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Examining the Response of Currency Outside the Banking System to the Rise in E-Payment Systems in Nigeria

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ABSTRACT

This study investigated the response of currency outside the banking system to the rise in the use of the e-payment outlets in Nigeria. The study is motivated by the recent rise in the use of e-payment systems and their likely tendency to reduce the currency outside the banking system. Using monthly series over the period from 2012M12 to 2022M12, the study applied the VAR model. The study found that currency outside the banking system responded negatively to shocks in the three e-payment channels included in the study, even though such responses were short-lived. The study equally revealed that while bank reserves responded positively to shocks in e-bills payment only in period one, its response to shocks in both NIP and POS was positive up to periods six and eight, respectively. These outcomes found support in the results of the variance decomposition. On grounds of the findings, the study concludes that the e-payment system led to a reduction in the currency outside the banking system with the likely implication of causing much liquidity in the banking system. It is the view of the study that the monetary authorities should encourage the use of the e-payment systems in order to reduce the currency outside the banking system, but should monitor the various e-payment channels to avoid financial instability.

KEYWORDS

E-payment; Bank reserves; Currency outside the banking system; Financial instability; VAR model

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1. Introduction

Monetary policy in Nigeria is beset with many obstacles and chief among them is the high currency outside the banking system. Several factors have been pointed to be responsible for the high currency outside the banking system in Nigeria, including the low level of literacy which has led to poor banking culture, especially among the rural dwellers. Among the problems posed by high incidence of currency outside the banking system is the difficulty in maintaining price stability and mobilizing savings for un-lending to investors. As a monetary policy reaction to this menace, the Central Bank of Nigeria (CBN) in January 2012 commenced the process of cashless policy. It is understandable that the policies and programs of the CBN to bolster the e-payment system as a way to reduce the currency outside the banking system have actually improved the use of these e-payment channels. Notwithstanding these efforts, Opoku-Asante *et al*. (2023) observed that much still needs to be done judging from the recently failed policy on the local currency (naira) redesign and placing of cash withdrawal limit which was announced in 2022. The failure of the policies to reduce the currency in circulation can also be judged from the manner in which the CBN continues to print more money despite angling to reduce the stock of cash in circulation. Despite the efforts of the monetary authorities in reducing the huge currency outside the banking system, the country still grapples with the menace as can be observed in Figures below.

Among the measures so far introduced to curtail the amount of currency outside the banking system, the impact of the innovations in the payment system on the economy has received much research attention as it has introduced radical transformations in the banking sector (Awwad, 2021). The cashless policy in Nigeria has of recent encouraged an intensive use of electronic payment (e-payment) systems which have come to revolutionize the payment system in the country. The e-payment system is an electronic mechanism that facilitates the exchange of payments (Imafidon, 2013). It is monetary transactions effected over the internet or a network of computers. Among the e-payment systems in Nigeria are the Nigeria Interbank Settlement Systems (NIBSS) Instant Payment (NIP), Automated Teller Machine (ATM), Point-of-sale (POS) terminals, Internet banking, mobile payment systems, e-bills payment, REMITA and National Electronic Fund Transfer (NEFT). In order to facilitate the automated processing and instructions for transfer of funds among the financial institutions in Nigeria, the NIBSS which commenced operation in June 1994 provides the requisite infrastructure.

In recent times, the use of e-payment channels in Nigeria has increased owing to the massive penetration of information and communication technology (ICT) in the country. More people, even in the rural settlements are beginning to make use of android phones that facilitate mobile banking and there are many POS operators scattered across the country that provide mini banking services. Both government and some private institutions have also embraced the e-bills payment system. All these developments have implications on the currency movement in the economy since the transactions pass through the banking system. For instance, innovations in the payment system could improve the reserve position of banks by bringing into the banking system, depositors who do not patronize the banking system (Huang *et al.*, 2024). On the other hand, the e-payment systems can move the bank deposits away from banks to nonbank financial institutions system (Huang *et al.*, 2024).

The primary goal of this study is to examine how currency outside the banking system responds to the growth in e-payments systems in Nigeria. This study is important because achieving a reduction in currency outside the banking system would assist the economy in several ways, such as improvement in the payment system, reduction in the cost of providing banking services and ensuring the effectiveness of monetary policy. A major motivation for the study is the current rise in the use of e-payment systems in the country and the consequences of these on monetary policy management, especially the need to reduce the currency outside the banking system. The key question that the study sought answer is whether the growth in the use of the e-payment channels has helped to reduce the currency outside the banking system in Nigeria. Also, the study sought to find out the response of currency outside the banking system to shocks in some monetary policy instruments. These objectives are relevant,

more so considering the fact that the introduction of the e-payment systems has come to influence monetary policy management (Gbadebo, 2010). Furthermore, the operating procedures of central banks have to change regularly in order to respond to innovations in financial system (Misati *et al*., 2010). This study is perhaps more relevant currently considering that the emergence of electronics banking and the penetration of information and communication technology (ICT) have shaped the way transactions are carried out. Currently, more individuals in Nigeria have access to cell phones, just as there are ATM stands at strategic locations. Point of sales (POS) operators are also scattered everywhere even in the rural areas as it have turned into a business opportunity for the operators. All these introduce dynamism in the way transactions are done and they have the tendency to influence the currency in circulation.

Despite the preponderance of works on e-payment systems, there is not much work done in this direction in Nigeria. Findings show that past studies that investigated the influence of e-payment systems in Nigeria focused on the impact of e-payment outlets on some macroeconomic variables such bank profitability (Ibenta & Anyanwu, 2017), economic growth (Chukwunulu, 2019) and human capital development (Nwokoro, Ikeora & Ogini, 2022). Muhibudeen and Haladu (2015) and Kanu *et al.* (2020) investigated the link between the e-payment systems and the currency outside the banking system using the ordinary least squares. This present study thus contributes to the literature by examining the influence of the e-payment systems on currency outside the banking system using monthly series that captured the period of the COVID-19 pandemic and beyond. The implication of extending the study to the COVID-19 pandemic period is to capture the dynamism in the e-payment systems within this period as the lockdown occasioned by the pandemic encouraged more use of the e-payment systems. The study also went further by including monetary policy variables into the VAR model to capture the response of e-payment systems to some monetary policy actions of the monetary authorities. Therefore, the use of the VAR approach in this present study is equally a methodological contribution to the literature since the VAR treats all the variables in a model as endogenous in such a way that it can deal with any effect a variable has on the others

The following are how subsequent sections of the paper are structured. First, the study provides stylized facts on the trends in some key variables and this is followed by a review of extant literatures. After these the study provided the methodology adopted, comprising data sources, methods used, model specification and estimation techniques. The analytical results are then presented and findings are discussed. Finally, the study summarizes the major findings and discusses their policy implications. In essence, this paper contributes to the literature by analyzing the response of currency outside the banking sector to the rise in the use of the various e-payment systems with a view to provide policy guideline to the monetary authorities with respect to the need to factor in the e-payment channels when designing policies to regulate currency in circulation.

1.1. Some Stylized Facts

The use of e-payment systems has been on the increase in Nigeria in recent times as observed in the trend of the three e-payment platforms, namely: E- bills payment (EBP), NIP and POS shown in Figure 1. Beginning from May 2020, the use of both EBP and NIP assumed a high growth and they maintained the growth trajectory despite experiencing mild fluctuations. Even though the use of POS was almost flat within the period, it exhibited marginal improvement from 2020. Coincidentally, 2020 was the COVID-19 year which truncated economic activities within the period. Therefore, it will be logical to conclude that the COVID-19 period led to much use of e-payment systems and this is not far from the truth because in that year the attendant lockdown forced both individuals and institutions to engage in much e-payment transactions. For instance, within this period people hardly went to banking halls for transactions as physical presence in the banks was prohibited. In another vein, Figure 2 indicates that bank reserves have been growing within the sample period. Before October 2019, the growth in bank reserves was low but after this period the variable experienced a phenomenal rise and got to a peak in October 2020. Prior

to December 2019, currency outside the banking system grew higher than bank reserves but the later rose higher than the former afterwards. Between February 2020 and September 2021, currency outside the banking system was below bank reserves. Again, this supports the initial contention that within the peak of the COVID-19 period, e-payment systems grew high resulting in improvement in bank reserves within the period.

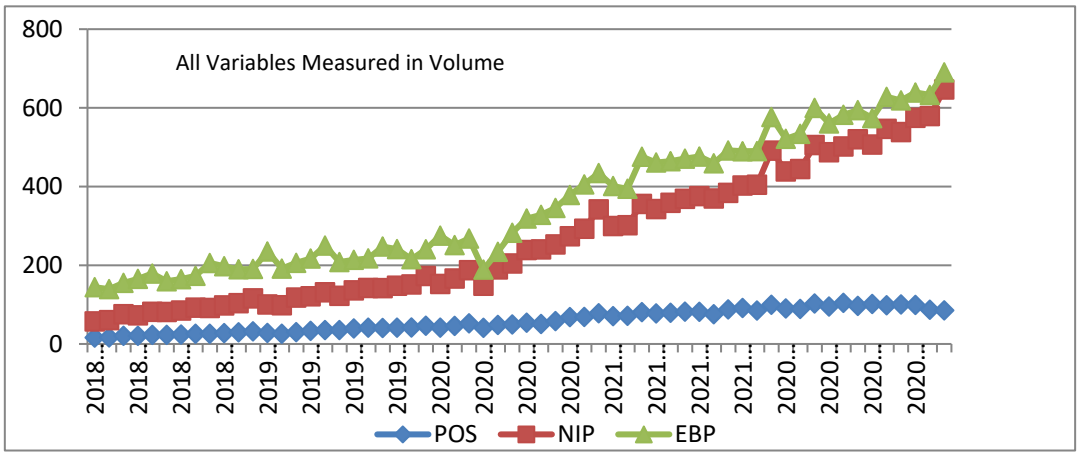

Figure 1. Movement of some E-payment Systems.

Note: EBP – e-bills payment, NIP - Nigeria Interbank Settlement Systems instant payment, POS –point of sales. Source: developed by the authors.

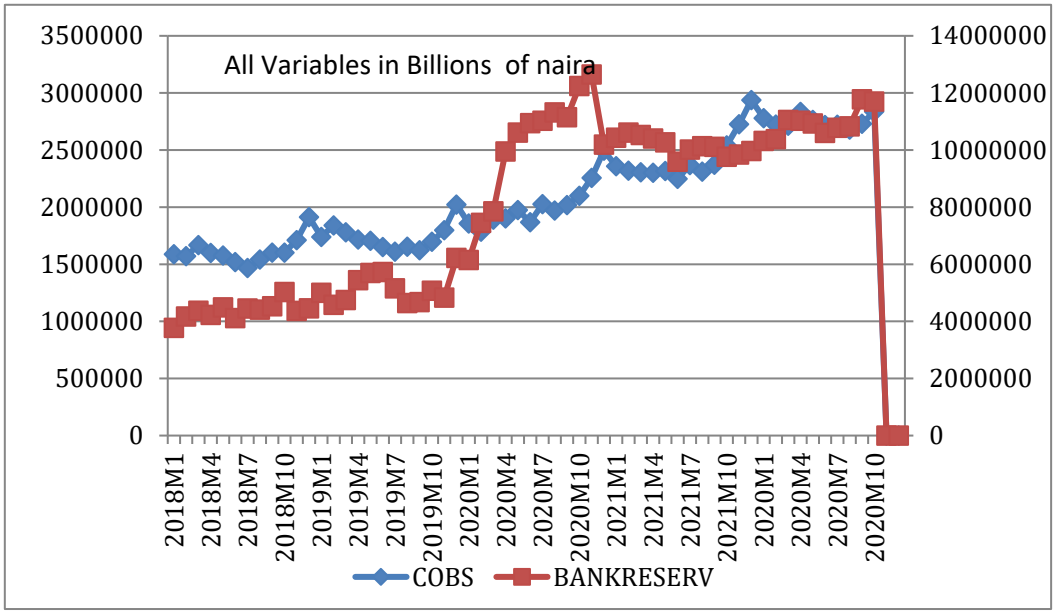

Figure 2. Movement of Currency outside the Banking System and Bank Reserves.

Note: COBS – currency outside the banking system, BANKRESERV – bank reserves. Source: developed by the authors.

2. Literature Review

2.1. Theoretical Background

The introduction of the e-payment systems has been noted to affect monetary policy transmission in several ways. As observed by Huang *et al.* (2024), four channels have been identified through which monetary policy transmission can be affected as a result of rise in the use of the e-payment systems. The first channel is that the e-

payment systems have the tendency to channel the currency in circulation which hitherto was outside the banking system into the banking system. This can be made possible when the agents of mobile network operators (MNOs) make deposit of banknotes and coins exchange for airtime. The deposits made thereafter raises the loanable funds at the disposal of banks which ultimately strengthens the credit channel of monetary policy transmission. The second channel is that the e-payment systems improve the efficiency of the market through their role in moving savings from the traditional instruments such as real estate and gold that are not too sensitive to monetary policy, into bank deposits. The third channel is that by encouraging high competition in the banking system as a way to attract huge wholesale depositors such as the MNOs, the e-payment systems lead to reduction of excess reserves of banks which is necessary for the transmission of monetary policy to bank lending. The fourth channel is the exchange rate channel. The exchange rate channel occurs when the e-payment systems encourage the appeal of domestic currency in relation to foreign currency. This could lower the demand for foreign currency deposits and hence, strengthens the local currency. The aftermath of this is the reduction in in risk premium of currency.

However, it has also been observed that the e-payment systems have the tendency to reduce monetary policy transmission through the substitution effect. These e-payment systems can curtail loans supply if the deposits at the bank are not loanable. This can occur if for instance there is a prudential guideline which requires that the e-money issuers (EMIs) maintain a certain pool of liquidity funds that is equivalent to their clients wallet aggregate balance (Shirono, 2021). Moreover, bank deposits may reduce, resulting in financial disintermediation if these channels are deemed safer than bank deposits and there is no restriction on the size of e-wallets. Also worthy of note is that these channels may encourage the shifting of savings away from the traditional bank deposits into other digital assets such as cryptocurrencies that are less responsive to monetary policy.

2.2. Empirical Literature

The cashless policy introduced in the Nigerian financial system has sparked off interests in investigating the influence of e-payment systems on some financial and monetary variables with varying outcomes. In a study by Muhibudeen and Haladu (2015), findings reveal that both Automated Teller Machine (ATM) and cheque impacted positively on currency outside the banking system even though the result is not significant. Oladejo (2016) used panel logistic regression to show that the adoption of e-payment systems such as POS, ATM, WEB and mobile banking enhanced the profitability of banks. However, mixed results were obtained by Ibenta and Anyanwu (2017) which revealed that both ATM and POS influenced bank efficiency negatively, while internet and mobile banking had a positive influence. In terms of the contribution of e-payment systems to growth, Chukwunulu (2019) used the generalized methods of moments (GMM) to reveal that POS, ATM, internet and mobile banking influenced economic growth positively. To corroborate this result, Ogunsakin and Alabi (2020) used the VAR method to show that both the ATM and POS impacted positively on sectoral output. In another study for Nigeria, Kanu *et al.* (2020) used the least squares regression analysis to reveal that both REMITA and WEBPAY had a negative and significant relationship with currency in circulation in Nigeria. However, ATM and POS exhibited a positive and significant relationship. With respect to the impact of e-payment systems on the demand for money, finding by Jonah, Idaka and Eja (2020) revealed mixed outcomes in terms of the lag of the e-payment variables. While the current period of ATM, two periods lag of mobile banking transaction, current and one period lag of internet banking transactions and current period of POS transactions influenced demand for money positively. Also, one period lag of POS transaction had a negative influence on money demand. As a further support of the positive impact of financial innovation on the economy, Nwokoro *et al.* (2022) show that mobile banking, POS, ATM and internet banking had positive impact on human capital development. Focusing on the COVID-19 pandemic, Afees, Sikiru and Omoke (2022) found that financial innovations captured in exchange traded funds (ETFs) can provide a hedge against risks

arising from the COVID-19 pandemic as well as financially engineered market risks. In their study, Oke and Olaiya (2023) did not find any significant link between the e-payment systems and banks' deposit mobilization.

Empirical evidences from other countries have also revealed some interesting results. In Turkey, Gündoğdu and Taşkin (2017) used simple regression analysis to indicate that of the e-payment systems employed in the study such as credit cards, telephone banking and online banking, only credit cards positively impacted on the Turkish banking system. In a study in Zimbabwe, Bara and LeRoux (2018) observed that financial innovation with its technology influenced the activities of banks with respect to risk management, credit extension and service delivery. In further support of the positive contributions of the e-payment systems, Nzyuko and Jagongo (2018) found that the use of mobile phone banking, ATMs and internet banking improved financial performance in Kenya. A study in Thailand by Chucherd *et al.* (2019) revealed that rampant use of e-payment channels did not have much influence on cash demand as the use of cash continues to rise. In a panel study in the Maghreb countries, Djaballah (2020) found that the use of e-payment systems such as the ATMs has a positive impact on money supply. In another cross-country study, Huang *et al.* (2024) found that the development of e-money has led to a strong monetary policy transmission.

3. Methodology

The study used monthly series that spanned the period from 2012M12-2022M12. The dependent variable is currency outside the banking system. Three e-payment channels, namely: E-bills payment (EBP), NIBSS instant payment (NIP) and point of sale (POS) were included. Also, three control variables, namely: monetary policy rate (MPR), Treasury bills rate (TBR) and bank reserves were considered. The NIP is a digital method that enables the financial institutions to offer instant fund transfer services and payments of bills to their customers based on bank account numbers. The POS is a real-time online platform that facilitates purchases and other transactions through the debit card that is slotted in the terminal. As the card is slotted, bank customer's account is instantly debited to reflect the value of purchases or services. The EBP is a means of sending and effecting payments digitally instead of the traditional paper billing processes. The reason for selecting the three e-payment channels was informed by their rapid use in the country. For instance, while transactions using the POS have penetrated every nook and cranny of the country, bills such as utility bills are now paid online instead of physical payment. The ATM and REMMITA are other channels whose use has gained much popularity in the country; however, the inability to obtain up-to-date data on them warranted their exclusion in the study. In addition to this, the study considers that lumping all the relevant variables into the model will result into the problem of over-paramitization of the model with its associated problem of loss in the degrees of freedom.

Monetary policy rate is included because it is the benchmark rate that controls other rates. The CBN often influences it as a way to regulate the economy to a desired direction. Its adjustment can help to attract more cash to the banking system and thus reduce currency in circulation. The TBR is considered on two grounds. One is that through the open market operation of the CBN, it can be used to regulate money supply and hence curtail the currency outside the banking system. Second, the Treasury bill is an investment outlet such that increase in the rate could attract much cash into the banking system. Bank reserve is considered because through its position, currency outside the banking system can be evaluated. Thus, continuous rise in bank reserve is an indication of a fall in the currency outside the banking system.

All the variables of e-payment systems are measured in volume. However, while currency outside the banking system and bank reserves are measured in billions of naira, both MPR and TBR are measured in percentage. The data for all the e-payment variables were sourced from the Nigeria Inter-bank Settlement System (NIBSS), while data on the remaining variables were sourced from the Central Bank of Nigeria Statistical Bulletin. POS, NIP, currency outside the banking system and bank reserves are in log form to ensure easy interpretation.

3.1. The VAR Model

Given the above background information, the VAR model is specified as:

$$X_t = \beta + \sum_{i-1}^{k} BX_{t-1} + \varepsilon_t \quad (1)$$

Where: x_t *is* a $(7x1)$ vector of endogenous variables, β is a $(7x1)$ vector of intercept terms, β_t is a fixed coefficient matrix, ε_t is a 7--dimensional white noise and k is lag order. The structural unrestricted VAR model is specified in a matrix form as follows:

$$\begin{bmatrix} EBP_t \\ LNIP_t \\ LPOS_t \\ MPR_t \\ TBR_t \\ LCOBS_t \\ LBRESERV_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \\ \beta_6 \\ \beta_7 \end{bmatrix} + \begin{bmatrix} B_{1,1} & B_{1,2} & B_{1,3} & B_{1,4} & B_{1,5} & B_{1,6} & B_{1,7} \\ B_{2,1} & B_{2,2} & B_{2,3} & B_{2,4} & B_{2,5} & B_{2,6} & B_{2,7} \\ B_{3,1} & B_{3,2} & B_{3,3} & B_{3,4} & B_{3,5} & B_{3,6} & B_{3,7} \\ B_{4,1} & B_{4,2} & B_{4,3} & B_{4,4} & B_{4,5} & B_{4,6} & B_{4,7} \\ B_{5,1} & B_{5,2} & B_{5,3} & B_{5,4} & B_{5,5} & B_{5,6} & B_{5,7} \\ B_{6,1} & B_{6,2} & B_{6,3} & B_{6,4} & B_{6,5} & B_{6,6} & B_{6,7} \\ B_{7,1} & B_{7,2} & B_{7,3} & B_{7,4} & B_{7,5} & B_{7,6} & B_{7,7} \end{bmatrix} \begin{bmatrix} EBP_{t-1} \\ LNIP_{t-1} \\ LPOS_{t-1} \\ MPR_{t-1} \\ TBR_{t-1} \\ LCOBS_{t-1} \\ LBRESERV_{t-1} \end{bmatrix} + \begin{bmatrix} \mu^{EBP_t} \\ \mu^{LNIP_t} \\ \mu^{LPOS_t} \\ \mu^{MPR_t} \\ \mu^{TBR_t} \\ \mu^{LCOBS_t} \\ \mu^{LBRESERV_t} \end{bmatrix} \quad (2)$$

Where: β and B are the fixed intercept terms and the regression coefficients, respectively. EBP = E-bills payment, $LNIP$ = log of NIBSS instant payment, $LPOS$ = log of point of sale, MPR = monetary policy rate, TBR = Treasury bills rate, $LCOBS$ = log of currency outside the banking system, $LBRESERV$ = log of bank reserves and μ_t represents the error term.

3.2. Technique of Estimation

The analysis of the study was done by first examining the behaviour of the variables used in the study. The descriptive statistics was first presented followed by the test for stationarity (unit root test) which was carried out to ascertain the order of integration of the series. The test for stationarity was conducted using both the augmented Dickey Fuller (ADF) and the Phillip Perron (PP) tests. Having ascertained the order of integration, the study went on to examine the cointegrating relationship among the series using the Johansen co-integration test. The choice of Johansen was informed by the result of the unit root which revealed that all the series were integrated after first differencing. With the result of cointegration pointing that the series are not cointegrated (there is no long-run relationship), the study estimated an unrestricted vector autocorrelation (VAR) from which the impulse response function and the variance decomposition results were obtained. Due to the possible feedback in the variables used in the study, the VAR model was used to capture this feedback. The study adopted a seven-variable VAR model consisting of three e-payment variables, namely: E-bills payment (EBP), NIBSS instant payment (NIP) and point of sale (POS), two monetary policy variables; namely; monetary policy rate (MPR) which is the benchmark rate that influences other rates in the economy and Treasury bills rate which represents the activities of the monetary authorities with respect to open market operation (OMO). The other two variables are currency outside the banking system and bank reserves.

4. Results

The study first interpreted the preliminary results which provide information about the behaviour of the variables used in the study. First, the result of the descriptive statistics in Table1 revealed that the mean and median of most of the variables are close, indicating that the variables are symmetric. In another vein, it is revealed that the mean value of currency outside the banking system is higher than the mean value of bank reserves. This is an indication that the Nigerian economy is still cash-based.

Table 1. Results of Descriptive Statistics.

	LBRESERV	LCOBS	EBP	MPR	LNIP	LPOS	TBR
Mean	6.20	6.64	18340.1	4.11	3.89	12.79	8.60
Median	6.18	6.60	80.55	4.39	4.39	12.50	10.13
Maximum	6.47	7.10	112499.	7.05	7.05	16.50	14.93
Minimum	6.03	6.04	0.00	0.00	0.00	11.00	0.00
Std. Dev.	0.12	0.27	36976.7	2.21	2.39	1.09	4.56
Skewness	0.58	-0.02	1.57	-0.11	-0.04	0.44	-0.58
Kurtosis	2.35	2.55	3.58	1.44	1.25	2.63	1.89
Jarque-Bera	9.55	1.12	54.80	13.28	16.53	4.98	13.77
Probability	0.00	0.57	0.00	0.00	0.00	0.08	0.001
Sum	799.9	856.4	2365873.	530.6	502.8	1649.5	1109.4
Sum Sq. Dev.	1.83	9.04	1.75	622.8	735.3	153.89	2663.3

Source: data output.

The results of the stationarity (unit root) of the variables are shown in Table 2. Under the ADF, finding showed that none of the series is stationary at level. However, after first differencing, they all achieved stationarity. That is to say the series became *I (1)* after they were first differenced. Under the PP test, findings showed that both E-bills payment and Treasury bills rate are stationary at level, while the other series are not stationary. However, as the series were first differenced, they attained stationarity.

Table 2. Results of the Test for Stationarity.

	ADF		PP	
	LEVEL	FIRST DIFF.	LEVEL	FIRST DIFF.
LBRESERV	-1.84(0.36)	-11.28(0.00)*	-1.83(0.36)	-11.29(0.00) *
LCOBS	-2.20(0.20)	-11.97(0.00) *	-2.20(0.20)	-11.97(0.00) *
EBP	-2.02(0.27)	-14.16(0.00) *	-3.36(0.01)	-12.91(0.00) *
MPR	-0.58(0.86)	-5.95(0.00) *	-1.49(0.53)	-11.43(0.00) *
LNIP	-2.36(0.15)	-11.34(0.00) *	-2.41(0.13)	-11.36(0.00) *
LPOS	-2.36(0.15)	-11.34(0.00) *	-2.41(0.13)	-11.36(0.00) *
TBR	-2.29(0.17)	-16.42(0.00) *	-2.71(0.07)	-18.08(0.00) *

Note: *Figures with asterisks (*) indicate rejection of the null hypothesis at the 5% level. Source: data output.*

With the ADF results showing that the series are *I (1),* the study went further to conduct a cointegration test using the Johansen cointegration test. However, before conducting the cointegration test, ascertaining the optimal lag length as well as examining the stability of the VAR model was carried out. In order to ensure that the stochastic variable follows a white noise, appropriate lag order selection is germane. This view finds support in Maddala and Kim (1998) who observed that the number of lags chosen in a model could play sensitive role in the power properties of the unit roots tests. In the selection of an appropriate lag length, empirical studies have mainly used some information criteria, notably: the Hannan-Quinn information criterion (HQ), the Schwarz information criterion (SIC) and the Akaike information criterion (AIC). This study borrowed a leaf from these studies by using these information criteria. In Table 3 below, it is found that both the SIC and HQ favoured lag 1, indicating that the

optimal lag adopted in the study is lag 1.

Table 3. Lag Length Selection Criteria.

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-1767.4	NA	12892.7	29.32	29.49	29.39
1	-1020.5	1395.02	0.12	17.79	19.08*	18.31*
2	-991.2	51.34	0.17	18.11	20.54	19.10
3	-948.5	69.93	0.19	18.22	21.78	19.66
4	-924.5	36.49	0.31	18.63	23.32	20.54
5	-883.4	57.70	0.37	18.76	24.59	21.13
6	-783.1	129.33	0.17	17.91	24.87	20.74
7	-695.8	102.41*	0.10*	17.28*	25.37	20.57
8	-652.3	46.06262	0.14	17.37	26.59	21.12

*Note: * indicates lag order selected by the chosen criterion. Source: data output.*

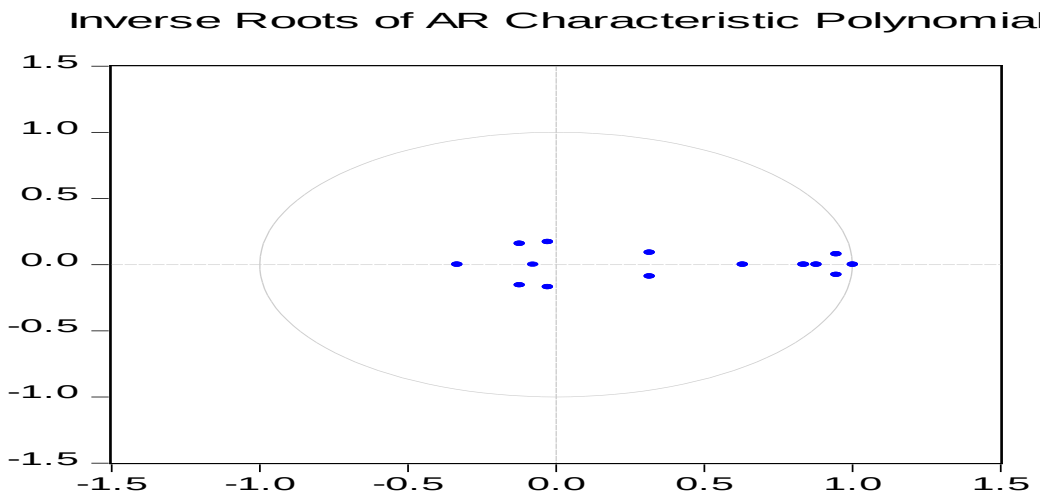

Figure 3. Inverse Roots of the Autoregressive Characteristic Polynomial.

Source: data output.

Having identified the optimal lag length and satisfied the condition for stability of the VAR model, the study went ahead to test for the cointegrating relationship among the series. In Tables 4 and 5, the results of the Johansen cointegration test revealed that the series are not cointegrated. This is confirmed from the results of both the trace and maximum eigenvalue tests which revealed that the p-values are higher than the 5% level of significance in all the levels. The result implies that there is no existence of a long-run relationship among the variables. On the basis of the result, the study can only focus on the short-run relationship among the variables using the standard unrestricted VAR at first difference. Impulse response and variance decomposition results are thus determined using the unrestricted VAR.

Table 4. Unrestricted Cointegration Rank Test (Trace).

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.48	174.01	125.6	0.09
At most 1	0.24	90.88	95.7	0.10
At most 2	0.18	56.07	69.8	0.37
At most 3	0.11	30.19	47.85	0.70
At most 4	0.06	14.84	29.79	0.79
At most 5	0.04	6.26	15.49	0.66
At most 6	0.001	0.21	3.84	0.64

*Note: Trace test indicates no cointegration at the 0.05 level, * Denotes rejection of the hypothesis at the 0.05 level. Source: data output.*

Table 5. Unrestricted Cointegration Rank Test (Maximum Eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.48	83.12	46.23	0.14
At most 1	0.24	34.8	40.07	0.17
At most 2	0.18	25.87	33.87	0.32
At most 3	0.11	15.35	27.58	0.71
At most 4	0.06	8.58	21.13	0.86
At most 5	0.04	6.04	14.26	0.60
At most 6	0.001	0.21	3.84	0.64

*Note: Maximum eigenvalue test indicates no cointegration at the 0.05 level, * Denotes rejection of the hypothesis at the 0.05 level. Source: data output.*

4.1. Discussion of the results of impulse response and variance decomposition

The results of the impulse response function in Appendixes 1 and 2 indicate that currency outside the banking system responded positively to shocks in E-bills payments only in period one. However, after this period, it responded negatively in subsequent periods. In a similar respect, while the study finds that currency outside the banking system responded positively to shocks in NIP in period one, it thereafter responded negatively in other periods. Also, it was found to respond positively to shocks in POS in periods one and two, but responded negatively in subsequent periods. By implication, as the use of e-payment systems increased, cash holdings of the populace reduced. The results point to the fact that the rise in e-payment systems could attract the hitherto unbanked public to the formal banking system and such enhances financial inclusion in the country. With respect to the response of currency outside the banking system to changes in monetary policy actions, the study found that while currency outside the banking sector responded negatively to shocks in MPR starting from period two, it responded positively to shocks in Treasury bills rate in all the periods. The study is of the view that while changes in MPR curtailed the growth of currency outside the banking system through its effect on credit extension from the deposit money banks (DMBs), open market operation measure encouraged more currency outside the banking system.

In another vein, the study revealed that while bank reserves responded negatively to shocks in E-bills payment starting from period two, its response to shocks in both NIP and POS was positive up to periods six and eight, respectively. The positive response of bank reserves to shocks in NIP and POS indicates that the increasing use of e-payment systems has the tendency to raise liquidity in the banking system and with increased liquidity, banks can extend more credit facilities. This finds corroboration in the finding by Oladejo (2016) which indicated that the use of e-payment platforms improved bank profitability. Similarly, the outcome of the present paper finds support in the works of Bara and LeRoux (2018) and Nzyuko and Jagongo (2018) for Zimbabwe and Kenya, respectively. For the response of the e-payment systems to shocks in both monetary policy rate and Treasury bills rate, findings showed that while E-bills payment responded positively to shocks in MPR in all the periods, it responded negatively to shocks in TBR starting from period four. However, both POS and NIP responded negatively to shocks in MPR and TBR in all the periods. The contention of the paper is that some monetary policy interventions could reverse the growth in the use of e-payment systems, especially as the policies affect money supply. The response of the monetary policy actions to shocks in e-payment systems revealed diverse outcomes. While MPR responded negatively to shocks in E-bills payment starting from period five, it responded positively to shocks in both NIP and POS in all the quarters. In another vein, while the Treasury bills rate responded positively to shocks in both E-bills payment and NIP, it responded negatively to shocks in POS up to period three.

The results of the variance decomposition in Appendix 3 indicate that apart from shocks to itself which was 100% in the first period, shocks in E-bills payment contributed about 1.9% shocks in currency outside the banking system in period two which marginally rose in period three but continuously fall in subsequent periods. Findings equally show that the contributions of NIP and POS to shocks in currency outside the banking system were on a continuous rise beginning from the fourth quarter. It is also revealed that apart from shocks to itself which was 97% in the first quarter, shocks in E-bills payment contributed about 0.48% of shocks in bank reserves which rose continuously in all the quarters. However, both NIP and POS experienced fluctuations in their contributions to bank reserves in all the quarters. While the contribution of MPR to shocks in E-bills payment was persistently rising in all the quarters, the contribution of Treasury bills rate experienced fluctuations. However, the contributions of both MPR and Treasury bills rate to shocks in NIP and POS rose continuously in all the quarters.

5. Conclusion

The poor banking culture in Nigeria which has led to so much currency outside the banking system has been a major monetary policy issue; mandating the monetary authorities to embark on a cashless policy. This study is thus motivated by the behaviour of currency outside the banking system owing to the growing use of the e-payment systems which is the outcome of the cashless policy. The study used monthly series over the period from 2012M12-2022M12 with findings showing that currency outside the banking system responded positively to shocks in E-bills payments only in period one. However, after this period, it responded negatively in subsequent periods Findings also showed that currency outside the banking system responded positively to shocks in NIP in period one and thereafter responded negatively in other periods. Similarly, it responded positively to shocks in POS in periods one and two, but responded negatively in subsequent periods. The implication of these results is that currency outside the banking system responded temporarily to changes in the e-payment outlets which indicate the high frequency in the transactions involved within such period. It shows that much as the e-payment channels attract cash to the banking system, the channels also encourage fast payment of cash to economic agents.

In another vein, currency outside the banking system responded positively to shocks in MPR from period one and thereafter its response became negative. This implies that by raising the MPR to fight inflation, this measure led to reduction in currency outside the banking system which is in line with apriori expectation. Raising the MPR results into high lending rate which affects borrowing and, hence currency in circulation. On the other hand, currency outside the banking system was found to respond positively to changes in Treasury bills rate in all the period. The implication is that rise in the Treasury bills rate encourages economic agents to prefer holding money in cash which could result in high currency outside the banking system.

The study revealed that while bank reserves responded positively to shocks in E-bills payment only in period one, its response to shocks in both NIP and POS was positive up to periods six and eight, respectively. Thus, while improvement in bank reserves arising from E-bills payment was short-lived, the contributions of both NIP and POS to bank reserves were significant within the study period.

The conclusion from the findings is that while currency outside the banking system reduced temporarily owing to the persistent rise in the use of the e-payment systems, the increase in the use of the e-payment systems encouraged more liquidity in the banking system. The policy implication of the findings is that the growth in the use of e-payment systems, though reduced currency outside the banking system, could however raise liquidity in the banking system beyond the level accepted by the monetary authorities. As observed by Oladejo (2016), if banks experience huge inflow of liquidity, its ability to extend credit improves. However, continuous growth of bank credit could have an adverse effect on the achievement of price stability which is the core mandate of the Central Bank of Nigeria. This present study is therefore of the view that while there is need to deepen the use of the e-payment systems to curtail the growth of currency outside the banking system; monetary policy authorities should of

necessity monitor closely the various forms of e-payment systems in order to understudy their likely impact on the stability of the financial system. Also, the reserve build-up in the banking system arising from the intensification of e-payment systems should not be allowed to adversely affect monetary policy management, especially the fight against inflation.

It should be stated that this work may have contributed to the literature as it has evaluated the behaviour of currency outside the banking system in the presence of rising e-payment channels, yet it has its limitations which future research could explore. The authors are of the view that future researchers should investigate the saving habit of the people since the emergence of the e-payment systems, especially the rural populace. This is to ascertain if the existence of these channels have inculcated saving habits in the people as this is essential when tackling the menace of huge currency outside the banking system.

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Appendix

A1. Tabular Results of Impulse Response Function.

Response of LCOBS

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	-0.00	-0.00	-0.00	0.00	-0.00	0.00
3	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00
4	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00
5	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00
6	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00
7	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00
8	0.01	0.00	-0.00	-0.00	-0.00	-0.00	0.00

Response of LBRESERV

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.00	0.04	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	-0.00	0.00	0.00	-0.00	-0.00
3	0.00	0.03	-0.00	0.00	0.00	0.00	-0.00
4	0.00	0.03	-0.00	0.00	0.00	0.00	-0.00
5	0.00	0.03	-0.00	0.00	0.00	0.00	-0.00
6	0.00	0.02	-0.00	-0.00	0.00	0.00	-0.00
7	0.00	0.02	-0.00	-0.00	0.00	0.00	-0.00
8	0.00	0.02	-0.00	-0.00	-0.00	0.00	-0.00

Response of LNIP

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.04	-0.05	0.18	0.62	0.00	0.00	0.00
2	0.08	-0.04	0.22	0.58	0.01	-0.00	-0.06

3	0.07	-0.04	0.19	0.52	0.03	-0.04	-0.05
4	0.05	-0.03	0.15	0.46	0.04	-0.06	-0.06
5	0.02	-0.02	0.13	0.41	0.04	-0.09	-0.06
6	-0.01	-0.00	0.12	0.37	0.03	-0.12	-0.06
7	-0.04	0.00	0.11	0.33	0.02	-0.14	-0.05
8	-0.07	0.02	0.10	0.29	0.02	-0.16	-0.05

Response of LPOS

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.04	-0.04	0.18	0.62	0.03	0.00	0.00
2	0.07	-0.04	0.22	0.57	0.03	-0.00	-0.04
3	0.06	-0.04	0.19	0.52	0.04	-0.04	-0.04
4	0.03	-0.02	0.16	0.47	0.05	-0.07	-0.05
5	0.00	-0.01	0.14	0.42	0.04	-0.10	-0.05
6	-0.02	-0.00	0.12	0.38	0.04	-0.12	-0.05
7	-0.04	0.00	0.12	0.34	0.03	-0.14	-0.05
8	-0.07	0.01	0.11	0.31	0.02	-0.16	-0.05

Response of EBP

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	530.8	-2270.9	20237.5	0.00	0.00	0.00	0.00
2	5739.1	-814.24	16021.0	1326.8	1430.9	1614.9	2257.4
3	3604.0	135.5	8975.1	2705.4	2749.7	2448.1	76.2
4	3093.6	275.3	5885.0	3903.2	2968.9	2302.3	-498.5
5	2665.1	429.5	4107.0	4596.4	2847.9	2202.0	-598.0
6	2260.6	508.7	3055.8	4989.2	2560.6	1980.3	-582.1
7	1977.7	535.9	2438.9	5180.1	2245.2	1713.4	-551.3
8	1750.4	525.1	2049.5	5217.7	1954.2	1420.1	-521.4

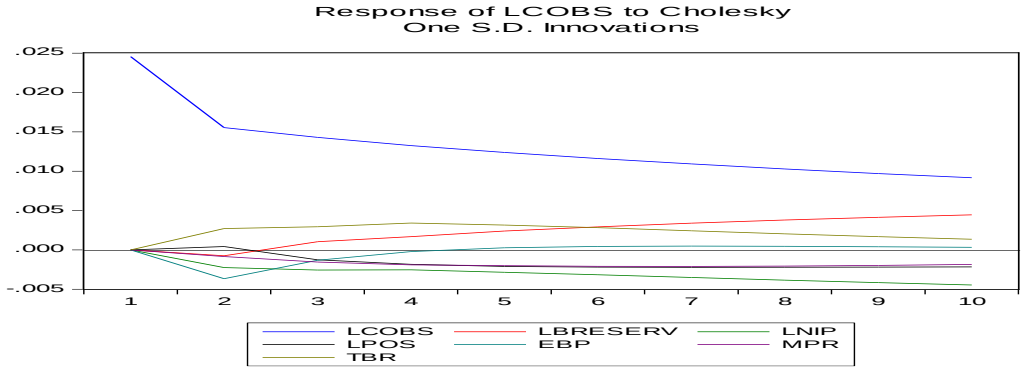
Response of MPR

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.00	-0.02	0.07	-0.00	0.04	0.36	0.00
2	0.00	-0.04	0.03	0.01	0.04	0.33	-0.00
3	0.07	-0.05	0.00	0.04	0.06	0.34	-0.02
4	0.10	-0.08	-0.01	0.05	0.07	0.33	-0.01
5	0.12	-0.09	-0.02	0.06	0.07	0.32	-0.00
6	0.15	-0.10	-0.02	0.07	0.06	0.30	0.00
7	0.17	-0.11	-0.02	0.08	0.06	0.29	0.02
8	0.18	-0.12	-0.01	0.09	0.05	0.27	0.03

Response of TBR

Period	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	-0.75	-0.39	0.17	0.09	-0.37	0.33	1.72
2	-0.41	-0.01	0.08	0.13	-0.31	0.61	0.48
3	-0.10	-0.37	0.08	0.26	-0.06	0.51	0.41
4	0.04	-0.40	0.02	0.24	0.04	0.52	0.26
5	0.10	-0.46	0.00	0.25	0.09	0.48	0.23
6	0.16	-0.48	0.02	0.26	0.10	0.45	0.21
7	0.19	-0.49	0.03	0.27	0.11	0.41	0.22
8	0.22	-0.49	0.05	0.28	0.10	0.37	0.22

A2. Graphical Results of Impulse Response Function.


Response of LCOBS to Cholesky
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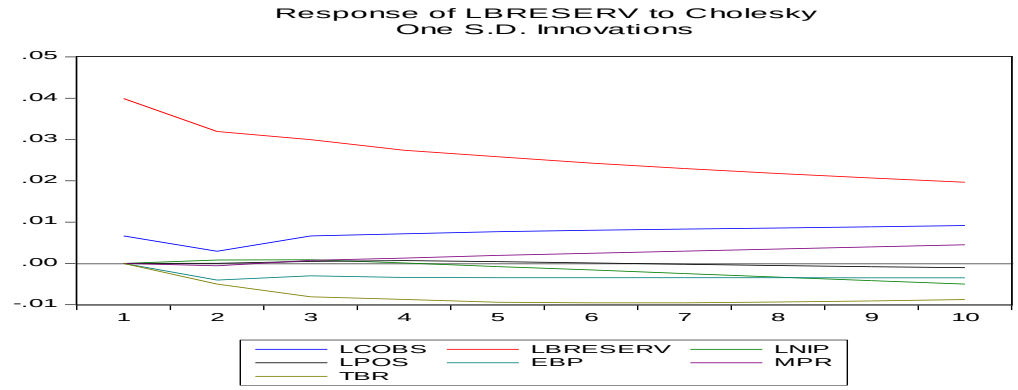
LCOBS
LBRESERV
LNIP
LPOS
EBP
MPR
TBR


Response of LBRESERV to Cholesky
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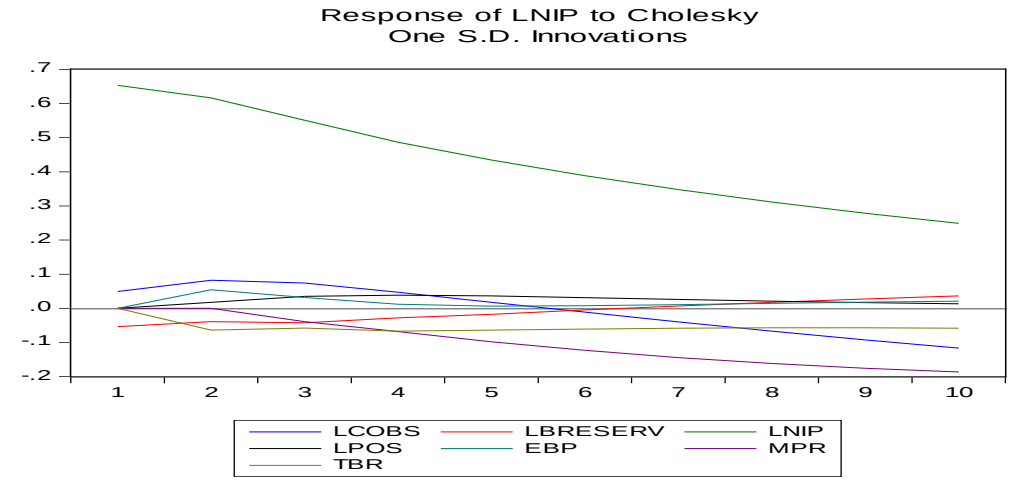
LPOS
EBP
MPR
TBR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LCOBS
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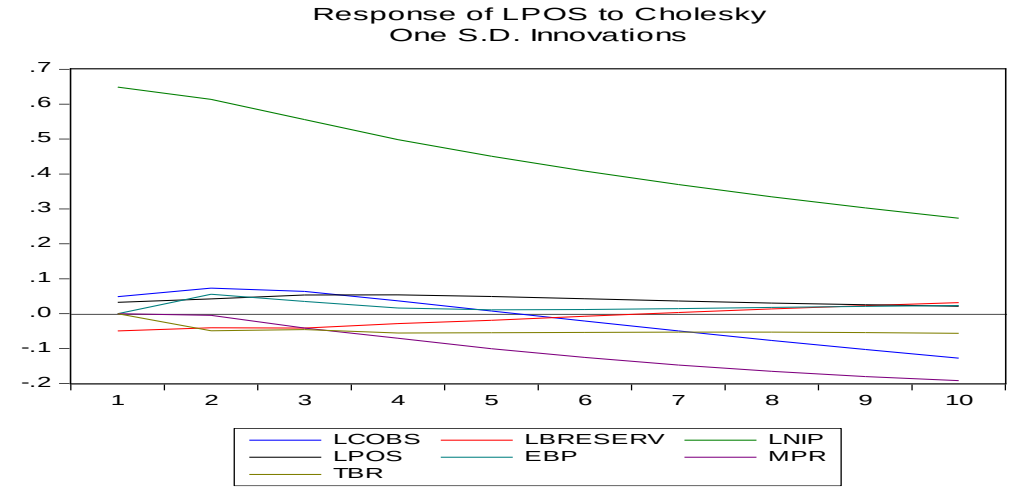
TBR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LCOBS
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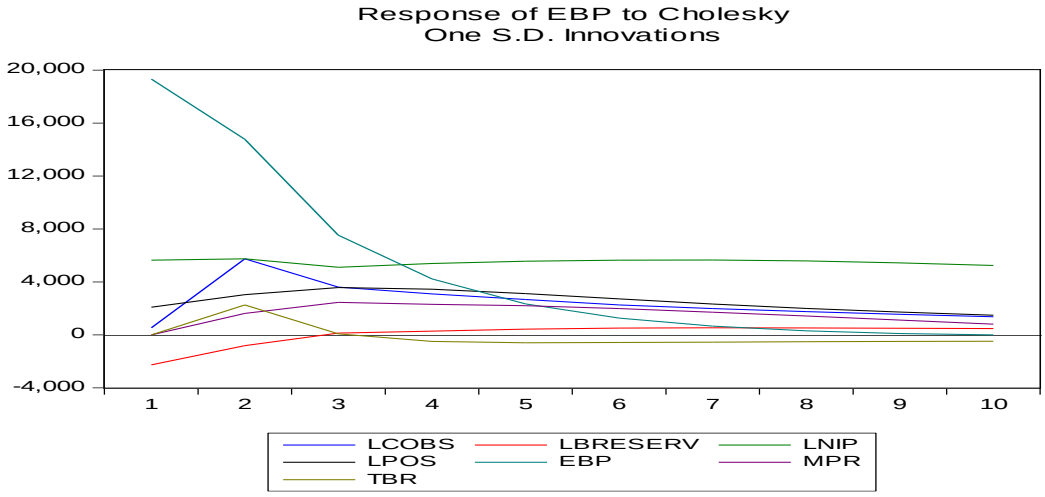
TBR


Response of EBP to Cholesky
One S.D. Innovations
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LCOBS
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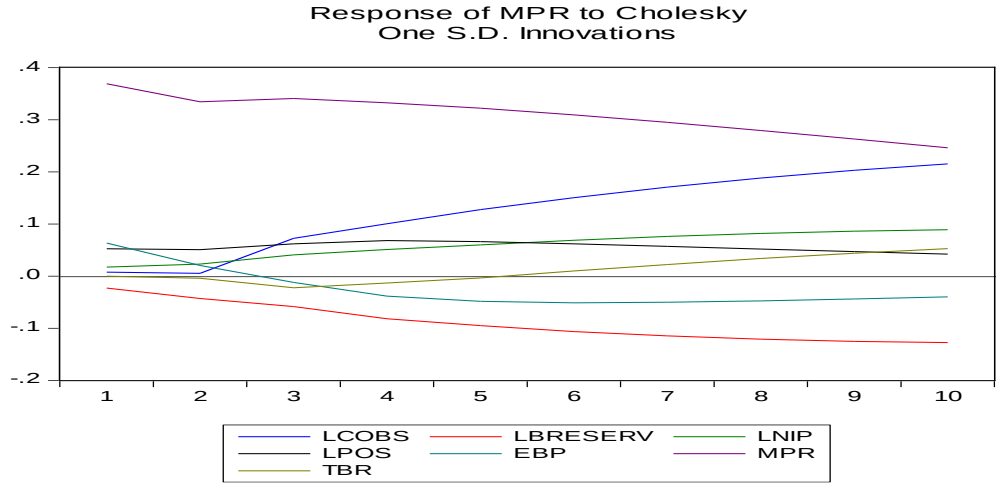
EBP
MPR
TBR


Response of MPR to Cholesky
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LCOBS
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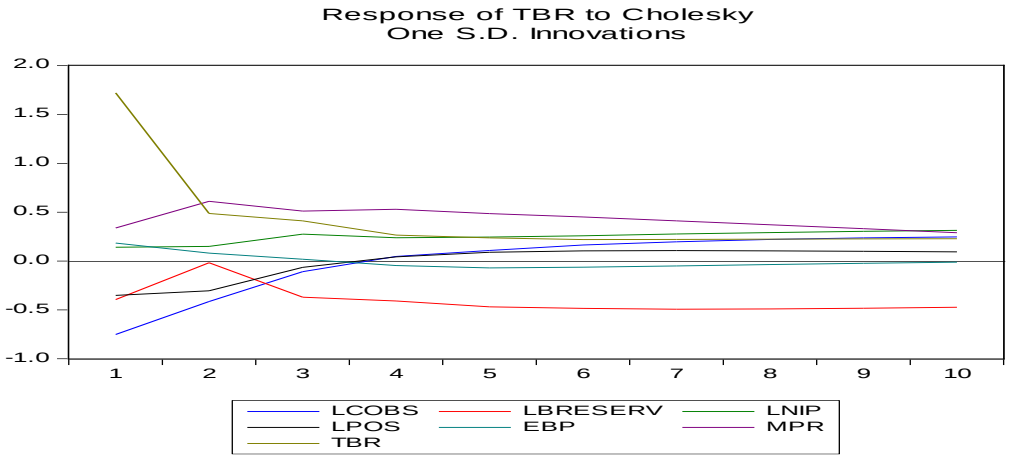
LNIP
LPOS
EBP
MPR
TBR


Response of TBR to Cholesky
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LCOBS
LBRESERV
LNIP
LPOS
EBP
MPR
TBR

A3. Results of Variance Decomposition.

Variance Decomposition of LCOBS

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.02	100.0	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	96.8	0.06	1.90	0.15	0.07	0.08	0.83
3	0.03	95.5	0.14	1.91	0.50	0.17	0.28	1.45
4	0.03	94.07	0.34	1.71	0.84	0.39	0.51	2.11
5	0.03	92.64	0.68	1.53	1.24	0.64	0.72	2.51
6	0.04	91.23	1.13	1.40	1.69	0.88	0.91	2.73
7	0.042	89.83	1.66	1.31	2.19	1.08	1.08	2.81
8	0.04	88.43	2.26	1.25	2.75	1.26	1.21	2.81

Variance Decomposition of LBRESERV

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.04	2.69	97.30	0.00	0.00	0.00	0.00	0.00
2	0.05	1.94	96.49	0.48	0.13	0.00	0.01	0.92
3	0.06	2.59	94.21	0.53	0.16	0.02	0.02	2.43
4	0.06	3.20	92.27	0.64	0.15	0.04	0.05	3.61
5	0.07	3.80	90.43	0.76	0.13	0.04	0.11	4.69
6	0.07	4.36	88.77	0.90	0.12	0.04	0.19	5.59
7	0.08	4.90	87.23	1.04	0.13	0.04	0.30	6.33
8	0.08	5.43	85.77	1.19	0.19	0.03	0.43	6.92

Variance Decomposition of LNIP

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.65	0.56	0.66	7.67	91.10	0.00	0.00	0.00
2	0.90	1.10	0.53	10.13	87.71	0.01	9.21	0.49
3	1.07	1.27	0.53	10.39	86.91	0.09	0.13	0.64
4	1.18	1.20	0.49	10.15	86.66	0.17	0.43	0.85
5	1.26	1.07	0.45	9.93	86.31	0.23	0.98	0.99
6	1.33	0.97	0.41	9.77	85.71	0.26	1.74	1.11
7	1.38	0.98	0.38	9.64	84.80	0.27	2.69	1.20
8	1.43	1.13	0.37	9.54	83.5	0.27	3.79	1.28

Variance Decomposition of LPOS

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.65	0.55	0.57	7.94	90.67	0.24	0.00	0.00
2	0.90	0.95	0.50	10.52	87.43	0.28	0.00	0.29
3	1.06	1.03	0.50	10.84	86.64	0.42	0.15	0.39
4	1.18	0.94	0.46	10.64	86.39	0.53	0.47	0.53
5	1.27	0.81	0.42	10.43	86.03	0.60	1.03	0.64
6	1.34	0.75	0.38	10.28	85.40	0.63	1.79	0.74
7	1.40	0.81	0.35	10.16	84.46	0.64	2.73	0.81
8	1.45	1.03	0.33	10.05	83.21	0.63	3.82	0.89

Variance Decomposition of EPB

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	20371.4	0.06	1.24	98.68	0.00	0.00	0.00	0.00
2	26772.8	4.6	0.81	92.94	0.24	0.28	0.36	0.71
3	28831.0	5.55	0.70	89.84	1.09	1.15	1.03	0.61
4	30084.9	6.16	0.65	86.33	2.68	2.03	1.53	0.59
5	31043.6	6.52	0.63	82.83	4.71	2.75	1.94	0.59
6	31845.3	6.70	0.62	79.63	6.93	3.26	2.23	0.59
7	32548.2	6.78	0.62	76.79	9.17	3.59	2.41	0.59
8	33170.1	6.81	0.62	74.32	11.30	3.81	2.51	0.60

Variance Decomposition of MPR

Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	0.37	0.04	0.37	3.46	0.00	1.43	94.69	0.00
2	0.51	0.03	0.91	2.27	0.08	1.67	95.00	0.00
3	0.62	1.35	1.48	1.52	0.48	2.12	92.89	0.13
4	0.72	2.91	2.36	1.17	0.98	2.55	89.86	0.13
5	0.81	4.75	3.22	1.00	1.49	2.77	86.64	0.10
6	0.89	6.72	4.06	0.89	1.99	2.84	83.36	0.09
7	0.97	8.79	4.84	0.81	2.46	2.83	80.11	0.13
8	1.04	10.90	5.56	0.73	2.88	2.75	76.92	0.22
Variance Decomposition of TBR:								
Period	S.E.	LCOBS	LBRESERV	EBP	LNIP	LPOS	MPR	TBR
1	1.99	14.22	3.91	0.79	0.22	3.45	2.88	74.50
2	2.20	15.12	3.19	0.80	0.53	4.80	10.00	65.53
3	2.35	13.53	5.30	0.84	1.70	4.31	13.52	60.77
4	2.47	12.28	7.54	0.77	2.48	3.94	16.82	56.13
5	2.59	11.36	10.15	0.70	3.20	3.72	18.83	51.99
6	2.70	10.80	12.53	0.65	3.89	3.58	20.08	48.42
7	2.81	10.49	14.68	0.63	4.56	3.47	20.72	45.43
8	2.91	10.35	16.53	0.62	5.22	3.39	20.94	42.93

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