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METHODS

Do exchange rate and inflation matters to Nigerian economy? New evidence from vector autoregressive (VAR) approach

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Currency fluctuations and inflation are the natural norm for most major economies. Numerous factors influence economic growth, including a country's exchange rate system performance, the outlook for inflation, and interest rate differentials. These are the most significant factors that hinder the economic growth of every nation. As a result, this analysis investigates the impact of exchange rate and inflation on Nigeria's growth performance from 1986 to 2021. Impulse response and variance decomposition were estimated. The real gross domestic product (RGDP) was used as a proxy for growth performance, while the inflation rate (IFNR), real exchange rate (REXR), and interest rate (INTR) were also used as proxies. The results of impulse response and variance decomposition estimates in the short-run (third quarter) and long-run (tenth quarter) show that real exchange rate D(REXR), INTR, and IFNR all have a positive impact on RGDP variation, with values of 13.38, 31.88, and 22.40%, respectively, in the third quarter. In the long run (the 10th quarter), REXR contributed approximately 28.76% of the variation in RGDP. The interest rate contributed 24.14%, while the IFNR has contributed about 28.27% of the variation in RGDP in the long run. Therefore, summing the contributions of REXR, INTR, and INFR to RGDP, these variables contributed about 81.17% of the variation in RGDP in the long run. Hence, the research concluded that REXR, INTR, and IFNR have a positive effect on growth performance as proxied by RGDP in Nigeria within the period of the research. The research recommended that the government should provide a policy that will reduce the excess growth of aggregate demand (AD) in the economy, which will reduce inflationary pressure, in order to achieve the sustainable development goals (SDGs) of 2030 in Nigeria, which include restoring economic growth and macroeconomic stability through macroeconomic variables such as the exchange rate, inflation, and other significant variables.

Keywords: exchange rate, economic growth, inflation rate, VAR

Introduction

Generally, the "gold standard" was unofficially created in 1875, enabling a two-way currency conversion to a set quantity of gold. Prior to Nigeria's independence in 1960, financial authorities attempted in vain to attain the goal of endogenous and exogenous justice in order to promote economic stability by raising living standards and reducing poverty. This can be accomplished by altering the internal currency's foreign exchange rate in an organized manner in response to the unusual and prevalent economic circumstances (1, 2).

Inflationary pressure combined with exchange rate volatility is one of the most critical difficulties confronting Nigeria and most developing countries. The negative effects of exchange rate fluctuations on inflationary pressures have long been a source of contention among economists and policymakers. In Nigeria, the Monetary Authority is in charge of preserving price stability and a reserve currency rate, which it does by assuring that inflation stays within a predetermined range (3).

Although evidence shows that the Nigerian economy endured mild inflation before the Structural Adjustment Program (SAP), the negative impacts of inflation have since

taken on an unacceptable dimension. Numerous authorities have attributed it to increasing public spending as a result of higher oil revenues, which has contributed to a massive increase in aggregate demand and inelastic domestic product supply (4, 5).

Given the foregoing, the persistent fiscal deficit over the last two decades, in which the budget deficit is financed in part by a financial institution, has put upward pressure on the general price level. These causes may have produced recent inflation, according to this scenario. While the components that cause the exchange rate to decline have long been known, one of the main motivations for the study is to see how this phenomenon affects Nigeria's constant rise in prices and growth performance (6).

The currency rate adjustment differs among nations. Several economies have employed varied exchange rate strategies in response to differences in exchange rate policy with the rest of the globe as well as the state of their economies (1, 7). The open market power of the naira swap rate through auction mechanisms was a fundamental component of the SAP.

This was the beginning of the unbalanced exchange rate (OEM). In the middle of 1986 and 2003, the central administration investigated numerous exchange rate regimes but was unable to trigger an unprecedented financial system collapse until it was compromised. This discrepancy in policies, as well as the lack of consistency in swap rate regulations, contributed to the naira's imbalanced existence (8).

According to Omojimite and Akpokodje (9), Nigerian variance has been inspired by changes in the global agreement template, systemic changes in the financial system, and structural changes in development. They claim that external shocks caused by global agricultural products and oil price increases have had a significant impact on Nigeria's true exchange rate; both are significant sources of overseas and overseas exchange pay for Nigerian sales. Musa et al. (4).

For any nation, of which Nigeria is inclusive, the main goals and objectives of monetary policy are to attain price stability. Reserve requirements, open market operations (OMO), discount window operations, liquidity ratios, selective credit regulation, and the monetary policy rate (MPR) are some of the primary policy instruments utilized in Nigeria to ensure price stability (10).

A breakdown in the organization's monetary policy to provide appropriate notice to market stability in recognition of the need to preserve sustainable state growth and development; the strengthening of the domestic currency's purchasing power is comparable to an attempt to halt the economy's progress (11). The Monetary Policy Committee (MPC) of the Apex Bank of Nigeria has kept its policy rate at 14% for a number of years in order to maintain financial stability. Given the continuing ills of the Nigerian economy, this step toward predicting and stabilizing commercial institution lending rates is welcome progress.

For example, in the work of Agalega and Antwi (12), the inflation rate (IFNR) is influenced by meaningfully lower bank credit amounts to the confidential sector and significantly lower capitalization of the stock market and volume trading levels, all of which are accompanied by low and average IFNRs. Furthermore,Frimpong and Oteng-Abayie (13) claim that an IFNR of greater than 14% will permanently harm gross domestic product (GDP), which is why the MPC of the Apex Bank of Nigeria ordered each plan to achieve a single-digit IFNR.

Although these policies may be effective for a variety of reasons, the impact of these macroeconomic variables on our economy has not been fully understood, which contributes to the text's weakness in this area. Understanding the effect of the interest rate and IFNR on Nigeria's economic progress is important. Inadequate study numbers on the efficacy of exchange rates, inflation, and economic growth have created a knowledge gap.

Scholars have debated the extent to which these distortions exist (do the exchange rate and inflation affect growth performance?). Their findings, however, contained contradictions. Some research has found that the exchange rate and inflationary pressure explain economic growth. Although others find that exchange rates and inflation do not have an impact on growth performance, this research aims to close that gap in the literature.

Second, this research sheds light on the exchange rate and inflation spillover effects in Nigeria, allowing policymakers and the monetary authority to meet the 2030 sustainable development objectives. Another contribution to this study is the theoretical framework, which is guided by the endogenous growth model.

According to Bharadwaj et al. (14), the endogenous growth hypothesis holds that the rate at which returns on capital are computed is determined by the rate at which the nation's economy increases. For example, it lowers the return rate, which affects the growth of capital in a cycle and, as a result, lowers the rate of growth. As a result, the primary goal of this research is to determine whether the exchange rate and inflation affect economic growth in Nigeria.

Literature review and theoritical framework

According to Kenen (15), foreign exchange is the price of a country's currency in terms of other currencies. They say that an exchange rate has two mechanisms: a home currency and a foreign currency, both of which can be stated overtly or implicitly. Changes in exchange rates, according to Eichengreen and Leblang (16), have an impact

on the value of overseas savings held by investors. For instance, due to Japanese protection, the value of Japanese assets for a Nigerian investor tends to drop as the yen value of the securities is worth less Naira as the Naira-Yen connection intensifies.

It's calculated as a percentage rise each year. Every naira owned buys one less percentage unit of good or service as inflation grows. During the inflationary period, the real value of the Naira has not been consistent. The determining criterion for the value of a Naira, the actual tangible things that can be purchased with currency, is referred to as "purchasing power."

While the rate of inflation rises, the purchasing power of the currency continues to fall. The consumer price index (CPI) is the most powerful inflation calculation tool, showing annual relative price increases suffered by the average purchaser as she or he purchases specified amounts of things and services that are fixed or variable from 1 year to the next. Typically, the Laspeyres approach is utilized (17).

Few inflation drivers induce aggregate demand to rise faster than aggregate supply, resulting in higher prices for goods and services. The government deficit, the rise in bank interest rates, and the growth in foreign demand all contribute to the imbalance of aggregate demand and supply.

Given the impact of inflation upon growth performance, Hossain et al. (18) proposes that low (single-digit) rates of inflation, as opposed to high inflation that restricts financial actions or zero inflation that stagnates them, are significant for economic growth. Despite the challenges that inflation poses, it remains a worldwide event since it cuts both established and emerging economies in half; as a result, its response remains "terrifying" to economic officials around the world.

Concerns have been raised in Nigeria recently about the country's persistently high IFNR, which is eroding the naira's value and causing price volatility. In this context, some experts have different perspectives on the exchange rate, inflation, and growth relations, some of which are listed below.

Adaramola and Dada (19) looked into how inflation affected Nigeria's future economy. The study's findings indicate that while the lending rate and money supply exert a positive as well as substantial effect on GDP growth, inflation as well as the real rates of exchange had a significant negative influence (6). The causation conclusion also finds one-way relationships among GDP and rate of interest, real exchange, consumption expenditure, but not between GDP and inflation or openness.

The analysis came to the conclusion that the Central Bank of Nigeria (CBN) ought to exert greater practicality with respect to those variables with negative effects. Though inflation's short-term impact on GDP is insignificant, according to Barro (20), it has a negative impact on standards of living. Kasidi and Mwakanemela (21) disagree that inflation might have a negative growth shock, emphasizing that growth and inflation have no long-term relationship (22).

It is also stated that growth slows considerably during periods of high inflation but that once the rate falls, inflation will stimulate growth. High inflation, however, does not promote economic growth; if it reaches a certain threshold, it might have a detrimental influence on economic growth (i.e., at a point where the effect begins).

Also, Obinna (23) and JonesL and Manuelli (24) stated that when economic activities (such as exchange rates) were combined with expansion, inflationary pressures would be produced, which manifested themselves in a variety of ways, including time waste, consumer and corporate capital, all while attempting to protect their wealth from inflation. This could happen as a result of inept allocation of manufacturing resources, resulting in a general drop in macroeconomic performance.

Furthermore, due to a loss in savings, investment may decline, resulting in a reduction in growth. Concerns about future price levels hinder investment and can cause the economy's capital arrangements to deteriorate.

Furthermore, inflation reduces investment returns, encouraging investors to engage in short-run capital investment than long-term investment of assets. Investors would rather put their money into assets that would outlast inflation than in high-yielding assets like plants and machinery (24).

Similarly, Nell viewed economic development as an important single metric of economic success in Munyeka (25). By comparing the level of current production to past levels, economic growth refers to an increase in a country's capacity to generate products and services. As a result, the contrast could lead to either positive or bad outcomes.

Similarly, using input and output analysis, Kembauw et al. (26) investigates the role of the Maluku province's growth sector using gross domestic product as proxy to economic growth. Their conclusion suggests that each sector's contribution to the province of Maluka's GDP value is unbalanced, demonstrating persistent economic inequities. But Musarat et al. (27) argue that the construction sector is critical to economic growth and that a country's economy is influenced by a number of factors, which includes inflation, and exchange rate which can react positively or negatively.

As a result, they looked at the impact of inflation on the economy and the building industry. They came to the conclusion that most budgeting and construction projects ignore inflation which causes project cost overruns due to annual changes in material building costs, labor compensation, as well rates of hiring equipment. Their findings revealed a substantial link between the rate of inflation, exchange rate and the building industry which can improve growth.

But in the context of Jhingan (28), growth is manifested in the expansion of an economy's productive potential, which is subsequently utilized to generate additional commodities as

well as service provision. The Nigerian economy is classified as a mono economy nation since it depends significantly on revenue generated from crude oil in large amounts. This indicates that crude oil earnings, which make up more than 80% of the national GDP, are the only source of income for the Nigerian economy.

Moreover, Jakob (29) further explores if the stability requirement of the fixed exchange rate structure has an impact on GDP growth. Using independent variables such as inflation, gross capital formation (percentage of GDP), government expenditure index, and human capital index per individual. The result, which is grounded on data from 74 nations for 2012, demonstrates that fixed exchange rates and GDP growth have a positive and significant relationship.

Furthermore, Amassoma (30) used time series data for 43 years to estimate model fluctuation for the impact of variation in rate of exchange on Nigerian growth performance through standard deviation. The model employs multiple regression, the Johenson co-integration test, and ECM. The findings recommend that rate of exchange volatility has a beneficial but minor influence on the Nigerian economy throughout a range of time periods.

So also Anidiobu et al. (31) studied whether inflation will have an impact on Nigerian economic growth using time series data from 1986 to 2015. This investigation uses an ex-post study approach due to the presence of variables. Some preliminary experiments were conducted using ADF test, descriptive statistics, and OLS technique. Explanatory variables include interest rate, IFNR, and exchange rate, with RGDP serving as an explanation variable. Their findings indicated that INFR had a positive but insignificant influence on growth performance of Nigeria.

Moreover, using quarterly data from 1999 to 2018 and the auto regressive distributed lag (ARDL) approach, Inim et al. (32) investigated additional factors influencing increase in price in Nigeria. This is instigated by a variety of factors, including inadequate public investment, exchange rate changes, political unpredictability, bribery, as well as excessive taxation, according to their research. The results showed a connection among inflation as well as number of other causal factors.

The ARDL results exhibited an important long-term as well as short-term relationship. In order to accomplish two objectives—first, low and stable inflation, mostly in single figures at most, and second, growth and development—the research suggests that non-monetary factors that contribute to inflation be managed. It also suggested that defense expenditures and related practices be assessed.

However, in the analysis on how variations in inflation expectations affect the effectiveness of monetary policy

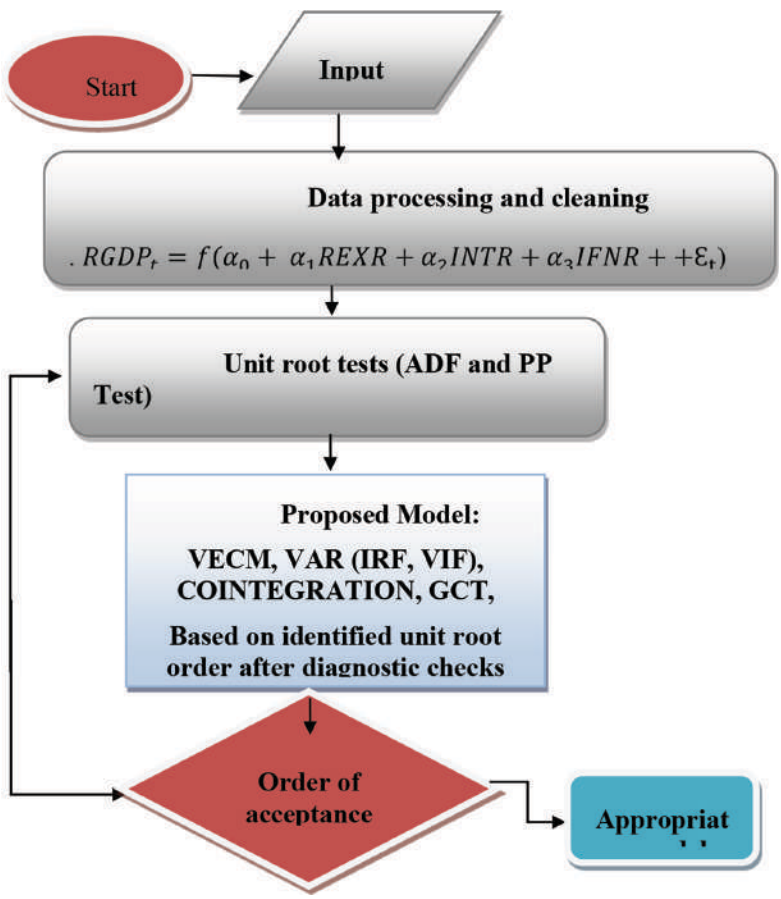

FIGURE 1 | Schematic view of estimated technique.

measures to stabilize the Nigerian economy and encourage investments using the vector error correction model proposed by Ezeibekwe (33). The research conclusions showed that the level of inflation affects how interest rates affect investments. Additionally, as inflation increases, the extent of the impact of lending rates on investment declines, suggesting that instruments for financial regulation like the monetary policy rate (MPR) were efficient stabilizers throughout low inflation periods.

Similarly, Osabuohien (34) used regular data from 2006 to 2015 for Nigeria to investigate the pass through effect in exchange rate and inflation. They used the generalized autoregressive conditional heteroscedasticity (GARCH) approach, often known as the "vector error correction model." Their findings show that while the official rate takes inflation into account over the long term, the unofficial exchange rate does not. Additionally, it reveals how inflationary pressure in the Nigerian economy is significantly affected and benefits long-term from exchange rate instability.

On the basis of peer-reviewed literature, none of them examined the impact of simultaneous impulsive shocks and variance decomposition of these main macroeconomic variables (real exchange rate and IFNR) over the specified period. In this empirical study, the influence (shocks) of currency rates and inflation on Nigerian economic growth must be investigated.

Theoretical framework

Endogenous growth model

According to Bharadwaj et al. (14), the rate at which returns on capital are computed is determined by the rate at which the nation's economy increases, which has an opposite association with inflation. An increase in price, for example, lowers the return rate, which affects the growth of capital the cycle and, as a result, lowers the rate of growth. Inflation lowers both capital return and growth rate, according to the monetary exchange system, which is a type of endogenous growth evidence. Taking into account a few brief theoretical reviews on the relationship between inflation and economic growth, it's been discovered that they all fit into one of four categories as discussed hereunder.

Some research have concluded that increase in price level has no effect on economic progress in the first group. Within this group, some of whom regard money as being extremely unbiased (35). The second group believes that because money is an alternative to capital, inflation is beneficial to growth (36).

However, Stockman (37) proposes a model in the third category in which money is used as a capital offset, resulting in inflation having a negative impact on economic growth, and the current class of theory/model supports the view that inflation has a negative impact on economic growth, but only when the door sills are larger.

Higher IFNRs, according to these models, exacerbates financial market activity frictions, reducing competence and finally causing massive economic growth reductions (38). As a result, the model of endogenous growth will be used to frame this investigation.

Methodology

Model specification

Real gross domestic product (RGDP) is the dependent variable, while real exchange rate (REXR), interest rate (INTR), and IFNR are the independent variables (FDI). The World Bank/World Secondary Time was obtained from the World Development Indicators (WDI) 2021 database, and this study will use annual data. The functional relationship is depicted in **Figure 1**:

$$RGDP = f\,(REXR,\ INTR,\ IFNR) \tag{1}$$

where

RGDP = Real gross domestic product
REXR = Real exchange rate
INTR = Interest rate
INFR = Inflation rate

Equation (1) can be econometrically be written as

$$RGDPt = \beta 0 + \beta 1 REXR + \beta 2 INTR + \beta 3 INFR + Ut - - - - - \text{ model one} \tag{2}$$

$$REXRt = \beta 0 + \beta 1 RGDP + \beta 2 INTR + \beta 3 INFR + Ut - - - - \text{ model two} \tag{3}$$

$$INTRt = \beta 0 + \beta 1 REXR + \beta 2 RGDP + \beta 3 INFR + Ut - - - - \text{ model three} \tag{4}$$

$$IFNRt = \beta 0 + \beta 1 REXR + \beta 2 INTR + \beta 3 RGDP + Ut - - - - \text{ model four} \tag{5}$$

$RGDP_t$ = Real gross domestic product at time t.
β_0 = Constant
β_1 = Coefficient of real exchange rate at time t
β_2 = Coefficient of interest rate at time t
β_3 = Coefficient of IFNR at time t
U_t = Error term or disturbance term

Various economic data are known to have a non-stationary pattern. However, in order to apply the optimal analytical technique, it is highly advised that they be integrated in the correct order (39). The research used ADF, Philip-Perron stationary tests, (40) and the variable was found to have different orders [i.e., I(0) and I(I)], so we used vector autoregression (VAR), as well as impulse response and variance decomposition, to check the effects and contributions among our studied variables.

Therefore, in summary, methodologically, the research analysis employed ADF and Philip-Perron unit root test, followed by VAR and variance decomposition analysis. Moreover, a diagnostic test such as Ramsey reset test, heteroscedasticity was conducted to test for the rationality of the data under the study (41–43).

Results and discussions

Unit root test

Although data may be initially differenced or regressed on dependable functions of unit root, once the data is stable, analyses can be used. The augmented Dickey Fuller unit root model is given below:

$$\Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + u_t \quad (6)$$

where $\Delta y_t = y_t - y_{t-1}$, $\psi = \phi - 1$. In each case, the tests are based on the t-ratio on the $yt-_1$ term in the estimated regression of Δy_t on y_t-_1.

Given the results of the unit root test using both augmented Dickey Fuller and Philip-Perron results in **Table 1**, RGDP is stationary at a level given the ADF test statistic (−3.734000) and PPT (−3.734000) greater than 95% (−3.557759) and (−3.557759) critical value in absolute term. Also, the real exchange rate is stationary at first difference with both ADF and PPT test statistics and critical vital importance of (−4.138887) (−3.881544), (−3.557759), and (−3.557759), respectively.

Similarly, the interest rate is stationary at a level with both ADF and PPT test statistics and critical values of (−3.829912), (−3.811555) (−3.574244), and (−3.574244), respectively. The IFNR also is stationary at a level with ADF test statistic (−6.363609) greater than 95% (−3.552973) critical value in absolute terms.

TABLE 1 | Unit root test using ADF and Philiph-Perron.

Variables	ADF t-statistics at 5%	PP Test Statistics at 5%	Critical values	Probability
RGDP	−3.734000	−3.734000	−3.557759 (−3.557759)	0.0343 (0.0343)
REXR	−4.138887	−3.881544	−3.557759 (−3.557759)	0.0137 (0.0248)
INTR	−3.829912	−3.811555	−3.574244 (−3.574244)	0.0292 (0.0304)
INFR	−6.363609	−6.788298	−3.552973 (−3.552973)	0.0000 (0.0000)

(The critical and probability values in brackets are Philip-Perron's values). Source: Authors computation using e-views 10.

Diagnostic checks

Econometrically, the basic aim of diagnostic checks whether there is an error in variables, incorrect functional form, structural breaks, or other irregularities in the deterministic part of econometric models.

Table 2 shows the Ramsey test of model specification. The likelihood ratio of 0.669261 is greater than the corresponding probability value of 0.4133 and as well the probability value is less than a 5% level of significance. Therefore, the model is linear and normally specified.

Also, the result of heteroscedasticity in the second part of **Table 2** shows that the obs $^*R$-square (11.34877) and the probability of chi-square value of (0.0100), implies that, we accept the null hypothesis of homoscedasticity since the probability value is less than 5% level of significance. Therefore, based on this, there is no problem with heteroscedasticity in the model.

Vector autoregressive model

Vector autoregressive is a system regression model, i.e., there is more than one dependent variable.

The simplest VAR model can be written as

$$Y1t = \beta 10 + \beta 11 y1t - 1 + - - + \beta 1ky1t - k + \alpha 21 y1t - 1 + - - + \alpha 1ky2k - k + ut \quad (7)$$

$$Y2t = \beta 20 + \beta 21 y2t - 1 + - - + \beta 2ky2t - k + \alpha 21 y1t - 1 + - - + \alpha 2ky1k - k + u2t \quad (8)$$

It can also be written in a matrix form as $\begin{pmatrix} Y_{1t} \\ Y_{1t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \alpha_{11} \\ \alpha_{21} & \beta_{21} \end{pmatrix} + \begin{pmatrix} Y_{1t-1} \\ Y_{2t-1} \end{pmatrix} + \begin{pmatrix} U_{1t} \\ u_{2t} \end{pmatrix}$ where u_{it} is an iid disturbance term with $E(u_{it}) = 0$, $i = 1, 2$; $E(u_{1t}\ u_{2t}) = 0$.

Based on the order selection criteria given in **Table 3**, four lags have been selected for the estimation of the

TABLE 2 | Heteroscedasticity test/model specification test.

Statistical Tests	Probability Values		
Ramsey Reset Tests			
t-statistics	0.750989	0.4597	
F-statistics	0.563985	0.4597	
Likelihood ratio	0.669261		0.4133
Heteroscedasticity Test (White Test)			
F-statistics	5.273434	Prob. F(5,28)	0.0056
Obs* R-square	11.34877	Prob. Chi-Square (5)	0.0100
Scaled explained SS	13.48563	Prob. Chi-Square (5)	0.0037

Source: Authors computation.

VAR model. The selected lags are grounded on Akaike information criteria (AIC) and also the fact that the lags have been able to satisfy the OLS assumptions of no serial correlation, constant error variance (homoscedasticity), and normality of residuals.

However, **Table 4** shows VAR estimates using four lags as determined by the lag length selection criteria. From the first through the second lags, past values of RGDP have a positive impact on its present value, with the exception of the third and fourth lags, which have a negative impact on current values. However, D (REXR) has a negative effect on RGDP in all four lags except the second, where it has a positive impact.

In all of its lags, the INTR has a negative impact on RGDP, with the exception of the third lag, which has a positive impact on RGDP. The IFNR coefficient has a positive effect

TABLE 3 | Lag selection criteria.

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	−374.1403	NA	1.61e + 08	30.25123	30.44625*	106.1580
1	−355.9511	29.10278*	1.39e + 08*	30.07609	31.05119	108.0262
2	−343.3949	16.07191	2.04e + 08	30.35159	32.10677	106.0788*
3	−319.7863	22.66431	1.52e + 08	29.74290	32.27816	30.35159
4	−294.7404	16.02935	1.55e + 08	29.01923*	32.33457	29.74290

(*) indicates the recommended lag by the criterion.

TABLE 4 | Vector autoregression estimates.

REGRESSOR	RGDP	D(REXR)	INTR	IFNR
REGRESSAND (At 4 Lags)				
RGDP(−1)	0.492935	−2.036546	−0.781167	0.933701
	(0.21490)	(1.79053)	(0.50198)	(3.47416)
RGDP(−2)	0.324011	0.757478	0.440425	−3.898399
	(0.16618)	(1.38459)	(0.38818)	(2.68652)
RGDP(−3)	−0.411513	−0.603657	−0.157367	−0.153028
	(0.17599)	(1.46631)	(0.41109)	(2.84508)
RGDP(−4)	−0.136791	−2.262082	−0.980318	1.878650
	(0.17968)	(1.49708)	(0.41971)	(2.90477)
D(REXR)(−1)	0.023896	−0.447992	−0.220525	0.671430
	(0.03842)	(0.32012)	(0.08975)	(0.62113)
D(REXR)(−2)	−0.008919	0.116876	0.002285	−1.120587
	(0.04180)	(0.34824)	(0.09763)	(0.67569)
D(REXR)(−3)	0.083892	−0.143250	0.007951	0.357586
	(0.04379)	(0.36483)	(0.10228)	(0.70788)
D(REXR)(−4)	−0.070874	0.280574	−0.008807	−0.107109
	(0.04488)	(0.37394)	(0.10484)	(0.72556)
INTR(−1)	−0.230622	0.297533	0.875667	−1.791824
	(0.11458)	(0.95464)	(0.26764)	(1.85228)
INTR(−2)	−0.044952	−0.833717	−0.632715	4.520670
	(0.15505)	(1.29183)	(0.36217)	(2.50654)
INTR(−3)	0.110871	0.688929	0.672857	−0.747055
	(0.17968)	(1.49705)	(0.41970)	(2.90473)
INTR(−4)	0.344052	−0.990097	0.094932	−0.322978
	(0.15947)	(1.32871)	(0.37251)	(2.57808)
IFNR(−1)	−0.024035	−0.234243	−0.122381	0.102468
	(0.02244)	(0.18698)	(0.05242)	(0.36280)
IFNR(−2)	−0.075865	−0.159453	−0.074750	−0.362521
	(0.02426)	(0.20210)	(0.05666)	(0.39213)
IFNR(−3)	−0.021138	−0.323476	−0.112521	0.144333
	(0.02344)	(0.19533)	(0.05476)	(0.37899)
IFNR(−4)	−0.040200	0.148561	−0.003588	−0.151969
	(0.01891)	(0.15760)	(0.04418)	(0.30578)

on RGDP in the first and fourth lags, but a negative effect in the second and third lags.

In addition, in the first and third lags, the REXR D values are negative to own shocks, whereas, in the second and fourth lags, they are positive. In the same way, the INTR values in **Appendix I Table A1** had a positive impact on own shocks in the first, third, and fourth lags, with the exception of lag two, which had a negative impact. Finally, the IFNR had a positive impact on their own shocks in the first and third lags but had a negative impact in the second and fourth lags.

(**Appendix I Table A1**) shows the (10) quarter estimated impulse response of the variables under investigation, which include the short-run (3) and long-run (3) periods (10). When looking at RGDP in quarter 3 (short run), it is clear that impulse innovation or RGDP shocks accounted for 1.23% of the variation in RGDP fluctuations (own shocks), but shocks to the REXR, INTR, and IFNR can cause RGDP fluctuations of about 1.40%, and negatively in the case of interest rate and inflation—2.24 and −2.05%, respectively.

However, total shocks or impulse innovation from INTR and IFNR can cause RGDP to fluctuate negatively in the near run, whereas REXR shocks might cause RGDP fluctuation to fluctuate positively. However, impulse innovation or own shocks accounted for a −0.34% variance in RGDP in quarter 10 (long run), whereas shocks in the REXR can produce roughly 0.25% variation in RGDP in the long run.

In the long run, INTR innovation or impulse shocks can generate a 0.09% variation in the RGDP, while IFNR shocks can produce a 0.58% fluctuation in RGDP. When the entire shocks from REXR, INTR, and IFNR are added together, RGDP can fluctuate by 0.92%. When looking at both the short-run and long-run contributions, the contribution to RGDP falls from 1.23 to −0.34%, indicating negative shocks to RGDP fluctuations.

In the long run, the REXR contributes less to RGDP than in the short run, with 1.40 and 0.25%, respectively. In the long term, the contribution of interest rates to real GDP improves from −2.24 in the short run to 0.09%. In addition, the long-term impact of inflation was positive, rising from −2.05 in the short run to 0.58% in the long run.

In the third (3) quarter, impulse responses or shocks to the REXR will account for 0.85% of the variation in the REXR, which is due to own shocks. However, shocks to the RGDP will cause a 0.35% fluctuation in the REXR D, while interest rate shocks will cause a −0.008% fluctuation in the short run, and IFNR shocks will cause a −1.99% fluctuation in the REXR.

Furthermore, its impulse innovation or own shocks contributed to 0.45% of the variation in the 10-quarter (long run) REXR, whereas shocks in the RGDP can generate roughly 2.44% variation in the REXR in the long run. In the long run, interest rate innovation or impulse shocks can generate the REXR fluctuations of about −1.23%, whereas IFNR shocks can cause REXR changes of roughly 3.50%. When the overall shocks from real the GDP, INTR, and INFL rate are added together, they can generate a 5.16% variation in the REXR in the long run.

Consider both the short- and long-term effects of these variables. The contribution of the REXR to its own shocks has decreased from 0.85 in the short run to 0.45% in the long run. The contribution of RGDP to the REXR has improved through time, from −0.35 in the short run to 2.44% in the long run. However, the contribution of the interest rate to the REXR has decreased in the long run, from −0.008 in the short run to −1.23% in the long run. Inflation contributed to −1.99% variations in the REXR in the short run, but inflation shocks on the REXR increased to 3.50% in the long run.

In the third (3) quarter, impulse shocks to the INTR will account for 0.54% of the interest rate variation, which is its own shock. However, shocks to the RGDP will cause a −0.18% change in the INTR, while shocks to the REXR will cause a −3.01 change in the INTR in the short run, and shocks to the IFNR will cause a −3.76% change in the INTR.

However, impulse innovation or own shocks accounted for 1.68% of the variation in the 10-quarter (long run) INTR, whereas shocks in RGDP can produce about −0.52% variation in the INTR in the long run. However, long run, innovation or impulse shocks in the REXR can produce INTR variations of roughly −0.02%, whereas INFR shocks can cause INTR changes of about 0.05%.

In the long term, the cumulative shocks from RGDP, REXR, and INFR can create a −0.18% INTR volatility. Impulse shocks to INFR will account for −9.46% of the variation in the INFR in the third (3) quarter, which is due to own shocks. However, shocks to the RGDP will cause a −4.03% change in the INFR, while shocks to the REXR will cause a −17.31% change in the INFR in the short run, and shocks to the INTR will cause an 8.36% change in the INTR.

In addition, its impulse innovation or own shocks accounted for a −4.46% variation in the 10-quarter (long run) INFR, whereas shocks in the RGDP can generate only −3.42% variation in the INFR in the long run. In addition, in the long run, innovation or impulse shocks in the REXR can produce −4.31% variations in inflation, whereas shocks in the INTR can create 4.76% changes in INTR. When the entire shocks from real GDP, REXR, and INFL are added together, the long-run IFNR can fluctuate by around −3.95%.

The standard deviation shocks or changes among the variables under inquiry are depicted in **Figure 2**. In the first, second, and third quarters, a one standard deviation shock on the RGDP to own shock has a favorable effect, while in the fourth and tenth quarters, it has a negative effect.

Throughout the quarters, a one-standard-deviation shift in the real exchange rate has a positive influence on RGDP. Considering one-standard-deviation shift, interest had a negative influence on the RGDP across the quarters. Until the eighth quarter, a one-standard-deviation increase in INFL had a negative impact on the RGDP, whereas the ninth and tenth quarters had a positive impact.

However, one-standard-deviation shock on RGDP to REXR have a negative impact until the half of the fifth quarter, after which they have a positive impact until the half of the sixth quarter, after which they have a negative impact until the ninth quarter, after which they have a positive impact until the tenth quarter. One-standard-deviation shock on the REXR has a favorable effect until the second and third quarters, then becomes negative in the seventh quarter and the rest of the time.

A standard deviation change (shock) in INTR has a negative impact on the RGDP until the seventh quarter when it turns positive until the ninth quarter when it continues to have a negative impact. INFR deviation shocks first have a negative impact on the REXR from the first quarter to half of the fifth quarter, after which it begins to have a positive impact throughout the quarters.

Throughout the quarters, a one-standard deviation shock in RGDP and REXR has a negative influence on INTR rates. Furthermore, one-deviation INTR shocks have a favorable effect on their own shock over multiple quarters. INFR deviation shocks will have a negative impact on INTR from the first to the ninth quarters, but a positive impact in the tenth quarter.

Similarly, one standard deviation in the RGDP has a positive impact on inflation in the first quarter until the second quarter, when it has a negative impact until the half of the fifth quarter when it becomes positive until the half of the seventh quarter when it remains negative for the remainder of the quarter. Also, deviation shocks in the REXR have a negative impact on inflation in the first and half of the year, but turn positive in the third and seventh quarters, exerting a positive impact until the eighth quarter, but then reverting to a negative impact in the tenth quarter.

Inflation will be positively influenced in the first half of the year, but adversely until the third quarter when it will be positively influenced until the fifth and ninth quarters, but negatively in the tenth quarter. Finally, one standard deviation shock in the INFR is beneficial from the first to the second quarter, but negative from the third to the sixth quarter. After the sixth quarter, it has a positive impact until the seventh quarter, then a negative impact for the remaining quarters.

Calculating the proportions of the prediction error variance of these variables owing to the corresponding orthogonal shocks is one technique to estimate how relevant the different exogenous shocks are in explaining the dependent variables (**Figure 3**). Because we would predict the variable to remain unaltered without the shocks, the variance of any given dependent variable in response to orthogonal shocks can be thought of as the variance of forecast errors. What fraction of these forecast mistakes is due to particular shocks is an important question. It's typically helpful to break down a succession of motions into the movements that occurred as a result of each individual shock.

Shocks decomposition and variance

Measurement of the total variation for each of the variables under inquiry to both their own shocks and shocks from other variables is the main goal of the variance decomposition approach.

Variance decomposition of RGDP

Decomposition of RGDP using the third and tenth quarters as short-run and long-run periods reveals that own shock explains 32.33% of the variation in RGDP in the third quarter and 18.82% in the tenth quarter. It also reveals that in the third quarter, the REXR explained only 13.38% of the fluctuation in RGDP, whereas in the tenth quarter, it explained roughly 28.76%.

In the third quarter, the INTR explained about 31.88% of the variation in RGDP, and in the tenth quarter, it explained around 24.14%. The INFR explained around 22.40% in the third quarter and 28.27% in the tenth quarter. When comparing the short-run and long-run variations, the RGDP's own shock variation reduces, while the exchange rate and INFR become more important in explaining RGDP variation in the long run.

Variance decomposition of D(REXR)

Own shock explains 70.83% of the variation in D(REXR) in the third quarter and 52.25% in the tenth quarter, according to D(REXR) variance decomposition. It also reveals that in the third quarter, RGDP explained about 14.95% of the variation in D's(REXR), whereas, in the tenth quarter, it explained around 10.21%.

In the third quarter, the INTR explained about 0.64% of the variation in D(REXR), and in the tenth quarter, it explained about 5.61%. The rate of IFNR able to explain roughly 13.58% in the third quarter and 31.93% in the tenth. D(REXR) own shocks variation reduces as the variation runs from short run to long run, whereas INTR and INFR are more significant in explaining D(REXR) variation in the long run.

Variance decomposition of INTR

Own shock has explained roughly 30.06% of the variation in INTR in the third quarter, and 31.89% in the tenth quarter, according to the variance decomposition of INTR. It also reveals that in the third quarter, RGDP explained only 3.40% of the fluctuation in INTR, whereas, in the tenth quarter, it explained roughly 6.56%.

In the third quarter, D(REXR) explained around 34.00% of the variation in INTR, and in the tenth quarter, it explained about 38.44%. The rate of inflation was able to explain 32.53%

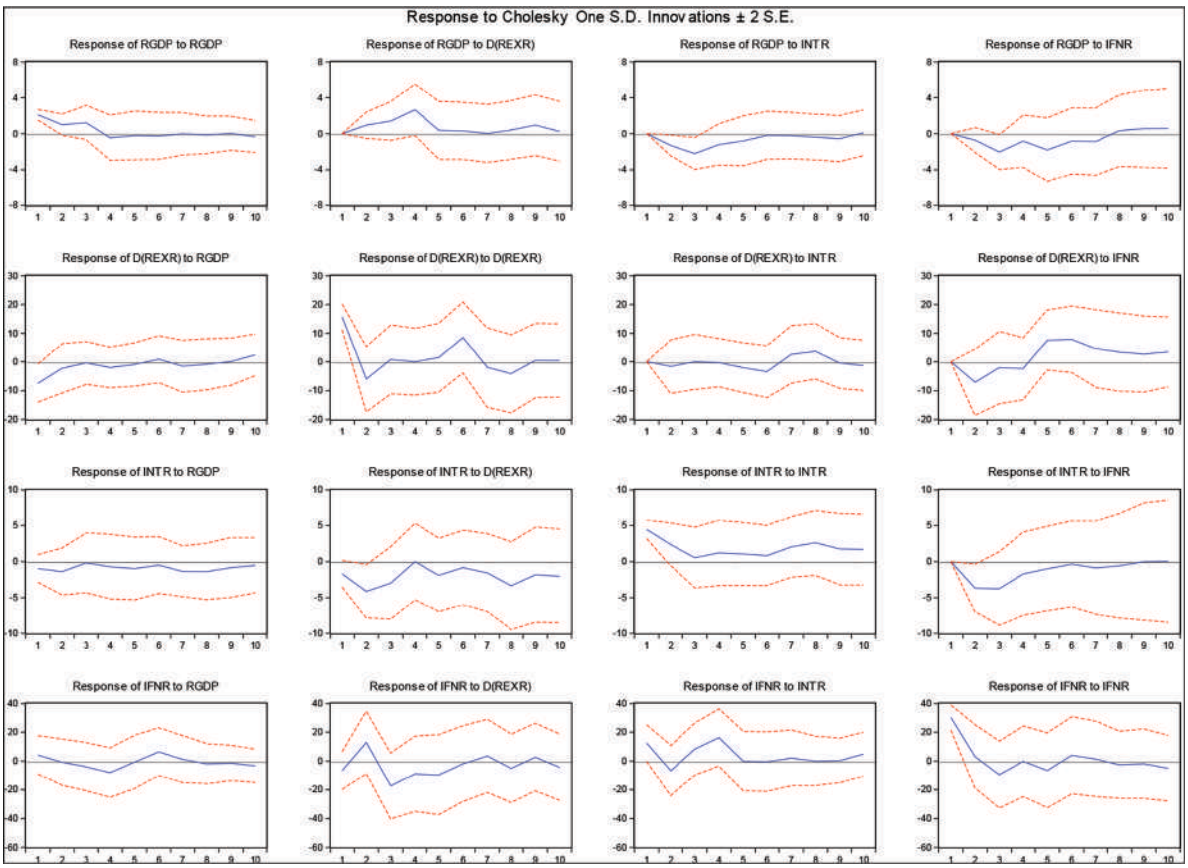

FIGURE 2 | Graphical presentation response to Cholesky one standard deviation.

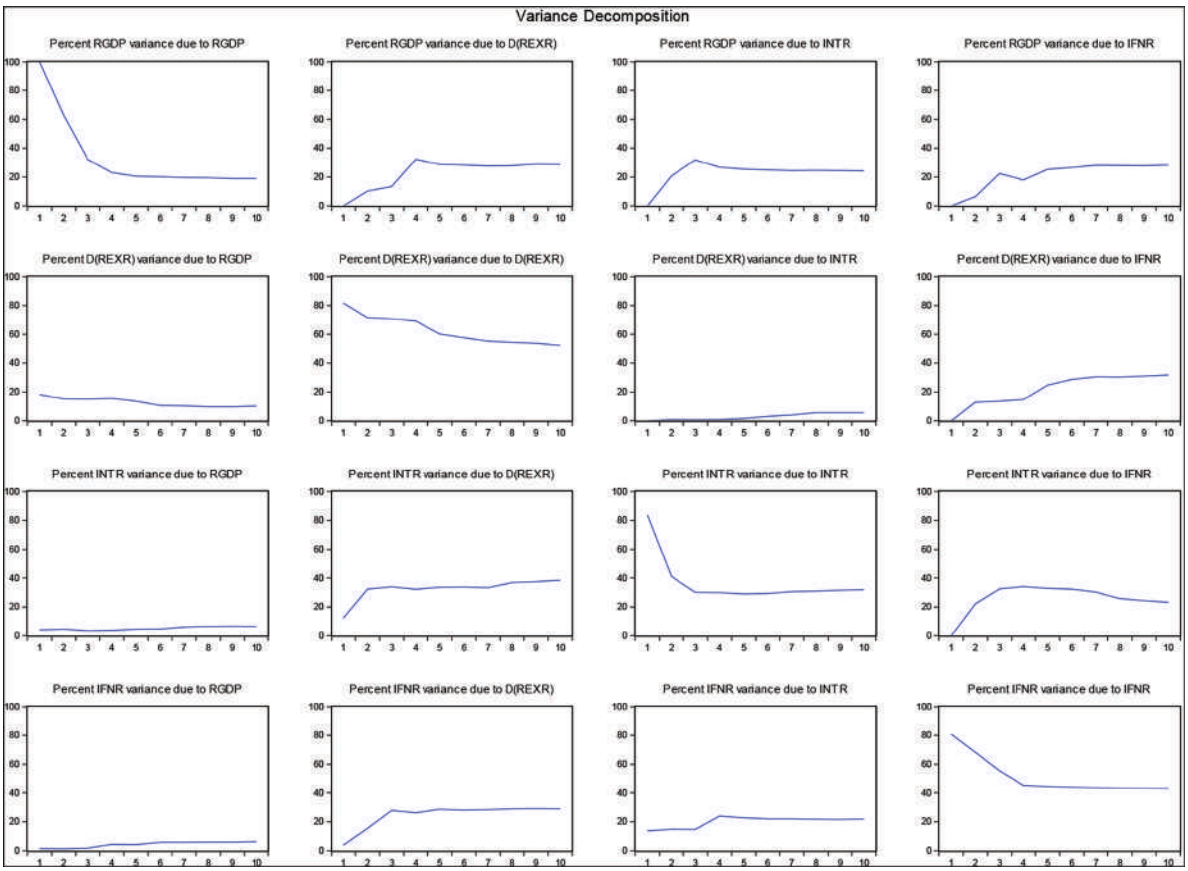

FIGURE 3 | Graphical presentation of variance decomposition.

in the third quarter and 23.12% in the tenth. The variance in INTR own shocks increases from short run to long run, whereas RGDP and REXR are more important in explaining the variation in INTR in the long run.

Variance decomposition of IFNR

In addition, the variance breakdown of IFNR reveals that own shock accounted for 55.44% of the variation in IFNR in the third quarter and 42.92% in the tenth. It also reveals that in the third quarter, RGDP accounted only for 1.91% of the change in IFNR, whereas in the tenth quarter, it explained roughly 6.26%. In the third quarter, D(REXR) explained about 27.85% of the variation in IFNR, and in the tenth quarter, it explained about 28.94%.

The rate of inflation was able to explain 14.76% in the third quarter and 21.88% in the tenth. The variance in IFNL own shocks lessens as time goes on, whereas RGDP, INTR, and REXR are more important in explaining the variation in IFNL in the long run (**Appendix II Table A2**).

Conclusion and policy recommendation

This study attempts to examine whether exchange rate and inflation have an impact on Nigerian economic growth from 1986 to 2021. The research takes into account the estimated outcomes of impulse response (shocks) and variance decomposition. Shocks to the D(REXR) caused about 1.40% positive variation in the RGDP, which is a proxy for economic growth, while shocks to the INTR and IFNR caused about −2.22 and −2.05% negative variation in RGDP, respectively, according to the short run (third quarter) estimates values.

Also, in the long run (ten quarters) the value of the estimates from **Table 6** shows that shocks in the REXR, INTR, and INFR contributed positively to the RGDP with about 0.25, 0.09, and 0.57%, respectively. However, the variance decomposition estimates in short run (third quarter) and long run (ten quarter) show that D(REXR), INTR, and IFNR have impacted positively the variation in RGDP with values of 13.38, 31.88, and 22.40% in third quarter, respectively. While in the long run (ten quarters), REXR contributed about 28.76% variation in RGDP. INTR contributed 24.14% while IFNR has contributed about 28.27% variation in RGDP in the long run.

Therefore, to sum up the contributed variation of the REXR, INTR, and INFR to RGDP, it is clear that these variables contributed about 81.17% variation in RGDP in the long run.

Hence, the researchers concluded that the REXR, INTR, and INFR have a positive effect on economic growth proxy to the RGDP in Nigeria within the period of research. Therefore, the research recommended that government should provide a policy that will reduce the excess growth of aggregate demand (AD) in the economy which will reduce inflationary pressure. Also, the government through the CBN could decrease interest rates, because higher interest rates make borrowing more expensive and saving more attractive.

This should lead to lower growth in consumer spending and investment. Though article 14th of the International Monetary Fund's Articles of Agreement allows only countries with so-called transitional economies to employ exchange controls but developing economies like Nigeria need to use foreign exchange controls to limit speculation against their currencies, restrict any or all foreign exchange to a government-approved exchanger (CBN), or limit the amount of currency that can be imported to or exported from the country in order to achieve SDGs of 2030 in Nigeria, which include restoring economic growth and macroeconomic stability through macroeconomic variables such exchange rate, inflation, and other significant variables.

Acknowledgments

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Further research

The researcher suggested that a fellow researcher(s) may consider the impact of exchange rate and inflation on some selected West African countries with similar economic characteristics to Nigeria to see the effect of these macroeconomic variables as a panel analysis.

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Appendix I

TABLE A1 | Impulse response estimates.

Periods	RGDP	D(REXR)	INTR	IFNR
Responses of RGDP				
1	2.084126	0	0	0
	−0.29474	0	0	0
2	0.975716	0.927566	−1.326743	−0.727969
	−0.60014	−0.73375	−0.5834	−0.68747
3	1.228631	1.398695	−2.224985	−2.045907
	−0.95232	−1.07772	−0.88312	−0.96472
4	−0.483498	2.647818	−1.205478	−0.844123
	−1.25492	−1.44007	−1.15213	−1.44974
5	−0.207192	0.367993	−0.803118	−1.819294
	−1.35713	−1.61072	−1.38592	−1.77233
6	−0.266871	0.299085	−0.186761	−0.825403
	−1.30016	−1.59254	−1.33391	−1.84226
7	−0.030311	0.018987	−0.223945	−0.885573
	−1.18034	−1.61227	−1.29097	−1.86794
8	−0.138475	0.38886	−0.387834	0.329395
	−1.03872	−1.6269	−1.26768	−1.98632
9	0.02058	0.93053	−0.541451	0.544006
	−0.9415	−1.68584	−1.28135	−2.14878
10	−0.337947	0.253914	0.094292	0.579283
	−0.89513	−1.66395	−1.26931	−2.21718
Responses of D(REXR)				
1	−7.40055	15.7086	0	0
	−3.31146	−2.22153	0	0
2	−2.220827	−5.991562	−1.598476	−7.094729
	−4.3108	−5.71438	−4.6665	−5.75152
3	−0.354542	0.84855	−0.008943	−1.998405
	−3.72589	−5.9985	−4.78494	−6.29763
4	−1.946664	0.049371	−0.332839	−2.421601
	−3.54995	−5.81741	−4.21327	−5.39296
5	−0.926936	1.462421	−2.072413	7.596217
	−3.79809	−6.00083	−4.33418	−5.24142
6	0.901732	8.514667	−3.429943	7.854621
	−4.0792	−6.18085	−4.52491	−5.79348
7	−1.489001	−1.940046	2.611912	4.625678
	−4.53516	−6.91401	−5.01185	−6.78571
8	−0.854131	−4.187176	3.67093	3.402821
	−4.44432	−6.81962	−4.85103	−6.82949
9	0.078805	0.469633	−0.486315	2.704305
	−4.1201	−6.48775	−4.41823	−6.65323
10	2.44309	0.451198	−1.227028	3.497476
	−3.62608	−6.40377	−4.40401	−6.09167
Responses of INTR				
1	−0.98705	−1.703569	4.452321	0
	−0.96359	−0.92248	−0.62965	0
2	−1.381835	−4.144732	2.371523	−3.706658
	−1.63511	−1.86063	−1.48706	−1.67203
3	−0.175399	−3.004686	0.535531	−3.756408
	−2.08442	−2.5293	−2.10644	−2.56369
4	−0.712724	−0.016821	1.190298	−1.723887
	−2.24137	−2.65402	−2.27002	−2.89841
5	−0.973427	−1.904103	1.030284	−1.005334
	−2.18375	−2.55728	−2.18886	−2.94741
6	−0.492178	−0.85164	0.83033	−0.353741
	−1.97526	−2.59967	−2.09224	−3.01049
7	−1.358397	−1.572643	2.027919	−0.868718
	−1.76852	−2.72319	−2.11923	−3.26141
8	−1.394413	−3.393025	2.596557	−0.602309
	−1.9542	−3.05789	−2.26097	−3.6544
9	−0.840586	−1.853716	1.737502	−0.010318
	−2.07595	−3.30939	−2.48839	−4.09536
10	−0.519406	−2.021072	1.67757	0.049496
	−1.90749	−3.26354	−2.46872	−4.25756
Responses of IFNR				
Periods	**RGDP**	**D(REXR)**	**INTR**	
				IFNR
1	4.26101	−6.628266	12.47927	30.28786
	−6.71148	−6.61832	−6.30942	−4.28335
2	−0.817764	12.92054	−6.699049	3.103532
	−8.06781	−10.8529	−8.68862	−10.9973
3	−4.026518	−17.30752	8.355642	−9.463598
	−8.39614	−11.495	−9.07939	−11.6539
4	−8.067523	−8.903609	16.401	−0.212903
	−8.61609	−13.0774	−9.87745	−12.3027
5	−0.683609	−9.537447	−0.167077	−6.493958
	−9.30402	−13.9122	−10.3317	−13.019
6	6.503815	−1.870362	−0.422869	3.982661
	−8.31686	−13.191	−10.3265	−13.4047
7	1.358926	3.584305	2.084527	1.476872
	−8.16882	−12.7383	−9.69298	−13.1396
8	−1.922478	−5.13895	0.085242	−2.568951
	−6.96969	−11.9091	−8.58583	−11.6569
9	−1.450007	2.760291	0.343406	−1.931185
	−6.15679	−11.7656	−7.76468	−12.1259
10	−3.424279	−4.306349	4.762177	−4.975715
	−5.81664	−11.5736	−7.66688	−11.4199

Cholesky ordering: RGDP D(REXR) INTR IFNR. Standard errors: Analytic. Source: Authors computation.

Appendix II

TABLE A2 | Variance decomposition estimates.

Periods	SE	RGDP	D(REXR)	INTR	IFNR
Variance Decomposition of RGDP					
1	2.084126	100	0	0	0
2	2.906229	62.69828	10.18661	20.8408	6.274308

TABLE A2 | Continued

Periods	SE	RGDP	D(REXR)	INTR	IFNR
3	4.587847	32.33098	13.38218	31.88282	22.40402
4	5.518946	23.10962	32.26546	26.80339	17.82153
5	5.881492	20.47249	28.80174	25.46541	25.26036
6	5.955568	20.16717	28.34192	24.9342	26.55671
7	6.025318	19.70549	27.69052	24.4984	28.10559
8	6.060838	19.52739	27.77855	24.62156	28.07249
9	6.17974	18.7843	28.98725	24.45089	27.77756
10	6.221923	18.82547	28.76207	24.14344	28.26902
Variance Decomposition of D(REXR)					
1	17.36457	18.16351	81.83649	0	0
2	19.88088	15.10443	71.51407	0.646459	12.73504
3	20.00223	14.95315	70.82901	0.638659	13.57918
4	20.2449	15.52141	69.14175	0.65047	14.68637
5	21.79108	13.57786	60.12836	1.465908	24.82788
6	24.93238	10.50278	57.59432	3.012337	28.89057
7	25.60905	10.29315	55.16479	3.895481	30.64658
8	26.44126	9.75976	54.25464	5.581599	30.40401
9	26.58791	9.653275	53.689	5.553653	31.10407
10	26.95973	10.21004	52.24629	5.608667	31.93501
Variance Decomposition of INTR					
5Periods	S.E.	RGDP	D(REXR)	INTR	IFNR
1	4.868221	4.11091	12.24557	83.64352	0
2	7.883609	4.639866	32.3098	40.9441	22.10624
3	9.252437	3.40449	34.00294	30.06051	32.53207
4	9.513382	3.781557	32.16348	29.99951	34.05546
5	9.856459	4.498247	33.69537	29.04007	32.76631
6	9.946452	4.662072	33.82152	29.21385	32.30256
7	10.39796	5.972688	33.23559	30.53556	30.25617
8	11.34369	6.529335	36.87157	30.89569	25.70341
9	11.65509	6.705249	37.45723	31.48918	24.34834
10	11.95878	6.557664	38.43518	31.87802	23.12913
Variance Decomposition of IFNR					
1	33.69238	1.599417	3.870226	13.71877	80.81159
2	36.84148	1.386946	15.53636	14.7801	68.29659
3	42.80694	1.91209	27.85499	14.75776	55.47516
4	47.39021	4.458158	26.25748	24.01868	45.26569
5	48.77972	4.227429	28.6057	22.67097	44.4959
6	49.40951	5.853016	28.02441	22.10404	44.01853
7	49.62378	5.87757	28.30463	22.09002	43.72778
8	49.99231	5.939116	28.94554	21.76583	43.34952
9	50.12784	5.990717	29.09245	21.65298	43.26385
10	50.89702	6.263657	28.93564	21.87891	42.9218

Cholesky ordering: RGDP D(REXR) INTR IFNR.