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HOW REGIONAL ECONOMIES REACT: INFLATIONARY SPILLOVERS FROM NIGERIA'S MONETARY POLICY

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Abstract: This study evaluates the relationship between monetary policy shocks and sub-national inflation dynamics in Nigeria, using the SVAR framework. Furthermore, using the Diebold-Yilmaz (DY) methodology, it also examines the extent of inflation volatility spillovers among the regions. Results show that monetary policy shock generates a heterogeneous but Usenobong Friday Akpan insignificant influence on sub-national inflation in Nigeria. We also found Department of Research, substantial evidence of spillovers among the regions. The South-West, Financial Sector Division, North-East and South-East regions were found as the only resilient regions Central Bank of Nigeria, and net transmitters of inflation volatility to other regions, while the South-Abuja, Nigeria South was the most vulnerable region, especially to shocks from the These findings suggest that an exogenous monetary policy shock is not sufficient to address sub-national inflation dynamics in Nigeria. Rather, a well-targeted policy may be required to address the challenge, including strengthening inter-regional network connectivity and addressing persistent insecurity challenges that have stamped its roots in the North-East and Southeast regions.

Keywords: Sub-National Inflation, Monetary Policy, Shocks, Spillovers

Introduction

High inflation remains one of the most serious macroeconomic problems confronting many economies around the world. Higher inflation, in general, has significant implications for other macroeconomic variables such as investment, employment, household welfare, and economic growth. Consequently, the Central Bank of Nigeria (CBN) prioritized price stability as its primary mandate through its monetary policy decisions. Empirically, many studies have looked at the impact of monetary policy on inflation dynamics using aggregate national data rather than sub-national inflation data. There are at least two possible explanations for the increase in this type of analysis. First is the ease of analysis that such efforts represent as aggregate national data for inflation are readily available in several countries. The second attraction may be influenced by the motivation of monetary policy decisions which typically focus on controlling the aggregate price level; sub-national inflation rates are not always the target of Central Bank's monetary policy decisions. Notably, states do not have control over monetary policies in any economy. As a result, monetary policy shock constitutes an exogenous shock to economic decisions at the sub-national levels and may have a heterogeneous impact across the sub-national economies due to their diversity. States, for example, differ in terms of firms' concentration and sensitivity to interest rate (monetary policy) shock. Other studies have found that a state with a high share of interest-sensitive industry may be more vulnerable to monetary policy tightening than others. Furthermore, given the importance of food inflation on headline inflation developments, a state that is heavily reliant on food imports may be more vulnerable to monetary policy innovations than others with greater local food production capacity. Structural issues within each state may also play a larger role in influencing subnational price disparities, limiting the impact of monetary policy formulation. Interestingly, emerging research strands in the literature are beginning to recognize the significance and implications of monetary policy shocks on sub-national inflation dynamics and economic activity, as well as regional interconnectedness and spillovers. Such evidence has been provided for several countries including the United Kingdom (Mandalinci, 2015), Sweden (Svensson, 2013), Poland (Anagnostou and Gajewski, 2019), the Netherlands (Arnold and Vrugt, 2002), Greece (Anagnostou and Papadamou, 2016), Indonesia (Ridhwan et al., 2014), Australia (Vespignani, 2011; Fraser et al., 2014), China (Chen and Groenewold, 2018; Guo and Masron, 2017) andArgentina (Montes-Rojas et al., 2019). To the best of our knowledge, no attempt in this regard has been made in the case of Nigeria, hence the current study. Thus, the purpose of this study is to provide empirical evidence from a macroeconomic Structural Vector Autoregressive (SVAR) model in addressing the question of whether there are asymmetries in inflation responses to monetary policy shocks at the sub-national levels in Nigeria. Furthermore, using the Diebold-Yilmaz (DY) methodology, the paper also examines the extent of inflation volatility spillovers among the regions. For policy, this direction of research is significant for Nigeria for at least three reasons. First, if significant inter-state differences in response to such shocks are evident, it could suggest that monetary policy alone may be insufficient to effectively offset differentially impacted external shocks. In essence, the presence of significant sub-national inflation asymmetries may necessitate policy actions other than monetary policy, such as selective or targeted interventions. Second, the persistence of high dispersion of inflation across sub-national economies may have implications for labour markets in terms of real wages and consequently, the standard of living across the states. Indeed, the actual prices that entered the consumption function of households are those reflected at the subnational levels. As a result, it will be misleading to evaluate monetary policy effectiveness based on a decline in headline inflation if this is not accompanied by a corresponding price moderation at the sub-national level, at least from the perspective of households' decision function (Weyerstrass et al., 2011). Ensuring that the benefits of low and stable prices accrue to all states, in particular, is critical for anchoring the credibility of the Central Bank of Nigeria's monetary policy and incentivizing buy-in from the larger segment of society for its monetary policy decisions. Third, given the diversities across the regions, proximity, and concentration of industries, amongst others, it would be of interest to also evaluate the extent to which the regions are connected in terms of the shocks received from or transmitted to others.

Overview of the Literature

Generally, drivers of inflation dynamics in any country could be a combination of both external and domestic shocks. Nguyen et al. (2017) found that domestic demand pressures and global supply shocks, especially output shocks, have been the main drivers of inflation in Sub-Saharan Africa (SSA). Kearns et al. (2023), on the other hand, discovered that given the level of their financial openness, economies with stronger financial linkage with the United States or the Euro Area are more susceptible to stronger interest rate spillovers. The disruptions occasioned by the Russian-Ukraine war provide another strong support to inflation dynamics due to global supply shocks. Within the domestic front, sources of economic fluctuations that affect economic activities can be either nationwide or state-specific (idiosyncratic) shocks (Fraser et al., 2014). An example of the first type of shock is a common policy that affects all states of the federation, such as a change in monetary policy rate. An example of the second type of shock includes a weather-related shock like drought in certain parts of the country or a sectional crisis-related shock, like the insurgency in the North-East. For the first type of shocks, the literature has suggested at least three main channels through which national monetary policy shock may generate different effects across the states or subnational levels. These include the credit channel, the interest rate channel, and the exchange rate channel. The credit channel is attributed to regional differences in the composition and concentration of large and small firms (Bernanke and Gertler, 1995; Ridhwan et al., 2010). Usually, large firms are expected to have easy access to external sources of financing (e.g., issuance of corporate stocks and bonds and commercial papers) while smaller ones typically rely on domestic financial institutions for their credit. Consequently, a region with a high concentration of small firms is expected to experience a relatively large negative impact on output following a monetary contraction. This is because, in a period of monetary tightening, small-scale firms will have higher transaction costs constraining them from tapping into alternative funding sources (Anagnostou and Gajewski, 2019). Empirical support for the regional operability of the credit channel has been found by Ridhwan et al. (2014) for Indonesia Duran and Erdem (2014) for Turkey and Mandalinci (2015) for the UK. However, Svensson (2013) found no support for this channel in the case of Sweden. For the United States, Carlino and DeFina (1999) also reported that the credit channel is not a significant determinant of regional responses to monetary policy. Dominguez-Torres and Hierro (2018), attributed the mixed evidence to the choice of proxy employed by various authors to measure credit channels, some of which include firm size (for the reasons earlier explained), the share of bank loans going to industrial firms and percentage of small and large banks prevalent in the region. The interest rate channel, on the other hand, is anchored on the proposition that some industries are more sensitive to interest rate changes than others. When there is a higher concentration of interest rate-sensitive industries in a particular state or region, it is argued that an increase in interest rate will have a higher effect in such states than in others. A survey by Ridhwan et al. (2010) indicated that the manufacturing and construction sectors are more creditdependent and therefore more interest-rate sensitive than the services sector. The argument is that industries that produce durable or investment goods, including those that are more capital-intensive such as construction tend to be more interest rate sensitive. A tighter monetary policy can decrease the demand for investment and durable consumer goods by raising the real cost of capital for firms and consumers (Taylor, 1995; Mishkin, 1996). Empirically, the interest rate channel has also been found to be regionally operative in several countries. For instance, Carlino and DeFina (1999); Owyang and Wall (2009) have obtained regional evidence of interest sensitivity of production for the United States. A similar confirmation has been found by Svensson (2013) for Sweden, Ridhwan et al. (2014) for Indonesia, Mandarin (2015) for the United Kingdom, and Vespignani (2015) for Australia. In Canada, Georgopoulos (2009) reported that the provinces with a higher concentration of primary-based industries experienced a greater impact of monetary policy shock, followed by provinces that are manufacturing-based. The author found these two industries to be interest-sensitive to monetary policy. However, the study by Guo and Masron (2017) indicated that the interest rate channel is rather weak in the case of Chinese provinces. In addition to the above channels, the exchange rate is seen as another important channel that could explain why monetary policy may have different impact at the subnational levels or across regions (Arnold and Vrugt, 2002; Anagnostou and Gajewski, 2019; Anagnostou and Papadamou, 2016; 2014; Li and Zhang, 2018; DominguezTorres and Hierro, 2018). The argument is that since monetary policy shocks also affect asset prices such as exchange rates, it also affects the competitiveness of the economy and net exports. A monetary tightening will lead to a higher relative interest rate and induce capital outflow which in turn leads to exchange rate appreciation. This would cause a relative increase in the price of domestic goods and a loss of competitiveness due to the combined effects of the decline in exports and increase in imports. Consequently, this channel suggests that states with more export-intensive industries may be more responsive to innovations in monetary policy. A counterargument to this hypothesis has been offered by Ber et al. (2001). Empirical analysis of the regional exchange rate channel has received some attention in the literature. In particular, evidence of the regional operability of this channel has been reported for Sweden by Svensson (2013). The author found that a contractionary monetary policy shock has symmetric effects across the Swedish regions where regions adversely affected have higher export intensity. However, Dominguez-Torres and Hierro (2018) argued that the final impact of this mechanism on economic activities and aggregates may be ambiguous as it depends on the export/import position of the region as well as the prevailing exchange rate regime. Beyond the aforementioned major channels, Anagnostou and Papadamou (2016) argued that the supply effect is another possible channel that could explain regional monetary policy transmission. Regions differ with respect to their supply curves, which may be due to regional differences in the endowment of certain natural resources and weather conditions as well as institutional features of labour and product markets. Other authors like Carlino and DeFina (1999); Ying (2000); Groenewold et al. (2007); Guo and Masron (2017) emphasized the role of spillover effects in explaining the regional effects of monetary policy shocks. Following the spillover channels, economic changes originating from one region or state are expected to filter into other regions/states through interregional links. Investigating this hypothesis in the case of China’s provinces, Guo and Masron (2017) found that in the short run, the influence of spillover effects on a province’s response to monetary policy shocks was significant. Other scholars have also linked the heterogeneity impact of monetary policy to socio-demographic and economic side effects. The idea is that a highly populated region (hence a large market size) is likely to be more responsive to monetary policy shocks than otherwise (Duran and Erdem, 2014 for empirical evidence in the case of Turkey). In sum, there is overwhelming evidence that monetary policy shock could generate a heterogeneous impact on regional economic activities and variables. The dominant channels for such transmission appear to be the credit, interest rate, and exchange rate channels the dominance of which depends on the structure of the country under focus. While some of the studies reviewed have analyzed the effect of the shock on a broad range of sub-national economic aggregates like regional employment, consumption, inflation, and output (for instance Fraser et al., 2014), this study for Nigeria focuses only on sub-national inflation dynamics primarily because of data constraints. Our focus therefore is not to investigate the dominance or otherwise of any of these channels in the case of Nigeria, as key data are currently unavailable. Stylized Facts on Sub-National Inflation Dynamics in Nigeria Inflation in Nigeria rose continuously from 14.53% in 2000 to a peak of 23.81% in 2003, just before the 2004/2005 banking consolidation (Fig. 1). The continuous increase in inflation could be attributed to the minimal effect of the Minimum Rediscount Rate (MRR) as a monetary policy anchor rate. The MRR was not truly a transaction rate and could not exert an immediate impact on short-term rates, also, the rates in the money market remained, largely, volatile leading to inefficiencies

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in the money market as it could not transmit monetary policy effectively. Inflation volatility (measured by the standard deviation of inflation rates) varied considerably between 2000 and 2005, ranging between 2.21 and 7.69% (Fig. 1). To entrench a true transactions policy rate that will effectively signal the direction of monetary policy and smoothen the volatility in the money market rates, a new framework for implementing monetary policy was introduced in December 2006.

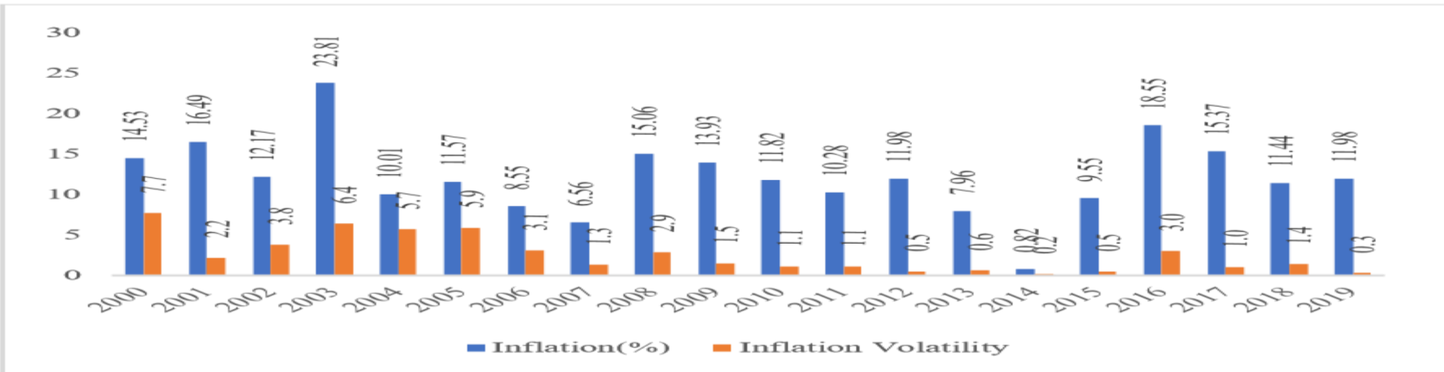


Fig. 1: All-item headline inflation in Nigeria; source: Authors' computation

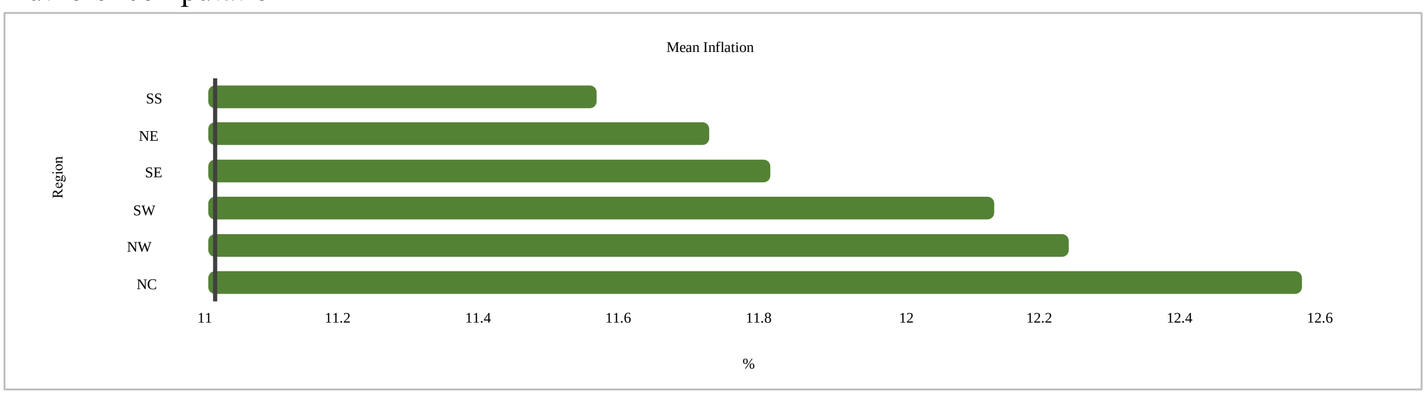


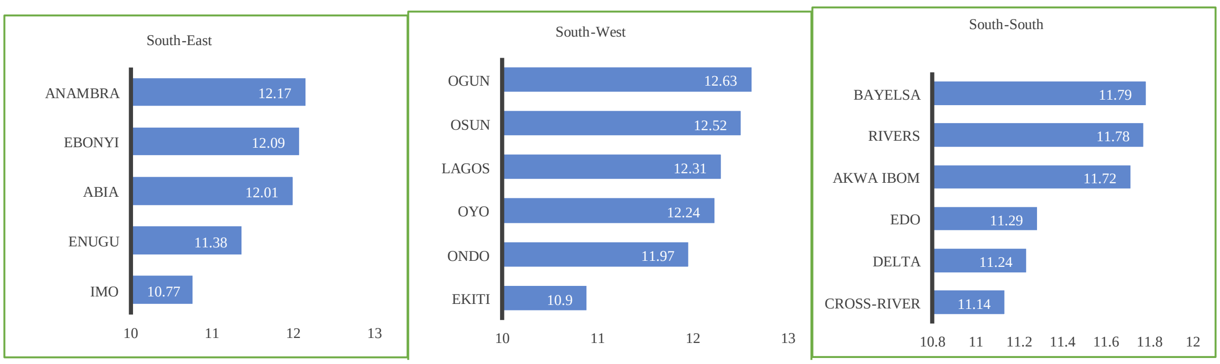
Fig. 2: Regional inflation in Nigeria; source: Authors' computation

The thrust of the new policy is the adoption of a Monetary Policy Rate (MPR) set by the CBN which replaced the MRR and is targeted at short-term overnight interest rates in the money market. The adoption of the new monetary policy framework coupled with the 2005 banking consolidation resulted in the economy's robust performance in 2007, including the continued stability of the exchange rate, strong external reserves, and the significant moderation in inflation to 6.56% in 2007 and inflation variability at 1.28 (Fig. 1). Following the economy's stability, inflation hovered within the single digits between 2005 and 2007. The effect of the 2007/2008 global financial crises and the subsequent 2009 banking crisis, hindered the gains from the various macroeconomic policies (banking consolidation, new monetary policy framework) as real GDP growth dropped from 6.1% in 2006 to 4.21% in 2012, inflation on the other hand, shot up to 11.98% by end-December 2012. Although inflation remained majorly above 10.0% between 2009 and 2012, it, however, remained stable. In 2013, the inflation fell to 7.96%. Following the oil price shock in the global market and the negative impulses and repercussions on the Nigerian economy, inflation rose to 9.55% in 2015 and further to a peak of 18.55% in 2016. The rebound in global oil prices and adjustment of the policy rate in line with economic fundamentals coupled with the implementation of the ERGP resulted in a more favorable output growth and a stable economy. Inflation fell to 15.37% in December 2017 and 11.98% at the end of December 2019 (Fig. 1). The marginal decline in the rate represented some progress, although it was a far cry from the expected inflation target. At the state level, it was observed that inflation moderated across states (Table 1), with wide variations relative to that of national-level inflation. Notably, most of the northern states (Kebbi, Kogi, Kwara) had higher average inflation compared to the southern states (Imo, Ekiti) with lower averages (Fig. 3). Although Rivers state recorded the highest inflation of 70.7% within the review period, it also had the lowest inflation level of negative 31.0% compared to the national maximum inflation level of 18.7% and a minimum of 7.7% within the same period (Table 1). We computed the mean of inflation rates across the regions of the country between 2013 and the first quarter of 2020 to examine how persistent the regional inflation differences are. As shown in Figs. 2-3, there are noticeable differences between average inflation rates across the regions and among the states. Most of the states in the north-central and north-west tend to experience higher inflation rates relative to other states with an average inflation rate of 12.34% in the two regions (Fig. 2). On the contrary, states in the south-south and northeast regions have sustained the lowest inflation rates averaging 11.54%. State-level inflation volatility (measured by standard deviation) tends to have significant differences ranging from 3.19% in Imo to 13.24% in Kogi (Table 1) indicating that the state-level inflation rate is volatile and that there is not likely to be a convergence across the state-level inflations, as shown further in Fig. 4. Hence, the responses of consumer prices to macroeconomic policies may differ across the states/regions. Also, although not very high, the coefficients of variation showed a wide disparity ranging from 0.30-13.24, buttressing the fact that there is some heterogeneity between the state-level inflation values.

Table 1: State-level inflation in Nigeria

PLATEAU	12.61	29.50	-7.40	5.73	0.45	-0.28	4.94

Source: Authors' computation based on data from the National Bureau of statistics



	Mean	Maximum	Minimum	Std. dev.	Coefficient of variation	Skewness	Kurtosis
ALL	11.95	18.13	6.29	3.20	0.27	0.37	2.07
SE	11.69	19.00	-4.90	4.39	0.38	-0.68	4.45
ABIA	12.01	46.30	-16.80	7.09	0.59	0.39	12.44
ANAMBRA	12.17	22.00	-8.80	5.69	0.47	-1.00	4.84
EBONYI	12.09	22.60	-5.70	5.48	0.45	-0.31	3.38
ENUGU	11.38	19.00	-3.90	4.14	0.36	-0.42	3.91
IMO	10.77	15.70	-4.40	3.19	0.30	-1.38	7.31
SW	12.09	20.40	0.80	4.09	0.34	0.13	2.73
EKITI	10.90	32.50	-6.80	5.21	0.48	0.17	6.19
LAGOS	12.31	20.30	0.60	3.86	0.31	-0.40	3.42
OGUN	12.63	24.90	-2.70	5.57	0.44	0.03	3.25
ONDO	11.97	23.70	-4.30	5.22	0.44	-0.71	4.40
OSUN	12.52	28.80	-3.40	5.91	0.47	0.01	3.14
OYO	12.24	26.00	-1.90	4.62	0.38	0.17	4.31
SS	11.49	30.30	-5.70	5.25	0.46	-0.13	6.58
AKWAIBOM	11.72	18.90	-0.20	4.09	0.35	-0.63	3.60
BAYELSA	11.79	58.10	-25.90	11.85	1.01	0.75	10.85

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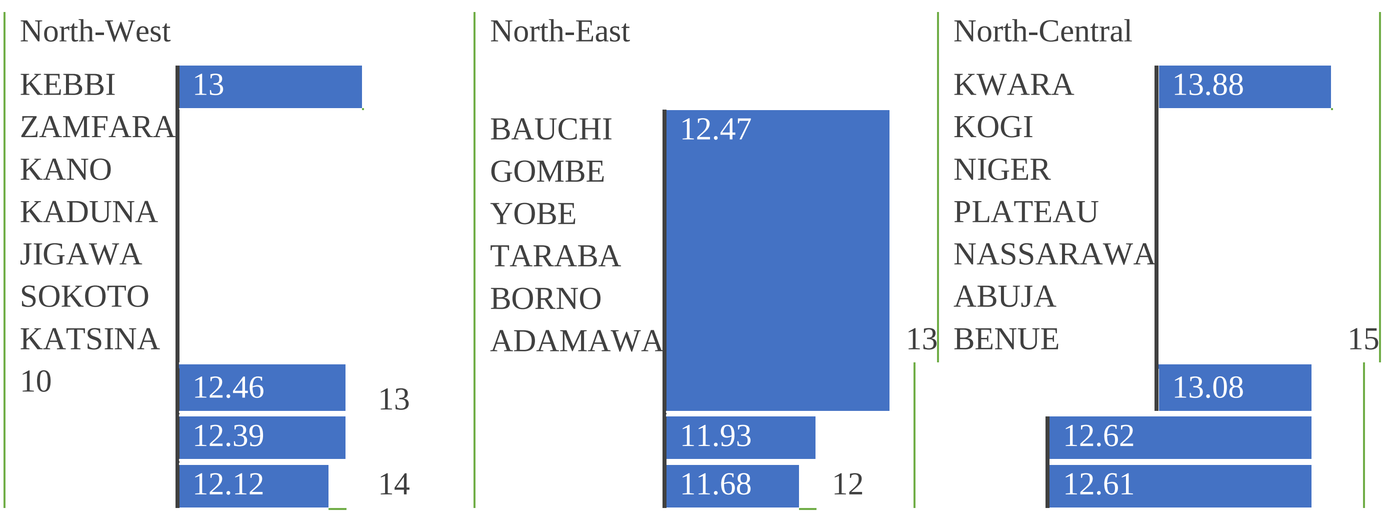
CROSSRIVER	11.14	26.60	-3.20	5.32	0.48	-0.23	3.76
DELTA	11.24	30.50	-10.90	5.90	0.53	-0.25	5.56
EDO	11.29	26.30	-6.40	4.94	0.44	-0.10	6.68
RIVERS	11.78	70.70	-31.00	10.02	0.85	0.56	21.80
NW	12.13	20.50	-4.10	4.95	0.41	-0.94	4.72
JIGAWA	11.76	26.80	-10.60	5.72	0.49	-0.87	5.68
KADUNA	12.12	22.40	-2.10	4.64	0.38	-0.97	4.20
KANO	12.39	29.70	-8.30	6.36	0.51	-0.79	5.53
KATSINA	11.45	27.20	-6.80	5.34	0.47	-0.97	5.72
KEBBI	13.00	21.20	-5.00	4.92	0.38	-0.79	3.97
SOKOTO	11.71	23.00	-4.30	5.77	0.49	-0.45	3.53
ZAMFARA	12.46	22.50	-3.80	5.35	0.43	-0.88	4.56
NE	11.59	17.60	4.50	3.49	0.30	-0.01	2.07
ADAMAWA	10.98	16.50	-29.90	6.11	0.56	-3.91	24.46
BAUCHI	12.47	33.10	-18.20	7.32	0.59	-1.02	7.04
BORNO	10.99	19.70	-1.40	4.64	0.42	-0.20	2.93
GOMBE	11.93	27.10	-6.00	5.23	0.44	-0.50	5.06
TARABA	11.59	24.50	-3.60	3.92	0.34	-0.34	5.39
YOBE	11.68	39.40	-17.50	7.34	0.63	-0.28	8.86
NC	12.54	30.60	-5.40	5.12	0.41	0.21	5.11
ABUJA	11.68	19.60	-5.60	4.38	0.38	-1.17	5.79
BENUE	11.55	26.80	-4.10	4.01	0.35	-0.16	7.62
KOGI	13.08	59.30	-9.40	13.24	1.01	1.76	5.42
KWARA	13.88	40.90	-6.20	11.65	0.84	1.03	3.35
NASSARAWA	12.41	23.80	-5.90	6.00	0.48	-0.66	3.86
NIGER	12.62	32.10	-8.20	5.88	0.47	-0.37	4.99



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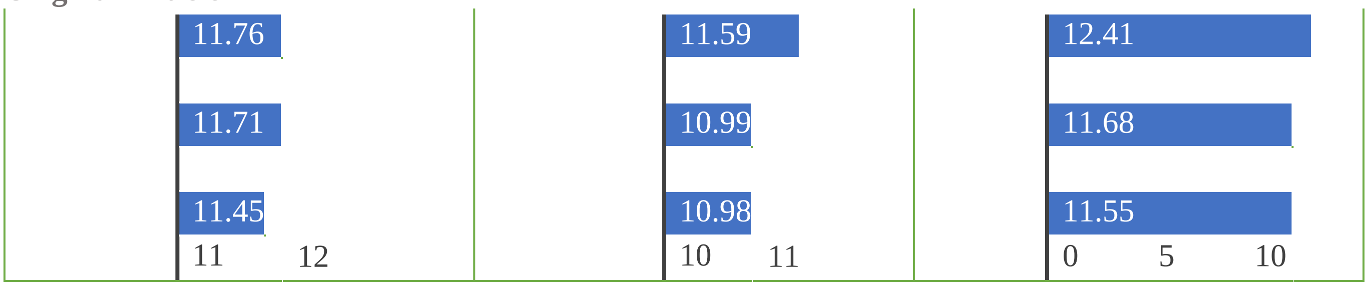

Fig. 3: State-level mean inflation in Nigeria; source: Authors' computation based on data from the National

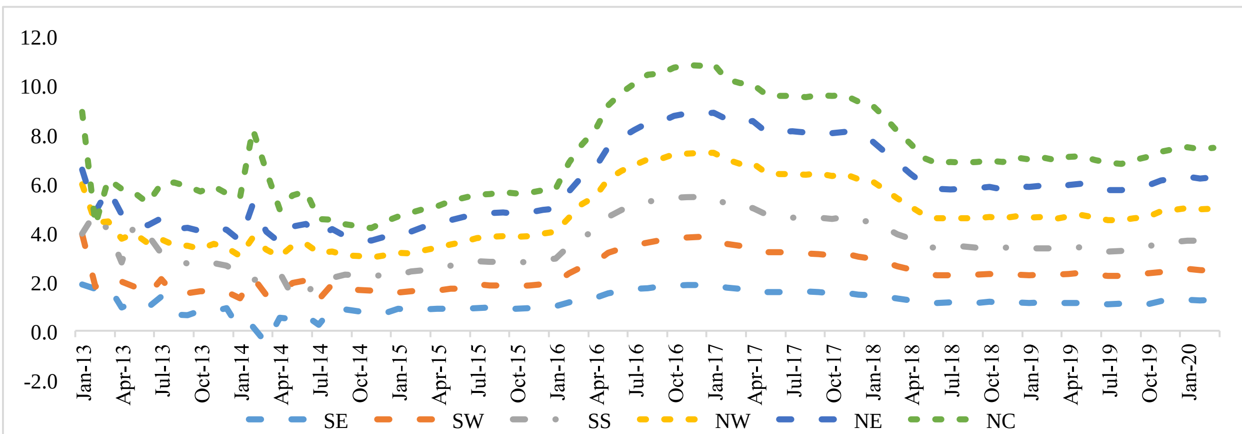

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Fig. 4: All-item headline inflation in Nigeria; source: Authors' computation

Materials and Methods

This study follows an econometric approach to analyze the relationship between monetary policy shock, sub-national inflation dynamics, and volatility spillovers in Nigeria. A macroeconomic Structural Vector Autoregressive (SVAR) model is formulated and applied to monthly data from 2012:1-2022:07 with money supply and real exchange rate introduced as control variables in the structural factorization. To gain further insight into the possibility of spatial spillover effect, the study also applied the Diebold-Yilmaz Connectedness Index (DYCI) estimation methodology to examine the spillover of inflation volatility and connectedness among Nigeria's six geopolitical regions.

Structural VAR Model

In the modelling framework, the sensitivity of subnational inflation dynamics to monetary policy shock is evaluated using the Structural Vector Autoregressive (SVAR) model which is a robust and conventional technique for examining monetary policy transmission. The model includes monthly data on monetary policy rate (mpr_t), broad money supply (m_t), an exchange rate (e_t), and sub-national inflation (π_{it}) where $i = 1,2, \ldots, 37$. The data span is 2012M1 through 2022M7, as monthly data on sub-national inflation were available from 2012. Sub-national inflation data were obtained from the National Bureau of Statistics, while the exchange rate, money supply, and monetary policy rate were sourced from the Central Bank of Nigeria (CBN).

In matrix notation, the SVAR model could be represented as:

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$\Gamma Y_t = (L)Y_{t-1} + \epsilon_t$ (1)

where Y_t is the vector of the endogenous variables, Γ is the matrix of coefficients of the endogenous variables, $A(L)$ is an autoregressive polynomial in the lag operator L, and ϵ_t is the vector of reduced-form innovations which are assumed to be normally distributed with a constant variance-covariance matrix: $E(\epsilon_t) = 0, E(\epsilon_t \epsilon_t') = \Sigma_\epsilon$ and $E(\epsilon_t \epsilon_s') = 0$ for $t \neq s$. In other words, the vector of the innovations is assumed to be contemporaneously correlated with full rank matrix Σ_ϵ, but uncorrelated with their leads and lags of the innovations and with all the right-hand side variables. Transforming Eq. (1) into a reduced form VAR model, yields:

$Y_t = A^*(L)Y_{t-1} + \zeta_t$ (2)

Where, $A^* = \Gamma^{-1}A$ and $\zeta_t = \Gamma^{-1}\epsilon_t$. Eq. (2) expresses each of the endogenous variables solely as a function of predetermined variables. Deriving the non-recursive orthogonalization of the error terms for impulse response analysis requires imposing certain restrictions on the impulse response functions to establish plausible economic structures. In particular, the reaction function of the central bank's monetary policy has to be specified. Thus, in our case, we assume that the monetary policy rate is strictly exogenous and predetermined and therefore does not react contemporaneously to shocks from other variables in the system. This assumption seems plausible given that monetary policy decisions by the Central Bank follow a predetermined calendar and are very unlikely to respond to the business cycle within a quarter. This restriction means that a monetary policy shock is influenced only by its shocks. The broad money supply is ordered next as we assume it to be affected by its shocks and contemporaneously by monetary policy shock in line with a typical monetary policy framework with monetary aggregate being an intermediate target of the Bank. Next, we assume that the exchange rate does not react contemporaneously to shocks in sub-national inflation, but is affected by shocks to monetary policy and money supply as well as shocks to itself. An expansionary monetary policy is expected to increase the level of domestic income which in turn raises the demand for imports with adverse implications for the real exchange rate. The last assumption is on sub-national inflation, which is allowed to react to changes in the other variables in the model. Hence, sub-national inflation is ordered last in the model. These structural restrictions can be summarised in the following matrix:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{mpr} \\ \mu_t^{m} \\ \mu_t^{e} \\ \mu_t^{\pi_i} \end{bmatrix} = \begin{bmatrix} \beta_{11} & 0 & 0 & 0 \\ 0 & \beta_{22} & 0 & 0 \\ 0 & 0 & \beta_{33} & 0 \\ 0 & 0 & 0 & \beta_{44} \end{bmatrix} \begin{bmatrix} \epsilon_t^{mpr} \\ \epsilon_t^{m} \\ \epsilon_t^{e} \\ \epsilon_t^{\pi_i} \end{bmatrix} \quad (3)$$

Before estimation, we determined the optimal lag selection using the standard information criterion and checked the integration properties of the variables to guide how to incorporate them into the model. The unit root tests were done using the traditional ADF and KPSS tests. Evaluation of the time series properties of the variables reveals that they are all stationary at the level expressed.

Regional Spillover Analysis

To gain further insight into the possibility of spatial spillover effect, we applied the Diebold-Yilmaz Connectedness Index (DYCI) methodology to model the spillover of inflation volatility and connectedness among the six geopolitical regions. The underlying framework for the DYCI analysis is the Generalized Vector Autoregressive (VAR) model, which is invariant to the variable ordering. Following Diebold and Yilmaz (2012; 2014), we consider the following compact form of a covariance stationary VAR (ρ):

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$$\pi_t = \sum_{i=1}^{p} \phi_i \pi_{t-1} + \mu_t; \ \mu_t \sim (0, \textstyle\sum) \quad (4)$$

where, $\pi_t = (\pi_{1t}, \pi_{2t}, \ldots, \pi_{nt})$ is an $N \times 1$ vector of regional inflation volatility series, ϕ denotes $the\ N \times N$ matrix of the parameters, μ_t is the vector of error terms assumed to be independently and identically distributed, while $\sum$ is the variance matrix for the error vector, μ_t. Respecifying Eq. (4) as a Moving Average (MA) yield:

$$\pi_t = \sum_{i=0}^{\infty} B_i \mu_{t-i} \quad (5)$$

Where, $Bi = \phi 1 Bi{-}1 + \phi 2 Bi{-}2 + \cdots + \phi p Bi{-}p$. $B0$ is a $N \times N$ identity matrix and $B_i = 0$ for $i < 0$. Eq. (5) serves as the foundation for deriving the variance decompositions necessary to calculate the sub-national inflation spillover index. The variance decompositions allow us to assess the fraction of H-step ahead error variance in forecasting π_i, $\forall j \neq i$, for each$_i$. Two key possibilities are worth noting:

Own shares of the variance decomposition, defined as the fraction of H-step ahead error variances in forecasting π_i that are due to shocks to π_i (for $i =$ 1, 2… N); and

(i) Cross variance shares or spillovers, defined as the fractions of H-step ahead error variances in Forecasting π_i that are due to shocks to π_j, for $j =$ 1, 2… N and $j \neq i$

Based on the generalized VAR framework of KPPS, the H-step ahead forecast error variance decompositions can be obtained from:

$$\Pi_{ij}^{g}(Z) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{Z-1} (e_i' \mathrm{B}_h \sum e_j)^2}{\sum_{h=0}^{Z-1} (e_i' \mathrm{B}_h \sum \mathrm{B}_h' e_i)} \quad (6)$$

Where, σ_{jj} is the standard deviation of the error term for the jth equation, while e_i is the selection vector, with one as the ith element and zeros otherwise. However, since the sum of the contributions of the variance error is not necessarily equal to one, Diebold and Yilmaz (2012) normalized each entry of the variance decomposition matrix by the sum of the row in other to use the full information of the matrix, thus:

$$\tilde{\Pi}_{ij}^{g}(Z) = \frac{\Pi_{ij}^{g}(Z)}{\sum_{j=1}^{N} \Pi_{ij}^{g}(Z)} \quad (7)$$

Where, $\sum_{j=1}^{N} \tilde{\Pi}_{ij}^{g}(Z) = 1$ and $\sum_{i,j=1}^{N} \tilde{\Pi}_{ij}^{g}(Z) = N$ by construction. Given these equations, the total spillover or connectedness index is computed as follows:

$$S^{g}(Z) = \frac{\sum_{\substack{ij=1 \\ i \neq j}}^{N} \tilde{\Pi}_{ij}^{g}(Z)}{\sum_{ij=1}^{N} \tilde{\Pi}_{ij}^{g}(Z)} \times 100 = \frac{\sum_{\substack{ij=1 \\ i \neq j}}^{N} \tilde{\Pi}_{ij}^{g}(Z)}{N} \times 100 \quad (8)$$

Where, the parameters remain as earlier defined. The total spillover index captures the contributions of inflation volatilities across the six geopolitical zones to the total forecast error variance. It is possible to measure the direction and degree of spillovers among the regions, using the following equations:

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$$S_{*i}^{g}(Z)=\frac{\sum_{\substack{j=1\\i\neq j}}^{N}\tilde{\Pi}_{ji}^{g}(Z)}{\sum_{ij=1}^{N}\tilde{\Pi}_{ji}^{g}(Z)}\times 100=\frac{\sum_{\substack{j=1\\j\neq i}}^{N}\tilde{\Pi}_{ji}^{g}(Z)}{N}\times 100 \quad (9)$$

$$S_{i*}^{g}(Z)=\frac{\sum_{\substack{i=1\\i\neq j}}^{N}\tilde{\Pi}_{ij}^{g}(Z)}{\sum_{ij=1}^{N}\tilde{\Pi}_{ij}^{g}(Z)}\times 100=\frac{\sum_{\substack{i=1\\i\neq j}}^{N}\tilde{\Pi}_{ij}^{g}(Z)}{N}\times 100$$

(10)

Where, $S_{*i}^{g}(Z)$ in Eq. (11) measures the directional volatility spillovers transmitted from region i to all other regions j; while $S_{i*}^{g}(Z)$ in Eq. (10) measures the directional volatility spillovers received by region i from all other regions j. Given Eqs. (9-10), the index for net spillovers, measuring if any of the regions is a net receiver or donor of volatility, can be obtained as the difference between the gross volatility shocks transmitted to and those received from other regions, thus:

$$S_{i}^{g}(Z)=S_{*i}^{g}(Z)-S_{i*}^{g}(Z) \quad (11)$$

To examine the net pairwise volatility index between regions i and j, we compute the difference between the gross volatility shocks transmitted from region i to region
j And those transmitted from j to i as follows:

$$S_{ij}^{g}(Z)=\left[\frac{\tilde{\Pi}_{ji}^{g}(Z)}{\sum_{i,k=1}^{N}\tilde{\Pi}_{ik}^{g}(Z)}-\frac{\tilde{\Pi}_{ij}^{g}(Z)}{\sum_{j,k=1}^{N}\tilde{\Pi}_{jk}^{g}(Z)}\right]\times 100 =\left[\frac{\tilde{\Pi}_{ji}^{g}(Z)-\tilde{\Pi}_{ij}^{g}(Z)}{N}\right]\times 100 \quad (12)$$

Results and Discussion

Monetary Policy Shock and Sub-National Inflation

For brevity and clarity of analysis, we segment the SVAR results on a regional basis and report only the response of sub-national inflation to the monetary policy shock. Figures 5-10 summarise our findings. In particular, Fig. 5 presents the estimated impulse response of sub-national inflation in the South-East States to a positive shock in monetary policy. The two dotted lines represent the 5% asymptotic error bands, while the solid blue lines represent the impulse function. The overall picture indicates that across the states, there is marked heterogeneity in the response of inflation to a positive shock in monetary policy. In the first quarter, there is a negative reaction of inflation rates in the Anambra, Enugu, and Imo States, but with a reversal in the second quarter. However, in the case of Abia, we observed a shocking spike in inflation within the first three quarters, while the impact was relatively muted in the case of Ebonyi State. From the fourth to sixth quarters, the results indicate that in all the states, the response becomes negative and dies out over time. Notably, none of the results is significant in any of the states in the region. This is a striking outcome which provides an indication that an exogenous monetary policy adjustment may not significantly explain inflation dynamics within the region. Figures 6-7 present the results for the South-West and the South-South respectively. Starting with the SouthWest, we found that apart from Lagos (which is surprising), monetary policy shock generates a negative impact on inflation in the region, at least within the first two quarters, and then an uptick before the impact dies off. In particular, the magnitude of contraction of inflation in the first two quarters ranges from -0.4% in Ekiti, -0.14% in Ogun, 0.03% in Oyo, -0.09% in Osun and -0.02% in Ondo. The case of Lagos shows an initial surprising uptick in prices in response to

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the shock before it assumes a negative path toward the equilibrium. Overall, just like the South-East region, none of the results are significant in the South-West. As one of the megacities and industrial hubs in Nigeria, one could have expected an immediate significant negative response of inflation to monetary policy innovations in Lagos. However, the impact seems to be felt from the second quarter and persists through the fifth quarter before wearing off. Looking at the results for South-South, the overall response is relatively subdued and generally insignificant as well (Fig. 7). The results suggest that the effectiveness of monetary policy in driving inflation in the sub-national economy is largely questionable. In the northern region, results further confirm that monetary policy shocks generate asymmetric regional effects. In contrast to a place like Kebbi and Sokoto, we observed that inflation responds negatively to a positive monetary policy shock in Jigawa, Katsina, Kaduna, and Kano (Fig. 8). However, the reaction is not persistent but short-lived within the first two quarters and tapers off thereafter. For Kebbi and Sokoto, inflation reacts positively within the first two quarters as well against the expected negative response. The same unexpected trends are observed in Bauchi and Borno in the North-East region (Fig. 9) and Nasarawa and Abuja in the North-Central region (Fig. 10).

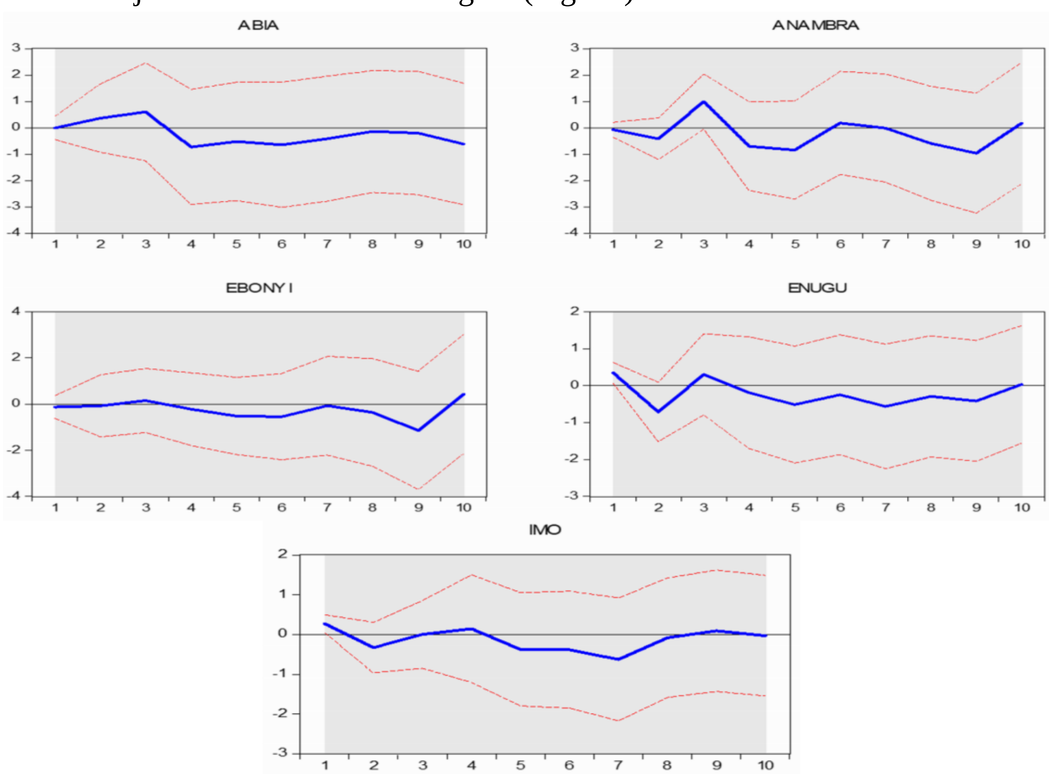

Fig. 5: Response of inflation in Southeast states to monetary policy shock (Cholesky one S.D innovations ┌2 S.E); source: Authors' estimation

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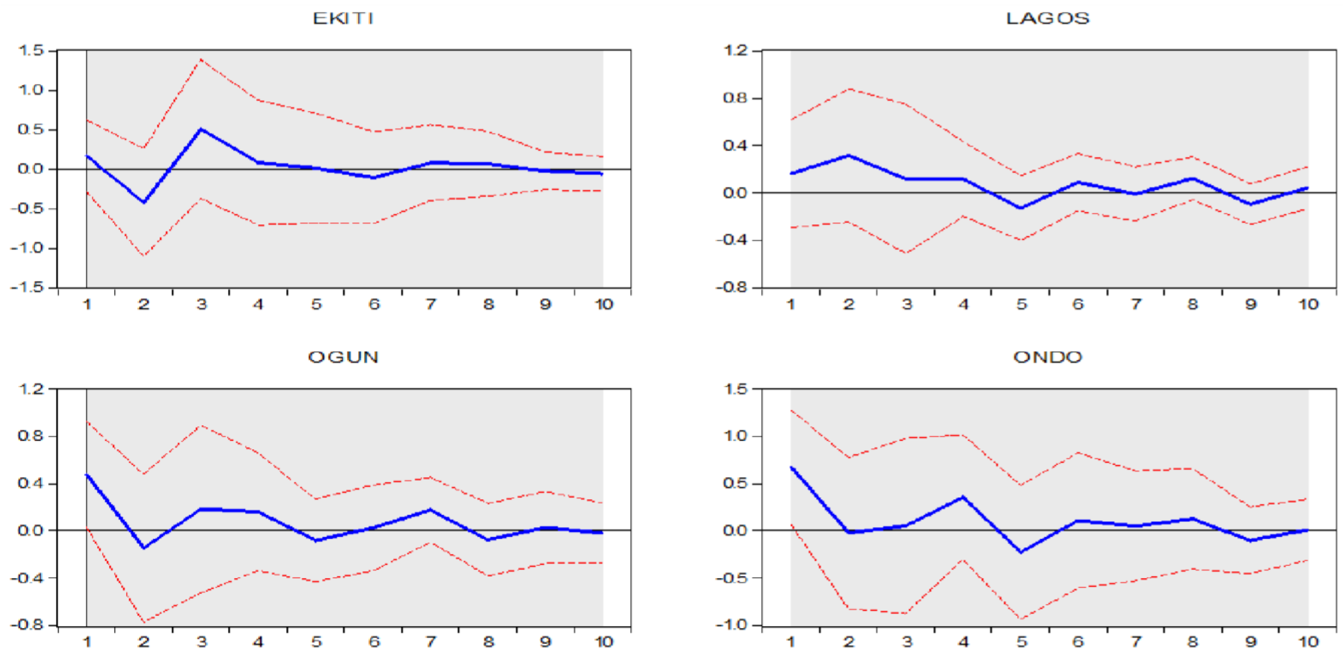

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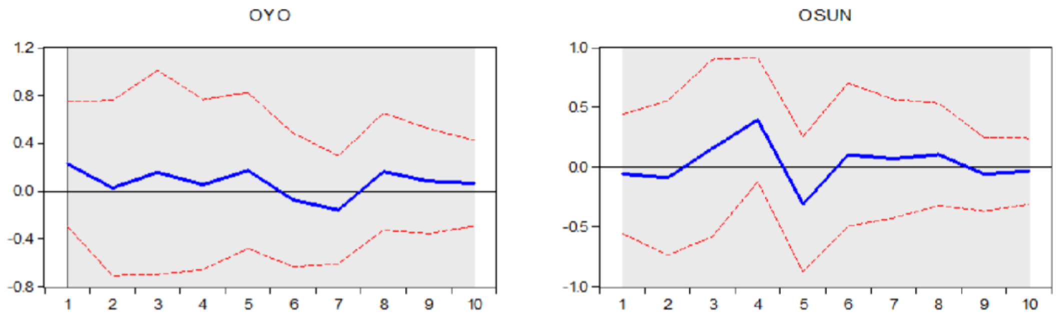
Fig. 6:



Response of inflation in South West states to a shock in monetary policy (Cholesky one S.D innovations □2 S.E); source: Authors' estimation

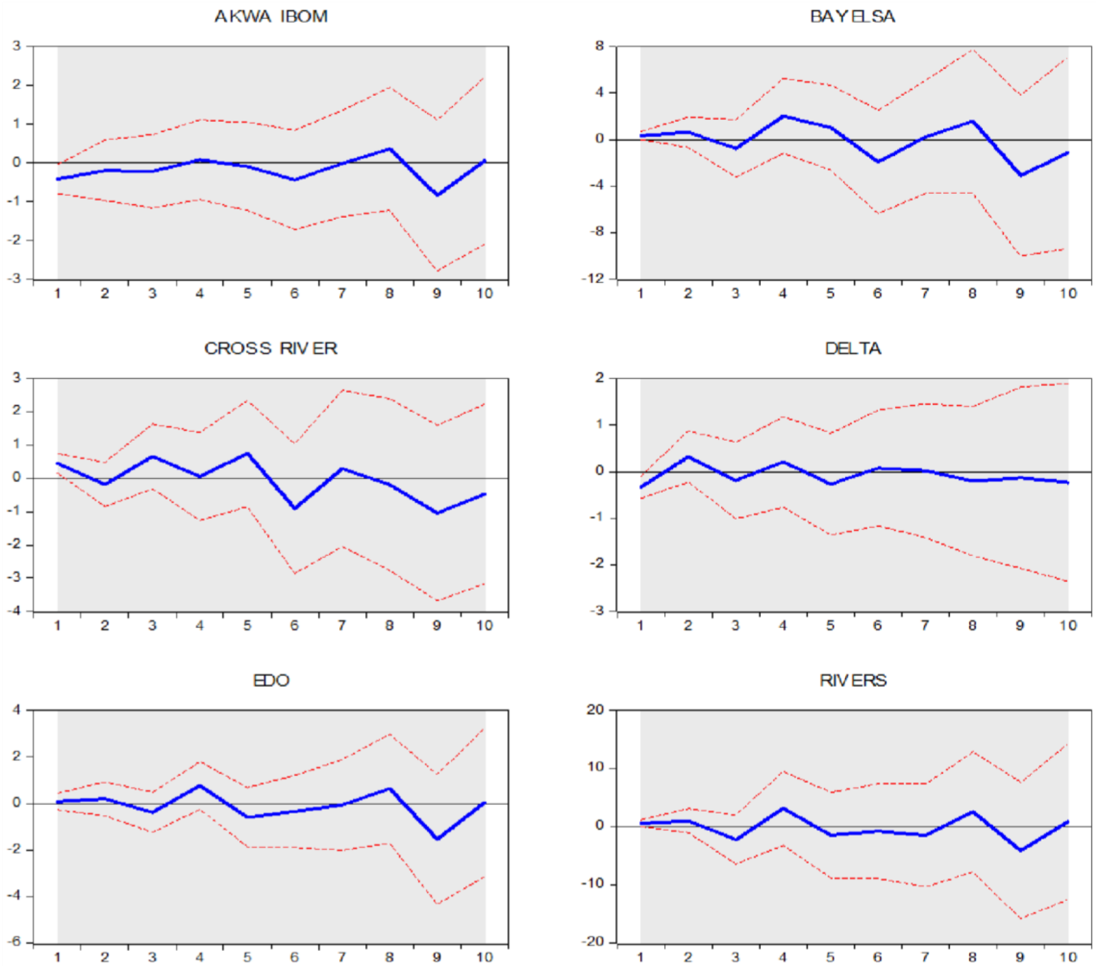


Fig. 7: Response of inflation in South-South states to monetary policy shock (Cholesky one S.D innovations □2 S.E); Source: Unlike other states, we found a significant negative response of inflation to an exogenous monetary policy shock within the first two quarters in the case of Yobe State. However, like others, the impact did not last. An important message from this study is that monetary policy shock generates a heterogeneous but insignificant influence on sub-national inflation in Nigeria. Given the overwhelming and shocking evidence, it seems that structural issues within individual states play a more significant role in influencing sub-national price differences, thereby limiting the impact of monetary policy shocks.

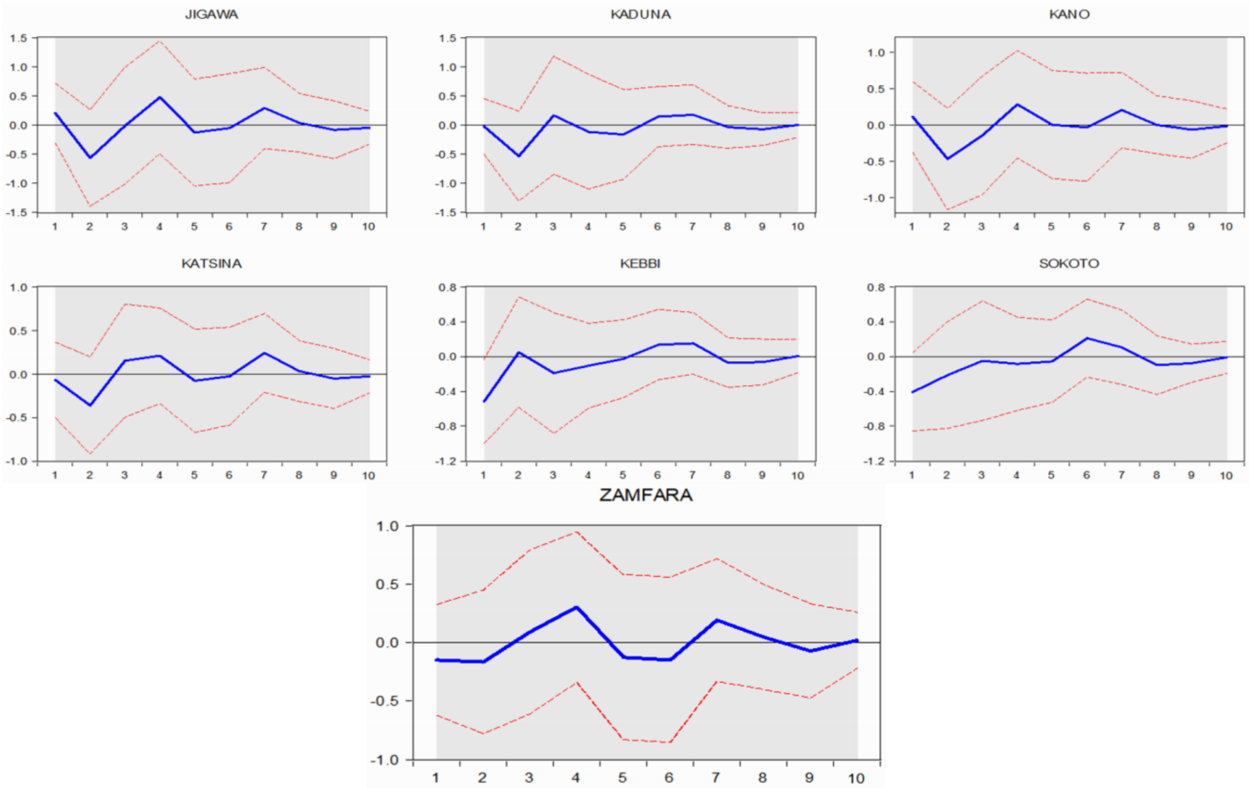
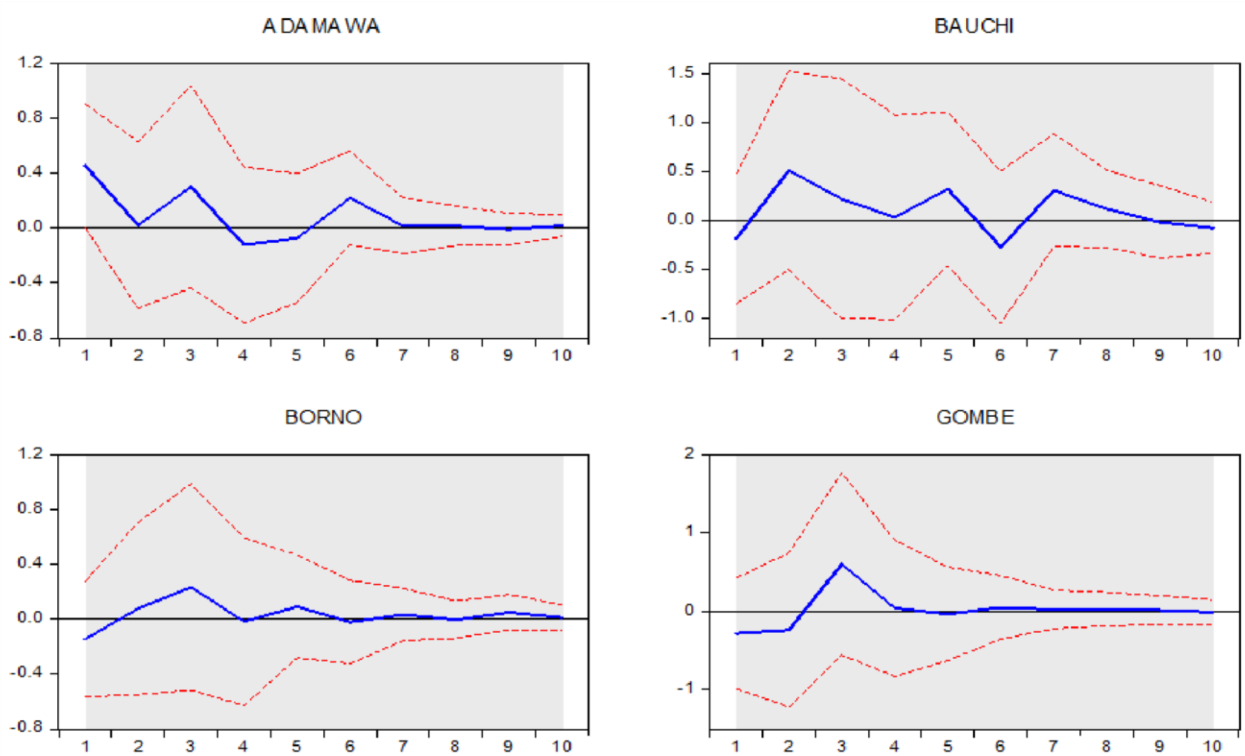


Fig. 8: Response of inflation in North We st states to monetary policy shock (Cholesky one S.D innovations ±2 S.E); source: Authors' estimation



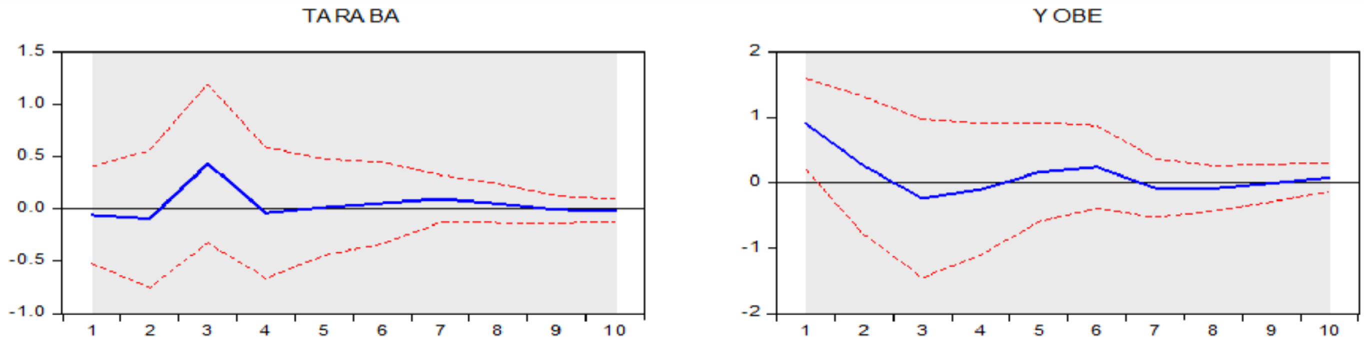


Fig. 9: Response of inflation in North East states to monetary policy shock
(Cholesky one S.D innovations □2 S.E); source:

Authors' estimation

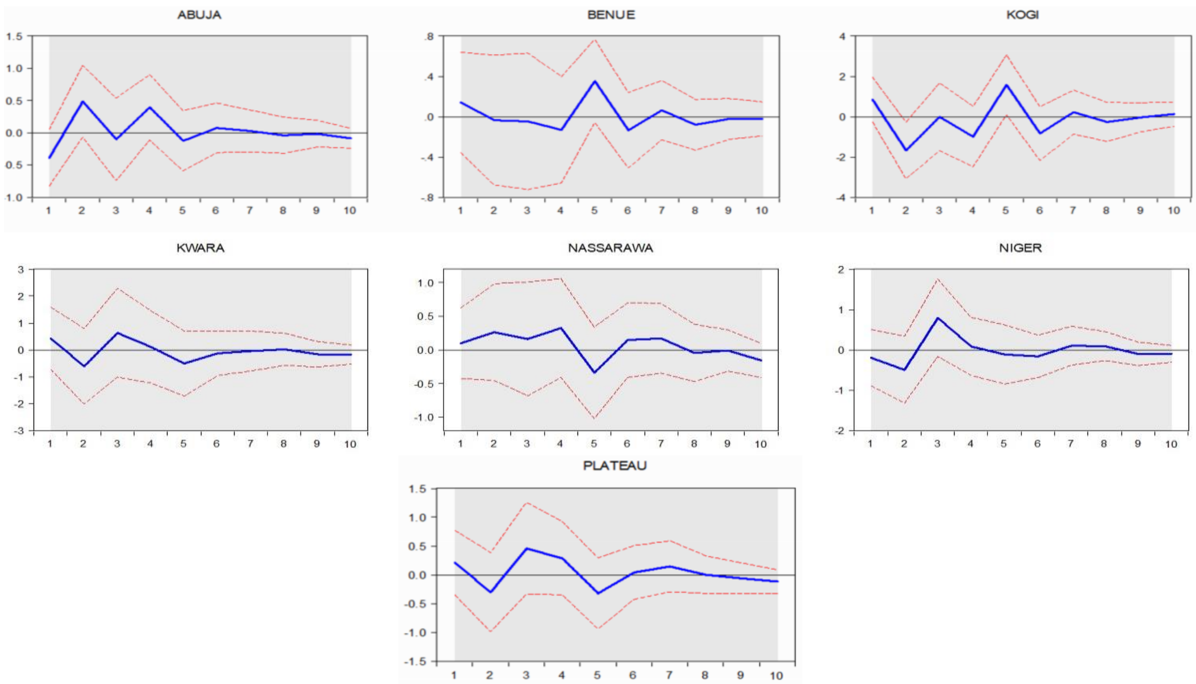


Fig. 10: Response of inflation in Northcentral states and FCI to monetary policy shock (Cholesky one S.D innovations □2 S.E);
Source: Authors' estimation

A closer examination of the impulse response shown in Figs. 5-10 offers preliminary confirmation that spatial spill-overs and geographical proximity are important in sub-national inflation dynamics. Neighboring states appear to exhibit similar reactions to monetary policy shocks.

Regional Inflation Volatility Spillover Results

We obtained the inflation volatility index by applying the Generalized Autoregressive Conditional Heteroskedasticity (GARCH (1,1)) process on the average inflation rates in each of the regions: North-East (NE), North-West (NW), NorthCentral (NC), South-West (SW), South-East (SE) and SouthSouth (SS). Figure A1 (in the appendix), which displays these trends, seems to uncover two major episodes of relatively high volatility of inflation including the era of the 2016 economic recession and the post-COVID-19 era of 2020-2021. To begin the analysis, we perform a pairwise correlation analysis using both the main series and

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Volatility series from each of the regions. This result, as shown in Table 2a (for the main series), indicates evidence of a high correlation of inflation dynamics between the SW and all other regions, except the SS. In particular, the correlation coefficient of the SW with other regions is stronger with the NW (over 80%) and the NC region (over 70%). This could indicate the importance of the SW states, probably Lagos, as either the major contributors or recipients of inflation volatility to or from the other regions. For the SS, the correlation evidence is higher with the SE region than elsewhere, suggesting that most of the volatility of inflation in the SS may have been driven, largely, by developments in the SE region of the country or vice versa. The same high linkage is observed between the NE and NW regions of the country. Alternative results using the volatility series did not generate any substantial variation in these observations (Table 2b). The main results of regional inflation spillovers based on the DYCI methodology are shown in Table 3. The offdiagonal column sums of the table give the ‘’contributions to others’’ while the off-diagonal row sums provide the ‘’contributions from others’’. Each element in each column, other than the main diagonal elements, captures an individual region’s contribution to the forecast error variance of other regions. Similarly, each element in each row, excluding the main diagonal elements, captures the amount of contributions of other regions to the forecast error variance of a particular region under consideration. More precisely, similar to the input-output table, the spillovers or connectivity table illustrates how inflationary pressures are received and transmitted within the sub-national levels. For clarity, it is important to analyze if the region is a net contributor to or receiver of inflation shocks from other regions. As earlier defined, the net inflation volatility spillovers for each of the regions are obtained by subtracting ‘the contributions to others’ from ‘contributions from others’. Using this, a positive percentage point indicates that the region under consideration has a greater inflationary effect on other regions than the inflationary pressures it receives from them. This makes such a region less vulnerable or more resilient to shocks from other geopolitical regions. Conversely, a negative percentage point implies that such a region is more vulnerable to the dynamics of inflation in other regions. Figure 11 displays these values.

Table 2a: Pairwise correlation of regional inflation in Nigeria (main series)

	NC	NE	NW	SE	SS	SW
NC	1 ----					
NE	0.296201***	1				
	0.006200	----				
NW	0.538839***	0.682062***	1			
	0.000000	0.000000	----			
SE	0.095066	0.650655***	0.374772***	1		
	0.389700	0.000000	0.000400	----		
SS	-0.040170	0.391408***	-0.263794**	0.555460***	1	
	0.716800	0.000002	0.015300	0.000000	----	
SW	0.782257***	0.599628***	0.864717***	0.341919***	-0.066526	1
	0.000000	0.000000	0.000000	0.000015	0.547700	

Note: P-values underneath the values; *** p<0.01, ** p<0.05, * p<0.1utation
source: Authors’ co mp

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Table 2b: Pairwise correlation of regional inflation in Nigeria (volatility series)

	NC	NE	NW	SE	SS	SW
NC	1					

NE	0.205765*	1				
	0.060400	----				
NW	0.429361***	0.786109***	1			
	0.000000	0.000000	----			
SE	0.330179***	0.657351***	0.652009***	1		
	0.002200	0.000000	0.000000	----		
SS	0.289882***	0.261658**	0.187326*	0.689805***	1	
	0.007500	0.016200	0.088000	0.000000	----	
SW	0.777938***	0.583918***	0.822830***	0.587971***	0.166818	1
	0.000000	0.000000	0.000000	0.000000	0.129400	----

Note: P-values underneath the values; *** p<0.01, ** p<0.05, * p<0.1 source: Authors' computation

Table 3: Regional inflation volatility spillovers (connectedness)

	NC	NE	NW	SE	SS	SW	Contributions from others
NC	27.0	14.8	14.5	13.8	8.6	21.3	73.0
NE	10.6	24.9	15.5	20.5	11.1	17.4	75.1
NW	17.1	18.0	21.5	15.6	6.3	21.5	78.5
SE	10.9	20.2	14.9	23.3	12.7	18.0	76.7
SS	7.8	19.2	11.8	23.0	24.7	13.4	75.3
SW	20.5	17.2	17.2	15.9	6.5	22.8	77.2
Contribution to others	66.9	89.4	74.0	88.9	45.1	91.6	455.9
Contribution including own	93.9	114.3	95.5	112.2	69.7	114.3	Spill-over index = 76.0%

Source: Authors' computation

Fig.11: Regional inflation net volatility spill-overs (percentage points); source: Authors' computation The results, shown in Fig. 11, indicate that the SW region, with a positive net spillover index of 14.4% points, is a net donor of inflation shocks to the rest of the regions, with 77.2 and 91.6% of gross volatility shocks received from and transmitted to other regions, respectively (Table 3). Inflationary shocks originating from the South-West (SW), where Lagos is a key state, have the most significant impact on other regions. These shocks account for 21.5% of the forecast error variance in the North-East (NE), 21.3% in the North-Central, 18.0% in the South-East (SE), and 17.4% in the NorthEast (NE). The South-South (SS) region experiences the least impact, with 13.4%. The second major shock to sub-national inflation dynamics is traceable to the Northeast (NE), with a positive net spillover index of 14.3% points, accounting for 89.4% of the forecast error variance of other regions. Developments NE's inflation has greater impacts on inflation dynamics in the SE (20.1%), the SS (19.2%), and the NW (18.0%). Furthermore, we also found the SE as the next major transmitter of inflation volatility to other regions, as it accounted for 88.9% of their forecast error variance. The region has a positive net spillover index of 12.2% points. Taken together, the results suggest that developments across the three regions SW, NE, and SE, have serious implications for inflation in the rest of the regions. Instructively, in the past few years to date, the NE and SE have experienced significant insecurity challenges that have contributed immensely to a spike in food inflation as farmers are displaced from their farmlands and movements of available foodstuffs across the countries are impaired. The evidence underscores the gains to price stability in Nigeria if the security situation in the country is satisfactorily addressed. Further analysis of the results indicates that the SouthSouth (SS) region is the most vulnerable region, being a net receiver of inflation volatility shocks from other regions, with the highest negative spillover index of 30.2% points. This is instructive as most of the shocks transmitted to the region are from the SE (12.7%), followed by the NE (11.1%) (Table 3). The NC and the NW, with a negative spillover index of 6.1 and 4.5% points, are also net receivers of inflation volatility shocks, influenced largely by developments in the SW region. Overall, we obtained a total spillover index of 76.0%, computed as the sum of 'contributions to others' (or sum of 'contributions from others') as a percentage of the sum of 'contributions including own'. This captures the total spillovers transmitted among the regions and the extent of their integration or connectedness. The computed value of 76.0% indicates that a significant portion of the total variance in forecast error is explained by shocks across sub-national levels, while the remainder is attributed to other idiosyncratic shocks. This may include shocks that pertain to an individual region, which are internally generated within the region.

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Conclusion

This study pioneers research on the relationship between monetary policy shock, sub-national inflation dynamics, and volatility spillovers in Nigeria. A macroeconomic Structural Vector Autoregressive (SVAR) model is applied to monthly data from 2012:1-2022:07 with money supply and real exchange rate introduced as control variables in the structural factorization. To gain further insight into the possibility of spatial spillover effect, we applied the Diebold-Yilmaz Connectedness Index (DYCI) methodology to model the spillover of inflation volatility and connectedness among the six geopolitical regions. Overall, we found that monetary policy shock has an asymmetric effect on sub-national inflation in Nigeria. In most cases, some states experienced the anticipated negative response, but usually within the first two quarters with a reversal in subsequent quarters. Others experienced a temporal spike in inflation before it died off. However, the impact is found to be generally insignificant. Furthermore, we found substantial evidence of interconnectedness among the regions. Evidence indicates that the South-West, North-East, and South-East are the only resilient regions and net transmitters of inflation volatility to other regions. On the other hand, we found that the South-South is the most vulnerable region, especially to shocks from the South-East. The North Central and North-West regions were also found to be net receivers of inflation volatilities, especially from the South-West region. What does this suggest for policy? For one, the findings indicate that an exogenous monetary policy is not sufficient to address the persistence of inflation at the subnational level. As states respond differently and insignificantly to monetary policy shock, a Complementary fiscal policy (both by the federal and subnational authorities) can be targeted to address the core drivers of inflation at the sub-national level. One of such possible areas include policies that remove any identified constraints to the supply chain such as strengthening interregional network connectivity. A poor road network between Abia State and Akwa Ibom, for instance, could be a significant factor driving higher prices in Uyo (in Akwa Ibom State) relative to Aba (in Abia State), despite the proximity of the two states. Second, possible explanations for inflation dynamics at the sub-national level appear to lie elsewhere than can be accounted for by the instrumentality of monetary policy. It appears that local economic diversities and interregional spillovers may be responsible for such dynamics. Given the importance of the North-East and South-East to regional inflation dynamics, we submit that addressing the insecurity challenges that have largely displaced farmers from their farms in the North-East, restricting movements in the South-East and generally constraining movement of foodstuffs to other regions, would be one of the surest ways of stabilizing prices across all the regions.

References

Anagnostou, A., & Gajewski, P. (2019). Heterogeneous impact of monetary policy on regional economic activity: Empirical evidence for Poland. Emerging Markets Finance and Trade, 55(8), 1893-1906.

Anagnostou, A., & Papadamou, S. (2016). Regional asymmetries in monetary policy transmission: The case of the Greek regions. Environment and Planning C: Government and Policy, 34(5), 795-815.

mpact of monetary shocks on regional output: Evidence from four south Eurozone countries. Region et Development, 39, 105-130.

Arnold, I. J., & Vrugt, E. B. (2002). Regional effects of monetary policy in the Netherlands. International Journal of Business and Economics, 1(2), 123-134.

Ber, H., Blass, A., & Yosha, O. (2001). Monetary transmission in an open economy: The differential impact on exporting and non-exporting firms. Israel: Bank of Israel, Research Department.

Bernanke, B. S., & Gertler, M. (1995). Inside the black box: The credit channel of monetary policy transmission. Journal of Economic Perspectives, 9(4), 27-48.

Montes-Rojas, G., Blanco, E., Pelosegui, P., & Izaguirre, A. (2019). Regional and state heterogeneity of monetary shocks in Argentina. Documentos de trabajo del Instituto Interdisciplinario de Economía Política, (39), 1-28.

Carlino, G., & DeFina, R. (1999). The differential regional effects of monetary policy: Evidence from the US states. Journal of Regional Science, 39(2), 339-358.

Chen, A., & Groenewold, N. (2018). The regional effects of macroeconomic shocks in China. China Economic Review, 48, 139-154. https://doi.org/10.1016/j.chieco.2015.12.003

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. International Journal of Forecasting, 28(1), 57-66.

Diebold, F. X., & Yılmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. Journal of Econometrics, 182(1), 119-134.

Dominguez-Torres, H. & Hierro, L. A. (2018). The regional effects of monetary policy: A survey of the empirical literature. Journal of Economic Surveys,00(0):1-35.

Duran, H. E., & Erdem, U. (2014). Regional effects of monetary policy: Turkey case. Regional and Sectoral Economic Studies, 14(1), 133-144.

Fraser, P., Macdonald, G. A., & Mullineux, A. W. (2014). Regional monetary policy: An Australian perspective. Regional Studies, 48(8), 1419-1433.

Georgopoulos, G. (2009). Measuring regional effects of monetary policy in Canada. Applied Economics, 41(16), 2093-2113.

Groenewold, N., Guoping, L., & Anping, C. (2007). Regional output spillovers in China: Estimates from a VAR model. Papers in Regional Science, 86(1), 101-122.

Guo, X., & Masron, T. A. (2017). Regional effects of monetary policy in China: evidence from China's provinces. Bulletin of Economic Research, 69(2), 178-208.

Original Article

Vespignani, J. L. (2011). On the differential impact of monetary policy across states/territories and its determinants in Australia: Evidence and new methodology from a small open economy. MPRA Paper No. 44998. muenchen.de/44998/, 2011

Vespignani, J. L. (2015). On the differential impact of monetary policy across states/territories and its determinants in Australia: Evidence and new methodology from a small open economy. Journal of International Financial Markets, Institutions and Money, 34, 1-13.

Kearns, J., Schrimpf, A., & Xia, F. D. (2023). Explaining monetary spillovers: The matrix reloaded. Journal of Money, Credit and Banking, 55(6), 1535-1568. https://doi.org/10.1111/jmcb.12996

Li, Y., & Zhang, T. (2018). RETRACTED ARTICLE: Incomplete Exchange Rate Pass-Through: Evidence from Exchange Rate Reform in China. Emerging Markets Finance and Trade, 54(3), 690-706.

Mandalinci, Z. (2015). Effects of monetary policy shocks on UK regional activity: a constrained MFVAR approach (No. 758). Working Paper.

Mishkin, F. S. (1996). The channels of monetary transmission: Lessons for monetary policy.

Nguyen, A. D., Dridi, J., Unsal, F. D., & Williams, O. H. (2017). On the drivers of inflation in Sub-Saharan Africa. International Economics, 151, 71-84.

Owyang, M. T., & Wall, H. J. (2009). Regional VARs and the channels of monetary policy. Applied Economics Letters, 16(12), 1191-1194.

Ridhwan, M. M., de Groot, H. L., Rietveld, P., & Nijkamp, P. (2014). The regional impact of monetary policy in Indonesia. Growth and Change, 45(2), 240-262.

Ridhwan, M. M., de Groot, H. L., Nijkamp, P., & Rietveld, P. (2010). The impact of monetary policy on economic activity: Evidence from a meta-analysis. http://dx.doi.org/10.2139/ssrn.1594036

Svensson, E. (2013). Regional effects of monetary policy in Sweden (No. 2012: 9). Working Paper.

Taylor, J. B. (1995). The monetary transmission mechanism: An empirical framework. Journal of Economic Perspectives, 9(4), 11-26

Weyerstrass, K., van Aarle, B., Kappler, M., & Seymen, Ying, L. G. (2000). Measuring the spillover effects: Some A. (2011). Business cycle synchronisation with (in) Chinese evidence. Papers in Regional the Euro area: In search of a 'Euro effect'. Open Science, 79(1), 75-89.