Rural and Urban price inflation components in Nigeria: Persistence, Connectedness and Spillovers

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Abstract

We checked against the law of one price between urban and rural consumer price indices of goods and services in Nigeria, using data that span January 1995 to April 2024. By first testing for persistence in price indices, we found a similar pattern of persistence that is non-mean reverting in all the CPI components except in Communication and Education where mean reversions are possible in the urban and rural areas. Communication and Restaurants & Hotels are major net inflation transmitters in both urban price region and rural price regions, while Clothing & footwear, and Furnishings & Household equipment maintenance also have minor roles to play in this regard at both price regions. Food & Non-alcoholic beverages; and Alcoholic beverages, tobacco & kola; transportation; Recreation and culture; and Miscellaneous goods and services are major net inflation shock receivers. We found Housing, water, electricity, gas and other fuel; Health; and Education to have different inflation shock transmitting roles for both urban and rural areas. Pricing at urban and rural areas are in tandem, thus policies that could further close the price gaps such as urbanisation and good road systems should be enacted.

Keywords: CPI inflation, Nigeria, Urban-rural price differentials
JEL Classification: C22

1. Introduction

One of the perpetual hindrances to every nation's growth, especially the developing country is inflation and inflation rate. Generally, inflation is the escalation in the price level of services and commodities against a specific standard level of purchasing power. The persistent escalation in prices diminishes the buying capacity of money, resulting in a deterioration of its purchasing power. The inflation rate is determined by the percentage alteration in the mean price level, such as the Consumer Price Index (CPI), or by an implicit price decline in Gross National Product (Gil-Alana, Shittu, & Yaya, 2012). Meanwhile, the CPI measures the changes in the price level of a market basket of these consumer goods and services.

Since the 1970s, Nigeria has encountered heightened and unstable inflation, primarily stemming from the structural features of the economy, such as the devaluation of the naira, escalation in the minimum wage, climatic conditions, and production framework (Masha, 2000). The volatility in inflation escalated in 1990 and peaked in 1995, attributed to an excessive money supply, shortages in commodity availability, limited foreign exchange reserves, as well as labour and political turmoil within the nation (Mordi et. al., 2007). Recent data from the National Bureau of Statistics reveals that Nigeria's headline inflation surged to 34.19% in 2024, marking the highest rate since March 1996. This upsurge in inflation occurred concurrently with the implementation of policies such as the removal of fuel subsidies and the adoption of a floating exchange rate, further depreciating the value of the domestic currency. Notably, within the various components of the inflation basket, food prices, housing & utilities, and beverages & tobacco recorded significant upward pressures. Based on this, inflation in Nigeria has been a continuous and diverse economic concern, with shifting rates having substantial effects on the country's socioeconomic fabric. Nigeria's inflation has fluctuated throughout the last decade, owing to a combination of domestic and external variables. Internal issues include government borrowing, fiscal deficits, inefficiencies in public sector spending, and structural flaws in critical sectors such as agriculture, infrastructure, and industry. Externally, fluctuations in global commodity prices, particularly oil, Nigeria's primary export, and revenue source have a significant impact on inflation dynamics.

The Central Bank of Nigeria controls inflation using methods such as interest rate adjustments and monetary policy measures aimed at stabilizing prices and encouraging economic growth. The monetary agency, the Central Bank of Nigeria (CBN), and the National Bureau of Statistics (NBS) often rely on estimates of inflation from the CPI. The monthly headline inflation is measured in terms of the year-on-year percentage change in the all-items CPI compiled by the NBS for the urban and rural regions, and the fluctuation in the prices characterizes inflation volatility in the country (Omotosho and Doguwa, 2012).

A sizeable number of researchers have studied inflation in Nigeria using varying methods, especially the Box-Jenkins methodology. Mordi et al. (2007) formulated a concise inflation forecasting framework intended for the analysis of inflation risks in Nigeria. At a specific level of disaggregation, the framework predominantly adopts a structural time series model for individual components of the CPI. Forecasts for short-term inflation of the overall CPI entail a weighted aggregation of the forecasts for the twelve CPI components. Subsequently, both the overall CPI and the twelve components are utilized to compute short-term inflation projections. Etuk (2012) applied a seasonal multiplicative autoregressive integrated model to the Nigerian CPI monthly series between March 1963 and December 2003 and found that the series is integrated with order 1, and it exhibits a seasonal component. Similarly, Akpanta and Okorie (2015) suggested a Seasonal Autoregressive Integrated Moving Average (SARIMA) model for Nigerian CPI data from 1996 to 2013, obtaining a non-seasonal integrated order of 2. Doguwa and Alade (2013) found that the headline CPI sub-indices are seasonal and nonstationary time series that are integrated into order 1. The authors therefore modeled the series with both SARIMA and SARIMAX models.

Chinonso and Justice (2016) consider Nigeria's urban and rural all-item CPI from January 2001 to December 2015 and found a significant relationship between them, with high persistent inflation in the case of rural CPI. Ebuh et al. (2021) find the contribution of urban and rural inflation to inflation persistence in Nigeria by employing the fractional cointegrating vector autoregression and the fractional integration models. The results show that urban inflation contributed more persistence than rural inflation to the overall inflation before the global financial crisis of 2007-2008 and the reverse is the case after the global crisis. Olalude et al. (2020) used the monthly inflation series that spanned January 2003 to October 2020 and found that the all-item CPI is trend stationary and exhibits seasonal components and hence modelled the series with a SARMA model. Tule et al. (2020) used the fractional cointegration VAR model developed by Johansen and Nielsen (2012) and supplemented with univariate fractional integration approaches, they discovered evidence of significant inflation persistence in Nigeria, albeit with a decreased trend following the global financial crisis. According to Akande et al. (2023), the primary driver of headline urban and rural inflation in Nigeria is the food CPI, whereas the primary driver of food inflation in Nigeria is bread and cereals. They also discovered that among the primary causes of bread and cereal inflation are biscuits, rice, and garri. The analysis also reveals that certain CPI basket components which are mostly responsible for inflation were given lesser weights. Therefore, focusing just on CPI weights without considering the tipping source could jeopardize Nigeria's ability to successfully control inflation.

The effects of rising inflation in Nigeria are far-reaching. One of the most immediate consequences is a loss of purchasing power for consumers, as the cost of products and services rises faster than income in both urban and rural regions. Inflation weakens the stability of the Nigerian naira, affecting both its currency rate and broader macroeconomic stability.

Broad economic factors like changes in national interest rates, or shifts in currency value can affect both urban and rural areas in similar ways, leading to parallel price movements (Hildebrand, 2019). If urban and rural areas are closely integrated in terms of supply chains, changes in production costs, transportation, or distribution networks can lead to similar price changes in both regions (Donaldson & Hornbeck, 2016). Government policies, such as changes in taxes, subsidies, or regulations, might impact prices across the board, affecting urban and rural areas similarly. As markets become more interconnected, prices in rural and urban areas might converge. This could happen due to improvements in transportation, communication, and technology, which reduce the price differences between these regions. If there is a shift in consumer preferences or demand patterns that affect both urban and rural populations, prices may move together as businesses in both areas respond similarly. Lastly, Events like natural disasters, pandemics, or international economic shifts can impact prices broadly, leading to synchronized price movements across different regions (World Bank, 2020). The law of One Price states that in a perfect market, prices of a commodity should be equal in different regions, given transportation costs, trade barriers and information costs. Furthermore, market segregation will lead to varying prices of commodities in different regions, and the profit-seeking behaviour of market participants will therefore force prices in different regions to the same level (see Cecchetti et al., 2002). Thus, urban and rural pricing might show differentials in their pricing for goods and services within the economy. Both urban and rural CPIs are computed using the 12 food baskets described here as of April 2024 (see NBS, 2024).

The non-exhaustive list of the components of the CPI from CIP baskets are given as: Food & Non-alcoholic beverages (food, bread and cereals, meat, fish, and soft drinks); Alcoholic beverage, tobacco and kola (spirits, wine, tobacco, and narcotics); Clothing and footwear (garments, shoes and other footwears, repair and hire of footwear); Housing, water, electricity, gas and other fuel (actual and imputed rentals for housing, water supply, liquid fuel, electricity, and gas); Furnishings & Household equipment maintenance (furniture and furnishings, household textiles, repair of household appliances, carpets and other floor coverings, and non-durable household goods); Health (pharmaceutical products, medical services, dental services, hospital services, and paramedical services); Transportation (motor cars, motor cycles, passenger transport by air, passenger transport by road, and passenger transport by sea and inland waterways); Communication (postal services, telephone and telefax equipment, and telephone and telefax services); Recreation and culture (photographic development, musical instrument, recreational and sporting services, and audio-visual photographic and information processing equipment); Education (books and stationery); Restaurant and Hotels (accommodation and catering services); and Miscellaneous goods and services (hairdressing salons and personal grooming establishments, jewelry, clocks and watches, appliances, articles and products for personal use, insurance and other services).

In this paper, urban and rural inflation persistence, and dynamic connectedness among basket prices of goods and services are investigated. Fractional integration, as a technique allows for the estimation of series persistence of which values have policy implications in macroeconomic modelling. The unit root is rendered previously as Box et al. (2015) stationary or nonstationary series, being replaced by fractional unit root persistence such that at unit value d from 1 and above, a shock to the series is non-mean reverting, that is it is difficult to revert its path to the mean level, while for d less than 1, shocks to the series are mean reverting, thus there is the tendency to change the dynamic path of the series towards its mean level. The dynamic connectedness approach employed in this work is given in Antonakakis and Gabauer (2017) which is a multivariate volatility modelling method. This is an upgrade to the static connectedness approach of Diebold and Yilmaz (2012) which has the limitation of not being able to provide measures of connectedness over the sampled periods but an average indicating the size and directions of overall connectedness.

The findings obtained in this paper will be of relevance to economic policy and database agencies such as the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS). Such policy recommendations are found at the end of the paper.

2. Data and Methods

2.1 The Data

The datasets analysed are the monthly urban and rural CPI of Nigeria, spanning January 1995 to April 2024. Each group has five main classifications[1]: all items (I1), all items less farm produce (I2), all items less farm produce and energy (I3), imported food (I4) and food (I5). These five classifications are further subdivided into different baskets of goods and services, which are of interest in this paper. These are Food & Non-alcoholic beverages (Ic1); Alcoholic beverage, tobacco and kola (Ic2); Clothing and footwear (Ic3); Housing, water, electricity, gas and other fuel (Ic4); Furnishings & Household equipment maintenance (Ic5); Health (Ic6); Transportation (Ic7); Communication (Ic8); Recreation and culture (Ic9); Education (Ic10); Restaurant and Hotels (Ic11) and Miscellaneous goods and services (Ic12). Altogether, there are 17 inflation series to be considered.

The market items included in the computation of CPIs include 740 goods and services that are regularly priced at both urban and rural sectors of each of the 36 states in the country. Subsequently, prices for each item are averaged within each sector across the state. The mean price is then utilized in determining the fundamental index for each product, by contrasting the current year's price with that of a reference year to derive a relative price. Following this, the

[1] https://nigerianstat.gov.ng/elibrary

Laspeyres price calculation is employed to assess a combined index for each category of goods and services with analogous consumption objectives. The total of the weights multiplied by the relative prices for each item is then divided by the sum of the weights of the items in that category, and the outcome is then multiplied by 100 (refer to NBS, 2024).

Prices in both urban and rural areas are considered, and Table 1 shows basket weights during the base period. The table presents the basket weights in the base period of November 2009 for classes of goods and services in rural and urban areas, including all items CPI. Generally, prices are higher in urban areas than in rural areas except for foods (I5), food and non-alcoholic beverages (I6), clothing and footwear (Ic3), Furnishings & Household equipment maintenance (Ic5) and Health (Ic6).

Table 1: Basket weights in the base period, November 2009 for both Urban and Rural areas

CPIs	Urban	Rural
All items (I1)	1000	1000
All items less farm produce (I2)	552.64	480.09
All items less farm produce and energy (I3)	418.67	394.61
Food (I4)	476.88	532.25
Food & Non-alcoholic beverages (Ic1)	490.59	540.89
Alcoholic beverages, tobacco and kola (Ic2)	11.19	10.61
Clothing and footwear (Ic3)	65.50	85.68
Housing, water, electricity, gas and other fuel (Ic4)	191.51	147.16
Furnishings & Household equipment maintenance (Ic5)	49.81	50.72
Health (Ic6)	27.40	32.25
Transportation (Ic7)	74.54	57.19
Communication (Ic8)	10.14	4.01
Recreation and culture (Ic9)	7.14	6.65
Education (Ic10)	40.05	38.93
Restaurant and Hotels (Ic11)	14.49	10.14
Miscellaneous goods and services (Ic12)	17.65	15.78

Each policy agency in the country has another modified formula for obtaining inflation rates from CPI. Also, due to the fact inflation rate may approach negative value, it is more convenient to work with CPI for price comparison of goods and services within the country. The present paper is of importance to the monetary policy in the country, the Central Bank of Nigeria since it anchors her monetary policy on price stability. The performance of any Central bank is determined by the way price inflation is managed to retain its current inflation rates each month. Each of the CPI price inflation series in Table 1 is obtained based on the Laspeyres price index formula,

$$CPI = \sum_{j} w_{0j} \frac{p_{tj}}{p_{0j}} \tag{1}$$

where p_{tj} and are prices of commodity j in current period t (June 2019)and based period 0 (November 2009), respectively and w_{0j} is the weight of commodity i during the based period.[2]

2.2 Fractional integration method

We employ Robinson (1994) persistence approach to check the persistence of urban and rural CPI basket prices. The approach uses time series x_t in (2), representing errors in a regression model of the form:

$$y_t = \alpha + \beta t + x_t, \quad t = 1, 2, \ldots \tag{2}$$

where y_t is the observed CPI series; α and β are the intercept and coefficient of the linear time trend, respectively; and based on (3), u_t is assumed to be *I* (0), thus, we examine three cases: no regressors ($\alpha = \beta = 0$ a priori), an intercept (α unknown and $\beta = 0$ a priori) and an intercept with a linear trend (α and β unknown):

[2] The National Bureau of Statistics (NBS) conducts monthly price survey in urban and rural areas of Nigeria on goods and services, and obtains both CPI and inflation rate made available to the Central Bank of Nigeria and other economic and financial agencies.

$$y_t = \alpha + \beta t + x_t, (1-L)^d x_t = u_t, u_t \sim I(0) \quad (3)$$

Robinson (1994) also assumes the noise process u_t to follow non-seasonal and seasonal AR which allows to check for seasonality in CPI series as in (4), and for the seasonal AR case, we use:

$$y_t = \alpha + \beta t + x_t, \quad (1-L)^d x_t = u_t, \quad u_t = \phi_1 u_{t-12} + \varepsilon_t \quad (4)$$

where ϕ_1 is the seasonal AR (1) parameter, and ε_t is the error process, assumed to be a white noise process. Estimating the above models involves simultaneously computing the estimates of α, β, and the fractional differencing parameter d with the seasonal AR(1) parameter.

2.3 Time-Varying Parameter VAR method

The persistence approach allows for checking dependencies among CPIs. The following method, which is an updated multivariate volatility modelling approach allows to investigate the volatility spillovers among variables. We employ the TVP-VAR method of Antonakakis and Gabauer (2017) to examine the dynamic connectedness among CPIs. The VAR(p) process is described by the equation:

$$\theta_t x_t = \theta_{1t} x_{t-1} + \theta_{2t} x_{t-2} + \cdots + \theta_{kt} x_{t-k} + \varepsilon_t \quad (5)$$

where $\varepsilon_t \sim N(0, \Sigma)$ is a $N \times 1$ vector; $x_t, x_{t-1}, \dots x_{t-k}$ are CPIs, and are vectors of $N \times 1$ dimension. The coefficients $\theta_{it}, i = 1, 2, \dots, k$ are $N \times N$ time-varying variance-covariance matrix of time-varying VAR coefficients. For any stationary time series vector x_t, the model in (4) can be rewritten as the TVP-VMA(∞) process as $x_t = \delta(B)\varepsilon_t$ with the derivation of $\delta(B)$ from $\theta(B) = [\delta(B)]^{-1}$ where $\theta(B) = [I_N - \theta_{it}B - \cdots, \theta_{pt}B^p]$ is defined as the matrix of moving average lag polynomial with I_N being an identity matrix. The $\delta(B)$ encompasses an infinite number of lags, approximated by $\delta_h(B)$ for horizons h = 1,2, ..., H. Similar to Pesaran and Shin (1998) with the use of the orthogonal version, we compute the generalized forecast error variance decomposition (GFEVD). The GFEVD measures the response of shocks from all variables *j* to a shock in variable *i* in terms of forecast error variance (FEV) given by:

$$\tilde{\vartheta}_{ij,t}(H) = \frac{(\Sigma_t)_{jj}^{-1} \sum_{h=0}^{H} \left[(\delta_h \Sigma_t)_{ijt}\right]^2}{\sum_{h=1}^{H} \left(\delta_h \Sigma_t \delta_h'\right)_{ii}} \tag{6}$$

where $\tilde{\vartheta}_{ij,t}(H)$ represents the contribution of variable *i*th to the FEV of variable *j*th at horizon *H*. The numerator shows the cumulative effects of shocks from *j* to *I*, and the denominator represents the cumulative effect of all shocks within the connected network. To ensure the rows of the decomposition sum to one, we normalize $\bar{\vartheta}_{ij,t}(H)$ as:

$$\bar{\vartheta}_{ij,t}(H) = \frac{\tilde{\vartheta}_{ij,t}(H)}{\sum_{j=1}^{n} \tilde{\vartheta}_{ij,t}(H)} \tag{7}$$

where $\sum_{j=1}^{n} \bar{\vartheta}_{ij,t}(H) = 1$ and $\sum_{i,j=1}^{n} \bar{\vartheta}_{ij,t}(H) = n$.

The degree of network connectedness, or average Total Connectedness Index, TCI_{ij}, of a given variable *i* to any of *j* variables, measures the overall connectivity within the network, calculated by:

$$TFCI_t(d) = n^{-1} \sum_{i=1}^{n} TO_{i,t}(d) = n^{-1} \sum_{i=1}^{n} FROM_{i,t}(d) \tag{8}$$

where $TO_{i,t}(d)$, overall directional connectivity, quantifies the impact of shocks from variable *i* on all other variables *j*. This computed as:

$$TO_{i,t}(d) = \sum_{i=1, i\neq j}^{n} \bar{\varphi}_{ji,t}\,(d) \tag{9}$$

and $FROM_{i,t}(d)$ measures the shocks received by variable *i* from all other variables, *j*, in the network. This is given as,

$$FROM_{i,t}(d) = \sum_{i=1, i\neq j}^{n} \bar{\varphi}_{ij,t}\,(d) \tag{10}$$

Directional connectedness or the difference between $TO_{i,t}(d)$ and $FROM_{i,t}(d)$ is computed as,

$$NET_{i,t}(d) = TO_{i,t}(d) - FROM_{i,t}(d) \tag{11}$$

If $NET_{i,t}(d)$ > 0, then variable *i* is a net transmitter of shocks in the network of connectedness whereas variables *j* become the net receiver of shocks. Otherwise, if $NET_{i,t}(d)$ < 0, variable *i* is a net receiver while variables *j* become the net transmitters.

At the bilateral level, the net pairwise directional frequency connectedness (NPDFC) assesses the risk transmission between two specific variables *i* and *j:*

$$NPDFC_{ij,t}(d) = NET_{i,t}(d) - NET_{j,t}(d) \tag{12}$$

A positive $NPDFC_{ij,t}(d)$ indicates variable *i* dominates *j* in terms of connectedness, suggesting that shocks to *i* spill over to *j*. Conversely, a negative $NPDFC_{ij,t}(d)$ value implies that variable *j* dominates variable *i*. Thus, shocks to asset price *j* have a spillover effect on asset price *i*.

3. Empirical Results and Discussion

3.1 Persistence results for Urban and Rural CPI inflations

Results of persistence computed from fractional integration models in (3) and (4) for white noise disturbance and seasonal autoregression of order 1 [i.e. AR(1)]. Thus, seasonality, that is, the monthly effect in the monthly CPIs basket prices are investigated using $u_t = \phi_1 u_{t-12} + \varepsilon_t$. In Table 2, it is observed that persistence of CPIs are above 1 in all basket prices under urban areas, while there are cases of mean reversion in prices in rural areas, for instance, in Communication and Education. By allowing for seasonality, the persistence of rural CPIs reduced in compared to those computed under white noise disturbance, while in the case of urban CPIs, the results are mixed. When compared the persistence at urban with those of rural, slight differences are observed and these warrant investigating variables linkages and spillovers using the dynamic connectedness approach.

Table 2: Estimates of Fractional persistence, d of CPI

	White noise disturbance	
Inflation (CPI)	**Urban**	**Rural**
Food & Non-alcoholic beverages (Ic1)	1.7839	1.6817

Alcoholic beverage, tobacco and kola (Ic2)	1.2473	1.1706
Clothing and footwear (Ic3)	1.2274	1.1874
Housing, water, electricity, gas and other fuel (Ic4)	1.3886	1.3281
Furnishings & Household equipment maintenance (Ic5)	1.1970	1.2003
Health (Ic6)	1.1204	1.1055
Transportation (Ic7)	1.4050	1.1483
Communication (Ic8)	1.1353	0.9006
Recreation and culture (Ic9)	1.0583	1.0172
Education (Ic10)	1.1600	0.9363
Restaurant and Hotels (Ic11)	1.2229	1.1555
Miscellaneous goods and services (Ic12)	1.2401	1.0485

	Seasonal AR(1) disturbance	
Inflation (CPI)	**Urban**	**Rural**
Food & Non-alcoholic beverages (Ic1)	1.7451	1.6505
Alcoholic beverage, tobacco and kola (Ic2)	1.2216	1.1382
Clothing and footwear (Ic3)	1.2442	1.1461
Housing, water, electricity, gas and other fuel (Ic4)	1.3865	1.3100
Furnishings & Household equipment maintenance (Ic5)	1.1698	1.1637
Health (Ic6)	1.1151	1.0683
Transportation (Ic7)	1.3923	1.1163
Communication (Ic8)	1.1296	0.8935
Recreation and culture (Ic9)	1.0399	1.0008
Education (Ic10)	1.1292	0.8742
Restaurant and Hotels (Ic11)	1.2017	1.1250
Miscellaneous goods and services (Ic12)	1.2142	1.0095

3.2 TVP-VAR modelling results

3.2.1 Preliminaries

Due to the fact that the dynamic connectedness model (TVP-VAR in this case) is a kind of multivariate volatility modelling approach, therefore, onus lies on us to transform price inflations via CPI to log-returns as stated. Let *i* represent each CPI time series, then the returns series $r_{i,t}$ is computed based on the transformation formular,

$$r_{i,t} = 100 \times \ln\left(CPI_{i,t}\right)$$

Thus, $r_{i,t}$ is now used as proxies for inflation rates in this context since theoretically, inflation rates are CPI changes.

Table 4: Summary statistics for the log-returns of CPIs

	Mean	Variance	Skewness	Ex. Kurtosis	JB	ERS	Q (20)	$Q^2(20)$
Urban Inflation (CPI)								
All items (I1)	0.011***	0.000***	0.804***	4.142***	288.6***	-2.780***	39.0***	56.8***
All items less farm produce (I2)	0.011***	0.000***	1.105***	5.583***	527.3***	-7.515***	20.6**	62.5***
All items less farm produce and energy (I3)	0.010***	0.000***	0.276**	4.637***	318.8***	-3.338***	17.7**	103.1***
Food (I4)	0.012***	0.000***	0.268**	4.662***	322.0***	-2.177**	44.1***	82.3***
Food & Non-alcoholic beverages (Ic1)	0.012***	0.000***	0.256**	4.787***	338.9***	-2.232**	49.5***	83.2***
Alcoholic beverage, tobacco and kola (Ic2)	0.009***	0.001***	-0.692***	13.683***	2766.1***	-1.384	119.9***	165.4***
Clothing and footwear (Ic3)	0.009***	0.001***	-4.063***	50.141***	37733.8***	-8.003***	42.8***	19.1**
Housing, water, electricity, gas and other fuel (Ic4)	0.012***	0.002***	0.762***	8.075***	987.4***	-3.674***	14.5	60.9***
Furnishings & Household equipment maintenance (Ic5)	0.008***	0.001***	0.146	31.407***	14427.4***	-6.305***	154.2***	146.7***
Health (Ic6)	0.009***	0.003***	-0.352***	25.957***	9861.2***	-9.451***	79.0***	159.1***
Transportation (Ic7)	0.011***	0.001***	0.411***	5.659***	478.2***	-5.095***	31.4***	91.7***
Communication (Ic8)	0.005***	0.001***	8.295***	100.188***	150824.4***	-7.689***	75.1***	53.2***
Recreation and culture (Ic9)	0.009***	0.002***	-0.472***	15.253***	3415.5***	-5.815***	79.2***	118.6***
Education (Ic10)	0.009**	0.006***	1.744***	38.573***	21937.8***	-9.781***	179.5***	166.6***
Restaurant and Hotels (Ic11)	0.007***	0.002***	0.560***	14.710***	3183.0***	-7.156***	41.2***	115.8***
Miscellaneous goods and services (Ic12)	0.012***	0.002***	3.116***	26.785***	11060.3***	-8.335***	26.0***	13.4
Rural Inflation (CPI)								
All items (I1)	0.011***	0.000***	0.249*	3.935***	230.0***	-1.912*	59.8***	68.7***
All items less farm produce (I2)	0.010***	0.000***	0.360***	7.891***	918.4***	-1.917*	16.4*	86.8***
All items less farm produce and energy (I3)	0.009***	0.000***	-1.531***	8.576***	1212.6***	-2.445**	21.8***	106.1***
Food (I4)	0.011***	0.001***	0.534***	5.995***	542.3***	-3.029***	88.7***	37.7***
Food & Non-alcoholic beverages (Ic1)	0.011***	0.000***	0.561***	6.096***	561.8***	-2.947***	87.1***	37.3***
Alcoholic beverage, tobacco and kola (Ic2)	0.009***	0.001***	0.012	4.420***	285.8***	-2.299**	58.9***	108.6***
Clothing and footwear (Ic3)	0.008***	0.001***	-0.195	9.824***	1413.6***	-1.339	73.9***	117.3***
Housing, water, electricity, gas and other fuel (Ic4)	0.012***	0.001***	0.552***	7.763***	899.3***	-1.363	37.1***	60.3***
Furnishings & Household equipment maintenance (Ic5)	0.007***	0.001***	0.632***	8.027***	965.8***	-1.453	27.9***	15.9*
Health (Ic6)	0.008***	0.002***	1.304***	16.855***	4254.3***	-4.342***	155.7***	110.5***
Transportation (Ic7)	0.009***	0.002***	0.246*	8.837***	1145.7***	-2.147**	67.3***	123.3***
Communication (Ic8)	0.005*	0.003***	2.130***	24.316***	8912.9***	-7.203***	35.5***	42.8***
Recreation and culture (Ic9)	0.009***	0.002***	1.107***	54.033***	42770.6***	-6.298***	38.6***	56.6***
Education (Ic10)	0.007	0.010***	-1.166***	37.649***	20809.8***	-11.548***	123.6***	134.5***
Restaurant and Hotels (Ic11)	0.008***	0.002***	0.730***	12.666***	2377.5***	-8.980***	59.3***	288.3***
Miscellaneous goods and services (Ic12)	0.011***	0.003***	0.577***	13.877***	2835.9***	-3.301***	70.9***	132.9***

3.2.2 Results of Average Connectedness

Tables 5 and 6 provide the average connectedness results for CPI inflation in urban and rural areas, respectively. The Housing, water, electricity, gas and other fuel (Ic4) showed the biggest proportion of own-variance spillover (71.44%) for overall connectedness in the network of other variables, meaning that the balance of 28.56% comes from other variables. As a result, this item can only transmit 28.55% of the return spillover to other variables in the network, making it a net shock receiver (NET = -0.01) in the network. On the other hand, Clothing and footwear (Ic3) had the lowest share of own-variance spillover (45.77%) for overall connectedness in the network of other variables, meaning that the balance of 54.23% comes from other variables. As a result, this item can transmit 59.70% returns spillover to other variables in the network, making it a net shock transmitter (NET = 5.47) in the system. Net shock transmitters for urban CPI inflation include Clothing and footwear (Ic3), Furnishings & Household equipment maintenance (Ic5), Health (Ic6), Communication (Ic8), and Restaurant and Hotels (Ic11), with lc8 being the strongest inflation shock transmitter. Others in the network if urban CPI price baskets are net shock receivers. Thus, Food & Non-alcoholic beverages (Ic1), Alcoholic beverage, tobacco and kola (Ic2), Housing, water, electricity, gas and other fuel (Ic4), Transportation (Ic7), Recreation and culture (Ic9), Education (Ic10), and Miscellaneous goods and services (Ic12) are in this category.

For rural CPI inflation (Table 6), the results are similar to that of the urban CPI inflation except that lc6 became a net inflation shock receiver, while lc10 became a net shock transmitter. Also, in contrast to urban CPI inflation, lc8 showed the biggest proportion of own-variance spillover (73.03%) for overall connectedness in the network of other variables, meaning that the balance of 26.97% comes from other variables. As a result, this item can transmit 71.67% of the return spillover to other variables in the network, making lc8 a strong net shock transmitter (NET = 44.71) in the network. On the other hand, lc11 had the lowest share of own-variance spillover (42.62%) for overall connectedness in the network of other variables, meaning that the balance of 57.38% comes from other variables. As a result, this item can transmit 73.95% returns spillover to other variables in the network, making lc11 a net shock transmitter (NET = 16.57) in the system. The results of NET above show that interactions among urban CPI prices for baskets of goods and services in Nigeria compares closely with those of rural areas, as a result of law of one price. Further, the connectedness index (TCI) is 42.41 for the urban CPI baskets and 44.14 for the rural CPI, of which this compares fairly.

Table 5: Average connectedness for urban CPI Inflation

	Ic1	Ic2	Ic3	Ic4	Ic5	Ic6	Ic7	Ic8	Ic9	Ic10	Ic11	Ic12	FROM
Ic1	54.31	3.69	4.16	2.05	4.92	3.17	3.46	7.27	2.56	3.22	7.82	3.37	45.69
Ic2	5.32	56.51	6.42	4.50	3.47	3.16	2.85	5.11	4.67	2.72	2.76	2.50	43.49
Ic3	4.83	2.08	45.77	1.68	10.45	10.56	3.89	4.14	3.77	4.04	4.05	4.73	54.23
Ic4	2.32	3.63	2.86	71.44	2.02	4.03	2.96	1.77	1.58	2.56	1.82	3.01	28.56
Ic5	4.88	1.38	11.50	2.16	52.83	4.33	3.60	5.46	2.96	3.18	4.65	3.05	47.17
Ic6	2.88	2.02	10.85	2.13	4.54	54.66	3.07	2.89	1.61	4.64	4.75	5.95	45.34
Ic7	3.24	2.37	6.27	4.88	5.69	3.01	59.88	1.97	1.64	2.58	3.31	5.17	40.12
Ic8	3.66	2.23	3.27	1.12	3.96	1.05	1.19	65.83	3.33	1.82	9.95	2.57	34.17
Ic9	3.62	5.10	4.12	1.54	3.40	1.68	2.08	8.12	61.25	1.50	3.67	3.93	38.75
Ic10	2.63	1.22	3.91	1.25	3.57	4.81	2.97	8.84	1.20	52.18	13.21	4.21	47.82
Ic11	3.43	1.82	1.25	1.35	2.52	1.77	1.64	17.86	2.17	2.52	62.39	1.30	37.61
Ic12	4.30	0.92	5.08	5.90	4.07	7.80	3.84	2.18	2.83	6.29	2.74	54.05	45.95
TO	41.10	26.48	59.70	28.55	48.63	45.37	31.56	65.62	28.32	35.07	58.72	39.78	508.90
Inc.Own	95.41	82.99	105.47	99.99	101.46	100.03	91.44	131.45	89.57	87.25	121.11	93.84	TCI
NET	-4.59	-17.01	5.47	-0.01	1.46	0.03	-8.56	31.45	-10.43	-12.75	21.11	-6.16	42.41

Table 6: Average connectedness for rural CPI Inflation

	Ic1	Ic2	Ic3	Ic4	Ic5	Ic6	Ic7	Ic8	Ic9	Ic10	Ic11	Ic12	FROM
Ic1	51.59	3.80	5.37	3.23	6.37	5.35	3.19	4.17	3.44	5.15	6.77	1.57	48.41
Ic2	5.30	60.68	4.51	3.69	5.33	2.03	3.07	7.17	1.88	1.93	2.50	1.92	39.32
Ic3	3.40	2.95	47.10	2.11	10.36	3.30	4.47	6.05	1.81	6.21	11.27	0.98	52.90
Ic4	2.50	2.15	6.31	62.11	2.86	3.36	3.28	4.14	2.03	2.84	4.15	4.28	37.89
Ic5	5.31	4.44	10.41	1.87	46.40	3.47	4.34	5.11	2.24	5.89	8.65	1.86	53.60
Ic6	5.13	1.52	7.96	2.84	6.31	48.93	3.61	2.88	2.55	7.29	6.18	4.81	51.07
Ic7	3.57	2.20	5.03	3.26	4.47	3.09	57.21	5.54	1.35	5.04	7.40	1.83	42.79
Ic8	1.15	1.36	1.84	1.14	1.87	2.22	1.87	73.03	2.55	6.95	5.08	0.94	26.97
Ic9	3.62	1.63	2.83	4.87	3.14	2.22	2.21	3.70	64.80	1.99	6.08	2.90	35.20
Ic10	2.77	0.79	4.11	1.55	5.65	4.63	2.84	11.36	1.09	51.37	13.17	0.67	48.63
Ic11	2.99	0.95	6.71	1.56	5.95	2.66	4.55	19.65	1.27	10.11	42.62	0.98	57.38
Ic12	1.78	1.92	2.63	4.75	2.49	6.69	2.76	1.92	3.91	4.01	2.69	64.43	35.57
TO	37.51	23.71	57.71	30.90	54.80	39.03	36.19	71.67	24.11	57.41	73.95	22.73	529.71
Inc.Own	89.10	84.39	104.81	93.01	101.20	87.96	93.40	144.71	88.91	108.78	116.57	87.17	TCI
NET	-10.90	-15.61	4.81	-6.99	1.20	-12.04	-6.60	44.71	-11.09	8.78	16.57	-12.83	44.14

3.2.3 Results of Dynamic Connectedness and Network plots

Figure 1 depicts the dynamic total connectedness for urban CPI inflations, which fluctuated between 35% and 79% and reached its peak (78-80%) between 2023 and 2024, coinciding with the withdrawal of fuel subsidies. The first peak, which occurred between 2003 and 2004, might be attributed to Naira devaluation, which increased the cost of imported commodities, leading to rising local prices and, as a result, boosted inflation in Nigeria during this period.

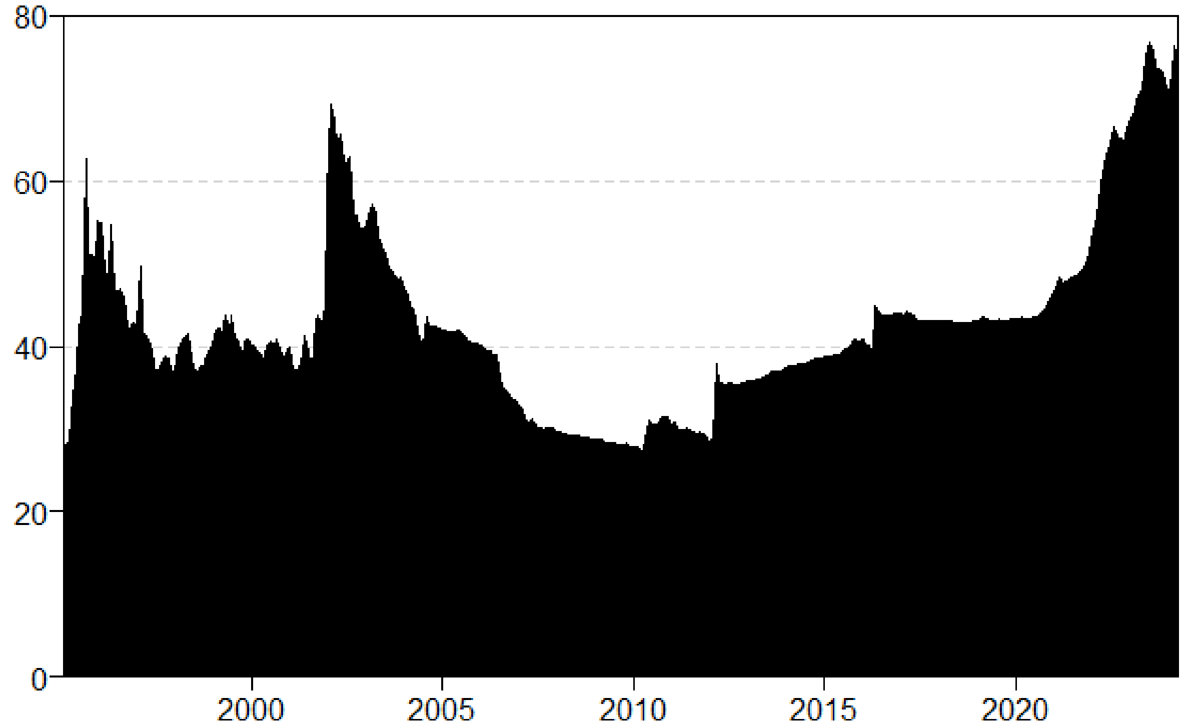

Figure 1: Dynamic Total Connectedness for Urban CPI inflation

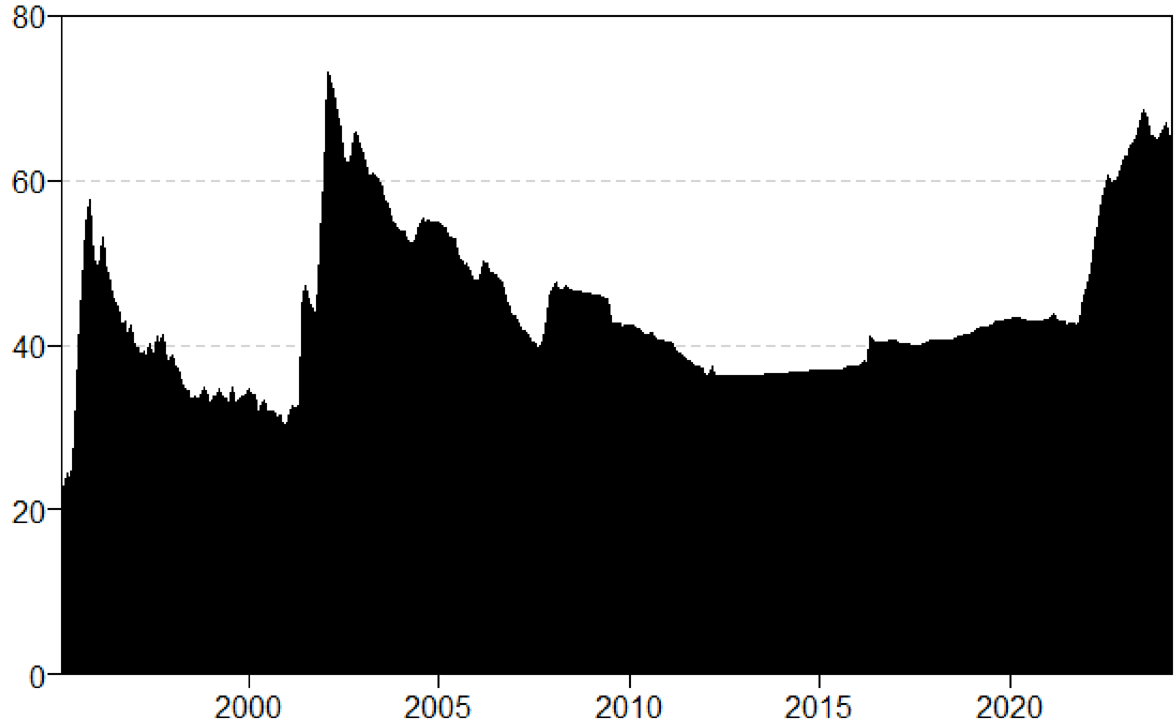

Figure 2: Dynamic Total Connectedness for Rural CPI inflation

Figure 2 depicts the dynamic total connectedness for rural CPI inflation, which shows a similar pattern with that of the urban CPI inflation. However, in contrast to the urban CPI inflation, the dynamic total connectedness for rural CPI inflation reached its peak (70-77%) between 2002 and 2004, coinciding with the period of Naira devaluation, which increased the cost of imported commodities, leading to rising local prices and, as a result, boosted inflation in Nigeria during this period in this price zone for CPI. Figure 3 indicates that Communication (Ic8) and Restaurant and Hotels (Ic11), over the historical period, have consistently maintained their net shock transmitting ability to other items in the urban CPI inflation, but Alcoholic beverage, tobacco and kola (Ic2) and Miscellaneous goods and services (Ic12) have consistently maintained their strong net inflation shock receiving abilities. Until roughly 2002, Housing, water, electricity, gas and other fuel (Ic4) and Health (Ic6) were net shock transmitters, but they eventually became consistent net shock receivers. Obviously, Communication (Ic8) and Restaurant and Hotels (Ic11) are major drivers of the remaining inflation basket items in the urban areas.

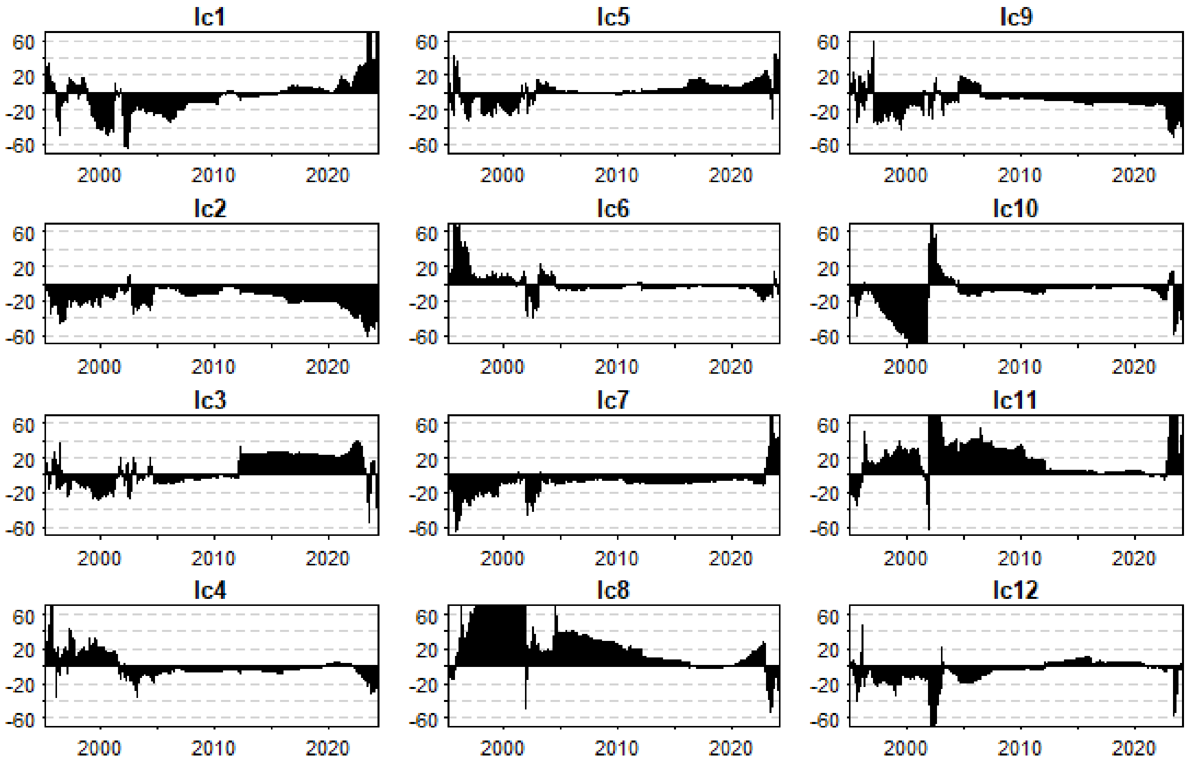

Figure 3: Net Total Directional Connectedness (Urban CPI inflation)

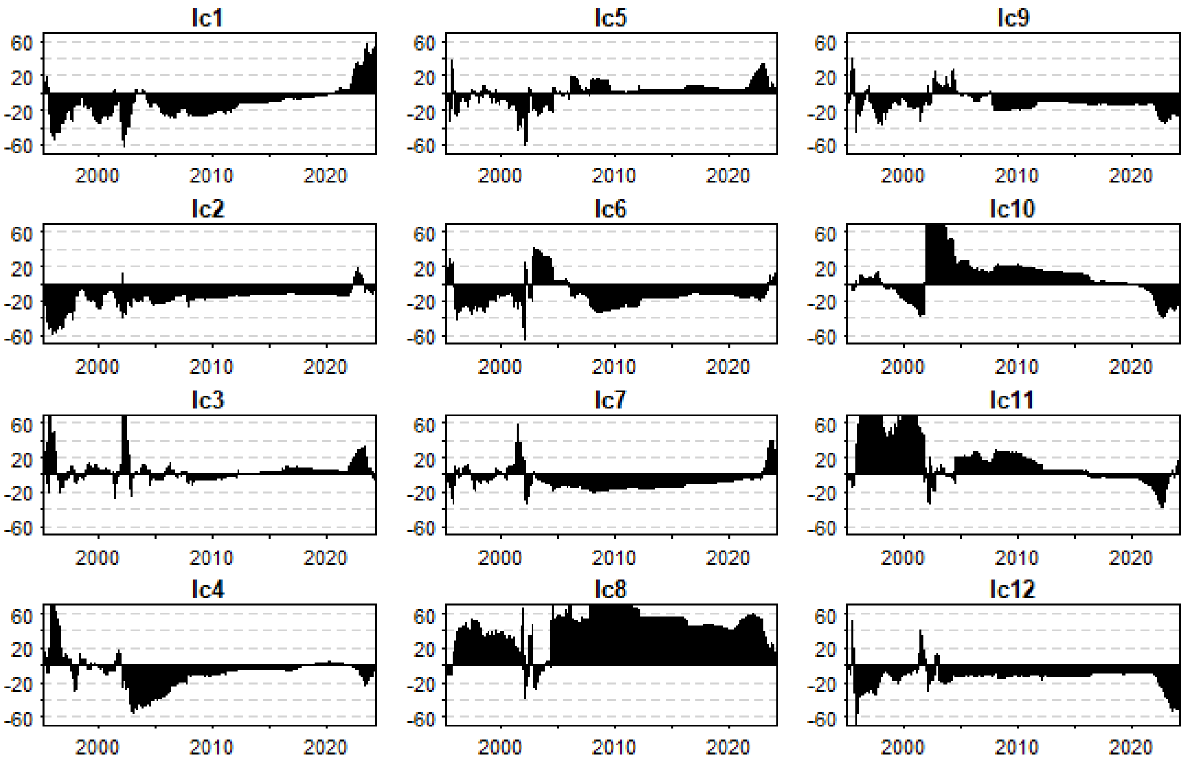

Figure 4: Net Total Directional Connectedness (Rural CPI inflation)

In the rural areas, Figure 4 indicates that the lc8 have consistently maintained its net shock transmitting ability to other items in the rural CPI inflation, but the lc2 and lc12 have consistently developed into a strong net inflation shock receiver. Until roughly 2002, Education (Ic10) was a net shock receiver, but developed into a net shock transmitter afterwards until 2020, a period of COVID-19 pandemic, when it became a net shock receiver. Ic11 was a net shock transmitter until 2012 and became a net shock receiver afterwards. Unarguably, Communication (Ic8) is the major driver of the remaining inflation items in the rural areas.

Figures 5 and 6 show the interconnectedness of the CPI inflation components, with arrows indicating the direction of shock transmissions among different CPI basket prices in urban, and in rural areas, respectively. The BLUE-coloured oval shapes are the net shock transmitters while the ORANGE-coloured ones are the net shock receivers. Obviously, as detected earlier in the results, Ic8 and Ic11 are very strong net inflation transmitters in both urban price region and rural price region. From Figure 5, most shocks from Communication (Ic8) are transmitted bilaterally to Restaurant and Hotels (Ic11), Education (Ic10), and Recreation and culture (Ic9). While Ic8 transmits very weak shocks to Food & Non-alcoholic beverages (Ic1) and Alcoholic beverage, tobacco and kola (Ic2). Ic8 does not connect, or have spillover effects on the following: Transportation (Ic7), Furnishings & Household equipment maintenance (Ic5), Housing, water, electricity, gas and other fuel (Ic4), Clothing and footwear (Ic3), and Miscellaneous goods and services (Ic12). Restaurant and Hotels (Ic11) transmits most shocks to Ic10, and the remaining to Ic1, Ic3, and Ic6.

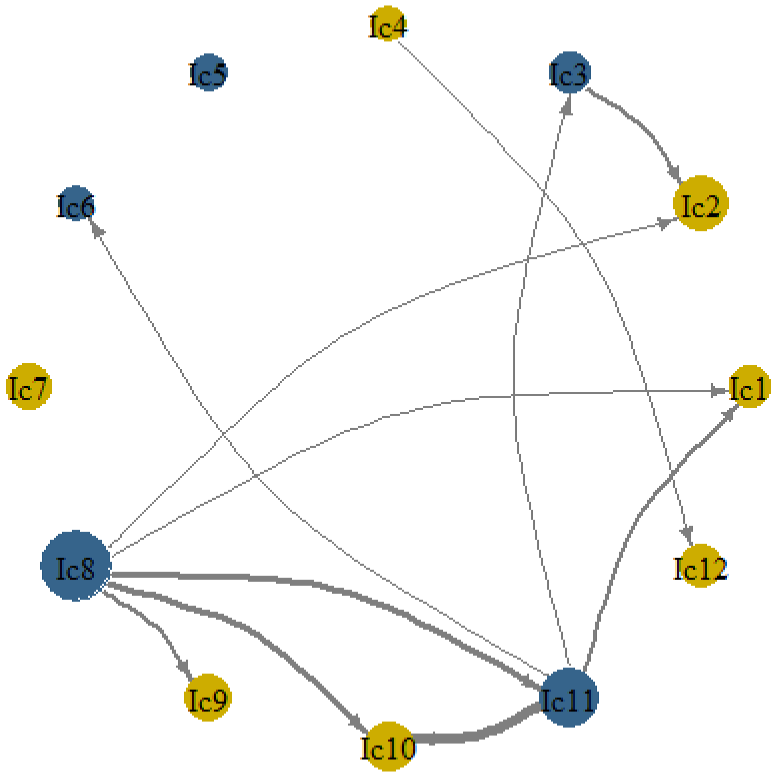

Figure 5: Network plots based on NPDC (Urban CPI inflation)

In the case of rural CPI baskets, similarly to urban pricings, Ic8 still transmits most shocks to 1c11, and the remaining shocks are transmitted to Ic7, Ic10, Ic3, and Ic2. Ic11 transmits shocks to Ic9, Ic3, and Ic1, while Ic3 transmits shocks to Ic4 and Ic6.

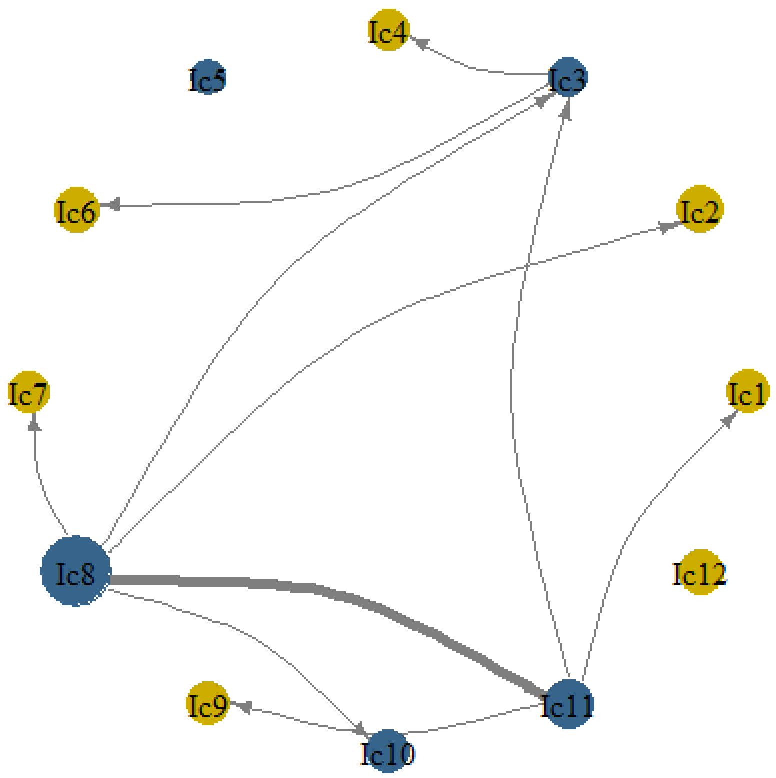

Figure 6: Network plots based on NPDC (Rural CPI inflation)

4. Conclusions

According to the law of one price, in an ideal market, a commodity's price should be the same across all regions. This law does not hold in Nigeria due to factors like transportation costs, trade barriers, and information costs. Additionally, consumers' purchasing power is diminishing because the cost of goods and services increases more quickly than income in both Nigeria's urban and rural areas. This article examines the durability of inflation in both urban and rural areas, as well as the dynamic connectivity between the basket prices of commodities and services. The monthly CPI of Nigeria for both urban and rural areas, with subdivisions of various baskets of goods and services that are relevant to this article, is one of the datasets analyzed. These are: Food & Non-alcoholic beverages; Alcoholic beverage, tobacco and kola; Clothing and footwear; Housing, water, electricity, gas and other fuel; Furnishings & Household equipment maintenance; Health; Transportation; Communication; Recreation and culture; Education; Restaurant and Hotels and Miscellaneous goods and services. The data spans the period from January 1995 to April 2024.

Results of persistence indicate similar pattern of pricing at both urban and rural areas with pronounced seasonality. CPIs are non-mean reverting in all cases except in Communication and Education where mean reversions are found. Communication, and Restaurant & Hotels are major net inflation transmitters in both urban price region and rural price region, while Clothing & footwear, and Furnishings & Household equipment maintenance also have minor role to play in this regard at both price regions. Food & Non-alcoholic beverages; Alcoholic beverage, tobacco & kola; transportation; Recreation and culture; and Miscellaneous goods and services are major net inflation shock receivers. At the rural areas, Housing, water, electricity, gas and other fuel, and Health have very strong net inflation shock receiving tendencies, while inflation shocks only have mild effect on the components of CPI at the sub-regions. Education is a strong net inflation shock receiver at the urban side, while Education emerged a strong net shock transmitter at the rural areas.

Most CPI components have CPI inflation patterns in the form of similar inflation shocks, even though law of one price does not hold but similar transmission pattern observed in findings can lead to the equality of pricing in the two regions if relevant policies to alleviate this are put in place. Thus, policies that will improve urbanisation, access roads for transporting goods and services, good transportation system, as well as subsidies and support programs will obviously further close the gap between urban and rural prices.

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