSDT, 2017). These financial sector developments are expected to be sustained and ultimately impact the transmission mechanism of the monetary policy in Tanzania, either by changing the overall impact of the policy on key macro-economic variables or by altering the channels through which it operates.

Similarly, insensitivity of lending rates to changes in a monetary policy stance that has been observed in Tanzania together with the recent decline[5] in the growth of credit to the private sector

2 Low and stable inflation is defined as inflation of 5.0 percent in the medium term.
3 Reserve money or base money is used as operational/policy variable in realizing extended broad money targets
4 The move is also justified by the unstable money demand following financial innovations.
5 For example, the growth of credit to the private sector in Tanzania averaged at 3.4 percent and 2.2 percent in 2018 and 2017 respectively compared with an average of 16.3 percent and 22.8 percent 2015 and 2016 respectively.

despite monetary policy easing makes it important to re-assess the effectiveness of monetary policy transmission mechanisms to key macro-economic variables.

Along the same line, the decision by the EAC central banks to adopt the Monetary Union (EAMU) by 2024, make it relevant for the central banks in the block to undertake regular assessment on the effectiveness of the monetary policy transmission mechanism in their respective countries for the purpose of harmonization of the monetary policies with appropriate[6] framework.

In studying the monetary policy transmission mechanism two key issues usually emerge including, the effectiveness of monetary policy transmission channels such as money/interest rate, credit, exchange rate and asset price in transmitting policy shocks to output and prices as well as the timing and magnitude of the effects of the monetary policy shocks on selected macroeconomic variables. This is what Mishkin (1995) called the 'timing and effect' of monetary policy in the economy.

For the case of Tanzania, several studies on the monetary policy transmission have been conducted and yielded some conflicting views but agreed on the weakness on the monetary policy transmission in the country, see for example (Davoodi et al., 2013), (Mbowe W., 2015) and (Montiel at al., 2012).

It is against this background that there seems a need for the Bank of Tanzania to re-assess the transmission mechanism on regular basis in order to first determine whether there is any change which could inform the Bank to on how to adjust its policy actions in order to meet the intended results (Tahir, 2012). The understanding is expected also to enlighten the Bank on the appropriate choice of the monetary policy anchor. Lastly, the understanding of the monetary policy transmission mechanism is important for the Bank in order to guide on the type of financial sector/monetary reforms which are needed (Mukherjee and Bhattacharya, 2011).

Thus, this paper attempts to assess the impact of changes in monetary policy on key macro-economic variables in Tanzania and explore the effectiveness of alternative monetary policy transmission channels.

The rest of the paper is structured as follows. Following the introduction section, section 2 gives an overview of the banking sector and monetary policy in Tanzania. Section 3 reviews both theoretical and empirical literature. The study's modelling approach, the model structure and data-related issues are described in Section 4. Section 5 provides the estimation results of the empirical model.

6 The appropriate framework that member countries agreed to embark on is the Interest Rate-Based Monetary Policy Framework.

Section 6 concludes the paper by summarizing the main findings and provides policy recommendations as well as areas for further research.

2.0 An Overview of the Financial Sector Developments and Monetary Policy in Tanzania

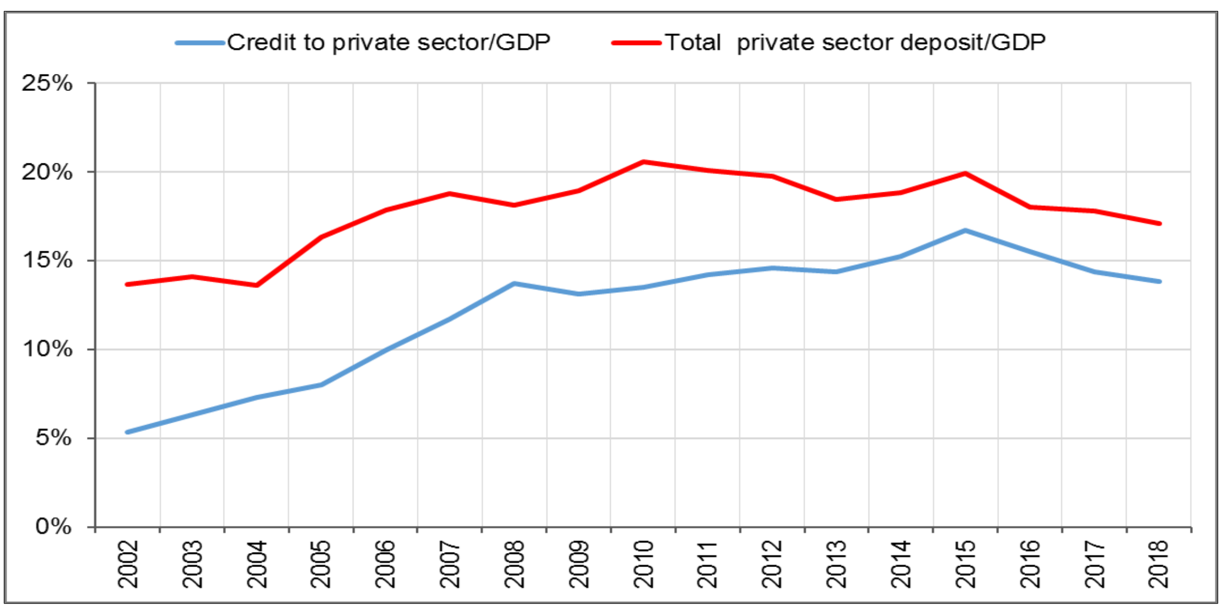
The effectiveness and efficiency of monetary policy depend on financial sector developments which facilitate the transmission of monetary policy actions to the real economy (Montiel et al, 2012). The financial sector in Tanzania has undergone various notable developments geared towards enhancing efficiency and inclusion.

Before the 1990s, the financial sector in Tanzania was characterized with financial repression, weak and unclear institutional framework, dominance of state-owned financial institutions which performed poor exacerbating Non-Performing Loans (NPL) to reach 65 percent in 1990. Fiscal and financial operations were intermixed, and regulatory system was characterized by inefficiencies (Cheng and Podpiera, 2008). These challenges were caused mainly by the intervention by the government in the day-to-day operation of financial institutions with regard to pricing and resource allocations coupled with lack of competition among financial institutions. During the period, the formulation and implementation of monetary policy were guided by Bank of Tanzania (BOT) Act, 1965 with multiple goals; to regulate money supply, to fix monetary variables (direct controls of interest rate and exchange rate) and to provide for development finance. As a result, the Bank lacked autonomy in setting monetary policy targets. The period also exhibited underdeveloped financial markets with absence of money and capital markets. These challenges necessitated the introduction of First-Generation Financial Sector Reforms (FGFSR) in 1991 following recommendations by Nyirabu Commission and were followed by the Second-Generation Financial Sector Reforms (SGFSR) in 2003 following recommendations of the World Bank/IMF mission of Financial Sector Assessment Programme (FSAP) 2003.

The implementation of FGFSR allowed for market determination of Interest rates and exchange rates; freedom of entry of the private banks (both domestic and foreign) into the banking business by enacting of BFIA 1991; enactment of Foreign Exchange Act 1992 and the Bank of Tanzania (BOT) Act 1995 (Nyagetera & Tarimo, 1997, pp. 71-77). These reforms strengthened the supervisory capacity of banks and with the BOT Act 1995, a new modality of monetary policy formulation and implementation was introduced. The Act mandated the BOT with a single objective of ensuring domestic price stability. Several indirect monetary policy instruments were introduced such as open market operations, repurchase agreement, discount and Lombard window, foreign exchange market operation as well as statutory minimum reserve requirements. The FGFSR succeeded in increasing the number of financial institutions in the market but did not succeed to make that service reach the majority of the people (financial inclusion) hence the necessitate the SGFSR. The SGFSR were focused on financial inclusion, tackling the remnants of the reforms under FGFSR, including putting in place structures and institutional arrangements to support the functioning of the market economy and improve the business environment. More specifically, the SGFSR recommended, among others, continue privatization of financial institutions, removal of the main obstacles to lending, enhancing access to financial services including promotion of microfinance and creation of credit registry.

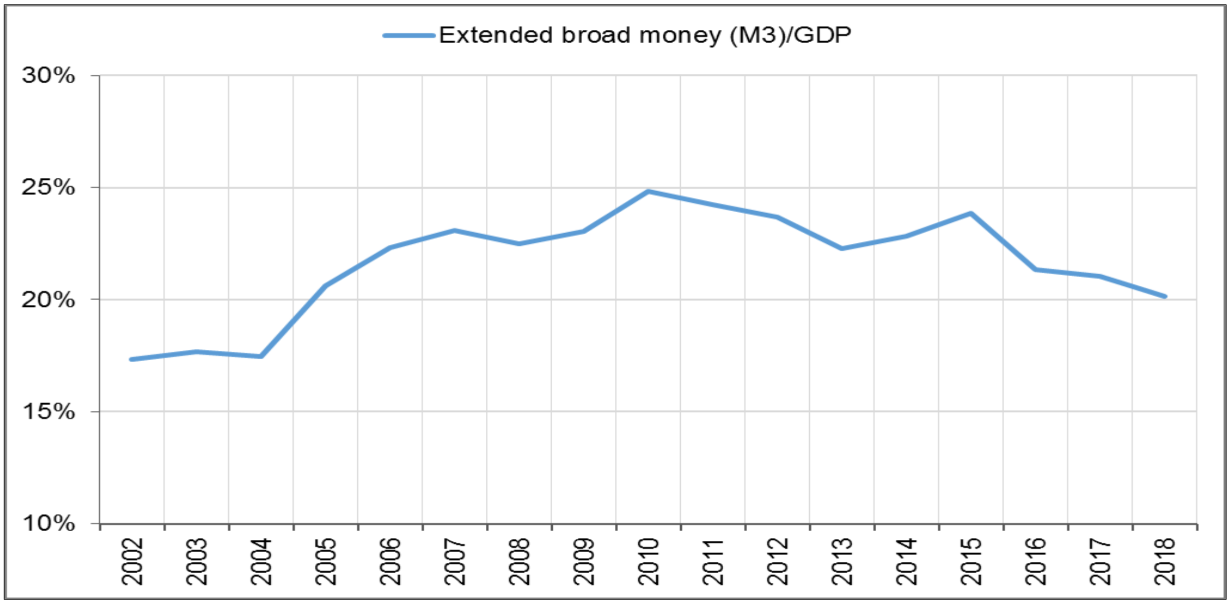
Notable financial sector developments since the onset of SGFSR include among others, the increase in the number of participants in the financial sector. For instance, the banks and financial institutions increased from 26 in 2004 to 58 in 2017 (BOT, Banking Supervision Report, 2004 and 2017). This reflected the increase in the financial deepening and financial intermediation as measured by the private sector credit to GDP and the ratio of bank deposits to GDP which increased to 13.7 percent and 17.0 percent in 2018 from 5.3 percent and 13.6 percent in 2002 respectively (figure 1), Meanwhile the level of monetization of the economy as measured by Extended Broad Money (M3) to GDP increased to 20.0 percent in 2018 from 14.0 percent in 2002 (figure 2). The increased number of banks and financial institutions also boosted competition which is important in providing consumers with a wide range of choices on financial services.

Figure 1: Financial Intermediation as measured by credit to the private sector and private sector deposit to GDP.



Source: Bank of Tanzania

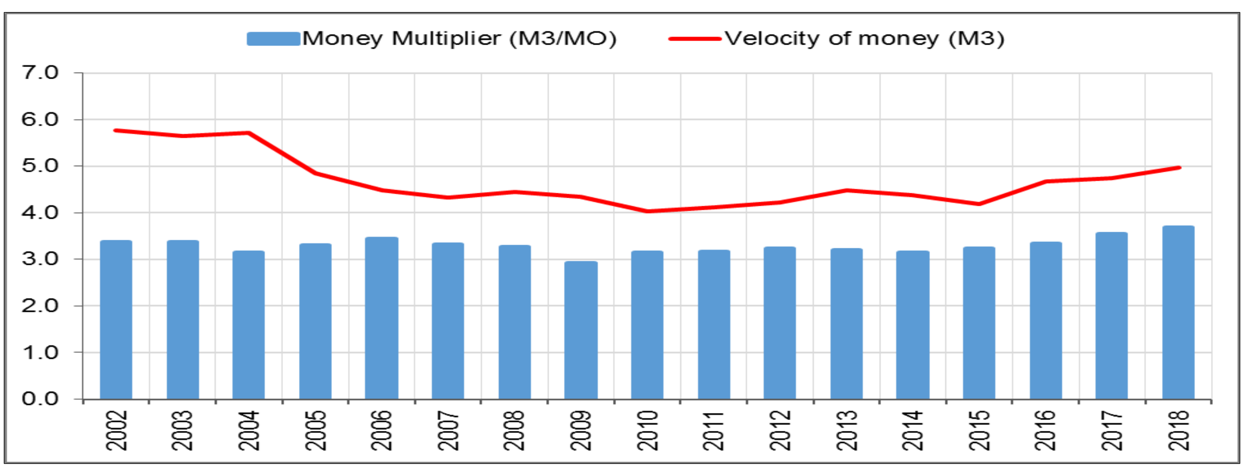
Figure 2: Financial Deepening as measured by the trend of broad money to GDP.



Source: Bank of Tanzania

The on-going developments in the financial sector and its products have also helped to improve financial inclusion driven mostly by the use of digital financial services and other innovative platforms, which have increased access to financial services to the majority of population. According to FinScope survey 2017 and 2006, the financial inclusion reached 65.0 percent from 11.2 percent in 2006 of the adult population in Tanzania. The use of innovative platforms has also impacted the velocity of money in circulation and ultimately the stability of money demand (figure 3). This has also necessitated the Bank to re-think on the appropriate channel of monetary policy transmission. It is worth to note that, financial inclusion improves sensitivity of macroeconomic variables to interest rate as compared to monetary aggregate.

Figure 3: Trend of Reserve Money Multiplier and the velocity of money.

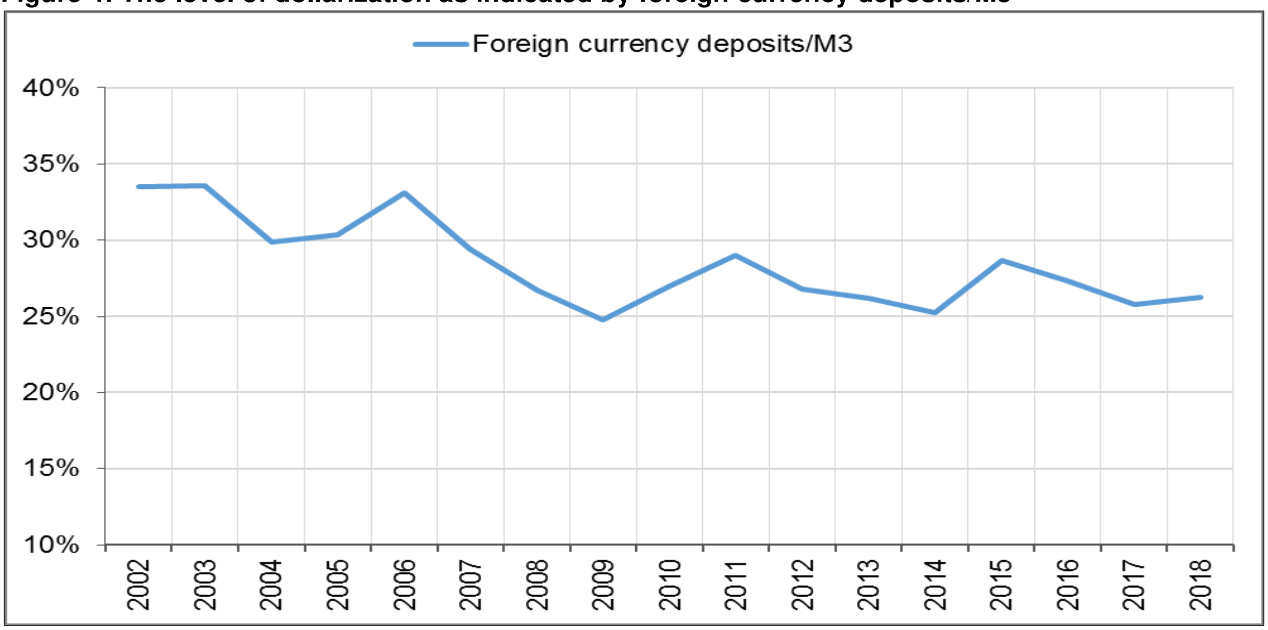


Source: Bank of Tanzania

Over the recent years, other developments have been registered in the financial sector including the capital account liberalization initiative which was carried out from 2014 to enhance the interlinkage of the domestic financial sector with the global financial system. This increased number of cross-listed companies in the equities market and instruments together with the participation in the equity market by non-residents. Meanwhile, participation in the government securities by EAC residents remained minimal probably a result of the existing speed bumps.

At the same time, the level of dollarization has significantly declined as indicated by the ratio of foreign currency deposits to extended broad money (M3) since a high level of dollarization indicate lack of confidence in the local currency and hence affects negatively the effectiveness of monetary policy. In 2018, the ratio declined to 26.3 percent from 34.0 percent in 2002 (**figure 4**).

Figure 4: The level of dollarization as indicated by foreign currency deposits/M3



Source: Bank of Tanzania

3.0 Literature Review

3.1 Theoretical Literature Review

According to Taylor (1995), the monetary policy transmission mechanism can be defined as the process through which monetary policy actions impact the key macroeconomic variables. As a result, monetary policy plays a crucial role in influencing economic activity and prices through a number of channels. The effective functioning of a particular channel depends on the properties and structure of the economy. The respective channels include; the interest rate channel, the exchange rate channel, asset price channel and credit channel.

3.1.1 Interest Rate Channel

The basis for an interest rate as transmission mechanisms is basic Keynesian models, which views on how monetary policy is transmitted to the real economy. According to Taylor (1995), the monetary transmission mechanism lies in two key assumptions that underlie most financial market price models; rational expectations and temporary rigidities of prices and wages. For example, a rise in the nominal interest rate will cause a rise in the real interest rate if the rationally expected inflation rate does not increase by the same value. Because of the slow adjustment of goods prices, the expectation of changes in goods prices over short time horizons will also adjust slowly if expectations are rational. Hence, an increase in the nominal interest rate results in a change in the real interest rate, over the period where prices and expectations are adjusting.

$$M \downarrow \Rightarrow i \uparrow \Rightarrow I \ \downarrow or\ C \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

Assuming a monetary contraction pursued by the Bank (M↓), lead to the increase in real interest rate (i↑), which in turn increase the cost of capital and decrease investment (I↓) or consumption $(C \downarrow)$ leading to declining in aggregate demand (Y↓) and ultimately inflation (π↓).

3.1.2 Exchange Rate Channel

This channel works through cross border trade. Monetary policy contraction by the central bank (M↓), leads to an increase in interest rate (i↑), this causes an increase in value of domestic currency (appreciation of exchange are (E↑)), the higher value of domestic currency makes domestic goods expensive than foreign goods, causing fall in net exports (NX↓) and aggregate output (Y↓) as well as inflation (π↓)

$$M \downarrow \Rightarrow i \uparrow \Rightarrow E \uparrow \Rightarrow NX \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

3.1.3 Asset Price Channel

This channel is based on Tobin's q theory (1969) of investment and wealth effects on consumption. It provides mechanisms through which monetary policy affects the economy through the valuation of equities. Q is defined as the market value of firms divided by the replacement cost of capital. If q is high means, the market value of a firm is high relative to the cost of acquiring a new plant, and investment capital is cheap compared to the market value of the business firm. Linking to monetary policy, when money supply falls (M↓), causes interest to rise ($i \uparrow$), making bonds attractive than equity, thereby causing price of equity to fall ($Pe \downarrow$) and subsequently lowers q (q↓) and thus decreasing investment (I↓), output (Y↓) and Inflation (π↓).

$$M \downarrow \Rightarrow i \uparrow \Rightarrow Pe \downarrow \Rightarrow q \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

Another way to look at this is through channel advocated by Franco Modigliani (1971) in his life cycle model. He explained that consumption spending is determined by the lifetime resources of consumers, which are made up of human capital, real capital and financial wealth. Financial wealth is composed largely buy stock. When stock price fall, the value of financial wealth decreases, decreasing the lifetime resources of consumers and consumption should fall as well.

$$M \downarrow \Rightarrow i \uparrow \Rightarrow Pe \downarrow \Rightarrow Wealth \downarrow \Rightarrow Consumption \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

3.1.4 Credit Channel

Monetary policy transmission through the credit channel affects the economy through the bank lending channel and balance sheet channel.

In the bank lending channel; the central bank contractionary monetary policy decreases banks' deposits and affects banks loans, investment and output.

$$M \downarrow \Rightarrow Bank\ deposits \downarrow \Rightarrow Bank\ loans \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

On another hand, the balance sheet channel operates though the net worth of business firms as described in the asset price channel. Low net worth, means borrowers have less collateral for the loans, hence decrease in demand for loans and therefore low investment and output.

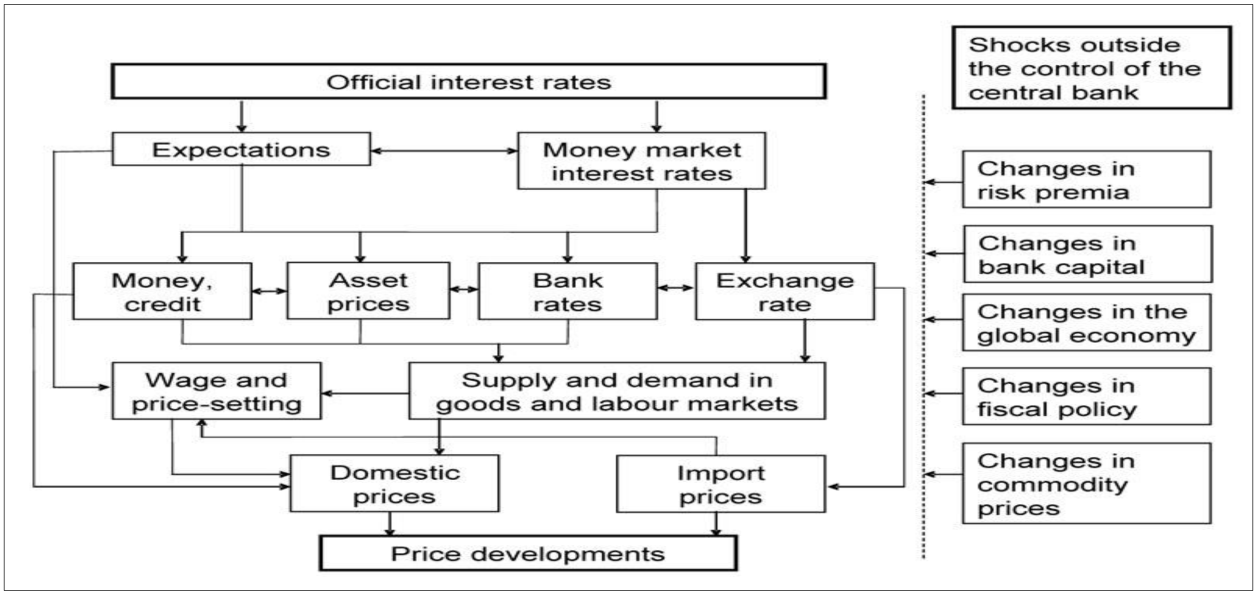
$$M \downarrow \Rightarrow Pe \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow \Rightarrow \pi \downarrow$$

On the other hand, monetary policy, which leads to an increase in interest rate also cause a deterioration in the firm's balance sheet by reducing cash flow. On the consumption side, contractionary monetary policy leads to a decline in equity prices, which reduces the value of financial assets, consumer spending and aggregate output.

3.1.5 Expectations channel

This channel works via the expectations that households and firms form about key macroeconomic variables, such as the GDP. There is an agreement amongst economists that expectations impact economic activity (Taylor J, 1995). For example, expectations of a depreciation in the Tanzanian Shilling is likely to result in an increase in consumer prices, thus exerting inflationary pressure to overall prices. A rise in consumer prices will spur economic agents' expectation of higher interest rates in the future to mitigate inflationary pressures, a situation which may lead to increased spending and amplified inflationary pressures in the short-run.

Figure 5: Summary of Monetary Policy Transmission Channels



3.2 Empirical Literature Review

The review of the empirical literature indicates that a number of studies have been done in different countries with respect to the subject matter. In this study, however, the review is done for some selected studies that were done in developing countries, East African countries and Tanzania, in particular.

Review of the studies which assess the effectiveness of monetary policy transmission mechanisms agrees largely on the weakness of transmission mechanisms in the developing countries (Mishra et al, 2010 and 2011). The reasons cited are underdeveloped financial system, limited international capital movements and the exchange rate regime which weakens the effectiveness of interest rate, the asset, or the exchange rate channel. Credit channel remains the only channel presumed to work in these economies due to the dominance of the banking sector in the financial system. However, due to underdeveloped institutions leading to high-cost financial intermediation, banks tend to hold a large percent of their deposits as reserves at the central bank and in the form of short-term foreign assets, Sacerdoti. E. (2005). This again could weaken the transmission through the credit channel.

Buigut (2009) applied structural VAR methods to annual data from 1984–2005 for EAC countries. The results indicated that the effects of monetary policy on output were relatively similar for the three EAC countries in terms of the pattern and timing however, the magnitude of the impact was insignificant. On the case of inflation, the effects were different in terms of speed and direction for all countries, but the of the impact were also small and insignificant.

Montiel and others (2012) using a recursive VAR model employed monthly data of Tanzania from January 2002–September 2010 and found that reserve money had a statistically significant effect on the price level, but the effect was not economically significant. He further employed a structural VAR model and found monetary policy expansion resulted in an increase in lending rate and reduction in prices. He also found out that the monetary policy had negative effects on output in the first eight months and a shock. The authors attributed the counterintuitive responses of monetary policy shock to the weak monetary policy transmission in Tanzania.

Davoodi et al, (2013) used a recursive VAR model and estimated for 2000–2010, to study the monetary transmission mechanism in the East African Countries and concluded that the precise transmission channels and their importance differ across EAC. For Tanzania, the authors found out that, the positive shock to reserve money increases inflation in the first year and a half though the effect was not statistically significant. However, when he applied VAR for a longer period, the results were highly significant. Similar conclusions were obtained using BVAR and FAVAR. Also using similar sample periods, they found out that a positive shock to the interest rate increases inflation, "price puzzle" however the impact was not statistically significant which indicates weak monetary transmission. The authors argue that weak monetary transmission mechanism can be a result of unstable money multiplier and velocity in the short run. The authors conclude that shocks to reserve money are transmitted to money, but transmission from money to prices or output is weak because of shifts in velocity, caused perhaps by financial innovations, may attenuate any aggregate demand effects. The other reason for the weak monetary transmission mechanism in Tanzania were cited as the presence of capital controls, especially on the exchange rate channel.

Mbowe W. (2015a), investigated the pass-through of the monetary policy rate to banks retail rates in Tanzania using an error correction model. The study aimed at providing insight into the pass-through of the monetary policy rate to the interbank rate and retail bank interest rates in Tanzania. The study concluded that the effectiveness of monetary policy transmission to the economy through the interest rate channel may be limited due to weak and lagged pass-through of interbank rate to deposit rate, though the pass-through of policy rate to interbank rate was generally strong.

The similar observation was noted by Berg, et al (2013) by using a narrative approach. The study also found out that, exchange rate was responding to the tightening monetary policy episodes, which is different from the findings from empirical studies by Montiel et al, (2012) and Davoodi et al, (2013) who found that this channel was weak due to controls imposed in the cross-border movement of capital. In the same vein, Balele, at al, (2018) obtained similar observation, where monetary policy seems to have a weak influence on core inflation.

On the other hand, the bank lending channel was noted to be strong in Tanzania, Mbowe W. (2015b); and Berg, et al (2013). However, Mbowe cautioned that the reaction by banks was asymmetric based on ownership structure, whereby lending channel was stronger through domestically-owned banks and privately-owned banks than foreign-owned banks and public-owned banks, possibly due to having other sources of funding.

4.0 Methodology

4.1 Model Specification

Vector Autoregression (VAR) model pioneered by (Sims, 1980) has been extensively used when assessing the monetary policy transmission mechanism. The Structural VAR is an extension of VAR, which intends to remove the drawbacks in VAR methodology, see for example (Pham, 2016).

In SVAR, there are a number of assumptions (grounded on economic theory) that have to be made with regards to the relationship among macroeconomic variables prior to estimation. Therefore, the SVAR approach helps to give several inferences for the model parameter and also describes the nature of the shock as whether transitory or permanent, see for example (Nguyen, 2014) and (Pham, 2016).

The current study employs structural VAR to assess the monetary policy transmission mechanism in Tanzania.

The Structural VAR takes the following general representation:

$$A_0 Y_t = A_1(L) Y_{t-1} + B\varepsilon_t \quad (1)$$

Whereby the Y_t is $n \times 1$ a vector of endogenous macroeconomic variables; A_0 and B are ($n \times n$) vector of parameters of the model; $A_1(L) = \sum_{i=1}^{n} A_{1i} L^i$ is the matrix of a polynomial in the lag operator, and ε_t is a $(n \times 1)$ vector of structural disturbances.

When multiplying equation (1) with A_0^{-1}, a reduced form VAR of the structural model in eq (1) is specified as;

$$Y_t = C(L)Y_{t-1} + u_t$$

(2)

Where $C(L) = A_0^{-1}A_1(L)$; u_t ε_t represent a vector of reduced form residual, that is $A_0^{-1}B\varepsilon_t$,

In condensed representation, an SVAR system relates to the following relations;

$$A_0 u_t = B\varepsilon_t$$

(3)

The equation (3) is known as the AB model where A_0 is $(n \times n)$ a matrix of contemporaneous relationships between endogenous variables; B is $(n \times n)$ that linearly relates SVAR residuals to the structural innovations, u_t is a vector of reduced-form residual, and ε_t is a vector of structural shocks. The residual u_t is presumed to be white noise. Therefore, we can estimate the AB model by Ordinary least squares.

Thus, the transmission mechanisms of monetary policy in Tanzania is studied by modelling explicitly the contemporaneous relations among the endogenous macroeconomic variables.

4.2 SVAR Specification

Grounded from earlier researches about monetary policy transmission mechanism in Tanzania and researches in other countries in the world, the following variables are chosen:

1. **Foreign block**: that represents international conditions: world oil price (OIL_BRENT), U.S. Federal fund rate (I_FED_US). The basic reason behind the inclusion of this foreign block in the model is due to the fact that Tanzania is a small open economy and is largely influenced by global developments. Thus, it means that changes in domestic conditions do not affect a change in the external environment. In contrast, changes in foreign environment such as change in international oil prices and change in US monetary policy stance are expected to have a significant impact on the Tanzanian economy.

2. **Domestic block**: The first two variables are Gross domestic product (GDP) and consumer price index (CPI) that represent the overriding goal of the monetary policy of the Bank of Tanzania. Other domestic variables include the average reserve money (MB)[7] which is the *de facto* monetary policy variable of the Bank of Tanzania and a measure of policy stance, credit to private sector (CRED_PRIV) in order to assess the credit channel, overall treasury bills rate (IR_TBILL_TOT), nominal effective exchange rate (NEER) that captures the exchange rate channel.

In this regard, the study specifies an eight-variable SVAR model as follows:

$$Y_t = (mb, ir\_tbill\_tot, cred\_priv, neer, cpi, gdp, i\_fed\_us, oil\_brent) \quad (4)$$

4.3 Identification of the SVAR Model

The fundamental concern in the estimation of the structural VAR model is the identification of the empirical model. The identification of monetary policy shocks requires adequate short-run restrictions on the SVAR model, Bernanke (1986) and Sims (1992). As a result, there is a need that equation (3) be restricted with parameters that are theory-consistent.

The canonical SVAR model is be represented as follows,

$$A_0 \begin{bmatrix} u_{oil\_brent} \\ u_{i\_fed\_us} \\ u_{gdp} \\ u_{cpi} \\ u_{mb} \\ u_{cred\_priv} \\ u_{ir\_tbill\_tot} \\ u_{neer} \end{bmatrix} = B \begin{bmatrix} \varepsilon_{oil\_brent} \\ \varepsilon_{i\_fed\_us} \\ \varepsilon_{gdp} \\ \varepsilon_{cpi} \\ \varepsilon_{mb} \\ \varepsilon_{cred\_priv} \\ \varepsilon_{ir\_tbill\_tot} \\ \varepsilon_{neer} \end{bmatrix} \quad (5)$$

The identification scheme of the contemporaneous matrix (A_0) is represented in the following table:

[7] In the alternative formulation, the overnight interbank cash market rate (IBCMR) was added to see the relative strength of the interest rate-based framework in attaining the policy objectives instead of reserve money.

Table 1: Identification scheme of the SVAR model

	oil_brent	i_fed_us	gdp	cpi	$cred\_priv$	mb	ir_tbill_tot	$neer$
oil_brent	1	0	0	0	0	0	0	0
i_fed_us	C(1)	1	0	0	0	0	0	0
gdp	0	0	1	0	0	0	0	0
cpi	0	0	C(4)	1	0	0	0	0
$cred\_priv$	0	0	C(5)	0	1	0	0	0
mb	0	0	C(6)	C(9)	C(12)	1	0	0
ir_tbill_tot	0	0	C(7)	C(10)	C(13)	C(15)	1	0
$neer$	C(2)	C(3)	C(8)	C(11)	C(14)	C(16)	C(17)	1

The first identification is with regard to foreign variables whereby we assume that the international oil prices are completely exogenous in the sense that they are contemporaneously affected by factors outside the specified model. In the second identification, US monetary policy (Fed's fund rate) is assumed to react contemporaneously to changes in the international oil prices.

The exchange rate (the most endogenous variable in the model) is assumed to be contemporaneously affected by all variables in the model.

Prices and supply of credit to the private sector are assumed to be instantaneously driven by output.

For the case of money demand behaviour. The money equation (M), represented as real money balance, follows the traditional money demand that is contemporaneously influenced by the level of output (GDP), and prices (CPI).

And lastly, interest on treasury bills is assumed to be driven by GDP, prices and shock to monetary aggregates both credit and the monetary base.

4.4 Data and Variables

The study uses quarterly data covering the first quarter of 2002 to the fourth quarter of 2018. As in many VAR studies, the analysis is done in the first difference of the variables which are seasonally adjusted. All the variables are expressed in logarithms.

Prior to the estimation of the model, we examined the time-series properties of each of the variables in the model, two widely-used unit root tests were performed: the augmented Dickey-Fuller (ADF) test and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test. The overall results suggest that the most variables under consideration have a unit root in a level form but are stationary in the first-order log-difference form.

Having specified the model, the appropriate lag length of the VAR model was decided using the Akaike information criteria (AIC). There is an advantage of selecting optimal lag length since choosing a relatively too large lag length will typically result into to poor and inefficient estimates of the parameters while a too short lag length, will lead into biased estimates, as unexplained information will be left in the error term. The adjustment was made to allow for more lags in order to ensure the residuals are white noise.

5.0 Empirical Results and Discussions

5.1 Unit Root Test for Model Variables

Results of the ADF and PP unit root tests are reported in Annex 2. With the exception of credit to the private sector and reserve money, all other variables have unit root in level. However, after differencing, the null hypothesis of unit root is rejected for all variables at all significance levels implying all variables are I (1).

5.2 Selection of Lag Length

The results of lag length based on various lag selection criteria are provided in Annex 3. The results indicate that Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) supported a lag length of 1 while sequentially modified LR test statistic and Final prediction error (FPE) proposed a lag length of 2. On the other hand, the Akaike information criterion (AIC) recommended a lag length of 5. The study picks the lag length of 2 in the baseline model and lag length of 3 in robustness check.

5.3 Model Estimation Results

5.3.1 Results of Contemporaneous Coefficients

Table 2 presents the coefficients of the SVAR identification restrictions that were estimated using the OLS method.

Table 2: Contemporaneous Structural VAR Estimates

Restriction	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.004195	0.002126	-1.973361	0.0485
C(2)	-0.055716	0.029110	-1.913971	0.0556
C(3)	-0.610605	2.067091	-0.295394	0.7677
C(4)	-0.037474	0.072263	-0.518578	0.6041
C(5)	0.073777	0.224802	0.328185	0.7428
C(6)	-0.426548	0.198385	-2.150100	0.0315
C(7)	-0.073092	0.126854	-0.576185	0.5645
C(8)	0.558958	0.278644	2.005991	0.0449
C(9)	-0.190033	0.348639	-0.545072	0.5857
C(10)	0.019394	0.215791	0.089875	0.9284
C(11)	-0.627533	0.454013	-1.382190	0.1669
C(12)	0.160826	0.112070	1.435048	0.1513
C(13)	0.071618	0.070310	1.018598	0.3084
C(14)	-0.224398	0.199520	-1.124687	0.2607
C(15)	-0.008148	0.077190	-0.105556	0.9159
C(16)	-0.027624	0.178176	-0.155040	0.8768
C(17)	0.177712	0.279222	0.636454	0.5245

The results indicate that 4 out of 17 estimated structural contemporaneous parameters are statistically significant. The majority of the parameters appear to be statistically insignificant meaning that there exists no meaningful instantaneous relationship between the variables in the SVAR model.

The first significant parameter is C (1) that captures the contemporaneous effect of the changes in international oil prices to the US fed fund rate. The coefficient carries a negative sign, implying that the Fed fund rate reacts negatively to the rising global oil prices.

The second parameter is C (2) that captures contemporaneous pass-through of the international oil prices to the nominal exchange rate of the Tanzanian Shilling against basket of currencies. Again, the coefficient carries a negative sign, which means that an increase in global oil prices leads to appreciation of the currency, this is counter-intuitive since Tanzania is not an oil-exporting country.

The third coefficient is C (6) that captures the instantaneous reaction of monetary policy (through the monetary base) to aggregate demand shock (output). The coefficient is negative implying that, the monetary policy responds negatively to a positive demand shock (increase in output). This is counter-intuitive based on the quantity theory of money[8].

[8]See for example Friedman, M., Schwarts A.J., (1963).

The last coefficient is C (8) that captures the contemporaneous reaction of the exchange rate to aggregate demand shock. The coefficient is positive implying that, increase in output causes depreciation of the nominal exchange rate.

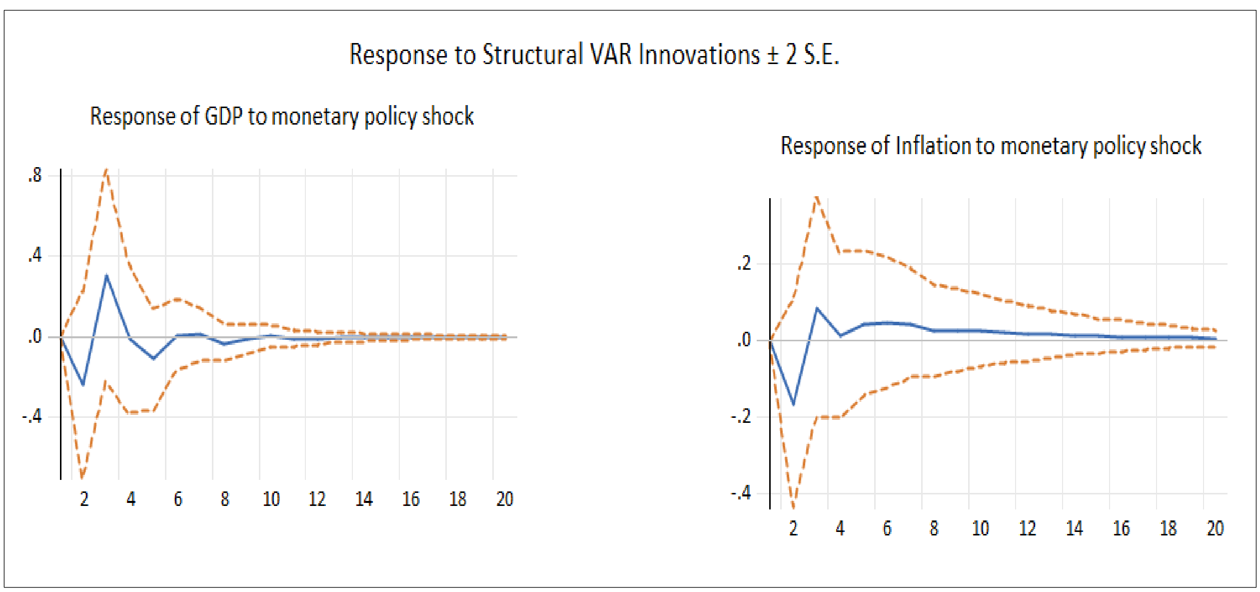
The nature of causality between macroeconomic variables present in the model was also assessed by using the Granger causality test as reported in Annex 5.

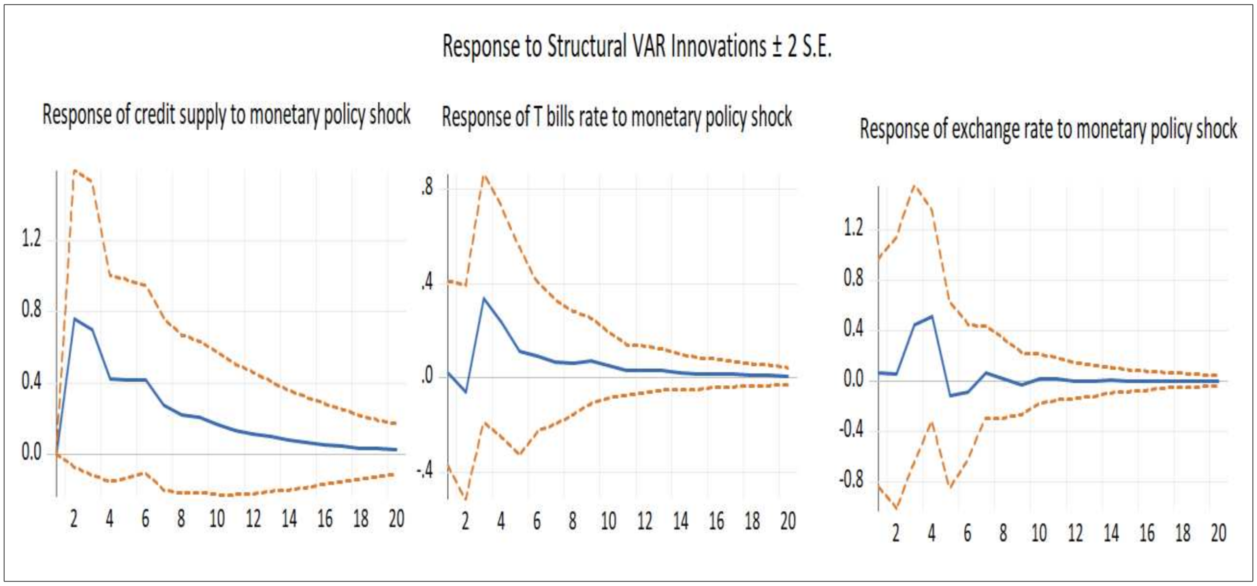
Although the SVAR is a very reliable method in econometric analysis, it is challenging to interpret the coefficients of the contemporaneous relationships straight. As a result, Stock and Watson (2001) suggested the impulse response functions and forecast error variance decomposition as more powerful explanatory techniques to understand the relationship among the variables.

5.3.2 Structural Impulse Response Function

Figure 6 reports the results of the structural impulse response functions for all variables in the SVAR model. The impulse response functions show the dynamic response of output, prices, exchange rate, credit to the private sector and nominal exchange rate to a positive monetary policy shock (increase in reserve money) over the period of 20 quarters. The reserve money is chosen as a proxy for monetary policy shocks since it is regarded as a de facto operating target in the monetary policy formulation and implementation by the Bank of Tanzania. Point estimates (the solid line) and the 90 percent confidence intervals (the dashed lines) are graphed for all the variables

Figure 6: Structural Impulse Response Functions





(i.) Initially, the monetary policy easing lowers output marginally in the first two quarters, which is inconsistent with the economic theory before starting increase in the succeeding quarters. The maximum impact of the monetary policy shock is attained after three quarters. This finding is consistent with the study by Montiel and others (2012) and perhaps indicates the dominance of supply factors in explaining output variation in Tanzania.

(ii.) Similarly, as a result of the initial decline in output, prices fall slightly in the first two-quarters consistent with economic theory. Thereafter, prices start to increase. The peak effect of monetary policy shock on prices is attained after four quarters. This finding is also consistent with the study by Montiel and others (2012).

(iii.) Following monetary policy easing, the supply of credit to the private sector responds positively peaking in the second quarter and remains positive throughout the period. This signals the effectiveness of the credit/bank lending channel in line with the findings of the study by Mbowe W. (2015b).

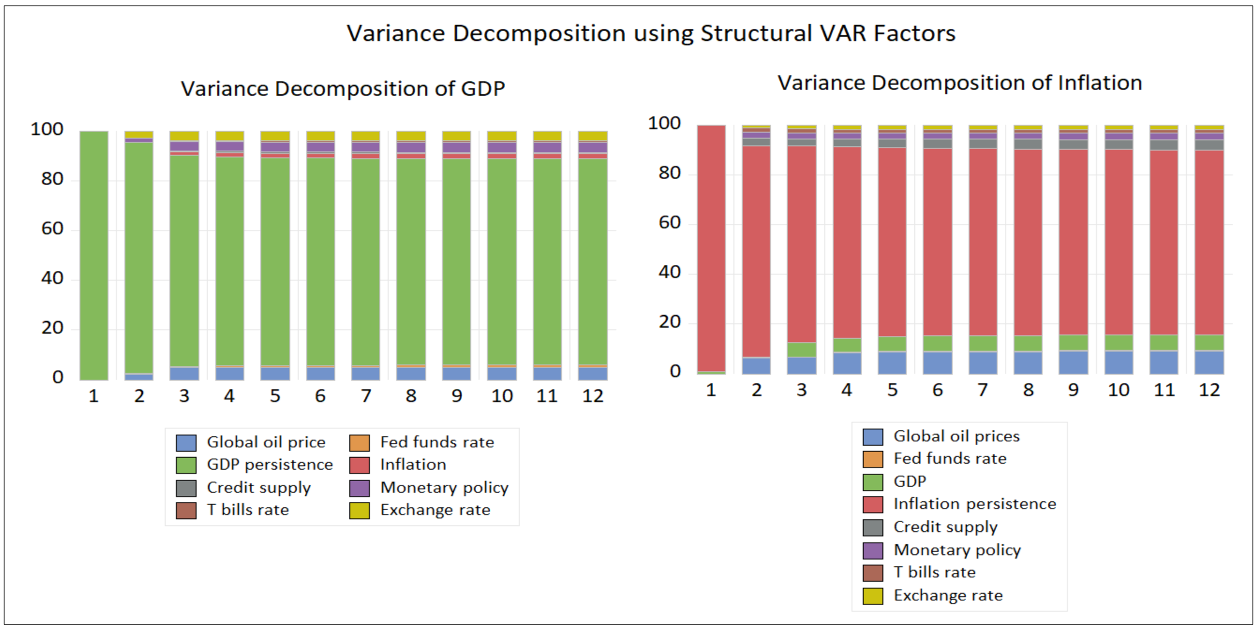
(iv.) As expected, following the monetary policy shock, the treasury bills rate responds negatively in the first two quarters before starting to increase in the successive quarters.

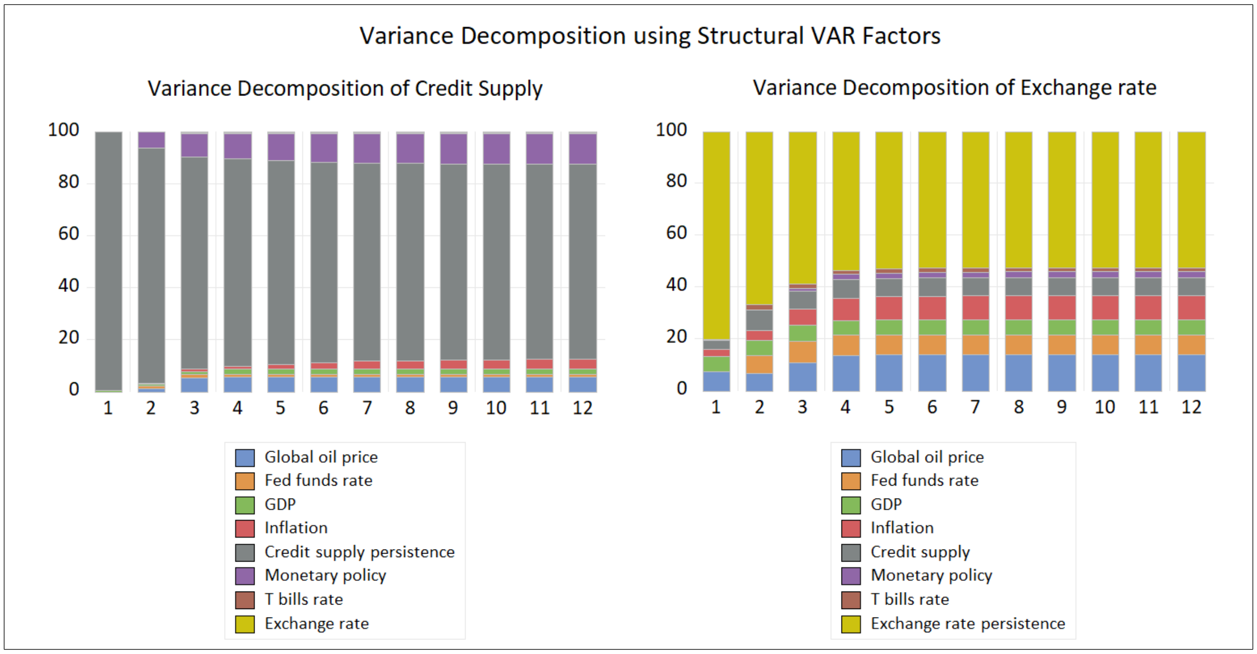
(v.) As a result of monetary policy easing, the exchange rate depreciates and remain so for about five quarters consistent with economic theory.

5.3.3 Forecast Error Variance Decomposition

The results of forecast error variance decompositions for GDP, Inflation, the supply of credit to the private sector and nominal effective exchange rate are illustrated in figure 7 and Annex 10. The variance decompositions are computed using the Monte Carlo approach of Runkle (1987). The forecast error variance decomposition splits the variation in an endogenous variable into the component shocks to the SVAR. Therefore, the variance decomposition gives information about the comparative importance of each shock in affecting the variables in the SVAR model.

Figure 7: Forecast Error Variance Decomposition





The results of the variance decomposition of the SVAR model show that the variation in output is mostly by itself. The fluctuations due to reserve money are not so large indicating that the transmission of the monetary shocks into the real economy is rather weak. Innovations in the monetary policy account for almost 3.7 percent of fluctuations in GDP after 4 quarters and 4.0 percent after 8 quarters (**Annex 10**). The GDP dynamics is mainly explained by changes in the global oil prices and changes in nominal exchange rate that account for 4.7 percent and 4.0 percent respectively in variation in output after four quarters. The high contribution of international oil prices on output may be explained by the fact that changes in global oil prices impacts production costs domestically.

About 77.1 percent of inflation dynamics after four quarters are mostly due to its own innovations, indicating a relatively high degree of inflation persistence. After four quarters, inflation dynamics is mainly explained by variations in global oil prices (8.2 percent) and domestic demand conditions (5.5 percent) while monetary policy explains only 2.3 percent. The results imply that the role of monetary policy in explaining GDP dynamics is relatively much stronger compared to inflation dynamics.

Thus, the forecast error variance decomposition results with regards to the effectiveness of monetary policy in explaining the ultimate policy variables indicate that the transmission is weak. On the other hand, results indicate that the money supply is relatively stronger in explaining variation in output compared to inflation dynamics.

The results also indicate that the contribution of monetary policy in the variation of supply of credit to the private sector is the largest among all variables in the model. It contributes about 10 percent after four quarters.

It can also be noted from the results of the forecast error variance decomposition that the significance of the variables own innovations may imply the importance of structural factors such as exogenous supply shocks, terms of trade and productivity shocks and expectations in explaining the dynamics of the model variables.

5.3.4 Variance Decomposition using interbank rate as an operating target

Figure 8 shows the forecast error variance decomposition using the interbank rate as monetary policy operating target. The results indicate that interbank bank rate is relatively weaker in explaining output and inflation variations than the monetary base. The weakness of the interest rate can be attributed to the fact that; monetary base has been used as monetary policy operating target while interest rate was taken exogenously.

Figure 8: Forecast Error Variance Decomposition interbank rate as the operating target

Variance Decomposition of GDP:

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	16.620	0.000	0.000	100.000	0.000	0.000	0.000	0.000	0.000
2	17.265	2.471	1.382	92.668	0.005	0.075	0.337	0.121	2.941
3	17.279	5.352	1.831	87.482	1.139	0.091	0.495	0.296	3.313
4	17.296	5.331	1.863	86.447	1.351	0.351	0.995	0.358	3.304
5	17.296	5.317	2.008	86.173	1.343	0.435	1.048	0.373	3.303
6	17.296	5.452	2.004	85.927	1.398	0.481	1.045	0.389	3.304
7	17.296	5.459	2.025	85.851	1.397	0.503	1.064	0.399	3.302
8	17.296	5.458	2.031	85.829	1.396	0.504	1.072	0.407	3.304
9	17.296	5.459	2.030	85.812	1.399	0.516	1.071	0.409	3.303
10	17.296	5.461	2.034	85.792	1.399	0.527	1.073	0.410	3.304
11	17.296	5.462	2.036	85.785	1.399	0.529	1.073	0.411	3.304
12	17.296	5.462	2.037	85.784	1.400	0.529	1.073	0.412	3.304

riance Decomposition of Inflation :

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	0.291	0.000	0.000	0.951	99.049	0.000	0.000	0.000	0.000
2	0.319	5.665	0.135	0.740	86.764	3.544	0.144	2.049	0.957
3	0.338	6.641	0.425	5.627	80.735	3.060	0.125	2.000	1.387
4	0.346	9.805	0.401	5.094	77.048	4.315	0.178	1.795	1.364
5	0.350	10.555	0.826	4.967	75.271	5.006	0.317	1.721	1.338
6	0.351	10.823	0.978	4.942	74.623	5.255	0.313	1.746	1.320
7	0.352	10.889	1.032	4.925	74.373	5.408	0.312	1.746	1.315
8	0.352	10.926	1.076	4.918	74.152	5.563	0.316	1.739	1.311
9	0.352	10.970	1.116	4.906	73.985	5.660	0.317	1.735	1.313
10	0.352	10.985	1.140	4.900	73.900	5.712	0.317	1.735	1.312
11	0.352	10.986	1.152	4.897	73.860	5.743	0.317	1.734	1.311
12	0.352	10.987	1.159	4.896	73.832	5.765	0.317	1.733	1.311

Factorization: Structural

5.3.5 Robustness Checks

For robustness purpose, two approaches are used. In the first approach, the results of forecast error variance decomposition using structural identification are compared with Cholesky identification using the same number of lags. The results are broadly identical confirming that the structural identification was robust in identifying responses to the monetary policy shock (**Annex 11**). In the second approach, the results of the forecast error variance decomposition using structural identification with two lags are compared with forecast error variance decomposition using structural identification with one lag (Annex 12). Likewise, the results are broadly the same, confirming that baseline specification of the model was appropriate.

5.3.6 Comparison with other Studies

The results of the study are broadly similar to those of Montiel and others (2012), Mbowe W. (2015a) and Berg, et al. (2013) on the weaker role of the monetary policy for macroeconomic stabilization. Also, the strength of the bank lending channel is similar to the findings by Mbowe, W (2015b

6.0 Conclusions and Policy Implication

This study endeavored to assess the monetary policy transmission mechanism in Tanzania over the period 2002 to 2018. The study used the average reserve money as a measure of the stance of the monetary policy.

Generally, consistent with other studies in developing countries; the empirical findings indicate that the effectiveness of monetary policy in explaining GDP and inflation variations is relatively weak. This implies that the responsiveness of output and prices to changes in monetary policy are generally limited and slow.

Nevertheless, it appears that the impact of monetary policy in Tanzania is relatively stronger in explaining the dynamics of credit supply and output than for the case of inflation. Inflation dynamics are highly influenced by developments in international oil prices. The global oil prices also explain much of the variations in the nominal exchange rate.

The result portrays two major policy implications, the first one being sustaining financial sector reforms geared towards eliminating the remaining structural impediments[9] that hinder financial deepening.

Secondly, in order to enhance price stabilization, the Bank may opt to switch to an alternative monetary policy framework. The alternative framework could be inflation targeting using interest as an operating target. The inflation-targeting framework has proved to be successful in other countries and is also set be the de facto framework under the envisaged East African Monetary Union (EAMU) in 2024.

With regards to the weak transmission of monetary policy to prices, the study recommends the Bank of Tanzania to embark on inflation targeting framework using the interest rate as operating target in order to enhance price stabilization.

Also, the Bank of Tanzania should continue monitoring the global developments especially the movements in the international oil prices in order to constrain the impact of the shocks and safeguard the domestic macroeconomic stability.

With respect to areas for further research, the study might benefit from further research in the following lines of enquiry.

The first inquiry should base on an investigation of the relative importance of fiscal policy in driving price and output dynamics. This might be achieved by the inclusion of the overall deficit to GDP ratio in the model to capture the stance of the fiscal policy.

Another interesting area for further research is to analyze as to whether the weak effects of monetary policy on key macroeconomic variables are present also in other East African countries.

Lastly, it is also recommended to do another study that will split the sample between two periods i.e. the period before and after financial innovations which started in 2013/14 to gauge the relative strength of the monetary policy in the two episodes. This was not done in the current study due to data limitation, particularly after the financial innovations.

[9] Include among other, large informal sector, high cost of financial services, limited financial education.

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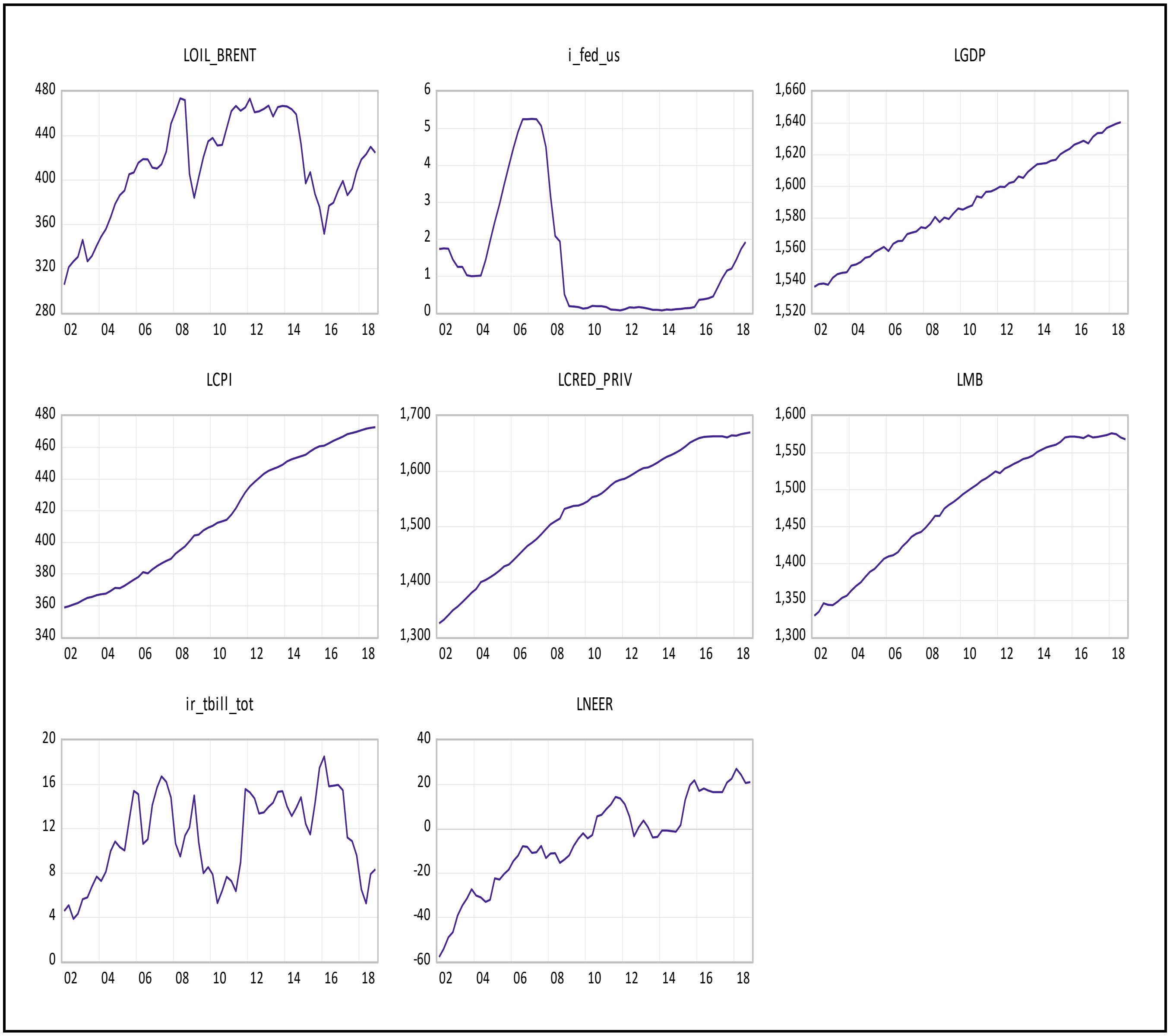
Annexes

Annex 1: Graphical presentation of Variables



Annex 2: Unit root test results

UNIT ROOT TEST RESULTS TABLE (ADF)									
Null Hypothesis: the variable has a unit root									
				At Level					
		LOIL_BRENT	**I_FED_US**	**LGDP**	**LCPI**	**LMB**	**LCRED_PRIV**	**IR_TBILL_364**	**LNEER**
With Constant	t-Statistic	-2.3728	-3.1174	-0.0631	-0.6133	-4.5136	-6.1593	-2.4483	-2.5789
	Prob.	0.1533	0.0303	0.9485	0.8600	0.0005	0.0000	0.1329	0.1024
		n0	**	n0	n0	***	***	n0	n0
With Constant & Trend	t-Statistic	-2.1706	-3.6747	-7.3667	-1.1981	2.4063	0.7360	-1.9097	-3.3450
	Prob.	0.4976	0.0315	0.0000	0.9025	1.0000	0.9996	0.6381	0.0680
		n0	**	***	n0	n0	n0	n0	*
Without Constant & Trend	t-Statistic	0.3681	-1.8044	8.8586	3.5770	2.4794	3.5223	-0.4258	-2.5604
	Prob.	0.7880	0.0679	1.0000	0.9999	0.9965	0.9998	0.5258	0.0111
		n0	*	n0	n0	n0	n0	n0	**
				At First Difference					
		d(LOIL_BRENT)	**d(I_FED_US)**	**d(LGDP)**	**d(LCPI)**	**d(LMB)**	**d(LCRED_PRIV)**	**d(IR_TBILL_364)**	**d(LNEER)**
With Constant	t-Statistic	-6.2202	-3.5390	-13.3584	-4.4808	-3.7248	-4.8262	-7.3504	-6.1645
	Prob.	0.0000	0.0099	0.0000	0.0005	0.0058	0.0002	0.0000	0.0000
		***	***	***	***	***	***	***	***
With Constant & Trend	t-Statistic	-6.2726	-3.5299	-13.2526	-4.4509	-7.5443	-7.2296	-7.5923	-6.2653
	Prob.	0.0000	0.0445	0.0001	0.0036	0.0000	0.0000	0.0000	0.0000
		***	**	***	***	***	***	***	***
Without Constant & Trend	t-Statistic	-6.2225	-3.5667	-0.4549	-1.5179	-1.3401	-1.3027	-7.4018	-5.8016
	Prob.	0.0000	0.0006	0.5136	0.1201	0.1652	0.1761	0.0000	0.0000
		***	***	n0	n0	n0	n0	***	***

UNIT ROOT TEST RESULTS TABLE (PP)									
Null Hypothesis: the variable has a unit root									
					At Level				
		LOIL_BRENT	**I_FED_US**	**LGDP**	**LCPI**	**LMB**	**LCRED_PRIV**	**IR_TBILL_364**	**LNEER**
With Constant	t-Statistic	-2.4722	-1.7031	-0.0419	-0.2982	-4.0147	-5.5226	-2.4799	-2.4719
	Prob.	0.1268	0.4251	0.9508	0.9190	0.0024	0.0000	0.1249	0.1268
		n0	n0	n0	n0	***	***	n0	n0
With Constant & Trend	t-Statistic	-2.1328	-1.7816	-7.3667	-1.5030	3.6067	0.6605	-2.2180	-3.0089
	Prob.	0.5183	0.7025	0.0000	0.8190	1.0000	0.9995	0.4719	0.1376
		n0	n0	***	n0	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	0.5994	-1.2888	31.2834	7.2771	5.5548	6.4865	-0.4789	-2.9141
	Prob.	0.8434	0.1803	1.0000	1.0000	1.0000	1.0000	0.5047	0.0042
		n0	n0	n0	n0	n0	n0	n0	***

		At First Difference							
		d(LOIL_BRENT)	**d(I_FED_US)**	**d(LGDP)**	**d(LCPI)**	**d(LMB)**	**d(LCRED_PRIV)**	**d(IR_TBILL_364)**	**d(LNEER)**
With Constant	t-Statistic	-6.0501	-3.7090	-39.5311	-4.5967	-5.8246	-4.8297	-6.5575	-6.0477
	Prob.	***0.0000***	***0.0061***	***0.0001***	***0.0004***	***0.0000***	***0.0002***	***0.0000***	***0.0000***
		***	***	***	***	***	***	***	***
With Constant & Trend	t-Statistic	-6.0800	-3.7064	-39.4180	-4.5566	-7.5443	-7.2382	-8.8499	-6.1473
	Prob.	***0.0000***	***0.0289***	***0.0001***	***0.0026***	***0.0000***	***0.0000***	***0.0000***	***0.0000***
		***	**	***	***	***	***	***	***
Without Constant & Trend	t-Statistic	-6.0754	-3.7359	-7.5008	-1.8073	-3.1033	-2.1217	-6.6061	-5.7649
	Prob.	***0.0000***	***0.0003***	***0.0000***	***0.0675***	***0.0024***	***0.0335***	***0.0000***	***0.0000***
		***	***	***	*	***	**	***	***
Notes:									
a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant									
b: Lag Length based on SIC									
c: Probability-based on MacKinnon (1996) one-sided p-values.									

Annex 3: Lag length selection

VAR Lag Order Selection Criteria						
Endogenous variables: LGDP LCPI LMB LCRED_PRIV IR_TBILL_364 LNEER						
Exogenous variables: C LOIL_BRENT I_FED_US						
Sample: 2002Q1 2018Q4						
Included observations: 62						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1635.000	NA	1.44e+13	53.00001	53.27448	53.10777
1	-946.7623	1176.665	26286.39	32.86330	35.33352*	33.83317*
2	-871.5075	109.2408*	20179.31*	32.50024	37.16622	34.33222
3	-812.5319	70.39026	31182.50	32.66232	39.52404	35.35641
4	-734.3235	73.16269	35507.10	32.20398	41.26146	35.76018
5	-628.3408	71.79477	29368.94	30.84970*	42.10293	35.26800
* 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						

Annex 4: Johansen test for cointegration

Sample (adjusted): 2002Q4 2018Q3	
Included observations: 64 after adjustments	
Trend assumption: Linear deterministic trend	
Series: LOIL_BRENT I_FED_US LGDP LCPI LMB LCRED_PRIV IR_TBILL_364 LNEER	
Lags interval (in first differences): 1 to 2	
Unrestricted Cointegration Rank Test (Trace)	
Trace Test	**Maximum Eigen Value Test**

Hypothesized No. of CE(s) No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.643725	221.4730	159.5297	0.0000	66.05132	52.36261	0.0012
At most 1 *	0.559868	155.4217	125.6154	0.0002	52.52355	46.23142	0.0094
At most 2 *	0.406420	102.8981	95.75366	0.0147	33.38133	40.07757	0.2333
At most 3	0.337636	69.51679	69.81889	0.0528	26.36420	33.87687	0.2990
At most 4	0.299745	43.15259	47.85613	0.1289	22.80390	27.58434	0.1820
At most 5	0.171212	20.34868	29.79707	0.3995	12.01862	21.13162	0.5458
At most 6	0.122013	8.330060	15.49471	0.4308	8.327913	14.26460	0.3464
At most 7	3.35E-05	0.002147	3.841465	0.9594	0.002147	3.841465	0.9594
Trace test indicates 3 cointegrating eqn (s) at the 0.05 level							
Max-Eigen value test indicates 2 cointegrating eqn(s) at the 0.05 level							
* denotes rejection of the hypothesis at the 0.05 level							
**MacKinnon-Haug-Michelis (1999) p-values							

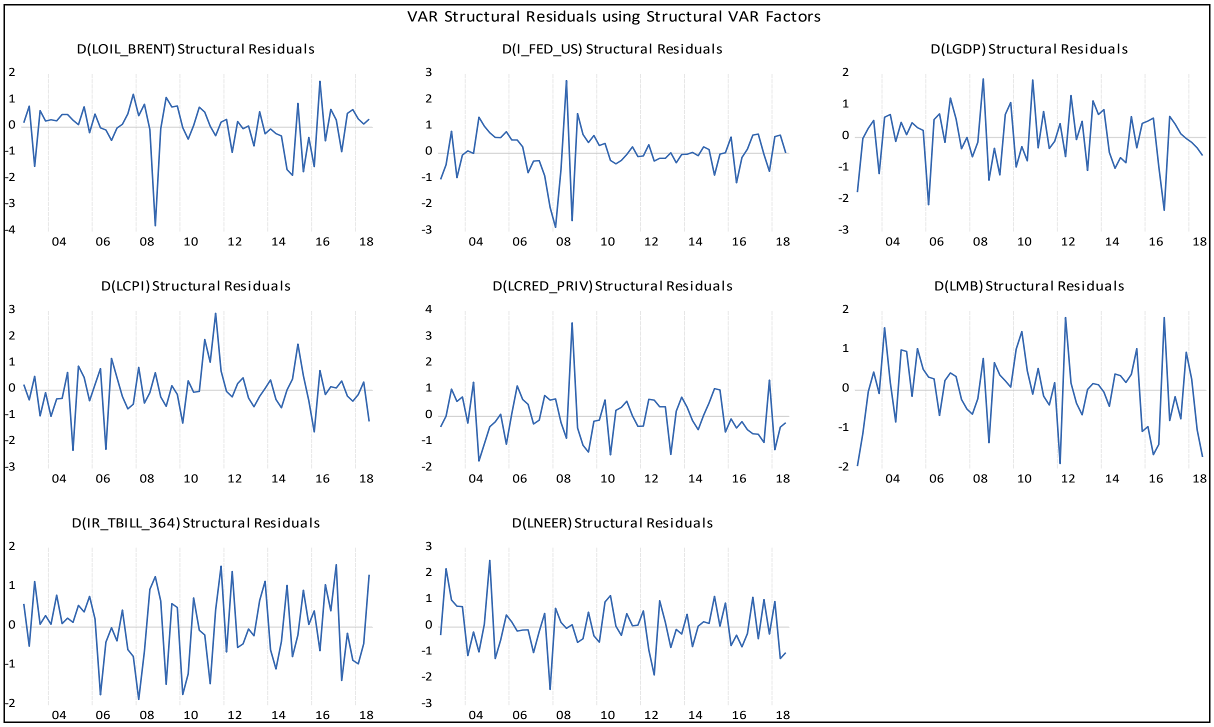
Annex 5: Granger Causality

Pairwise Granger Causality Tests
Sample: 2002Q1 2018Q4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D(I_FED_US) does not Granger Cause D(LOIL_BRENT)	64	1.85817	0.1650
D(LOIL_BRENT) does not Granger Cause D(I_FED_US)		1.95947	0.1500
D(LGDP) does not Granger Cause D(LOIL_BRENT)	64	1.89165	0.1599
D(LOIL_BRENT) does not Granger Cause D(LGDP)		0.79743	0.4553
D(LCPI) does not Granger Cause D(LOIL_BRENT)	65	0.27138	0.7633
D(LOIL_BRENT) does not Granger Cause D(LCPI)		0.69062	0.5052
D(LCRED_PRIV) does not Granger Cause D(LOIL_BRENT)	65	0.15082	0.8603
D(LOIL_BRENT) does not Granger Cause D(LCRED_PRIV)		2.53324	0.0879
D(LMB) does not Granger Cause D(LOIL_BRENT)	65	0.09912	0.9058
D(LOIL_BRENT) does not Granger Cause D(LMB)		0.26493	0.7682
D(IR_TBILL_364) does not Granger Cause D(LOIL_BRENT)	65	0.87945	0.4203
D(LOIL_BRENT) does not Granger Cause D(IR_TBILL_364)		2.03884	0.1391
D(LNEER) does not Granger Cause D(LOIL_BRENT)	65	0.13228	0.8763
D(LOIL_BRENT) does not Granger Cause D(LNEER)		1.34927	0.2672
D(LGDP) does not Granger Cause D(I_FED_US)	64	2.49785	0.0909
D(I_FED_US) does not Granger Cause D(LGDP)		0.40673	0.6677
D(LCPI) does not Granger Cause D(I_FED_US)	64	0.15950	0.8529
D(I_FED_US) does not Granger Cause D(LCPI)		1.62765	0.2051
D(LCRED_PRIV) does not Granger Cause D(I_FED_US)	64	0.39124	0.6780
D(I_FED_US) does not Granger Cause D(LCRED_PRIV)		3.73536	0.0297
D(LMB) does not Granger Cause D(I_FED_US)	64	0.18119	0.8347

D(I_FED_US) does not Granger Cause D(LMB)		3.36758	0.0412
D(IR_TBILL_364) does not Granger Cause D(I_FED_US)	64	0.37949	0.6859
D(I_FED_US) does not Granger Cause D(IR_TBILL_364)		2.68909	0.0763
D(LNEER) does not Granger Cause D(I_FED_US)	64	0.94118	0.3959
D(I_FED_US) does not Granger Cause D(LNEER)		0.33962	0.7134
D(LCPI) does not Granger Cause D(LGDP)	64	1.64804	0.2012
D(LGDP) does not Granger Cause D(LCPI)		2.55097	0.0866
D(LCRED_PRIV) does not Granger Cause D(LGDP)	64	0.07169	0.9309
D(LGDP) does not Granger Cause D(LCRED_PRIV)		2.84365	0.0662
D(LMB) does not Granger Cause D(LGDP)	64	0.80941	0.4500
D(LGDP) does not Granger Cause D(LMB)		1.03911	0.3602
D(IR_TBILL_364) does not Granger Cause D(LGDP)	64	0.62091	0.5409
D(LGDP) does not Granger Cause D(IR_TBILL_364)		2.03523	0.1397
D(LNEER) does not Granger Cause D(LGDP)	64	2.56252	0.0857
D(LGDP) does not Granger Cause D(LNEER)		1.82243	0.1706
D(LCRED_PRIV) does not Granger Cause D(LCPI)	65	2.70457	0.0751
D(LCPI) does not Granger Cause D(LCRED_PRIV)		0.66552	0.5178
D(LMB) does not Granger Cause D(LCPI)	65	2.67373	0.0772
D(LCPI) does not Granger Cause D(LMB)		0.95439	0.3908
D(IR_TBILL_364) does not Granger Cause D(LCPI)	65	0.04520	0.9558
D(LCPI) does not Granger Cause D(IR_TBILL_364)		2.03723	0.1393
D(LNEER) does not Granger Cause D(LCPI)	65	0.21934	0.8037
D(LCPI) does not Granger Cause D(LNEER)		2.04552	0.1382
D(LMB) does not Granger Cause D(LCRED_PRIV)	65	4.33811	0.0174
D(LCRED_PRIV) does not Granger Cause D(LMB)		7.36864	0.0014
D(IR_TBILL_364) does not Granger Cause D(LCRED_PRIV)	65	0.00938	0.9907
D(LCRED_PRIV) does not Granger Cause D(IR_TBILL_364)		5.47297	0.0066
D(LNEER) does not Granger Cause D(LCRED_PRIV)	65	1.11337	0.3351
D(LCRED_PRIV) does not Granger Cause D(LNEER)		0.38993	0.6788
D(IR_TBILL_364) does not Granger Cause D(LMB)	65	0.47334	0.6252
D(LMB) does not Granger Cause D(IR_TBILL_364)		1.51834	0.2274
D(LNEER) does not Granger Cause D(LMB)	65	1.03144	0.3627
D(LMB) does not Granger Cause D(LNEER)		0.11311	0.8932
D(LNEER) does not Granger Cause D(IR_TBILL_364)	65	0.90423	0.4103
D(IR_TBILL_364) does not Granger Cause D(LNEER)		0.84580	0.4343

Annex 6: Structural Residuals



Annex 7: Inverse Roots of the SVAR model

Roots of Characteristic Polynomial
Exogenous variables: C GFIN
Lag specification: 1 2

Root	Modulus
0.829512	0.829512
0.683949	0.683949
0.041086 - 0.680557i	0.681796
0.041086 + 0.680557i	0.681796
0.673581	0.673581
-0.177248 - 0.619648i	0.644501
-0.177248 + 0.619648i	0.644501
0.342637 - 0.372705i	0.506270
0.342637 + 0.372705i	0.506270
-0.406151 - 0.006740i	0.406207
-0.406151 + 0.006740i	0.406207
-0.226229 - 0.312303i	0.385633
-0.226229 + 0.312303i	0.385633
0.140634 - 0.318484i	0.348152
0.140634 + 0.318484i	0.348152
-0.211567	0.211567

No root lies outside the unit circle.
VAR satisfies the stability condition.

Annex 8: Residual correlation LM test

VAR Residual Serial Correlation LM Tests
Sample: 2002Q1 2018Q4
Included observations: 64

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	79.12051	64	0.0965	1.278725	(64, 185.3)	0.1052
2	64.07568	64	0.4738	0.998264	(64, 185.3)	0.4901
3	64.31394	64	0.4655	1.002555	(64, 185.3)	0.4818
4	64.67251	64	0.4530	1.009023	(64, 185.3)	0.4693
5	56.69102	64	0.7300	0.867578	(64, 185.3)	0.7421

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	79.12051	64	0.0965	1.278725	(64, 185.3)	0.1052
2	121.3654	128	0.6481	0.910550	(128, 178.6)	0.7125
3	204.2218	192	0.2595	1.000839	(192, 129.8)	0.5021
4	305.9299	256	0.0176	1.024491	(256, 71.4)	0.4635
5	427.0023	320	0.0001	0.357032	(320, 9.9)	0.9975

*Edgeworth expansion corrected likelihood ratio statistic.

Annex 9: Normality test

VAR Residual Normality Tests
Orthogonalization: Estimated from Structural VAR
Null Hypothesis: Residuals are multivariate normal
Sample: 2002Q1 2018Q4
Included observations: 64

Component	Skewness	Chi-sq	df	Prob.*
1	-1.018332	11.06133	1	0.0009
2	-0.347180	1.285697	1	0.2568
3	-0.232375	0.575982	1	0.4479
4	0.137131	0.200585	1	0.6542
5	0.544210	3.159086	1	0.0755
6	-0.115692	0.142768	1	0.7055
7	-0.122260	0.159439	1	0.6897
8	0.122178	0.159227	1	0.6899
Joint		16.74412	8	0.0329
Component	Kurtosis	Chi-sq	df	Prob.
1	4.073059	3.070547	1	0.0797
2	3.188636	0.094889	1	0.7581
3	1.673766	4.690390	1	0.0303
4	2.669644	0.291028	1	0.5896
5	3.196060	0.102505	1	0.7488
6	1.515157	5.879354	1	0.0153
7	1.241260	8.248441	1	0.0041
8	2.071020	2.301344	1	0.1293
Joint		24.67850	8	0.0018
Component	Jarque-Bera	df	Prob.	
1	14.13188	2	0.0009	
2	1.380586	2	0.5014	
3	5.266372	2	0.0718	
4	0.491613	2	0.7821	
5	3.261591	2	0.1958	
6	6.022123	2	0.0492	
7	8.407880	2	0.0149	
8	2.460570	2	0.2922	
Joint	41.42261	16	0.0005	

*Approximate p-values do not account for coefficient estimation

Annex 10: Variance decomposition of Structural VAR model[10]

[10] Shock 1 means Global oil prices, Shock 2 means Fed funds rate, Shock 3 means GDP, Shock 4 means inflation, Shock 5 means Credit supply, Shock 6 means monetary base, Shock 7 means T bills rate, Shock 8 means nominal exchange rate.

Variance Decomposition of D(LGDP):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	16.61964	0.000000	0.000000	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	17.26453	1.836757	0.456203	92.92994	0.141304	0.027676	1.535760	0.027896	3.044462
3	17.27870	4.540332	0.417184	85.26182	1.380243	0.188583	3.748444	0.503259	3.960140
4	17.29556	4.668033	0.780348	84.07909	1.815501	0.505335	3.687586	0.495197	3.968913
5	17.29604	4.688317	0.774573	83.69175	1.803239	0.544608	3.948833	0.617365	3.931315
6	17.29613	4.715849	0.773778	83.50256	1.844772	0.601181	3.939112	0.616106	4.006645
7	17.29616	4.712470	0.797551	83.43798	1.846831	0.619005	3.937886	0.633461	4.014817
8	17.29616	4.720984	0.797022	83.38571	1.848574	0.619304	3.963430	0.633201	4.031774
9	17.29616	4.721537	0.797221	83.37112	1.848481	0.627076	3.964823	0.636207	4.033534
10	17.29616	4.731033	0.799364	83.34531	1.848594	0.642609	3.963657	0.636004	4.033431
11	17.29616	4.731007	0.799865	83.33948	1.849473	0.643635	3.966044	0.636271	4.034230
12	17.29616	4.730791	0.799959	83.33681	1.849904	0.644246	3.967999	0.636240	4.034055

Variance Decomposition of D(LCPI):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.291123	0.000000	0.000000	0.418434	99.58157	0.000000	0.000000	0.000000	0.000000
2	0.319095	6.065528	0.034455	0.342115	84.97302	3.234369	2.376945	1.823863	1.149700
3	0.338254	6.362254	0.080742	5.777286	79.21571	2.787253	2.479452	1.574164	1.723139
4	0.346364	8.240481	0.287640	5.517086	77.11984	3.177941	2.289067	1.477393	1.890554
5	0.349789	8.468812	0.344436	5.924614	76.02569	3.632330	2.319439	1.459826	1.824856
6	0.351256	8.588920	0.344140	5.946211	75.71045	3.696173	2.429104	1.460010	1.824988
7	0.351923	8.573499	0.355408	6.106761	75.37831	3.757575	2.527718	1.457925	1.842808
8	0.352228	8.602750	0.358953	6.157805	75.14405	3.894372	2.550337	1.454662	1.837069
9	0.352367	8.658228	0.357981	6.156711	74.94612	4.015335	2.580051	1.453535	1.832035
10	0.352430	8.683643	0.357799	6.157882	74.83399	4.073240	2.612633	1.451357	1.829461
11	0.352458	8.688973	0.358261	6.163141	74.76328	4.116207	2.632164	1.450040	1.827938
12	0.352471	8.691423	0.358163	6.164246	74.71100	4.154890	2.644360	1.449265	1.826648

Variance Decomposition of D(LCRED_PRIV):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	1.600191	0.000000	0.000000	0.168007	0.000000	99.83199	0.000000	0.000000	0.000000
2	1.922956	0.922202	0.849942	0.844261	0.452307	90.72087	5.909693	0.292999	0.007728
3	2.017295	5.110976	1.117325	1.038048	1.010137	81.85794	9.044397	0.245044	0.576129
4	2.034866	5.264483	1.033807	2.121684	1.224141	79.91539	9.658749	0.247941	0.533807
5	2.044810	5.359385	0.985161	2.064964	1.795883	78.61985	10.39068	0.280732	0.503343
6	2.047431	5.345967	0.944855	2.161011	2.452957	77.14737	11.17187	0.291274	0.484699
7	2.048446	5.409273	0.920350	2.201757	2.849346	76.45939	11.40202	0.284806	0.473062
8	2.049260	5.450549	0.905118	2.192220	3.100121	76.07719	11.52832	0.282090	0.464391
9	2.049610	5.464092	0.893977	2.191328	3.304071	75.72992	11.67256	0.285739	0.458308
10	2.049938	5.477621	0.886064	2.193940	3.447210	75.49211	11.76053	0.287015	0.455508
11	2.050010	5.484943	0.881280	2.190126	3.548977	75.34673	11.80850	0.286312	0.453129
12	2.050070	5.483363	0.878021	2.188223	3.626481	75.23741	11.84915	0.286148	0.451201

Variance Decomposition of D(LNEER):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.927014	7.028739	0.223177	5.891144	2.593158	3.366248	0.032876	0.577817	80.28684
2	1.091981	6.310125	7.026458	5.718788	3.973900	7.994507	0.045560	1.857792	67.07287
3	1.194193	10.55987	8.464378	5.959433	6.245371	7.090478	1.047828	1.676475	58.95617
4	1.244597	13.48627	7.694739	5.774202	8.578862	7.083163	2.124504	1.538742	53.71952
5	1.266855	13.67029	7.637290	5.737388	8.972560	7.037263	2.165811	1.531913	53.24749
6	1.271392	13.59764	7.782317	5.851601	9.005163	7.127478	2.185929	1.532525	52.91735
7	1.274792	13.57074	7.812407	5.872965	9.098752	7.111614	2.201028	1.532803	52.79969
8	1.277123	13.56624	7.814313	5.870369	9.125653	7.108120	2.201018	1.534079	52.78021
9	1.278877	13.56790	7.821922	5.871365	9.127317	7.109993	2.203181	1.534122	52.76420
10	1.279836	13.57049	7.827226	5.871135	9.131046	7.108838	2.203698	1.535035	52.75253
11	1.280451	13.57036	7.828019	5.870628	9.134629	7.108220	2.204559	1.535291	52.74829
12	1.280911	13.57009	7.828715	5.870684	9.135764	7.108119	2.204540	1.535394	52.74669

Factorization: Structural

Annex 11: Variance decomposition using Cholesky decomposition

Variance Decomposition of GDP:

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	15.314	4.254	6.353	89.393	0.000	0.000	0.000	0.000	0.000
2	15.785	3.327	10.298	81.803	0.147	0.008	2.012	0.007	2.397
3	15.814	3.223	10.989	81.033	0.144	0.064	2.072	0.110	2.366
4	15.816	3.209	10.986	80.905	0.155	0.086	2.169	0.110	2.380
5	15.816	3.208	11.025	80.842	0.155	0.111	2.167	0.111	2.381
6	15.816	3.208	11.020	80.826	0.155	0.122	2.176	0.111	2.380
7	15.816	3.209	11.021	80.818	0.155	0.129	2.177	0.111	2.380
8	15.816	3.209	11.020	80.813	0.155	0.132	2.179	0.111	2.380
9	15.816	3.209	11.020	80.811	0.156	0.133	2.179	0.111	2.380
10	15.816	3.209	11.019	80.810	0.156	0.134	2.180	0.111	2.380
11	15.816	3.209	11.019	80.810	0.156	0.134	2.180	0.111	2.380
12	15.816	3.209	11.019	80.810	0.156	0.135	2.180	0.111	2.380

riance Decomposition of Inflation :

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	0.273	1.120	3.039	0.030	95.810	0.000	0.000	0.000	0.000
2	0.307	1.043	5.795	1.898	84.738	0.664	1.989	3.125	0.748
3	0.316	1.570	5.424	1.763	82.625	1.057	1.871	4.369	1.321
4	0.319	1.785	5.372	1.722	81.551	1.594	1.887	4.694	1.396
5	0.319	1.892	5.339	1.746	80.866	2.036	1.973	4.750	1.398
6	0.320	1.944	5.318	1.777	80.435	2.339	2.050	4.747	1.390
7	0.320	1.967	5.303	1.806	80.172	2.523	2.108	4.735	1.386
8	0.320	1.977	5.293	1.826	80.023	2.626	2.144	4.726	1.384
9	0.320	1.981	5.288	1.838	79.941	2.681	2.165	4.722	1.384
10	0.320	1.983	5.285	1.844	79.899	2.709	2.176	4.719	1.384
11	0.320	1.983	5.284	1.848	79.878	2.722	2.182	4.718	1.385
12	0.320	1.983	5.283	1.850	79.867	2.729	2.185	4.718	1.385

Cholesky Ordering: D(LOIL_BRENT) D(I_FED_US) D(LGDP) D(LCPI) D(LCRED_PRIV) D(LMB) D(IR_TBILL_364) D(LNEER)

Annex 12: Variance decomposition of Structural VAR model with one lag

Variance Decomposition of GDP:

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	15.314	0.000	0.000	100.000	0.000	0.000	0.000	0.000	0.000
2	15.785	1.587	0.588	92.855	0.100	0.123	2.347	0.007	2.392
3	15.814	1.905	0.667	92.136	0.098	0.316	2.409	0.115	2.354
4	15.816	1.894	0.665	92.007	0.105	0.322	2.523	0.115	2.369
5	15.816	1.923	0.669	91.931	0.105	0.366	2.520	0.116	2.369
6	15.816	1.925	0.669	91.909	0.105	0.377	2.530	0.116	2.369
7	15.816	1.928	0.669	91.895	0.106	0.386	2.532	0.116	2.369
8	15.816	1.929	0.669	91.889	0.106	0.389	2.534	0.116	2.369
9	15.816	1.929	0.669	91.886	0.106	0.391	2.534	0.116	2.369
10	15.816	1.929	0.669	91.884	0.106	0.392	2.535	0.116	2.369
11	15.816	1.930	0.669	91.884	0.106	0.392	2.535	0.116	2.369
12	15.816	1.930	0.669	91.883	0.106	0.393	2.535	0.116	2.369

riance Decomposition of Inflation :

Period	S.E.	Global oil prices	Fed fund rate	GDP	Inflation	Credit supply	IBCM rate	T bill rate	Exchange rate
1	0.273	0.000	0.000	0.243	99.757	0.000	0.000	0.000	0.000
2	0.307	5.160	0.127	4.854	81.551	2.458	2.140	3.021	0.690
3	0.316	6.980	0.331	4.543	77.883	2.948	1.975	4.146	1.196
4	0.319	7.814	0.371	4.418	76.117	3.637	1.976	4.415	1.252
5	0.319	8.171	0.390	4.352	75.169	4.156	2.059	4.454	1.250
6	0.320	8.329	0.400	4.324	74.625	4.500	2.137	4.443	1.241
7	0.320	8.392	0.407	4.317	74.322	4.702	2.196	4.428	1.236
8	0.320	8.415	0.412	4.316	74.158	4.812	2.232	4.419	1.235
9	0.320	8.423	0.415	4.317	74.073	4.870	2.254	4.414	1.234
10	0.320	8.425	0.417	4.318	74.030	4.898	2.265	4.411	1.234
11	0.320	8.425	0.418	4.319	74.009	4.912	2.271	4.410	1.235
12	0.320	8.425	0.419	4.320	73.999	4.918	2.274	4.410	1.235

Factorization: Structural