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# TRANSMISSION MECHANISM FROM EXCHANGE RATE TO CONSUMER PRICE INDEX: EVIDENCE FROM VAR MODEL IN NIGERIA

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ABSTRACT
*The direction of flow is not certain in which variations in the exchange rate could be transmitted to the consumer price index. To examine the transmission mechanism arising from the exchange rate to consumer price index in the Nigerian economy, eight variables-VAR model was employed in this regard. The data for the study span from the period first quarter of 2009 to the fourth quarter of 2021. The results had it that exchange rate devaluation is transmitted directly to consumer price index through a rise in the net exports and also the aggregate demand. The study therefore, recommends a rise in terms of outputs in local production so that the weight of the inflationary impact of the exchange rate devaluation could be minimal.*
**Keywords**: transmission mechanism, exchange rate, consumer price index, import price, money supply, net export and the producer price index.
**JEL Classification:** D11, D12, O24

## 1.0 Introduction

The direction of flow is not certain in which variations in exchange rate could be transmitted to the consumer price index. McCarthy (2008) examined the exchange rate transmission in the developed countries using the model analysis of price-distribution chain which emanates from exchange rate to the import price index (IPI), import price to the producer price index (PPI), and also from producer price to consumer price(CPI). No doubt that Volkan, Satcioglu, and Korap (2017) agreed with McCarthy and employed the VAR technique to examine the pass-through effect of exchange rate and import price changes penetrating into the producer price (PPI) and consumer price (CPI) inflation. On the other side of the coin, Holod (2020); and Imimole and Enoma (2021) found out that exchange rate devaluation is transmitted directly to the consumer price index through the imported goods channel paid by the domestic consumers.

By these studies, exchange rate devaluation can only exhibit a direct impact on the price level through overall supply shocks. For us to ascertain this, we should note that exchange rate devaluation can be transmitted to the consumer price index through a rise in the net export and aggregate demand. Base on this, the argument on the demand side holds. Hence, the rationale for this research is to establish the type of transmission mechanisms arising from the exchange rate to the consumer price index in Nigeria's economy.

The research study is structured into five sections. One and two are the introduction and literature review. Section three is methodology. section four is the

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findings and discussions, while section five is the conclusion and policy recommendations.

## 2.0 Literature Review

In line with the provision of the objective of this study, we provide the following provisions arising from the economic theory which demonstrate transmission mechanism from exchange rate to consumer price index.

The floating rate exchange has it that exchange rate fluctuations can have a strong positive relationship on price level through the aggregate demand and supply. On the side of aggregate supply, devaluation of local currency can affect the price level through the import of foreign goods.

By this situation it connotes that the country is the recipient country of the international prices. No direct influence from the devaluation of currency against the price level of a country can occur from the price of capital goods imported by the manufacturers inputs.

Achani, Fauzi and Abdullah (2021) found that exchange rate devaluation makes the price of inputs more expensive thereby making the cost of production high. By this, the manufacturers increase the price of their final products. As a result, the aggregate price level increases.

In an open economy, a devaluation of domestic currency is inflationary because by this action, the price of our local currency will rise. Therefore, the exchange rate affects economic activities through which is the channel for monetary policy drive. A decrease in interest rates stimulates aggregate demand and increases inflation for the reason being that monetary policy generally affects inflation more quickly through the exchange rate channel than through the aggregate demand channel. It becomes more appropriate to use the direct exchange rates channel to regulate inflation in a short term (Ryan and Thompson, 2015).

To establish the flow of the transmission mechanism between the exchange rate and the consumer price index, the study found it relevant to examine the various channels through which the impact in which the variations from money supply is transmitted to price index as well as exchange rate. Based on this, the study considered two transmission mechanisms arising from money supply to exchange rate. These are:

(i) If there exist a rise in money supply a corresponding increase in the output level, the marginal money supply will increase prices in the economy. This increase in the price level will warrant an increase in the exchange rate.

(ii) A reduction in the interest rate is a reaction function of a rise in the money supply.

The transmission Mechanism from exchange rate to the consumer price index can exist taken a look at the following:

(a) A rise in the money supply act as function of a fall in the domestic interest rate. The fall in interest rate arising from this will warrant exchange rate depreciation.

(b) Exchange rate devaluation is transmitted directly to the consumer price index through the import of goods and services.

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(c) The devaluation of the exchange rate can be transmitted to the consumer price index through a rise in the price of capital goods imported which form the factor costs to the manufacturers of goods and services.

The other part of the review takes a look at the related literature to this study.

Imimole and Enoma(2021) investigated the impact of exchange rate depreciation on inflation in Nigeria from 1986 – 2015, applying Auto Regressive Distributed Lag (ARDL) and Johansen Co-integration was used to determine the existence of long-run equilibrium relationship, and this was attained. In line with the Lag Length Selection Criteria, the study regressed one year lagged value of inflation rate, current nominal exchange rate of the naira in terms of US dollar, current nominal broad money supply, current government expenditure and real GDP in the current period on current inflation rate. The results reveal that exchange rate depreciation, money supply and real gross domestic product remained the main determinants of inflation in Nigeria. That naira depreciation exhibits direct relationship with inflationary trend in Nigeria and also found statistically significant at the 0.05 with inflation.

Volkan, Satcioglu, and Korap (2017) examined the level to which variation in exchange rates affect changes in the Turkish inflationary level. Based on this, there area of focus is to investigate if there has been a change in the magnitude of the impact from the pre–2003 period to the post–2003, when there was a floating exchange rate. The study applied monthly time series data using VAR technique which allows impulse-response functions and variance decomposition. The results reveal that exchange rate shock feed into the domestic inflation, first at the level of manufacturers' prices and then at the level of consumer prices and that the impact of the shocks on the price at various stages of supply chain varies. The findings revealed that the magnitude of the impact has fallen within the post-2003 period compared to the pre-2003 period during the early stages of the production process and this reflection of the predominance of the manufacturer price index to determine the inflationary rate in Turkey. More also, the impact of reduction in the exchange rates pass-through on domestic prices agrees with 0.25 decline in the post-2003 consumer price inflation. However, the consideration of the impact of exchange rate variation on the domestic inflationary process remains the key to enable the monetary policies in the Turkish economy to achieve its target.

McCarthy (2008) examined the impact of exchange rates and import prices on domestic producer price index (PPI) and CPI in six industrialized OECD countries using data from 1976:1 to 2007:4. The study employed a recursive VAR framework in the examination. From the impulse response function and variance decomposition the study found out that the exchange rate has a moderate effect on domestic price over the post-Bretton Woods era. Another finding is that the pass-through is stronger in countries with a large import share.

Holod (2021) investigated the relationship among the consumer price index

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(CPI) exchange rate and money supply in Ukrain economy by employing the vector error correction technique. The findings shown that exchange rate shock has a direct relation with the price level variable. In addition, the result also demonstrates responsiveness of money supply shock to the price level.

Quite a number of studies on the Exchange Rate Transmission Mechanism (ERTM) took place in Africa nations, in this regard Mohamadu and Phillip (2019), examined the relationship among exchange rate, money supply and inflation rate in Ghana applying the Error Correction Mechanism (ECM). The findings revealed that there exist long-run equilibrium relationship among real income, exchange rate and money supply. The result also found out that in the long-run, the inflationary trend in Ghana would have a positive impact on the economy in line with the money supply, and that the exchange rate demonstrates inverse relationship to real income.

Madesha, Chidoka and Zaranmoyo (2018) investigate the relationship that exists between exchange rate and inflation in Zimbabwe during the period 1980 to 2015, hence they carried out econometric examination, in the process, they used Granger causality test stimate and the results revealed that both the exchange rate and inflation rate have long-run equilibrium relationship. On the other hand, inflation and exchange rate are found to granger cause each other during the period under study.

Odusola and Akinlo (2021)used vector autoregressive (VAR) technique to examine whether or not currency devaluation could impact on the domestic output and inflation in the Nigerian economy. Quarterly time series data for Gross Domestic Product (GDP), broad money supply, official exchange rate, parallel exchange rate, consumer price index; CPI and lending rates were used in the study beginning from the period 1970Q1 to 1995Q4. The restricted vector autoregressive (VAR) model demonstrate how devaluation impacted on output and inflation in Nigeria.

The studies reveal that exchange rate depreciation can be transmitted to consumer price index through the aggregate supply shocks. This may or may not be true because demand side argument may also hold.

## 3.0 Methodology

### 3.1 Methodological Framework

The Purchasing Power Parity theory suggests that the nominal exchange rate is determined mainly by factors that influence the domestic price level. The money supply might be an important determinant of the price level, and therefore could be an indirect factor influencing the exchange rate. The rise in money supply may also lead to exchange rate depreciation through a fall in domestic interest rate. The money supply, price level (proxy by CPI), interest rate, and exchange rate are included in the model in order to establish the channel through which the impact of a variation in money supply is transmitted to exchange rate.

No doubt that quite a good numbers of empirical research studies such as McCarthy (2008) used VAR method to determine the pass-through impact of exchange rate and import price variation to producer (PPI) and consumer (CPI) inflation. McCarthy (2008)

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examined the ERPT in the industrialized countries by analyzing the model of pricing through a distribution chain, from an exchange rate variation to the import price to the producer price (PPI) and finally from producer price to the consumer price (CPI). To achieve the objective for this study, we modified McCarthy's model in this research work by including retail price index and Wholesale price index for the reason of transmitting the impact of the exchange rate shocks to CPI. The retail price index and wholesale price index were integrated into the model hence we can track the pass-through effect from exchange rate fluctuation to the distribution chain. The net export is also included in the model to take care of the price effect of an increase in aggregate demand caused by exchange rate devaluation when exchange rate experienced a devaluation.

### 3.2 The Vector Autoregressive (VAR) Model

Equation (1) below accounts for a VAR model having eight dependent variables i.e consumer price index (CPI); exchange rate (EXR); money supply (MSP); interest rate (INT); net exports (NXP); import price index (IPI); producer price index (PPI); and retail and wholesale price index (RWI). The model is summarized in the reduced-form of VAR as in equation (1) below:

$$Y_i = \alpha_o + \sum_{i=1}^{n} \beta_i Y_{t-i} + u_i \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where $Y_t$ is a 8*1 vector of variables (CPI, EXR, MSP, INT, NXP IPI, PPI, RWI. $\beta_i$ is coefficient matrices of size 8×8 and $u_i$ is the one-step ahead prediction error with variance-covariance matrix $\Sigma$, $\alpha_o$ is the intercept. All variables are in normal form.

In this research study, the VAR technique is applied in order to determine the transmission mechanism arising from exchange rate to consumer price index in the Nigerian economy. VAR model technique is important because it plays a key role in the interpretation of findings. The most appropriate ordering is: CPI – EXR – MSP – INT– NXP – IPI – PPI – RWI. The CPI act as a great impact on the money supply, hence CPI should appear first in our estimated VAR. Money supply affects the exchange rate indirectly through the interest rate channel. Therefore, exchange rate affects CPI through net exports, hence we can rightly say that, exchange rate also affects CPI directly or indirectly through import price index, producer price index, and retail and wholesale price index.

### 3.3 Model Estimation Techniques

#### 3.3.1 Unit Root Test

For us to test for stationarity which has been considered necessary for the time series data, the study used Augmented Dickey Fuller (ADF) test to ascertain stationarity. In this respect, the hypothesis is that: If the absolute value of the Augmented Dickey Fuller (ADF) test is found greater than the critical value at the 5 percent level of significance, then we reject the hypothesis of no stationarity. The Augumented Dicky Fuller test equation is specified as follows:

$$\Delta\hat{u}_t = \beta\hat{u}_{t-1} + \sum_{i=1}^{k} \Delta\hat{u}_{t-1} + \varepsilon_t$$

…….…….. (2)

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### 3.3.2 Co-integration and Error Correction

The traditional economic theory is based on the assumption that economic series have a constant mean and finite variance, implying that the variables are stationary. On the other hand, a non-stationary series is characterized with varying the mean or variance, and any reference to it must be within a particular time frame. However, most economic series are not stationary hence any Ordinary Least Squares (OLS) estimation will yield spurious results. In recent time, Engle and Granger (1987), have demonstrated that OLS estimation can still be valid if a linear combination of any non-stationary series is stationary. By this, the variables are said to be co-integrated. If the variables are found unit root free, then we can apply VAR technique for the estimation, in which case any shock to the stationary variables will be temporary. If the variables are non-stationary and not co-integrated, then they have to be transformed into stationary variables by differencing, before VAR technique can be applied. Shocks to the differenced variables will only have a temporary effect on the growth rate but permanent effect on its level. It is important to note that co-integrated non-stationary variables require the inclusion of a vector of co-integrating residuals i.e adjustment matrix in the VAR with differenced variables. This is known as a vector error correction model (VECM) which has been found relevant for Granger Representation Theorem that co-integrated variables could be related through an error correction mechanism, hence we specified the equation bellow:

$$\Delta y_t = Lagged(\Delta y_{t,} \Delta x_t) - \lambda u_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where

$u_{t-1}$ denotes the disequilibrium error term

$y_t = \beta_0 + \beta_1 x_1 + u_t$

$\lambda$ = short adjustment parameter

### 3.3.3 Lag Length Selection Criteria

The lag length selection criteria for the VAR (p) model can be determined by using model selection criteria. The overall rule is to fit VAR (p) models with orders p = 0…p max and select the value of p which minimizes some model selection criteria. Model selection criteria for VAR (p) models can be characterized as:

$$IC(p) = \ln\left|\tilde{\Sigma}(p)\right| + C_T.\psi(n, p) \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where $\tilde{\Sigma}(p) = T^{-1}\sum_{t=1}^{T}\hat{\Sigma}_t\,\hat{\Sigma}_t'$ which is the residual covariance matrix without degrees of freedom correction from a VAR(p) model, $C_T$ is a sequence indexed by the sample size T, and $\psi(n, p)$ is a penalty function which penalizes large VAR(p) models and these are vital in our VAR lag length selection.

### 3.4 Sources of Data

The empirical analysis is conducted using quarterly data from the first quarter 2009 to the fourth quarter 2021. The data were obtained from various issues of the

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Central Bank of Nigeria Statistical Bulletin 2000 and 2021. Exchange rate data weighted average nominal exchange rate of the naira per unit of U.S. dollar. The import commodity price index of January 2017=100 is used as import price index. An average implicit price deflator for agricultural and industrial goods and services is used as a measure of producer price index. Implicit price deflator for retail and wholesale trade is used as a measure of RWI. CPI of November 2019=100 is used for the estimation of the model. The treasury bill rates (average discount rates on 3-month instruments) is the interest rate used to capture the variation arising from the Central Bank's behavior. The quarterly data of narrow money supply ($M_1$) was preferred to broad money supply ($M_2$) for the reason being that $M_2$ includes foreign currency deposits and is there more difficult to be control by the monetary authorities. The annual time series data for the net export were collected and interpolated into the quarterly data time series. We applied the quadratic-match average technique for data processing for the interpolation to appropriately capture the objective of the study.

## 4.0 Findings and Discussions

### 4.1 Unit Root Test Results

No doubt that empirical work based on the time series data assumes that the underlying time series is stationary. Now, the tests for stationarity of the time series data should precede our model estimation. A well-known test that is valid for large samples is the Augmented Dickey Fuller (ADF) test which was developed by Dickey and Fuller (1979). The results of the Augmented Dickey Fuller (ADF) test for the variables used in our estimation of VAR model in this study are presented in table1 below.

**Table 1 Augmented Dickey-Fuller Test Results**

| Variable | Level | Prob. | 1st Diff | Prob. |
|---|---|---|---|---|
| CPI | -4.2051 | 0.0321 | - | - |
| EXR | -1.2469 | 0.6470 | -5.3707 | 0.0000 |
| MSP | 1.0774 | 0.9968 | -8.1425 | 0.0000 |
| INT | -2.4443 | 0.1351 | -8.3492 | 0.0000 |
| NXP | -0.7336 | 0.8278 | -5.5899 | 0.0000 |
| IPI | -2.5729 | 0.1052 | -9.7390 | 0.0000 |
| PPI | 0.4827 | 0.9841 | -2.8703 | 0.0561 |
| RWI | -1.2597 | 0.6407 | -16.2476 | 0.0023 |

SourceExtracted from ADF test results estimated using E-view 9

Critical values: 1% = -3.6601, 5% = -2.9199

The ADF test outputs indicate that only the CPI variable is stationary at level while others are stationary at first difference. These can be seen by comparing the absolute

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values of the ADF statistics with the critical values at the 5 percent level of significance. Since the variables used in the study are stationary at level and at first differences, the null hypothesis of non-stationarity of the time series data is however rejected. The ADF test indicates that the variables are in different order of integration. Therefore, we can now proceed for the co-integration test.

**4.2 Lag Length Selection**

Find below in table 5 the results of the lag length selection criteria. Quarterly time series data are employed for this study and the maximum lag is 4 as indicated by the Final prediction error (FPE) denoting the minimum value.

**. Table 5 VAR Order Selection Criteria**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -2770.352 | NA | 2.65e+22 | 122.7521 | 122.8242 | 122.3303 |
| 1 | -2464.254 | 451.8211 | 3.45e+25 | 103.1432 | 113.8055 | 105.1721 |
| 2 | -2521.423 | 127.7501 | 6.72e+27 | 102.2611 | 112.4412 | 108.2230 |
| 3 | -2331.551 | 102.7411 | 1.73e+22 | 104.1771 | 113.6685 | 107.1140 |
| 4 | -224 | 95.1250* | 2.17e+26* | 101.55 10* | 111.44 21* | 104.37 10* |
| | 1.991 | | | | | |

*Indicates lag order selected by the criterion

Source: Author's Computation from the estimated output 2023

**4.3 Co-integration Test**

Now that we have ascertained the stationarity of the time series data used in this study, we proceeded to test whether or not there exist co-integration among the variables used in the study. This has become relevant because by differencing the time series data of the variables, the truth is that they would have lost some degrees of freedom hence, diverging from long-run equilibrium.

The Johansen multivariate co-integration technique is applied thereby ignoring the Engle Granger technique. The two justifications that account for the use of Johansen technique are: first the unit root results reveal that the variables are of different order of integration, and this is a precondition for the adoption of Johansen technique. The second justification is that the model specified denotes a multivariate type. This is a violation of the Engle-Granger technique (1987) which is only found suitable for testing for co-integration between two variables. Therefore, the results obtained from Johansen multivariate co-integration technique are given in table 2 and 3 below.

Table 2: Unrestricted Co-Integration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critica |
|---|---|---|---|
| None* | 0.8122 | 259.7465 | 157.42 |
| At most 1* | 0.5553 | 174.4833 | 126.62 |

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| | | | | |
|---|---|---|---|---|
| At most 2* | 0.5352 | 121.2243 | 94.7435 | 0.0000 |
| At most 3* | 0.4749 | 72.8132 | 68.8843 | 0.0132 |
| At most 4* | 0.4610 | 46.4431 | 47.7541 | 0.0422 |
| At most 5* | 0.2361 | 24 4501 | 29.7650 | 0.1488 |
| At most 6* | 0.1402 | 12.8865 | 15.8471 | 0.1637 |
| At most 7* | 0.0671 | 5.8898 | 3.6452 | 0.0124 |

Source: Researcher Co-integration test Results 2023
*denotes rejection of the hypothesis at the 0.05 level
**Mackinnon-Hauq-Michlis

Table 3: Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value |
|---|---|---|---|
| None* | 0.71223 | 82.3632 | 52.4637 |
| At most 1* | 0.7453 | 51.2682 | 45.2285 |
| At most 2* | 0.5256 | 40.4112 | 39.0566 |
| At most 3* | 0.4639 | 33.2467 | 34.8852 |
| At most 4* | 0.3622 | 22.1030 | 26.3621 |
| At most 5* | 0.2632 | 14.3551 | 21.2314 |
| At most 6* | 0.1501 | 6.8764 | 14.1625 |
| At most 7* | 0.0461 | 4.6683 | 3.9524 |

Source: Researcher Co-integration test Results 2023
Max-eigenvalue test indicates 3 co-integrating eqn(s) at the 0.05 level
*denote the rejection of the hypothesis at the 0.05 level

From table 2 and 3 above, the trace test shows 5 co-integration equations at the 5 percent level and the maximum eigenvalue test also shows 3 co-integrating equations at the 5 percent level. The two tests indicate the rejection of the null hypothesis of no existing co-integration at 5 percent level.

**4.4 Vector Error Correction Mechanism**

The results from the co-integration test show that there exist a significant long-run relationship among the variables. However, for the reason of the presence of long-run equilibrium relationship among the variables in the model does not completely mean that every variable in the model exhibit significant impact on the endogenous variable. Therefore, there is to ascertain which variable actually explain the observed long run relationship, hence the need to estimate the long run model and then analyze the findings. Based on this, Vector Error Correction estimates are presented in table 4 below:

**Table 4: Vector Error Correction (VEC) Estimates**

| Short-Run VEC Estimates | | Long-Run VEC Estimates | |
|---|---|---|---|
| Error Correction | D(CPI) | Co-integrating Eq | CoinEq 1 |
| CointEq 1 | -0.0711 [-1.1861] | _ | _ |
| CPI(-2) | 0.2429 [0.6659] | CPI(-1) | 1.0000 |
| D[MSP(-1)] | 1.55E-1 [1.0346] | MSP(-1) | -2.02E-03 [-0.7701] |
| D[INT(-3)] | -0.0446 [-0.3264] | INT(-1) | -0.0662 [-0.2454] |
| D[EXR(-3)] | 0.1303 | EXR(-1) | 0.0319 |

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| | | | |
|---|---|---|---|
| | [1.4132] | | [0.0670] |
| D[NXP(-2) | 2.44E-05 [1.5434] | D[NXP(-1)] | -2.31E-04 [-6.4173] |
| D[IPI(-3)] | 0.0216 [1.4425] | IPI(-1) | 0.4523 [3.6401] |
| D[PPI(-1)] | -0.0147 [-1.4837] | PPI(-1) | -0.0446 [-5.6692] |
| D[RWI(-1)] | 0.0023 [2.5542] | RWI(-1) | 0.0217 [5.7624] |
| C | 1.3840 [1.2165] | C | -42.3635 |

Note that the: t – statistics is in parentheses.

Source: Author's Computation from the estimated output 2023

From table 4, the first part of table shows that money supply, interest rate, net exports and producer price index all have inverse relationship on the CPI in the long run. On the contrary, exchange rate, import price index, and retail and wholesale price index exhibit direct relationship with CPI in the long run. Of all these exogenous variables, only net exports, import price index, producer price index, retail and wholesale price index have significant impact on the CPI in the long run time. Certainly, the regression co-efficient of the producer price index indicates inverse relationship implying reduction in the mark-up and the profit margin on the side of the producers. This is to keep the price stable in a perfectly competitive market, given the exchange rate devaluation. Therefore, the negative effect arising from the interest rate is justified; by this, the negative effects of money supply and net exports generate another problem about the theoretical linkage among the exchange rate, money supply and consumer price index. In line with our macroeconomic theory, net export and money supply are characterized with positive and significant relationship with the price level in the long-run economy. The possible justification for the existence of negative effect of net export and the money supply on the CPI is that the occurrence of inflation may not be as a result of the pressure arising from the aggregate demand rather as a result of the hiccups in the supply chain of the domestic and foreign outlets. It is worthy to note here that the fluctuation arising from the price level is more or less aggregate supply induced when compared with aggregate demand.

From the short-run effects, only net export, exchange rate, import price index, producer price index, retail and the wholesale price index have significant effect on the CPI. The net export, money supply and exchange rate are characterized with positive impact on the CPI, this is in line with our a priori expectation. No doubt that increase in net export, exchange rate and money supply stimulate aggregate demand in the economy. The slow response of supply induces the short-run and the unexpected increase in the demand pressure on the prices of the limited

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supply, hence inflationary disease surface within the short-run in the economy

The long-run results show that the aggregate supply would have increased thereby resulting to a lower consequence of exchange rate devaluation and monetary expansion, by this increase, supply remains the key determinants to price fluctuation. The import price index, retail and wholesale price index are positively related to the CPI. The reason for this is that in an imperfect market some firms can decide to sum up the mark-up to prices for them to maintain their profit levels at the prevailing exchange rate devaluation price.

The producer price index negatively affects the CPI and the findings are in line with economic theory. The reason is that the producers may not only found in reducing the mark-up on price level but also the profit margins in order to allow price stability. There is no cause for alarm here because the features of the economy are the co-existence of the perfect and imperfect market.

From the vector error correction results, any past disequilibrium in the long-run among the variables will be corrected over time as indicates by the negative sign of the error correction coefficient in the model. However, the error correction coefficient of the CPI model is not statistically significant, but the given value of -0.0711 suggests that CPI will converge towards the long-run equilibrium with the speed of 71 per cent. By this result, the implication is that in the next one quarter the model will restore to equilibrium at the prevailing shock in the short-run.

### 4.5 Results of the Estimated VAR Model

No doubt, there exists suspicious arguments on the statistical efficiency on VECM estimate, hence often time quantitative scholars found some degree of confidence with the impulse response and variance decomposition as a better means for analyzing the relevance of policy variables to target variables in the macroeconomic model (Akinbobola, 2019). The impulse response function is employed in this study having found it relevant to analyze the exchange rate transmission mechanism to the consumer price index. However, there is no general agreement on the explicit criterion for the significance in a VAR model framework. Sims (2007) indicated that for impulse response, the level of significance can be measured by the degree to which the functions are bounded away from zero.

Based on this, table 6 to 13 below show the impulse responses of the consumer price index, money supply, interest rate, exchange rate, net exports, import price index, producer price index, retail and wholesale price index to positive exchange rate shock respectively.

**Table 6: Response of Consumer Price Index**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.03332 | 0.00000 | 0.00000 | 0.00000 | 0/00000 | 0.00000 | 0/00000 | 0.00000 |
| 2 | 1.74333 | 0.84222 | 0.75111 | 0.12110 | 0.11132 | -0.00462 | -0.20114 | 0.55574 |

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|---|---|---|---|---|---|---|---|---|
| 3 | 1.5321 | -2.2214 | 1.2991 | 0.6213 | 0.4253 | -0.0323 | -0.2421 | 0.3655 |
| 4 | 0.9888 | -0.0772 | 1.2540 | 0.5162 | 0.3342 | -0.2350 | -0.2346 | 0.3512 |
| 5 | 2.0823 | 0.2344 | 1.7624 | 0.6143 | 0.5464 | -0.2953 | -0.1558 | 0.2214 |
| 6 | 2.0266 | 0.7154 | 2.2315 | 0.7045 | 0.4552 | -0.4364 | -0.2321 | 0.5114 |
| 7 | 1.7663 | 0.3456 | 2.2204 | 1.0112 | 0.5387 | -0.5490 | -0.3215 | 0.4313 |
| 8 | 1.5677 | 0.3688 | 2.5552 | 1.1510 | 0.5790 | -0.4757 | -0.3923 | 0.5278 |
| 9 | 2.1612 | 0.5342 | 2.4550 | 1.1440 | 0.5256 | -0.6428 | -0.3211 | 0.5142 |
| 10 | 2.1522 | 0.4476 | 2.6381 | 1.0520 | 0.6166 | -0.4013 | -0.3100 | 0.6533 |

Source: Computed by the Researcher 2023

The response of CPI to money supply is positive, which means that money supply increased from 0.75 in the second quarter to 2.63 in the tenth quarter. The impulse response of the CPI to money supply is statistically significant. This implies that as the money supply rises, the price level of the consumer goods equally increase.

The response of the CPI to the exchange rate shows 0.84, -2.22 and -0.07 in the second, third and fourth quarters respectively, however, the tenth qurters indicate 0.44

The response of CPI to net export is 0.52 to 0.61 during the ninth and the tenth quarter horizon. The implication of this is that as the net export increase, there exist a corresponding rise in the aggregate demand leading to increase in the CPI. The response of CPI to net exports is positive and statistically insignificant. The reason for this is the restrictive monetary policy put in place by the monetary authority (CBN).

The response of CPI to retail and wholesale price index ranges from 0.52 to 0.51 during the eighth and the ninth – quarter horizon. Though it returns a positive sign but it is not statistically significant. This shows that a rise in CPI is not warranted by a rise in retail and wholesale price index. This implies that the impact of exchange rate devaluation does not have an indirect transmission to the CPI through a rise in the price level of the capital goods.

**Table 7: Response of Money Supply**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 3811.02 | 0.0000 | 277641.2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | -2033.76 | -1456.66 | 177832.5 | -2641.44 | -26671.6 | -47321.8 | -687.43 | 7276.7 |
| 3 | -36744.02 | -1724.42 | 275063.7 | 2753.67 | -31655.1 | -64451.5 | -133.70 | -8691.4 |
| 4 | 26142.66 | -1872.91 | 224133.7 | -3332.71 | -73394.1 | -64224.5 | -283.88 | 2770.6 |
| 5 | 64479.11 | -1812.11 | 288072.0 | -5720.33 | -63352.3 | -16623.1 | -148.30 | 1284.7 |
| 6 | 42441.18 | -2213.5 | 233375.3 | 9237.62 | 87294.7 | 12641.4 | -293.42 | 5817.4 |
| 7 | 54112.43 | -1803.7 | 222465.0 | -2122.71 | -63353.3 | -12213.0 | -565.39 | 5171.04 |
| 8 | 47351.32 | -4474.4 | -46674.4 | -4424.31 | -12246.2 | -97798.3 | -110.22 | 6674.33 |
| 9 | 31262.26 | -1502.5 | 17250.3 | -3739.75 | -95491.2 | -12472.5 | -227.28 | 2121.14 |
| 10 | 57387.12 | -1738.0 | 16686.2 | 3346.83 | -10840.7 | -11402.0 | -129.79 | 1907.33 |

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Source: Computed by the Researcher 2023

From table 7, the response of money supply to CPI indicates 3811.02, -2033.76 and -36744.02 in the first, second and third quarters respectively. The result also shows that impulse response of money supply to that of CPI ranges from 26142.66 to 64479.11 as at the last five quarters. No doubt, these indicate a positive relationship implying that when there is a rise in CPI, there is also a corresponding rise in the money supply in a given economy. Further interpretation of this is that, the Central bank of Nigeria does not reduce the available money supply as a result of the increase in the price level. The reaction of this behavior is that increase in the price level does not warrant increase in money supply rather it is the money supply that influences the price of the available goods and services in any economy. By this, there is no price stability and credible monetary policy during the period under review. The reason for this is that, in the most of the developing countries in the world, there exist the rationale to reduce money supply when there is a rise in the general price level for the reason of inflationary control.

**Table 8: The response of interest rate**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | -1.4300 | 0.000000 | 0.1875 | 3.23540 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | -1.27480 | -0.14422 | 0.24107 | 2.37950 | 0.08077 | -0.72227 | -1.04266 | 0.72440 |
| 3 | -0.98887 | -0.59333 | 0.68152 | 2.13396 | -0.48556 | -0.64486 | -0.42766 | 0.57180 |
| 4 | -0.16699 | -0.62229 | 0.64191 | 1.28103 | -0.20003 | -0.44744 | -0.45066 | 0.45210 |
| 5 | 0.32210 | -0.41285 | 0.53470 | 1.55513 | -0.66655 | -0.52277 | -0.23337 | 0.34320 |
| 6 | 0.23375 | -0.27775 | 0.78500 | 1.90632 | -0.28882 | -0.63100 | -0.41380 | 0.51369 2 |
| 7 | -0.27240 | -0.43167 | 1.03380 | 1.98560 | -0.25222 | -0.63433 | -0.58300 | 0.60410 |
| 8 | -0.39080 | -0.42088 | 0.63110 | 1.92770 | -0.50644 | -0.64493 | -0.40933 | 0.58030 |
| 9 | -0.01010 | -0.27133 | 1.13300 | 1.82190 | -0.24133 | -0.55558 | -0.35188 | 0.39130 |
| 10 | 0.22200 | -0.35225 | 0.86870 | 1.87410 | -0.56322 | -0.74466 | -0.30799 | 0.43340 |

Source: Computed by the Researcher 2023

From table 8, response of interest rate to money supply ranges from 0.19 to 1.13 during the nine quarters as indicated in the results. The results show that, interest rate rises as the money supply increases. A possible explanation is that in the developing countries like Nigeria, if there is a rise in the money supply, there will be no reduction in the interest rate for the reason of excess demand for loanable funds. This means that the impact arising from the variation in

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money supply is not transmitted to CPI through the money supply – interest rate channel.

**Table 9: The Response of Exchange Rate**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.06066 | 3.82840 | -0.21667 | -0.25230 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 0.36628 | 5.37790 | -0.12333 | -0.55529 | 0.33339 | 0.27009 | 0.79111 | -0.84458 |
| 3 | -0.00424 | 6.27000 | -0.89115 | 0.58080 | -0.22278 | -0.29026 | 1.21172 | -1.42446 |
| 4 | -0.10428 | 6.16337 | -0.62657 | 0.75889 | 0.24778 | 0.88016 | 0.90003 | -1.22888 |
| 5 | -0.00701 | 5.13341 | 0.62678 | 0.96010 | 0.13838 | 1.17335 | 1.71142 | -1.53773 |
| 6 | -0.45557 | 4.32203 | 1.08039 | 0.95528 | 0.41446 | 0.54546 | 1.52007 | -1.82558 |
| 7 | 0.33324 | 4.13347 | 1.93331 | 1.02251 | 0.46118 | 1.18669 | 1.60118 | -1.76767 |
| 8 | 0.71666 | 4.17718 | 2.56619 | 1.47700 | 0.65100 | 0.64616 | 1.4381 | -1.53707 |
| 9 | 0.54444 | 4.51776 | 2.64114 | 1.72758 | 0.77334 | 0.55501 | 1.12129 | -1.27720 |
| 10 | -0.00232 | 5.09938 | 2.32340 | 1.94224 | 0.57656 | 0.61335 | 0.89171 | -1.02424 |

Source: Computed by the Researcher 2023

From table 9, he response of exchange rate to CPI ranges between -0.46 to 0.72 during the ten–quarter horizon. The response of exchange rate to CPI is directly related and also statistically significant which means as CPI increases, exchange rate also increase. The findings support the purchasing power parity theory and the exchange rate monetary theory, that the impact of money supply on exchange rate passes money supply–price channel

The response of exchange rate to interest rate equally ranges between -0.25 and 1.94 during the ten quarters. The response of exchange rate to interest rate is positive in most of the quarters except in the first two quarters where it is negative. That is, as interest rate increases, exchange rate increases (depreciates). The exchange rate is expected to decrease (appreciate) as interest rate rises. The positive correlation between these two variables indicates that the impact of the variation on money supply is not transmitted to CPI through the money supply– interest rate transmission.

**Table 10: The Response of Net Export**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 1921 3.52 | -7231.24 | 2122 49.4 | 522 6.40 | 1120 8.2 | 0.00000000 | 0.00 | 0.00 |
| 2 | -23 | -40 | 8812 | 412 | 9419 | -44 | -74 | 423 |

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| | 35.20 | 11.33 | 6.52 | 4.01 | 8.14 | 23.28 | 02.09 | 9.23 |
| 3 | -4609.01 | 5462.09 | 1212727.3 | 7341.76 | 12224.3 | -2332.21 | -75 16.13 | 7452.07 |
| 4 | -4261.22 | 9271 0.33 | 1350 10.7 | 9724.31 | 1314 2.7 | -5224.30 | -8622.21 | 5148.03 |
| 5 | -7520.13 | 1334 61.2 | 8781.05 1 | 6554.01 | 8213 6.5 | -8260.11 | -1027.10 | 7863.27 |
| 6 | -1657.32 | 1671 7.7 | 6280 4.43 | 6414 4.42 | 1134 3.7 | -1246.20 | -6419.31 | 5067.11 |
| 7 | -3256.11 | 1328 0.0 | 5610 0.67 | 5352.21 | 1047 3.4 | -3414.23 | -5249.12 | 4581.10 |
| 8 | -3431.01 | 1229 8.6 | 4088 8.03 | 5776.60 | 9443 7.07 | -4220.20 | -5162.03 | 3228.03 |
| 9 | -3501.12 | 9447 7.04 | 1236 43.4 | 6118.33 | 1333 4.2 | -3221.17 | -4784.77 | 3486.50 |
| 10 | -2236.46 | 6113 2.18 | 1137 71.1 | 7754.06 | 1193 9.1 | -5102.07 | -5128.22 | 3212.12 |

Source: Computed by the Researcher 2023

From table 10, the responses of net export to exchange rate are 7231.24, -4011.33 and 5462.09 in the first, second and third quarters respectively. The responses of net export to that of exchange rate ranges from 92710.33 to 12298.6 for the last eight quarters. On the average, the response of net export to exchange rate is 29818.19 and it has a direct relationship and also statistically significant. This implies that when the exchange rate depreciates, the net export appreciates. This is in supports of the economic literature which has it that when the exchange rate depreciates, the level of net exports becomes relatively cheaper hence imports becomes expensive. No doubt, our exports increase relative to that of imports. This further leads to a rise in our exports

**Table 11: The Response of Import Price Index**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | -7.5249 | -3.51 09 | -5.4317 | 1.5253 | 4.1262 | 18.2252 | 0.0000 0 | 0.0000 0 |
| 2 | -5.3390 | -3.7441 | -0.9925 | 3.9410 | 0.3324 | 12.9327 | 5.7211 | -4.5133 |
| 3 | -1.0516 | -3.8715 | 0.8720 | 1.8946 | 5.1867 | 15.8713 | 4.0543 | -4.5215 |
| 4 | -1.0441 9 | -2.9138 | 4.3019 | 1.9144 | 2.7406 | 20.3819 | 4.0354 | -3.3783 |
| 5 | -2.4366 | -4.3177 | 3.8028 | 6.6664 | 4.7153 | 18.8003 | 5.553 | -4.4427 |

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|---|---|---|---|---|---|---|---|---|
| 6 | -4.6727 | -1.6002 | 5.5411 | 6.2529 | 6.3219 | 19.8022 | 2.5763 | -3.2615 |
| 7 | -3.3516 | 0.8145 | 0.3010 | 5.7126 | 1.6334 | 22.1916 | 4.922 | -2.447 |
| 8 | -2.2333 | 1.5450 | 5.2833 | 6.0227 | 5.5758 | 22.5049 | 5.4035 | -5.1615 |
| 9 | -2.5532 | 1.3806 | 0.5161 | 6.1528 | 1.7226 | 21.8209 | 5.452 | -4.7067 |
| 10 | -1.4512 | 1.8778 | 1.6326 | 5.6042 | 3.4234 | 24.0392 | 5.416 | -4.1723 |

Source: Computed by the Researcher 2023

From table 11, the response of import price index to exchange rate shows inverse relationship in most of the quarters. This implies that as the exchange rate increases, the import price index decreases. The reason attributed to this is that many importing firms will respond to this by a way of reducing their mark-ups and profit margins so as to keep the price stable particularly in a perfectly competitive market at a time when the economy is characterized with exchange rate depreciation. The inverse correlation between these two variables reveal that the impact of exchange rate depreciation is not transmitted directly to CPI through a rise in the price of the capital goods that are imported from the foreign counties which serve as factor costs.

**Table 12: The Response of Producer Price Index**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.8322 | -120.736 | 4.4661 | -25.5221 | -34.522 | 205.7442 | 113.233 | 0.0000 |
| 2 | 2.4365 | -114.632 | 58.7224 | 59.3452 | -23.2552 | 133.5221 | 40.2211 | -48.5521 |
| 3 | 104.3005 | -165.820 | 37.3721 | 68.671 | -35.4660 | 192.5219 | 59.7819 | -22.6006 |
| 4 | 80.2189 | -141.320 | 132.3085 | 50.0603 | 40.5023 | 134.1049 | -13.3015 | 30.3559 |
| 5 | 72.6222 | -108.863 | -12.4905 | -32.0315 | -61.1520 | 281.0553 | 80.2331 | 58.3410 |
| 6 | -14.2414 | -2.483 | 41.5047 | 41.6509 | -26.4064 | 236.5362 | 53.1716 | -32.8026 |
| 7 | 117.1703 | -37.536 | -47.1990 | 67.7176 | -70.2308 | 250.5328 | 101.8334 | -64.0355 |
| 8 | 89.7004 | -27.079 | 10.4514 | 41.8066 | -11.1349 | 184.0806 | 12.4206 | 10.6427 |
| 9 | 99.4639 | -82 | -24. | -44.4 | -69.2 | 382.7 | 132.8 | 24. |

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|---|---|---|---|---|---|---|---|---|
| | | .429 | 9061 | 301 | 713 | 713 | 003 | 7666 |
| 10 | -54.8718 | -53.778 | 26.5552 | 22.5277 | -47.5331 | 280.03335 | 93.5231 | -65.533 |

Source: Computed by the Researcher 2023

From table 12, the response of producer price index to import price index lies between 133.5221 and 382.7713 for the ten-quarter period. The response of the producer price index to import price index as shown in the findings exhibit direct relationship and is statistically significant. This implies that the as producer price index rises, the import price increases. The justification for this is that, considering an imperfect market situation, producers will definitely sum up the mark-ups on prices when there is a rise in the import price index in order to achieve the profit maximizing target.

**Table 13: The Response of Retail and Wholesale Price Inedex**

| Period | CPI | EXR | MSP | INT | NXP | IPI | PPI | RWI |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.422 | -67.3327 | -9.2622 | -2.60002 | 20.73222 | 89.5170 | -41.34442 | 131.9448 |
| 2 | 28.332 | 2.5321 | -63.5720 | -14.2522 | -40.6512 | 160.2337 | -5.3712 | 110.9175 |
| 3 | -144.289 | -8.1744 | -24.6811 | 56.6063 | -46.8662 | 9.009549 | -33.4558 | 34.2771 |
| 4 | 65.849 | -64.7449 | -80.2048 | 0.634167 | -18.5013 | 40.43801 | -24.9193 | 30.7338 |
| 5 | 52.5448 | -45.7091 | -55.7312 | -95.5029 | -46.3068 | 71.21099 | -37.2129 | 145.5187 |
| 6 | 37.529 | -58.7553 | -52.8991 | -86.9064 | -65.2915 | 155.9236 | 71.3016 | 62.2889 |
| 7 | -122.209 | -59.8034 | -29.5264 | 23.6145 | -46.4013 | 32.72407 | -23.4663 | 1.4720 |
| 8 | 95.755 | -104.216 | -88.9021 | 18.8771 | -40.4258 | 37.80181 | -16.2653 | 36.6337 |
| 9 | 36.934 | -89.4032 | 19.9330 | -72.0451 | 1.7712 | 47.62625 | -62.2330 | 152.2919 |
| 10 | -19.661 | -83.3068 | -81.3942 | -95.7230 | -83.8228 | 139.0278 | 36.6016 | 88.2927 |

Source: Computed by the Researcher 2023

From table 13, the response of retail and wholesale price index to the producer price index ranges from -62.23 to 71.30 during the ten-quarter period. The results of the retail and wholesale price index to the producer price index is inversely related as shown in most of the periods under study. This is a violation of the economic theory because as shown in our findings, the

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variation in retail and wholesale is not explained by the changes in the producer price index. The inverse correlation between these two variables signify that the impact arising from the exchange rate devaluation could not be transmitted indirectly to the consumer price index through a rise in the price of the imported capital goods from the foreign countries.

It is important to note the following from the analysis of the impulse response function:

(i) There exist two transmission mechanisms from exchange rate to the consumer price index, that is:

(a) The devaluation of exchange rate could also be transmitted to consumer price index through a rise in the net exports and aggregate demand.

(b) The devaluation of exchange rate could as well be transmitted directly to consumer price index through a reduction in the final goods and services imported from the foreign nations.

(ii) The impact of a variation in money supply could be transmitted to exchange rate through the channel of money supply-price level.

## 5 Conclusions and Recommendations

The paper's findings reveal a positive and significant impact of increase in money supply on the consumer price index, hence persistent increase in money supply acts as a causal factor of the incessant rise in the general price level in the Nigerian economy.

The excessive monetary expansion in Nigerian's economy where endemic corruption and conspicuous spending is characterized to be the general trait of the government, makes the money demand argument more potent than the supply side argument where inflation is warranted by supply rigidity. Therefore, increases in the money supply above the output growth is inflationary. The increase in exchange rate, net exports and aggregate demand due to a rise in money supply is also inflationary. Therefore, if the monetary policy and fiscal policy are properly managed to prevent excessive monetary increase, exchange rate and inflation will be minimized.

The estimated VAR results also reveal that the impact of exchange rate devaluation can be transmitted directly to consumer price index through a decline in the final goods and services imported abroad, hence the supply side argument holds. The decline in the supply of goods and services from abroad coupled with the slow growth of domestic output also led to the decrease in aggregate supply. The fall in aggregate supply in the phase of an increase in aggregate demand, necessitated an up-ward pressure on domestic prices, hence the study concludes that the inflationary pressure from the exchange rate devaluation will

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be minimized by a rise in the domestic outputs.

Based on the findings, the study recommends the following:

(i) The government should establish policy that will stimulates increase in export goods as this could enhance the foreign exchange earnings and go a long way to minimized excessive exchange rate increase as well as inflation in the economy.

(ii) . The government should also formulate policy that can encourage increase in aggregate supply in the phase of an increase in aggregate demand as this could necessitate a decline in an up-ward pressure on domestic prices.

(iii) The Nigerian government should pay attention to policies that can warrant a rise in terms of outputs in the local production so that weight of the inflationary impact of the exchange rate devaluation could be minimal.

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