The Casualty Evidence for Interest Rates and SME's Outputs Relation from A Developing Economy

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ABSTRACT

Purpose
Small and medium-scale enterprises (SMEs) play a significant role in many economies. Governments often employ various policies, especially monetary policy, to support their operations. This study aims to illustrate the interdependence between SMEs' output growth and monetary policy instruments, specifically the interest rate.

Methodology
The study utilized data spanning 1980 to 2021 to investigate evidence of symmetric Granger causality and asymmetric causality between interest rates and SMEs' outputs in Nigeria.

Findings
The symmetric approach reveals unidirectional causality evidence from the interest rate to SME output, without potential feedback effects. The asymmetric causality demonstrates that both positive and negative shocks in interest rates drive shocks in SMEs' outputs, but not vice versa.

Conclusion
The study concludes, among other findings, that to enhance the impact of policies on SMEs' outputs, authorities should establish state agencies as coordinating units to monitor policy implementation. Additionally, efforts should be directed towards putting adequate infrastructural facilities in place for the proper operation of the SMEs.

Practical Implications
The study provides insights indicating that positive (negative) shocks in the interest rate cause negative (positive) shocks in SMEs output, thus aligning with the associated economic theory.

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1. Introduction

SME businesses are relevant in supporting innovations, job creation, and economic growth in most economies. In 2021, they account for 99.8 percent of firms, 65 percent of total employment, and 53 percent of total value added in Europe. The SMES have always been affected by difficulties in finance. The global financing gap volume varies considerably for different regions. In developing nations, records show that over 40 percent are unable to meet annual fiscal requirements estimated at $5.2 trillion (European Commission, 2022; IFC, 2023). The Middle East and North Africa regions, and Latin America and the Caribbean, respectively share the highest proportion of the financial gap related to potential demand, measured at 88 percent and 87 percent (World Bank, 2022).

Many problems are faced by the SMEs, these include the lack of a steady power supply, lack of finance, poor technology, and others. In ensuring that the SMEs are well funded and overcome some of these difficulties, many governments use different policies, especially monetary policy to aid their operations (Andreeva, & García-Posada, 2021; European Commission, 2022; Finnegan & Kapoor, 2023). In Nigeria, the CBN reports that only 5 percent of SMEs have access to adequate finance covering their working capital and that about N617.3 billion financing gap is required for the SMEs each year. The apex bank has continued to engage in some intervention policies to address the paucity of funding. Although private banks have often made funds available for SMEs but this has continued to deteriorate. For instance, the lending of commercial banks to SMEs as a percentage of total credit to the economy is reported to be about 7.58 percent, 0.14 percent, and 0.32 percent, respectively, in 2000, 2010, and 2020 (Ogundele et al., 2022).

Some studies examine the relationship between small and medium-sized enterprises (SMEs) and monetary policy instruments and offer limited and mixed results. Ilegbinosa and Jumbo (2015) find that finance provided to SMEs and interest rates are negatively related. Kareem et al. (2022) demonstrated a positive effect of interest rates on SME outputs three years later. Ibi-Oluwatoba et al. (2020) found a negative relationship between interest rates and SMEs' outputs of GDP. There is no current evidence that has shown an asymmetric relationship between conventional monetary policy instruments and SMEs' outputs. This paper aims to resolve this by examining whether interest rates exhibit asymmetry with SMEs' outputs.

The rationale for the Nigerian case study is threefold. First, the economy is stressed, and the SMEs are experiencing substantial deterioration in operations and credit ability. With the recent subsidy removal, many of the SMEs hold large debts, and the skyrocketing price continuously causes stock depletions and pushes funding costs up (Evans, Nwaogwugwu et al., 2023). Second, many banks in the country suffer higher non-performing loans, thus restraining SMEs' opportunity to lend since the banks are more concerned about their balance sheets due to tighter macro-prudential policy (Kure et al., 2017; Umorene al., 2018; Popoola, 2023). Third, current evidence for the monetary policy impact has not considered the evidence of asymmetric causality relations (Ilegbinosa & Jumbo, 2015; Ibi-Oluwatoba et al., 2020; Kareem et al., 2022). Therefore, the asymmetric relation between monetary policy, and in particular interest rates and SME outputs remains an unanswered question for empirical investigations.

There is a potential reason to consider the potential existence of asymmetric causal relations for SMEs' outputs and interest rates. Since the interest rate is a monetary policy tool, it inhibits the usual policy shocks and may demonstrate randomness in impacting targeted economic variables. The interest rate effects on output performance may not be uniform, and vice versa. Consequently, for the first time, the article offers insight into the asymmetric connectedness between the SMEs'– interest rate links with expectations that sufficient evidence is obtainable when the asymmetric causality is analyzed. To achieve the aim, the paper first shows the outcome of the Granger-typed causality, from Toda-Yamamoto (1995), for a simple and direct symmetric relation between the two considered variables. If robust evidence of Granger causality is established, this supports the outputs–interest rate nexus for the sector. Next, the paper exploits the asymmetric causality, from Hatemi-J (2012), by reclassifying the outputs and interest rate series to positive and negative accumulated disturbance components, to confirm whether perturbation wields asymmetric effects.

The findings show that the variables are non-stationary, but their combination has long-run and cointegration relations, thus aiding the existence of a parameterized and unified framework. The result further recognizes symmetric causality evidence for interest rate and SME's output growth, and particularly a unidirectional causality from interest rate to SMEs output growth, but no potential feedback. This supposes that expansionary monetary policy stimulates SMEs' output but does not retain any feedback effects from SMEs' growth to the interest rate. The asymmetric causality shows that only both positive and negative shocks in interest rates drive shocks in SMEs' outputs, but not vice versa. A positive (negative) shock in the interest rate causes negative (positive) shocks in SMEs, consistent with the associated economic theory of monetary policy through the interest rate pass-through (Borio & Zhu, 2012; Bethune et al., 2021). The interest rate holds a counter-productive impact on SMEs' growth. The findings support the need for policymakers to consider sustained growth targets for SMEs when considering the implementation of monetary policy. This paper is structured as follows: Section 2 (literature), section 3 (methods), section 4 (results), and section 5 (conclusions).

2. Literature Review

Literature on monetary policy transmission to the real output considers how the operations of monetary policy, using the interest rate, exchange rate, money supply, and other instruments, affect the asset side of bank balance sheets (Bernanke & Blinder, 1988). Moreover, how the balance sheet may alter this effect (Kiyotaki & Moore, 1997; Kapoor & Peia, 2021). Some models including Bernanke and Gertler (1989) and Bernanke et al. (1996), explain the role of the borrowers' balance sheets, whereby monetary expansion strengthens firms' balance sheets by increasing cash flow net and thus causes an increase in the value of collateral assets. Some others, including Kashyap et al. (1993), focus on the role of lenders' balance sheets, advancing that monetary policy influences funds available to bank-dependent borrowers.

Generally, the monetary transmission channel depicts the mechanism via which monetary policy impacts outputs. Monetary policy may be tailored towards achieving a conducive environment for SMEs' development. In the literature, the traditional model, and some other alternative models, including the risk-taking channel (Borio & Zhu, 2012) and credit channel model are among the different models that consider how monetary policy impacts the SMEs' operations (Bethune et al., 2021).

The traditional approach of monetary policy impacts output and focuses on aggregate demand. The models emphasize that when monetary authority lowers interest rates, the cost of borrowing decreases, and thus, demand for credit increases. The channel shows a link to money supply impulses via the interest rate pass-through medium to output growth. The study assumes that the output growth process follows the transmission process such that if the monetary authority increases money increases or lowers the interest rate or cost of credits, the investment will increase since investors would be willing and able to borrow due to the low costs. Thus, managing the interest rates presents monetary policy operations that impact SMEs. The risk-taking channel explains how monetary policy may cause firms to be involved in excessive risk-taking. For instance, asset purchases by the central bank may increase asset prices, lead to a decrease in yields, and thus, make lending more attractive for banks (Kapoor & Velic, 2022). In addition, monetary policy actions such as low interest rates may encourage higher yields aiming banks to extend loans to risky firms (Andreeva & García-Posada, 2021; Jiménez et al., 2018; Jimenez et al., 2014).

The credit channel model postulates that monetary policy affects the credit supply via the bank-link channel. The model postulates likely asymmetric transmission of monetary policy based on SMEs' cost of internal finance and access to external credits, for the banked and unbanked firms. The basis of the model is that, unlike large corporations, SMEs are often unable to source funds in the stock market. Rather, they finance their operations internally with owners' funds and/or retained earnings or externally with bank credits, based on their longstanding relationships with the banks. The methods consider that when authorities increase interest rates, financial institutions form relationships with firms to increase their income via higher interest expenditures and fees (Bethune et al., 2021). The new link with the banks creates an increase in loans to firms, providing more funds that the firms can utilize for investments in the long run. Bethune et al. (2021) develop a model that considers the process through which monetary policy affects the creation of lending links. The model predicts a response to an unanticipated banking crisis and analyzes the model's optimal monetary policy responses with different central bank commitments.

Phelps and Wong (2020) advance a search model, which suggests that banks and SME firms search for and develop connections with each other to maximize lifetime utility. The model is composed of three stages: In the first stage, investment opportunities arise that are financed by cash or bank credit. In the second stage, unbanked firms search for lending relationships with banks, and in the third stage, firms settle bank loans, trade assets, and raise more cash internally if needed. The model assumes that a nominal bond is the only asset, and the central bank controls its interest rates by trading the bonds and cash in the open market. Banked firms may finance investments via bank credits in addition to cash holdings. The loan rate and credit line are determined by bargaining between firms and banks. Monetary policy affects the bank relationship channel via the interest rates. For instance, if the central bank increases (decreases) the interest rate, holding nominal bonds would suppose higher (lower) returns. Since banked SMEs may depend on their loans more than cash, they can afford to hold less cash in exchange for more bonds. Thus, the banked SMEs find the banking connections more beneficial. Moreover, any rise in the interest rate allows the banks to increase their revenue – through increased loan rates – and stimulates them to create more relationships with firms. Lastly, since there are now more banked SMEs, total aggregate investment would increase.

For many nations, both developed and developing ones, creating access to funds for SMEs has been the most critical pursuit of government intervention policies. However, some studies consider the influence of fiscal policies to stimulate SMEs' performance (Zhang and Wang, 2023). Further, many studies, including Ferrando et al. (2019), Moreira et al. (2016), Fu and Liu (2015), Fasano and La Rocca (2023), Finnegan and Kapoor (2023), found a link between monetary policy to SMEs. Zhang and Wang (2023) reported how the Chinese government policies over the years influence SMEs and other businesses. In particular, the study shows that non-state-owned SMEs have a low sense of policy gain. Moreover, recent studies are exposing policy biases towards the nature of enterprise, particularly with a preference for state-owned and large enterprises in strategic emerging industries. Meng et al. (2022) indicate that state-owned enterprises benefit more from financial subsidies more easily and that the subsidies have been abused, leading to excessive investment. Wang et al. (2022) find that government subsidies tend to support large enterprises and play a more considerable role in it.

Many articles have focused on different aspects of SMEs. Depending on the different countries and analyses applied, the evidence presents mixed results. Finnegan and Kapoor (2023) showed a link between monetary policy and SMEs' finance in Greece, Ireland, Italy, Portugal, and Spain, and confirmed that in stressed (non-stressed) countries, monetary policy significant (insignificant) raises the likelihood that SMEs with higher debt remain credit conditioned. They find that because risky firms are credit-constrained, monetary policy is unevenly diffused to leveraged SMEs. Ferrando, McAdams et al. (2023) observed circumstances under which fluctuations in marginal costs have diverse impacts on output and credit constraints under different competitive environments. They exploit monetary policy surprise to examine whether policy pass-through is constrained by market structure in the eurozone. They found that SMEs that operate in less concentrated sectors experienced a greater reduction in loan conditions relative to counterparts in highly concentrated industries.

Ferrando et al. (2019) used datasets from eight Eurozone economies to assess the ECB's monetary transaction notice influence on the SMEs' access to finance and found that monetary policy enhanced firms' potential for expected debt finance. Notably, due to the press releases the access to credit and finance in the zone enhanced more for the entities that obtain credits from banks with greater balance sheet exposures. Moreira et al. (2016) confirm the links between monetary policy's effective and expected short-term interest rate in Brazil and found that authorities adjust the effective short-term interest rate because the previous rate does move the expected short-term rates and induces the long-term interest rates - which are key for the regulation of SMEs' output. Fu and Liu (2015) examined the monetary policy effects of corporate investment in China and found there is a faster change in investment adjustment for expansionary compared to contractionary policy.

Two shreds of evidence based on African countries showed that monetary policy affects the SMEs. Adongo et al. (2020) investigated how monetary policy affected SMEs in the agricultural sector in Kenya from 1981 to 2019. The evidence showed that the money supply was positive, and the exchange rate had a negative influence on the agricultural share of GDP performance. Bawuah et al. (2014) verified how interest rates affect SMEs' access to funds in Ghana. The evidence suggested that the majority of the SMEs have experienced the use of equity financing. This is due to the leading influence of interest rates, amongst other factors. The interest rate is noted to have affected the financing choice of SMEs. In Nigeria, the SMIEIS introduced in 2001 aimed at providing solutions to the dearth of long-term funding for small businesses by backing banks to consider interest in SMEs by distributing part of their retained profit to the SMIEIS funds. Obokoh et al. (2017) observed the high dependence of the Nigerian economy on the importation of raw materials and finished goods, and thus, investigated how exchange rates affect the performance of SMEs. The paper finds that monetary policies in Nigeria have been unsuccessful due to high dependence on importation, poor infrastructure, scarcity of skilled labor, and high-risk environments.

Omonigbo (2017) found a significant positive link between Nigeria's SMEs' output contribution to GDP and the GDP growth, during 1982–2012. Gbam (2017) identified that through improved growth, job creation, and market growth for local goods, SMEs have a significant impact on employment generation. Bello et al. (2018) find that that SMEs positively influence growth through job creation, during 1986–2016. Adebayo (2020) showed that over 60 percent and 72 percent variation, respectively, in poverty reduction and employment generations, was accounted for by the SMEs' contributions. Sangodapo (2020) argued that SMEs positively influence employment generation, however, there was a gap between SMEs' generated employment and poverty reduction. Ogundele et al. (2022) showed that financing of SMEs through credits and interest was not significantly related to poverty reduction.

3. Methodology

3.1 Data for the Estimation

The paper examined whether there is symmetric and asymmetric causality between monetary policy and SMEs' outputs. The study supposes that more evidence may be recovered when the causality is analyzed based on asymmetric. The paper reflects the periodic interest rate (denoted, ($INTr_t$) as an indicator of the monetary policy due to its key role in influencing investment and, ipso facto, the real sector's output. The study further uses the growth rate of SMEs' contribution to GDP (denoted, ($SMEGr_t$) as an indicative measure of SMEs' outputs. This variable is simply the contribution of SME growth to the overall economic growth of the country. Because of the limitation to obtain complete information for other frequency data, annual series (1980–2021) from the CBN statistical bulletin, are applied for ($INTr_t$) and ($SMEGr_t$). Because the method used reflects isolating the series into positive and negative shocks, and, obtaining their cumulation for the two partitioned series, thus, the periods applied are certainly sufficient in order not to omit events of that link their shocks, but rather to ensure it capture their connectedness. In line with standard procedure, the variables are standardized using the log-normalization approach (Hatemi-J, 2012).

3.2 Pre-test Evaluation for Causality Estimation

To determine whether there is an asymmetric relationship between monetary policy's interest rates and small and medium-sized enterprises' (SMEs) output growth, the analysis first conducts a preliminary evaluation. This evaluation aims to identify the stochastic property that characterizes the unit-root (or stationarity) behavior of the considered series. To achieve this, each series is identified as integrated or trended using methods described by (Gbadebo, 2023 & Hamilton, 2020). Considering the interest rate ($INTRr_t$) and SMEs' output's growth ($SMEGr_t$) series are denoted $x_t^j (j = 1,2)$, the ADF test assumes empirical process that reflects (1), with corresponding and computed statistic [$ADF(\mu)$] shown by (2). The pre-estimations reflect x_t^1, and x_t^2, simply as $I(d)$, for d's difference order before attaining stationary (Hamilton, 2020).

$$x_t = a_0 + \varphi x_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta x_{t-i} + \Omega_t;\ i = 1, 2, \ldots, p-1 \qquad (1)$$

$$ADF(\mu) = \hat{\varphi}_T - 1/se(\hat{\varphi}_T) \qquad (2)$$

Where: $\delta_i = -\sum_{j=i+1}^{p-1} \varphi_j$, p is the lag-length and $se(\hat{\varphi}_T)$ is $\hat{\varphi}_T'$'s standard error. ADF tests null of non-stationarity ($H_0\colon \varphi = 1$) over an alternative of stationarity ($H_1\colon \varphi > 1$), and is rejected (i.e., significant), if $ADF(\mu) > ADF(\alpha)$ (i.e., critical value).

The article reveals both the short- and long-term characterization based on the cointegration context required for finding the long-term links. The system's ideal lag for parsimonious parameterization for cointegration would be first established for the integrated series. The Johansen test, from Johansen (1988), confirms the cointegration evidence. The test verifies the rank (r) of the cointegrating space of the matrix $\pi = \gamma a'$[α and γ are $n \times r$], where Vector $\pi \mathrm{y}_{t-k}$ contains both $I(0)$ and $I(1)$, for the parsimonious parameterized linear equation system below:

$$\Delta \mathrm{y}_t = \sum_{i=1}^{k-1} D_i \Lambda \mathrm{y}_{t-i} + \pi \mathrm{y}_{t-k} + e_t,\ \ t = 1, \ldots, T \qquad (3)$$

The Trace and Maximum eigenvalue are used to determine the rank. The Trace [Maximum eigenvalue] null of no co-integrating vectors [$H_0 = rank(\boldsymbol{\pi}) = r$] is tested against the alternative hypothesis of at least one co-integrating vector [H_1: r > 0]. The Trace statistic (η_r: equation 4) and Maximum eigenvalue (ζ_λ: equation 5) and $\mathbf{y}_t$, are defined:

$$\eta_r = T \sum_{i=r+1}^{n} ln(1 - \lambda_i) \quad (4)$$

$$\zeta_\lambda = T\, ln|(1 - \lambda_{r+1})| \quad (5)$$

Where, $\lambda_{i+1}, \dots, \lambda_n$ are the $n + r$ smallest squared canonical correlations between $\mathbf{y}_{t+k}$, for $k = 1, 2, \dots, n$ The estimated eigenvalues need to be larger than the critical values, for the null to be rejected. Lastly, the paper presents symmetric and asymmetric causality.

3.3 Considered Symmetric and Asymmetric Causality Tests

First, the symmetric Toda-Yamamoto (1995) test infers causality directly based on the estimations of the VECM system. Toda and Yamamoto (1995) suppose that the short- (or long) run Granger-type causality is based on the evidence of the significance of the t-statistics of the regressors (or error term) of the estimated VECM. The VECM describes potential system's interdependence to make statistical inference for the casual relation. This exogeneity test found causality when the null (of no causality) is rejected at p-value less than 0.05. Strong causality is follows if the regressors and ECM term's t-tests reflect significance (Lütkepohl, 2006; Pfaff, 2008).

Based on the $INTRr_t$ and $SMEG\mathrm{r}_{t-i}$ relation, the Bivariate VAR(p) process is:

$$INTRr_t = \alpha_0 + \sum_1^p \alpha_1 INTRr_{t-1} + \sum_1^p \alpha_2 SMEGr_{t-i} + u_{1t}$$

$$SMEGr_t = \beta_0 + \sum_1^p \beta_1 SMEGr_{t-1} + \sum_1^p \beta_2 SMEGr_{t-i} + u_{2t} \quad (6)$$

Where $p = k + q$, k is lag length, q is highest cointegration degree *(dmax)*, and u_{1t} and u_{2t} are VAR residuals. Implying symmetric causality between $SMEG\mathrm{r}_t$ and $INTRr_t$ is based on α_{2i}, β_{2i}, of the VAR (Sims, 1980). The causality tests the null $\alpha_{2i} = 0$ supposing $SMEG\mathrm{r}_t$ does Granger-causes $INTRr_t$, and β_{2i}, supposing that $INTRr_t$ does Granger cause $SMEG\mathrm{r}_t$.

Second, the asymmetric (Hatemi-J) test assumes that positive and negative perturbations of interest rate and SMEs growth exert diverse causal impacts. The test isolates the series into positive and negative shocks, and, obtained the cumulation for the two partitioned series. If (*$INTr_t$*) or (*$SMEGr_t$*) is confirmed I(1) (due to drift (α) or trend (*t*), or both), their series is expressed as:

$$INTRr_t = a + bt + INTRr_{t-1} + \varepsilon_{1t}$$

$$SMEGr_t = a + bt + SMEGr_{t-1} + \varepsilon_{2t} \quad (7)$$

The stochastic residuals ($\varepsilon_{1t}, \varepsilon_{2t}$) are quantified in positive and negative partial additions with $INTR_0$ and $SMEGr_0$ initial values:

$$INTRr_{1t}^{+} := INTRr_0 + \sum_{1=1}^{t} \varepsilon_{1i}^{+}$$

$$INTRr_{1t}^{-} := INTRr_0 + \sum_{1=1}^{t} \varepsilon_{1i}^{-} \quad (8)$$

$$SMEGr_{2t}^{+} := SMEGr_0 + \sum_{1=1}^{t} \varepsilon_{2i}^{+}$$

$$SMEGr_{2t}^{-} := SMEGr_0 + \sum_{1=1}^{t} \varepsilon_{2i}^{-}$$

The accumulative positive ($\varepsilon_{1i}^{+}, \varepsilon_{2i}^{+}$) and negative ($\varepsilon_{1i}^{-}, \varepsilon_{2i}^{-}$) values is such that $\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0)$, $\varepsilon_{2i}^{+} = \max(\varepsilon_{2i}, 0)$, $\varepsilon_{1i}^{-} = min(\varepsilon_{1j}, 0)$, $\varepsilon_{2i}^{-} = min(\varepsilon_{2i}, 0)$. The asymmetric causality between any two components of ($INTRr_{1t}^{+}, INTRr_{1t}^{-}, SMEGr_{2t}^{+}$, $SMEGr_{2t}^{-}$) is verified.

In testing causality between $INTRr_{1t}^{+}$ and $SMEGr_{2t}^{+}$, the VAR(p) process is represented:

$$INTRr_t^{+} = A_0^{+} + A_1^{+} INTRr_{t-1}^{+} + \cdots + A_p^{+} INTRr_{t-p}^{+} + A_{p+1}^{+} INTRr_{t-p-1}^{+} + v_t^{+} \quad (9)$$

Where A_0^{+}, A_r^{+} and v_t^{+} are 2×1 vector of intercepts, 2×2 matrix of estimates for r-lag $(r = 1, \ldots, p)$ and 2×1 residual vector. The null, of jth element ($INTRr_t^{+}$) does not cause kth element ($SMEGr_t^{+}$), is evaluated with Wald (1939) statistic. The general VAR(p)-process is rewritten as to be able to reflect the Wald statistic in compact form based on equation (10) (Lutkepohl, 2006):

$$Y = DZ + v \quad (10)$$

$Y(n \times T) = (y_1^{+}, \ldots, y_T^{+})$, $D(n \times (1 + np)) = (v, A_1, \ldots, A_p)$, and $v(n \times T) = (u_1^{+}, \ldots, u_T^{+})$.

$$Z_{t((1+np)\times 1)} = \begin{bmatrix} 1 \\ y_t^+ \\ y_{t-1}^+ \\ \vdots \\ y_{t-p+1}^+ \end{bmatrix} \qquad (11)$$

The parsimonious parameterization of the VAR needs a p-lag, using the HJC (Hatemi-J, 2003):

$$HJC = ln\left(\left|\Pi_p^+\right|\right) + p\left(\frac{n^2 lnT + 2n^2 \, ln(lnT)}{2T}\right), \; p = 1, \ldots, p_{max} \qquad (12)$$

$|\Pi_p^+|$ is modulus of residuals variance–covariance matrix. The null is tested with the Wald statistic:

$$Wald = (C\beta)'[C((Z'Z)^{-1} \otimes s_U)C']^{-1}(C\beta) \qquad (13)$$

Where $\otimes$ is Kronecker multiplication that specifies function with C limitations, $\beta = vec(D)$ and vec is the column stacking operator, and s_U is the variance–covariance matrix of the VAR. If the observed Wald statistics, which is based on the Chi-square (χ^2) distribution, from (13), is greater than the simulated bootstrap critical value algorithm with leverage conditions (c_α^*), then the null [i.e., H_0: $C\beta$ = 0] cannot be maintained at the defined α-significance level.

4. Results and Discussions

For the relationship between the monetary policy indicator (interest rate, $INTRr_t$) and the SME output (SMEs' growth, $SMEGr_t$), Table 1, 2, 3, 4 and 5, respectively, presents tests evidence for the stationarity tests, cointegration tests, optimal lag selection, symmetric causality, and asymmetric causality. The correlation of 0.416 (with -value, 0.001) between the variables is moderately positive (and significant), suggesting normal interest rate- SMEs output co-movement. This is consistent with positive correlation found in prior studies, but clearly in consistent with theory that if the increase the interest rate, the high cost of credits will discourage investment since investors would be unwilling to borrow, thus, output will fall. This connects interest rate to the SMEs' output growth, and vice versa, supposing evidence that the continuous implementation of the monetary policy to ease access to SMEs' finance and promote output expansions.

According to the stationarity tests (Table 1), at level forms for both interest rates and SMEs output growth, $ADF(\mu)$ > $ADF(\alpha)$, thus, supposing the tests are non-significant

and the null holds. The difference forms for the variables support evidence that the unit root tests are significant, and the first difference forms are stationary for both. The interest rate and SME outputs are trended with drift (α), and confirmed integrated order of 1 (i.e., I (1).

Based on procedure, a sufficient lag-length is required, and the process considers lag 3 as optimal for the equilibrium's parametric parsimony of the interest rate and SMEs output relation. The different diagnostics are conducted to decide the most parsimonious lag for the estimation. The outcome, reported in Table 2, shows that both the AIC and HQ selector unanimously suppose lag 2 as optimal. Thus, the system dynamics for the consideration of the reflects a deterministic trend and lag of 2 during the estimation.

Both Trace and Max-Eigen tests are applied, and the outcome reported in Table 5. Each test is insignificant at cointegration rank of 3 for the 5 percent level. The result supposes only 3 co-integrating likelihood, and at the rank level, the Trace test statistic ($\eta_r = 0.0012$) and maximum eigenvalue ($\zeta_\lambda = 0.0012$) are less than corresponding

critical value of 2.9382, for both tests. The existence of the cointegrating rank supposes the VECM suitably depicts the interdependence for the unified framework using the optimal lag for the system parameterization. Because the aim is to infer causality influence, the study does not represent the VECM dynamics that relates the long-run and ECM estimates, for the $INTRr_t$ and $SMEGr_t$ relation.

The study (Table 2), further, shows the outcomes of the symmetric causality evidence for interest rate and SME's output growth. The Wald statistic computed, based on the chi-square test, shows a value of 5.826, suggesting the test is highly significant at 1 percent and the first null (i.e., $\mathrm{INTRr}_t \nRightarrow SMEGr_t$) is rejected. Thus, causality runs from interest

rate to SMEs output growth. The direct impact would be identified from the short run coefficients of the VECM dynamics. Contrary, the chi-square value of 0.1655 suggests that the Wald test is not significant, thus, the second null ($SMEGr_t \nRightarrow \mathrm{INTRr}_t$) is held.

Thus, causality does not run from SMEs output growth to interest rate. Overall, the evidence supposes a unidirectional causality, from interest rate to SMEs output, and not vice versa. This is comparable with extant evidence, for instance, Ilegbinosa and Jumbo (2015) find negative link for the SMEs' finance and interest rate causal relations. Kareem et al. (2022) found a unidirectional causality between poverty and SME growth, and more directly, Ibi-Oluwatoba et al. 2020 found negative relationship between interest rate and SMEs' outputs.

Lastly, the study shows the outcomes of the asymmetric causality evidence for interest rate and SME's output growth. Based on the procedure, asymmetry in Granger-causality framework accommodate to reflect the cumulative positive and negative shocks components. To achieve this, since the variables are I (1), they series are transformed according to (8), and their residuals, ε_{1t} for $INTRr_t$ and ε_{2t}, for $SMEGr_t$, are fitted, and examined. The paper reflects the estimates into positive and negative cumulative components for system perturbations $(\varepsilon_{1t}, \varepsilon_{2t})$, according to (9). The regression (OLS) estimation of change in interest rate (SME output growth) on the stochastic residuals ε_{1t} (ε_{2t}) is estimated, i.e. $\Delta \mathrm{INTRr_t} = a + bt + \varepsilon_{1t}$ and $\Delta SME\mathrm{Gr_t} = a + bt + \varepsilon_{2t}$. The fitted estimates, and the residuals (shocks) are removed. Afterwards, their shocks are cumulated into positive and negative for interest rate ($INTRr_t^+$, INTRr_t^-) and SMEs output growth ($\mathrm{SMEGr}_t^+, SMEGr_t^-$). The accumulated positive and negative shocks is used to complete the asymmetric causality tests. Table 5 presents the evidence for the asymmetric causality tests, based on the bootstrapping for shock's cumulative components.

Evidently, the asymmetric causality simulation shows that only both positive and negative shocks in interest rates drives shocks in SMEs outputs, but not vice versa, supporting the first null for the symmetric test. A positive (negative) shock in the interest rate causes negative (positive) shocks on SMEs, consistent with the associated economic theory of monetary policy through the interest rate pass-through. Clearly, the interest rate holds a counter-productive impacts on SMEs growth. With the estimated Wald statistic of 4.822, the significance of the null ($\mathrm{INTRr}_t^+ \nRightarrow SME\mathrm{Gr}_t^-$) only holds at 10 percent, where its value is greater than c_α^* at 1.165. For the test confirming the influence of the negative shocks interest rate to SMEs output, the significance of the null ($\mathrm{INTRr}_t^- \nRightarrow SME\mathrm{Gr}_t^+$), holds at 5 percent, where the Wald test estimate (5.061) becomes greater than c_α^* at 2.358. Except for negative perturbations in interest rate to SME output ($\mathrm{INTRr}_t^- \nRightarrow SME\mathrm{Gr}_t^-$), which surprisingly was significant at 10 percent, other shocks in interest rate or SMEs outputs growth do not Granger cause disturbances in the other associated shocks. Overall, the intuition is that the evidence supports theoretical preposition that interest rate, as leading conduit of monetary policy, remains vital to influence outputs growth (Mohanty & Turner, 2008). The transmission process follows that if the Nigerian authority increases (lowers) the interest rate, investment will decrease (increase) since investors would be willing and able to borrow due to the high (low) costs of funds. The fall (rise) in investment supposes that employment has risen, thus, leading to a fall (rise) in the SMEs outputs to it growth.

Table.1.Stationarity Evidence for Interest Rate and SMEs Output Growth

Variable x_t	Deterministic Terms: Trend	Deterministic Terms: Intercept	Lag	$ADF(\mu)$	$ADF(\alpha)$: 1 percent	$ADF(\alpha)$: 5 percent	$ADF(\alpha)$: 10 percent
$INTRr_t$	Yes	Yes	4	-1.242	-5.213	-3.286	-3.602
$SMEGr_t$	Yes	Yes	3	-2.186	-3.841	-3.286	-3.602
$\Delta INTRr_t$	No	No	1	-16.13*	-5.133	-3.432	-3.174
$\Delta SMEGr_t$	No	No	1	-8.561*	-3.834	-3.432	-3.174

Note: * (**) Shows test is significance at 1 percent (5 percent) based on the probability ($p|t| = 0$). $ADF(\mu)$ test statistics and ADF null (H_0) of non-stationarity is significant, and rejected where $ADF(\mu)$ > $ADF(\alpha)$ (Critical values)

Source: Author's own elaboration

Table.2.Optimal Lag Selection for Parameterization

Selection Criteria	Lag 1	2	3	4
AIC(n)	-8.526	-9.314*	-8.278	-8.088
HQ(n)	-6.881	-7.753*	-7.523	-7.218
SC(n)	-5.336*	-5.852	-4.655	-4.542

Note: Akaike Information Criterion (AIC), Schwarz Criterion (SC) and Hannan Quinn (HQ).
***Selected optimal lag (p) based on the indicated criteria. n is No. of lag implemented during the specific criterion iteration.**

Source:Author's own elaboration

Table.3.Cointegration Test for the Interest Rate and SMEs Output Relation

Hypothesized No. of CE(s)	Statistic	Critical Value	p-value
Trace:	$[\eta_r]$	[0.050]	$p_r(\eta_r)$
None *	182.31	39.512	0.0000
At most 1 *	48.503	18.154	0.0000
At most 2 *	11.356	10.147	0.0000
At most 3	0.0022	2.9382	0.9621
Max-Eigen	$[\zeta_\lambda]$	[0.050]	$p_r(\zeta_\lambda)$
None *	87.654	25.017	0.0000
At most 1 *	39.831	13.835	0.0000
At most 2 *	12.510	9.0585	0.0000
At most 3	0.0022	2.9382	0.9621

Note: The Johanson tests, based on Trace and Max-eigenvalue statistics, indicate 3 cointegrating equations at the 0.05 level.
*** Denotes rejection of the null at the 5 percent level, thus, the selected number of cointegrating relation.**

Source: Author's own elaboration

Table.4.Symmetric Causality Evidence for Interest Rate and SMEs Output Growth

Causal directions: Test null (H_0):	Lag	Critical value (5 percent) χ^2-statistic	p-value
$INTRr_t \nRightarrow SMEGr_t$	2	5.826**	0.0081
$SMEGr \nRightarrow INTRr_t$	3	0.1655	0.5120

Note:$\nRightarrow$: Implies does Granger-causes. The symmetric analysis, based on VECM estimates ($\alpha_{2i}, \beta_{2i}, for\ i = 1, 2$), supposes that $INTRr_t$ does Granger cause $SMEGr_t$.

Source: Author's own elaboration

Table.5.Asymmetric Causality Evidence for Interest Rate and SMEs Output Growth

Causality null: H_0	$Wald$ (χ^2-stat)	Lag	Bootstrap critical values (c_α^*) 1 percent	5 percent	10 percent
$INTRr_t^+ \nRightarrow SMEGr_t^+$	0.049	2	4.520	3.144	0.976
$SMEGr_t^+ \nRightarrow INTRr_t^+$	3.161	2	12.53	8.032	6.159
$INTRr_t^- \nRightarrow SMEGr_t^-$	2.821	2	3.950	3.254	2.966
$SMEGr_t^- \nRightarrow INTRr_t^-$	0.048	3	3.281	1.817	0.668
$INTRr_t^+ \nRightarrow SMEGr_t^-$	4.822***	3	9.201	6.201	1.165
$SMEGr_t^+ \nRightarrow INTRr_t^-$	1.231	2	11.02	5.414	2.126
$INTRr_t^- \nRightarrow SMEGr_t^+$	5.016**	2	5.881	2.358	0.088
$SMEGr_t^- \nRightarrow INTRr_t^+$	0.336	2	4.761	3.091	1.825

Note: **,***Implies the relation is significant at 5 percent, 10 percent. The null does not hold at α-significance, if $Wald > c_\alpha^*$.

Source: Author's own elaboration

5. Conclusion

The SMEs remains relevant sectors in many countries. Thus, many governments use monetary policy to aid their operations. Although, several studies based on Nigerian evidence have investigated the relationship between the SMEs operations and monetary policy, especially, the interest rate, none has considered the likelihood of asymmetric causality between them. The study presents the first evidence. Based on annual frequency series, from the CBN statistical, covering1975–2021, the paper verifies the evidence of symmetric Granger causality (Toda-Yamamoto, 1995) and asymmetric causality approaches (Hatemi-J, 2012).

The evidence establishes that the variables are non-stationary, but their combination has long-run and cointegration relations, thus aids the existence of a parameterized and unified framework. The result further recognizes symmetric causality evidence for interest rate and SME's output growth, and in particular, a unidirectional causality from interest rate to SMEs output growth, but no potential feedback. This supposes that expansionary monetary policy stimulates SMEs output, but does not retain any feedback effects from SMEs growth to interest rate. The asymmetric causality shows that only both positive and negative shocks in interest rates drives shocks in SMEs outputs, but not vice versa. In particular, a positive (negative) shock in the interest rate causes negative (positive) shocks on SMEs, consistent with the associated economic theory of monetary policy through the interest rate pass-through.

Based on the findings, the paper makes the following suggestions. One, the authorities should set up of state enterprise development agencies to serve as coordinating unit that will monitor the operations of implemented policies. The governments at all levels should endeavor to put adequate infrastructural facilities in place for proper operations of SMEs. There should also be other support services, such as consultancy advice from professional and experts are not easily accessible by entrepreneurs. Due to the limited resources at their disposal, some SMEs venture into operations without having the idea of the cost implication as well as prospective of the business without carrying out feasibility study.

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