



THE EFFECT OF EXCHANGE RATE CHANGES ON CONSUMER PRICES IN NIGERIA: EVIDENCE FROM VECM MODEL

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ABSTRACT

The continuous adoption of trade openness policies and floating exchange rates regime by developing countries exposed them to speculative pressures. It makes exchange rate shocks easily transferred to domestic consumer prices. That makes tremendous impacts on the domestic consumer price inflation. This paper thus examines the response of domestic consumer prices to exchange rate changes otherwise known as 'Exchange rate pass-through'. The paper uses vector error correction (VECM) model to examine the relationship. A quarterly time series data for a period ranging from 1986Q1 to 2013Q4 for Nigeria was used. The study found a substantial but incomplete and slow pass-through of exchange rate changes to domestic prices.

Keywords: Exchange rate pass-through, Consumer price, Inflation, Vector error correction.

JEL Classification: F31, F41, E31, E41.

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Contribution/ Originality

This study contributes in the existing literature by estimating the ERPT using Nigerian data as there are very few studies on ERPT for developing countries and particularly Nigeria. This study uses VECM model against the SVAR model used by other studies.

1. INTRODUCTION

Most developing countries including Nigeria adopted floating exchange rates regime and removed capital controls over the last three decades. As the result, the financial markets in the countries became more connected to the global markets. However, that made them more exposed to speculative pressures. Consequently, monetary policy authorities in those small, now open economies face tremendous challenges of more imported inflationary pressures and exchange rate volatility. This situation kindled the renewed interest in the studies on exchange rate changes and its effects on domestic consumer prices known as 'Exchange rate pass-through'(ERPT). Though there is a large volume of studies on ERPT, those in developing countries are very limited. This study, therefore, aims to investigate the response of consumer prices to changes in the exchange rate in Nigeria.

To investigate ERPT is very important particularly to developing countries considering that most of the developing countries pursue an export-led growth strategy where exchange rate policy plays a crucial role. Secondly given that most developing countries import technology and capital goods (Aziz *et al.*, 2014).

The need to achieve low inflation levels and stable price compelled monetary policy authorities to embrace monetary policy frameworks which closely monitors and influence the determinants of inflation. Exchange rate change is one of those important inflation determinants. There is agreement in the empirical literature to the fact

that exchange rate movements have an impact on the level of inflation particularly in open economies with floating exchange rate (see (Menon, 1995; Kara and Nelson, 2002; Devereux and Yetman, 2008)).

When exchange rate changes, foreign firms will either pass the exchange rate changes entirely to their selling prices in export markets (which is called complete pass-through), or absorb the exchange rate changes in their profit margin to maintain selling prices unchanged (which is called a zero pass-through), or some combination of the two (which is called a partial pass-through). The pass-through of the change in the exchange rate to consumer price takes some time and it also seems to vary immensely across different countries, times and industries. The overall effect of ERPT depends on various microeconomic factors like market structure, the pricing behavior of firms, as well as macroeconomic conditions (Dornbusch, 1987).

Therefore, to be familiar with the nature of ERPT is very important particularly for developing countries with an export lead growth strategy. The knowledge of the degree and timing of pass-through is also crucial for the accurate assessment of monetary policy impact on prices and forecasting inflation (An, 2006).

However, there are couples of studies on ERPT in Nigeria; this study took a different approach by using a VECM model. This study examines the long-run effect of the exchange rate changes on consumer prices. The remaining part of the paper is divided into four sections. Section 2 presents a theoretical background and literature review. Section 3, discusses the methodology. Section 4, presents the results of the estimation carried out. Section 5, provides the conclusion and policy implication.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

This section presents a brief review of the theoretical and empirical literature. It begins with providing some theoretical background about the determinants of exchange rate pass-through in subsection 2.1 and in subsection 2.2 the empirical studies are reviewed.

2.1. Theoretical Background

Dornbusch (1987) suggests that the adjustment of mark-up to changes in exchange rate depends on the relative market shares of foreign and domestic firms, the degree of product homogeneity and substitutability, the market concentration and the level of price discrimination possible.

While according to McCarthy (2000) in bigger countries the inflationary effect of currency depreciation on domestic prices is offset by decrease in world price due to lower world demand, sinking the pass-through. While in smaller countries, currency depreciation cannot have impact on world prices hence, a complete pass-through. The more open a country is, the more import to it and therefore there will be higher import share in the total production, hence a higher pass-through to the domestic prices.

More so, Mann (1986) asserts that exchange rate shock volatility is negatively correlated to pass-through. Due to the cost of adjusting prices, exporters will not change price when they perceive a shock to be transitory. They will absorb the changes in their markup, hence decreasing the pass-through. But when they perceive the change to be permanent they would change the price.

Furthermore, Taylor (2000) described inflation environment as another determinant of pass-through. According to Taylor (2000) perceived persistence of cost changes is likely to be positively correlated to the persistence of aggregate inflation, which also tends to be positively correlated to the inflation. Therefore in an economy with stable price, a rise in marginal cost will have less persistence than in an economy with unstable price. Hence a low inflation environment may lead to a lesser pass-through of exchange rate changes to prices.

While Devereux and Engel (2002) suggested that nations with relatively low money growth volatility have relatively low rates of ERPT and vice versa.

2.2. Empirical Literature

The literature relating to ERPT can be roughly categorized into those carried out on microeconomic level and those carried out on macroeconomic level. Studies carried out on microeconomic level mainly concentrate on investigating ERPT into disaggregated import prices of particular home industries. While those carried out on macroeconomic level investigate ERPT into aggregate price indices and that can be categorized into two more groups. The first group studied the level of pass-through into aggregate import prices as the second group examined pass-through into the consumer prices.

Menon (1995) conducted a survey of the ERPT literature. Most of the studies examined by Menon (1995) survey are in industrialized countries, mainly the US. On the other hand, a recent survey by Aron *et al.* (2014) examined studies on developing and emerging countries. All together most of the studies in the two studies discovered a partial ERPT, but the extent differs greatly among countries.

Some studies also examined the ERPT at industry levels. A study by Yang (1997) examines ERPT in manufacturing industries of US. The study found a partial pass-through and differs across industries. In a cross-sectional study, Yang (1997) found that ERPT is higher in industries with a high level of product differentiation and lesser elasticity of marginal cost. In addition, the study showed a negative relationship between ERPT and import share.

Similarly, Goldberg and Knetter (1997) found that the effect of exchange rate changes on US home prices is partial. Only about 60% of the changes in exchange rate was passed to the import prices on average. But, the reaction of home price to changes in exchange rate varies across the sectors and a substantial share of the muted price reaction appears to come from changes in export prices mark-ups.

More so, McCarthy (2000) who used a Vector autoregressive (VAR) model found that exchange rates and import prices have a modest influence on home price inflation. The study discovered that pass-through is higher in economies with a high import share. In addition, the rate of pass-through was found to be positively correlated with the openness of the economy and negatively correlated with the exchange rate volatility.

Likewise, An (2006) examined the ERPT at different stages of distribution, the import prices, producer prices and consumer prices of eight industrialized economies. The study discovered a partial ERPT at various horizons, however, complete pass-through is observed occasionally. The study also revealed that the degree of pass-through declines along the distribution chain. Furthermore, the time required for complete pass-through turn out to be longer along the chain of distribution.

On studies carried out on emerging economies, Rowland (2003) estimates the ERPT of Columbia with Vector error correction model (VECM). The study also provides a partial ERPT to import and consumer prices. The study revealed that the reaction of import prices to changes in exchange rate is about 80% per annum. While, the reaction of producer prices and consumer prices to the change in exchange rate are 28% and below 15% respectively. Hence the study suggested that the effect of exchange rate change on consumer price is very small.

While Ito and Sato (2006) examined ERPT in Asian countries using Structural VAR and discover that the level of pass-through of exchange rate changes to prices differs among the indices. The impact of the pass-through is higher on import prices, followed by producer price and lower on the consumer price. The extent of pass-through of the exchange rate changes was larger on import prices of the countries that were more affected by the Asian crises. However, the pass-through was very small across all the countries except in Indonesia.

Bhattacharya *et al.* (2011) also examined the ERPT in India. The study adopted a Cointegrated VAR model with six variables: GDP, domestic price, import price, oil price, short-term nominal interest rate and exchange rate. The result of study produced a partial ERPT. The study also reveals that even though there might be no relationship between the inflation and output the presence of higher though partial pass-through indicates that interest rate could influence inflation via the channels of exchange rate. Hence they concluded that exchange rate regulation is the effective means via which monetary policy controls inflation.

Similarly, Kiptui *et al.* (2005) also got a partial ERPT in Kenya for the period between 1972 and 2002. They showed that 46% of the changes in inflation were caused by the exchange rate changes in the first year, rising to 57% in year three. However, they suggest that the influence dies out four years afterward.

Aliyu *et al.* (2010) examine ERPT to import and consumer prices in Nigeria between 1986Q1 and 2007Q4. The paper found that ERPT in Nigeria during the period was low although slightly higher in the import than in the consumer prices but significant and persistent.

The empirical studies generally suggest that the ERPT to consumer prices are incomplete, both in the short and long run. The size and the speed of adjustments decline along the different price stages. The effect of changes in exchange rate is bigger on import prices, followed by producer prices, and is smaller on consumer prices.

The analytical frameworks of the empirical studies on the effect of exchange rate on consumer prices have been mostly laid on microeconomic base. The two commonly used models for the ERPT estimations are the single equation model and the vector autoregressions (VAR) model.

The literature shows a declining trend in the level of ERPT to consumer prices in both the developed and developing countries. Some reasonable explanations were offered for the decline in the literature. They include changes in the composition of import goods towards sectors with lesser rates of exchange rate pass-through, changes in monetary environment towards a low-inflation regime, growing significance of non-traded goods in consumption and structural reforms, especially in developing economies. However, there is no harmony in the literature and the debate is still on concerning the causes of the changed behavior of the pass-through relation. In general, the level of ERPT to consumer prices is smaller in developed countries compared to developing countries.

Considering the inconsistent findings of the empirical literature on the speed and size of ERPT this study aims to contribute to the empirical literature on ERPT to developing and emerging markets, using Nigerian data. With the increased globalization and the fact that most of the countries in Africa particularly Nigeria embrace openness trade policy, it is imperative to contribute to the empirical literature on this topic. Mores so, looking at the persistent inflation figures in Nigeria coupled with the fact that Nigeria is an import based economy, understanding very well the dynamics of ERPT is very important. The study is aimed at investigating the degree and speed of ERPT to consumer prices in Nigeria.

3. METHODOLOGY

This section discusses the method adopted for the estimation and the data used and their sources. Section 3.1 discusses the estimation approach while section 3.2 states the data set and data sources.

3.1. Estimation Approach

This study uses a Cointegrated VAR (CVAR) model to examine the pass-through of changes in exchange rate to consumer price. The standard ERPT literature uses SVAR model in first differences (see for example (McCarthy, 2000; Ito and Sato, 2006)). However, the limitation of SVAR model is the use of differenced series which leads to loss of information concerning the long-term relationships between the variables. A solution to the loss of information problem is provided by cointegration theory through integrating short-run dynamics with long-run equilibria. Hence the motivation for this study to adopts the CVAR model.

One very important benefit of using CVAR estimation is that it makes distinction between permanent and transitory shocks. This is an important distinction as permanent shocks often have non-zero long run equilibrium pass-through effect, whereas transitory shocks hardly bring about significant short-run changes in pricing behavior, where firms face costs associated with frequent price changes (Masten *et al.*, 2003).

Starting with the reduced form VAR, Johansen approach assumes that the joint behavior of a set of n $I(1)$ variables can be adequately described as follows:

$$X_t = \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + \dots + \Pi_k X_{t-k} + (\Phi D_t + \varepsilon_t) \dots \dots \dots (3.1)$$

Where: ε_t is a stochastic disturbance vector and D_t represent the values at time t of any strictly deterministic variables, which are usually intercept terms and/or time trends and k is the maximum lag length. The disturbance processes, $\{\varepsilon_t\}$ are assumed to be independently multivariate normal with zero mean vector and a covariance matrix Ω .

The levels VAR

$$X_t = \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + \dots + \Pi_{k-1} X_{t-(k-1)} + \Pi_k X_{t-k} + (d + \varepsilon_t) \dots \dots \dots (3.2)$$

Can be rewritten as the VECM as follows:

$$\Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{k-2} \Delta X_{t-(k-2)} + \Gamma_{k-1} \Delta X_{t-(k-1)} + (d + \varepsilon_t) \dots \dots \dots (3.3)$$

With $\Gamma_i = -\sum_{j=i+1}^k \Pi_j$ and $\Pi = (-\Gamma_0 - I) = \Pi_1 + \Pi_2 + \Pi_3 + \Pi_4 \dots + \Pi_{k-1} + \Pi_k - I$

And the Stationarity properties of the system are closely linked to the properties of the matrix Π .

The main objective of this study is to examine the transmission of exchange rate changes into consumer prices. Therefore, the key variables for the empirical analysis are the exchange rate (*neer*), import prices (*mpi*) and consumer prices (*cp*). The model also contains national output (*gdp*) to control for domestic economic activity (demand shock). A money market interest rate is also built-in to capture monetary policy influence. Lastly, oil price (*oilp*) is included to capture international supply shocks (imported inflation) which could have an impact on the exchange rate and domestic prices. The growth rate and oil price were used following McCarthy (2000); Hufner and Schroder (2002) and Ito and Sato (2006). However, this study uses money market interest rate against the money supply used by the aforementioned studies.

The six-variable VAR model used for the estimation is:

$$y_t = (\Delta cpi_t, \Delta imp_t, \Delta neer_t, \Delta gdp_t, \Delta oilp_t, \Delta int_t) \dots \dots \dots (3.4)$$

Where: *cpi* denotes the natural log of domestic consumer prices, *imp* denotes the natural log of import prices, *neer* denotes the natural log of the nominal effective exchange rate, *gdp* denotes the national output, *oilp* denotes the natural log of oil prices; *int* is the short-term interest rate; and Δ is a first difference operator. The series for consumer price index, interest rate, national output (*gdp*) and oil price are seasonally adjusted using Census X-12 method.

The analysis starts with the check for unit root in the time series properties of the variables using the Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests to ascertain the order of integration of the series. Then a cointegration test is carried out using Johansen procedure.

3.2. Data Set and Data Sources

The study uses quarterly data of all the variables for the period from 1986q3 to 2013q4. The sources of the data used include Central bank of Nigeria (CBN) statistical database, CBN statistical bulletin, OPEC website and Penn World Table. Nominal effective exchange rate data was obtained from CBN Statistical bulletin which uses November 2009 base of 100. While the consumer price index data was generated from CBN Statistical database. Oil price data which is OPEC reference basket is obtained from OPEC website. For the money market interest rate, commercial banks interest rate on time deposits maturing in 3 months is used to proxy the money market interest rate. The interest rate data is also generated from CBN statistical database. The GDP data was also generated from CBN statistical database. Import Price was constructed from the import at constant 2005 and current national prices obtained from Penn world table.

4. EMPIRICAL RESULT

The results are presented starting with the unit root test result in subsection 4.1. The cointegration test and VECM result are presented in subsection 4.2.

4.1. Unit Root Tests

Using Augmented Dickey-Fuller and Philip-Perron unit root test all the variable are checked for unit root and found that all are stationary at I(1) except the interest rate which is stationary at levels. Schwarz information criterion was used for the lag length selection. The result of the unit root test is presented in Table 1, below.

Table-1. Augmented Dickey-Fuller and Philip-Perron unit root test

Variable	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)		I(d)
	Level	First Difference	Level	First Difference	
CPI	-1.4361	-4.6419***	-0.9099	-4.5144***	I(1)
IMP	-1.2770	-5.3989***	-1.9817	-5.0065***	I(1)
NEER	-2.8321	-10.2907***	-2.8564	-10.5220***	I(1)
INT	-3.0250**	-6.6624***	-3.3539	-6.0617***	I(0)
OILP	-2.7205	-10.4317***	-2.6629	-12.3199***	I(1)
GDP	0.6368	-3.6431**	0.0848	-12.0554***	I(1)

Note: *** and ** denotes significant at 1%, and 5% significance level, respectively.

4.2. Cointegration test and VECM

The cointegrated VAR (CVAR) approach is adopted to determine the long run relationship between the exchange rate and the consumer prices. The SVAR approach is also very popular in the exchange rate pass-through literature but, because SVAR is estimated in first difference of the variables information about the long run relationship is lost. As shown in Table 1, above all the variables included in the model are stationary at first difference (I (1)) except the interest rate. To enable us to estimate the CVAR we first test for cointegration to establish existence of any long run relationship between the variable. Johansen cointegration test is used and the result of the test is presented in Table 2 and Table 3 below.

Table-2. Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	0.05 critical value	Probability
None *	0.925599	614.3177	95.75366	0.0001
At most 1 *	0.816722	364.8823	69.81889	0.0001
At most 2 *	0.653514	201.9941	47.85613	0.0000
At most 3 *	0.439489	100.2425	29.79707	0.0000
At most 4 *	0.366832	44.66743	15.49471	0.0000
At most 5	0.008232	0.793516	3.841466	0.3730

* denotes rejection of the hypothesis at the 0.05 level

Table-3. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen statistics	0.05 critical value	Probability
None *	0.925599	249.4354	40.07757	0.0001
At most 1 *	0.816722	162.8882	33.87687	0.0001
At most 2 *	0.653514	101.7516	27.58434	0.0000
At most 3 *	0.439489	55.57510	21.13162	0.0000
At most 4 *	0.366832	43.87392	14.26460	0.0000
At most 5	0.008232	0.793516	3.841466	0.3730

* denotes rejection of the hypothesis at the 0.05 level

The result shows 5 cointegrating equations in both the Trace and Maximum Eigenvalue tests at 5% level. This can be observed from the table that, trace statistics are greater than the critical values in all the hypothesized number of cointegrating equations denoted with asterisk. Hence we reject the null hypothesis of no cointegration at 95% level of significance. The maximum eigenvalue statistics were also greater than the critical values for the

hypothesized number for cointegrating equations denoted with asterisk. The null hypotheses of no cointegration are rejected. Therefore, the restricted vector autoregressive is used to test the model.

As the objective of the paper is to estimate the degree and speed of the ERPT to the consumer prices, the VECM is estimated with normalization on CPI. The coefficients on the exchange rate variables indicate the degree of pass-through, while the adjustment coefficients show the speed of the pass-through in long run. The CVAR is estimated with thirteen lags selected by AIC information criteria. Diagnostic tests carried out shows no problem of VAR stability, autocorrelation and heteroscedasticity, but there is a vector normality problem.

The results of the Normalized cointegrating coefficients and the adjustment coefficients normalized on CPI are presented in Table 4.

Table-4. Long-run relation of variables with CPI

Variables	CPI	IMP	NEER	INT	GDP	OILP
β	1.0000	-0.2867 (0.1234)	-0.5837 (0.1127)	-1.4826 (0.2328)	-3.9213 (0.5208)	0.1607 (0.1278)
α	-0.0629 (0.0209)	0.0022 (0.0351)	0.6452 (0.2255)	-0.2368 (0.1195)	-0.0165 (0.0125)	0.3247 (0.2635)

The parentheses () are used to denote t- values

The long run equilibrium relationship normalized on CPI can be written as follows:

$$CPI = 0.2867 IMP + 0.5837NEER + 1.4826INT + 3.9213GDP - 0.1607OILP$$

The coefficient suggests that in the long run, 1 percent increase in the NEER (depreciation in domestic currency) increases CPI by 0.58 percent. This implies that if NEER changes by 100 percent, 58 percent of it will pass into consumer prices. Therefore, in the long-run ERPT to consumer price in Nigeria is substantial but incomplete.

For the other variables included in the model, in the long-run import price has significant positive impact on consumer prices. One percent increase in IMP increases consumer prices by about 0.29 percent which means the consumer prices responds slightly to changes in the imported goods prices. This shows that apart from the change in exchange rate a change in the price of imported goods which come about due to factors such as change in exporter's production cost, change in demand structure and other exogenous factors that affect the price of imported goods denominated in the exporter's currency have some impact on consumer prices. GDP is found to be highly significant in the long run, 1 percent increase in the GDP increases CPI by a 3.92 percent. The money market interest rate (INT) is found to be wrongly signed and insignificant.

The short-run dynamics imply that the speed of adjustment of CPI to its long-run equilibrium is sluggish. The adjustment coefficient for consumer price is -0.0629. This suggests that when the CPI inflation exceeds its long-run equilibrium by 1 percentage point, 6.2 percent of this deviation is adjusted for every quarter, thus it will take about 16 quarters for the CPI to adjust to its long-run equilibrium.

5. CONCLUSION AND POLICY IMPLICATION

The paper uses cointegrated VAR model to estimate the long-run exchange rate pass-through to consumer prices in Nigeria. The long-run pass-through coefficient is measured by the coefficient of exchange rate term in the cointegrating vector normalized on consumer prices, while the adjustment coefficient measures the speed of the pass-through.

The evidence from the analysis of the data covering the period from 1986Q3 to 2013Q4 reveals that the exchange rate pass-through to consumer prices was substantial but incomplete and the speed of the pass-through is slow. This result is in line with some previous studies which used different approaches like Aliyu *et al.* (2010) and Zubair *et al.* (2013) who also found incomplete pass-through. The result is also in line with studies in some West

African countries like Ghana. For instance Sanusi (2010) who studies the ERPT in Ghana also found an incomplete but substantial pass-through.

The result suggests that the importing firms tend to absorb some proportion of the exchange rate change in their profit mark-up either in an attempt to maintain their market shares or perception of the change in the exchange rate as temporary. However, the importing firm pass-through substantial proportion of the exchange rate changes when the size of the change exceeds a certain threshold that they could not absorb in their profit mark-up or perceive that the change is not temporary.

The large pass-through obtained can be attributed to the incessant depreciation of the naira throughout the sample period. Hence the importing firms probably perceive any depreciation on the naira exchange rate as permanent and pass-through the change in exchange to consumer prices. Another theoretical explanation for the large exchange rate pass-through is the persistent inflation throughout the sample period. Furthermore, the high ERPT could be due to the high share of imports in the Nigerian consumption basket during the sample period.

The result from the analysis suggests that some substantial amount of the exchange rate depreciation pass to the domestic consumer prices inflation in addition to the domestic cost push and demand pull inflation factors. The domestic consumer prices are therefore affected tremendously by the exchange rate depreciation. Hence effort by the central bank to stabilize the exchange rate would have a positive effect on the domestic price inflation. Effort should be made to control the domestic inflation by reducing the share of import in the consumption basket.

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