Exchange Rate Pass-Through to Inflation in Nigeria

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Concerns about the magnitude and length of exchange rate pass-through to consumer prices have increased in many developing countries in view of its profound implications on price and exchange rate stability as well as the macroeconomic policy environment. This paper examines the exchange rate pass-through effect at the aggregate level into import and consumer prices in Nigeria for the period 1995Q1 – 2015Q1. Utilizing the Johansen approach to cointegration and a vector error correction methodology, the paper found the exchange rate pass-through into Nigeria's CPI inflation to be incomplete. The long run pass-through elasticities were found to be 0.24 and 0.30 for the baseline and alternative models. The effect was discovered to be higher in import than in consumer prices, implying that the pass-through effect declines along the pricing chain. These findings were useful in the design and implementation of monetary and exchange rate policies by the Central Bank of Nigeria.

Keywords: Exchange rate pass-through, Prices, Cointegration, Vector Error Correction, Impulse response.

JEL Classification: C32, E31, F31, O55

1.0 Introduction

One of the key challenges to economic policy management all over the world and particularly in emerging and developing economies has been the effect of changes in exchange rates on inflation and economic activities. It is believed that exchange rate movements would create domestic economic distortions and affect a country's economic competitiveness. The deleterious effect of exchange rate misalignment is well documented in literature and there is often reluctance on the side of policy makers to adjust exchange rates due to perceived negative effect on the economy, mainly due to pass-through effects.

The literature has also underscored the importance of exchange rate as a veritable tool for achieving overall economic progress. This is based on the

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link between exchange rate and other economic variables and the crucial role of exchange rate in monetary policy formulation, as it serves as an essential part of signaling channel of the transmission of policy decisions to achieve the desired macroeconomic objectives. Therefore, an in-depth understanding of exchange rate pass-through is essential for policy formulation, especially for central banks, saddled with the responsibility of managing exchange rate and ensuring price stability.

Goldberg and Knetter (1997) defined exchange rate pass-through (ERPT) as the percentage change in local currency import prices resulting from a one per cent change in the exchange rate between the exporting and importing economies. ERPT is generally used to refer to the effect of exchange rate changes on import and export prices, consumer prices, investments or trade volumes (Frimpong and Adam, 2010). The significance of exchange rate changes in macroeconomic adjustment is determined, to a large extent, by its influence on domestic prices and the speed of its transmission. If the degree of pass-through is high, the exchange rate movements will change the relative prices of commodities, thereby resulting in rapid adjustment in trade balances. For example, if the degree of ERPT is high, imported goods become expensive, demand for imports decline, and consumers shift to domestically-produced goods. On the other hand, if the degree of ERPT is low, the exchange rate does not have much impact on domestic prices and trade balances.

Exchange regimes play an important role in ERPT. In a fixed exchange rate regime, economic agents adjust prices rapidly because they perceive any change in exchange rate to be permanent. However, in a flexible exchange rate regime, economic agents do not adjust their prices swiftly because they perceive changes to be temporary. In a high income country, economic agents do not adjust prices rapidly in response to exchange rate changes because higher incomes create opportunity for higher degree of competition in the domestic market, thereby constraining the pricing power of firms. On the other hand, in low income countries, the reverse is the case (Razafimahefa, 2012).

Contractionary monetary policy lowers the degree of ERPT, while expansionary monetary policy is associated with large ERPT, as economic agents perceive the policy as unstable and tend to rapidly adjust prices. In the

same vein, expansionary fiscal policy will lead to increase in the degree of pass-through because economic agents fear that government will address accumulated fiscal deficit by increasing taxes or cutting expenditure, which will invariably reduce profitability of firms or contract the market. Contractionary fiscal policy, on the other hand, will reduce the degree of pass-though. Overall, good macroeconomic policy is associated with low pass-through.

Empirical literature for both developed and emerging economies has found evidence of incomplete ERPT, as well as considerable differences across countries, leading naturally to the question of what the underlying determinants of pass-through are (Ca' Zorzi et al, 2007). Taylor (2000) puts forward the hypothesis that the responsiveness of prices to exchange rate fluctuations depends positively on inflation. Evidence across different studies appears supportive of the Taylor hypothesis. The positive relationship between the degree of pass-through and inflation appears to emerge more strongly in emerging markets (Choudhri and Hakura, 2006).

Previous studies on ERPT in Nigeria employed different methodologies such as Granger causality tests, vector autoregression (VAR), cointegtation and vector error correction framework and unrestricted error correction method (UECM). This study reexamines exchange rate pass-through to inflation in Nigeria, utilizing the vector error correction methodology (VECM), by extending the period of study and introducing additional variables into the modeling framework. The use of nominal exchange rate (NER) and United States producer price index (USPPI) in the baseline model and the replacement of NER with nominal effective exchange rate (NEER) in the alternative model is the novel introduced in this work. The use of NEER was predicated on two reasons; it was found to be broader and witnessed more variability than the NER.

This study, therefore, investigates the degree and speed of ERPT to inflation and import prices in Nigeria. Specifically, the objectives of this work are to determine if there is a long run relationship among the variables of interest; estimate the pass through elasticity between exchange rate and inflation, and other variables in the model; investigate the speed of adjustment of exchange rate shock; and assess the magnitude of CPI changes as a result of fluctuations in exchange rate.

The rest of this paper is organized as follows. Section 2 reviews theoretical and empirical literature. Section 3 presents the methodology, while Section 4 presents the findings. Section 5 concludes the paper, and proffers policy recommendations.

2.0 Theoretical and Literature Review

2.1 Theoretical Review

The theoretical literature on exchange rate pass-through draws their strength from the law of one price (LOOP), the purchasing power parity (PPP) and the monetary theory to exchange rate determination. In this study, we present the basic postulates of these theories in order to have firm grasp of the theoretical underpinnings of exchange rate movements.

2.1.1 Law of One Price and Purchasing Power Parity

The theoretical foundation on which the relationship between prices and exchange rates is based evolves from the doctrine of purchasing power parity (PPP), an offshoot of the law of one price (LOOP), with the assumptions that there are no trade barriers and transport costs. However, in real world situations, trade frictions exist and these distort the underlying assumptions of PPP. Notwithstanding these developments, the law of one price is still useful in understanding the relationship between prices and exchange rates. This relationship, linking the domestic price to exchange rate, follows from the LOOP which states that in the absence of trade frictions and under conditions of free competition and price flexibility, identical goods sold in different locations must sell for same price when prices are expressed in a common currency. Therefore, at equilibrium, the prices of tradable goods in two markets are not expected to differ when expressed in the same currency and thus, guaranteeing a complete pass-through. Thus, a change in domestic currency in a market would have equal change in price in the other market, even though the markets are in two different countries. Algebraically, PPP with no transport costs and tariffs can be written thus:

$$P_t^a = EXC_t P_t^* \quad (1)$$

where P_t^a represents domestic price at time t, P_t^* stands for the world import price and EXC_t is the nominal exchange rate.

However, because of trade frictions, the LOOP may or may not hold in certain instances. This is based on the fact that many factors such as cost of production, producers' mark up and exchange rate movements influence domestic import prices. The principle of PPP is the macroeconomic counterpart to the microeconomic LOOP. While LOOP relates exchange rates to the relative prices of an individual good, PPP relates exchange rates to the relative prices of a basket of goods. Both theories are used as theoretical background of exchange rate pass-through depending on whether the emphasis is at firm level or at macroeconomic level. However, PPP does not hold in the short run due to transaction costs, non-traded goods, price stickiness, imperfect competition and some legal obstacles (Feenstra and Taylor, 2008).

2.1.2 Monetary Approach to Exchange Rate Determination.

The monetary theory combines monetary exchange rate model by Krugman (1986) using the LOOP and the PPP to explain how changes in exchange rates would directly affect price levels. The monetary approach to prices and exchange rates suggests that all else equal, increase in the rate of money supply growth should be the same size as increase in the rate of inflation and the rate of exchange rate depreciation. The approach shows that, in the long run, all nominal variables- the money supply, interest rate, price level and exchange rate are interlinked. Hence, monetary policy choices can radically affect some important economic outcomes, notably prices and inflation.

2.2 Empirical Literature Review

Extensive empirical literature on the exchange rate pass-through to producer and consumer prices has provided evidence of considerable cross-country differences in the magnitudes of the pass-through effects. Though some of the studies documented complete ERPT, majority found that ERPT was far from being complete. Some literature indicated increases or decreases in ERPT effects overtime, and the reasons for such changes. Studies have shown that developed countries tend to have lower pass-through effects than developing countries.

Berben (2004) found that the degree of pass-through of the guilder-mark exchange rate into the price differential between the Netherlands and Germany increased during the run-up to the European Monetary Union (EMU), supporting the view that the two countries became more integrated

during that period. The study also indicated that lower inflation was not necessarily associated with a lower degree of pass-through of costs to prices. Klitgaard (1999) examined the effect of fluctuations in the dollar/yen exchange rate and indicated that the US import price of Japanese goods rose by less than the exchange rate in the early 1990s as Japanese firms accepted lower export prices in yen terms. Also, McCarthy (2000) found the exchange rate pass-through to consumer prices to be modest in a number of industrialized economies. The study found the rate of pass-through to be positively related to trade openness and negatively related with exchange rate volatility. Gagnon and Ihrig (2001), however, couldn't find a systematic relationship between ERPT and the monetary behaviour in advanced countries studied.

Kang and Wang (2003) evaluated the impact of exchange rate fluctuations on import and consumer prices in Japan, Singapore, Korea and Thailand. The authors found that the transmission of exchange rate changes to import and consumer prices were more during a post-crisis period (1998–2001) than in the pre-crisis one (1991–1996). Campa and Goldberg (2005) provided evidence of partial pass-through in 23 OECD countries in the short run. The study indicated that import prices in local currencies reflected about 46 per cent of exchange rate fluctuations in the short run, and about 65 per cent over the long run. Even though individual pass-through elasticities were found to be closer to 1 in some of the case countries, complete pass-through was still rejected for many of them. The authors also found that macroeconomic variables play a significant but limited role in explaining cross-country differences in pass-through elasticities, as the pass-through into import prices was lower for countries with low average inflation and low exchange rate variability.

Shintani et al (2009) showed that declines in the ERPT in the US during the 1980s and 1990s were associated with lower inflation. Similarly, Sahaa and Zhanga (2011) tested whether the ERPT to import prices was complete and estimated the pass-through to CPI. Their findings, using structural VAR model, indicated that exchange rates had less effect on the rising domestic prices in China and India. Jiang and Kim (2013) utilized the structural VAR approach to examine the impact of exchange rate changes on producer and retail prices in China. The study found that ERPT to producer and retail prices

were incomplete, but the pass-through to producer prices was higher than that to the retail prices.

However, Hoque and Razzaque (2004) showed distinct pass-through effects to Bangladeshi export prices across the 18 commodities included in their study. It also showed complete pass-through effects for all their primary export commodities, except the country's major export item – readymade garments, which was found to be insensitive to changes in the exchange rate. The study further revealed that exporters displayed distinctive pass-through behaviour in various export markets depending on the demand pattern of the commodities in those markets.

McCarthy (2007) showed that ERPT declined since the mid-1990s in sub-Saharan African (SSA) economies. He also found that the shift in the coefficient of the NEER variable was the most distinct and statistically significant in the mid-1990s. The elasticities substantially decreased in all model specifications. The reduction in pass-through elasticities was estimated at about 50 percent. Ghosh and Rajan (2007) estimated the ERPT into India's consumer prices, and found a pass-through elasticity of 40 per cent in the long run and 10 per cent in the short run. They also showed evidence of a higher pass-through in the post-liberalization era and attributed it to greater openness of the economy. In a similar study, Ghosh and Rajan (2009) found ERPT to inflation in Thailand to be higher than in Korea in all cases. They also showed that ERPT was larger into import prices than consumer prices for both countries, further indicating that pass-through declines along the price chain. Alim and Lahiani (2014) investigated whether a credible monetary policy aimed at controlling inflation reduces the exchange rate pass through in three East Asian and two Latin American economies. Their results indicated that lower ERPT were associated with a credible monetary policy regime aimed at controlling inflation. They also found that ERPT was higher in Latin American countries than in the East Asian economies.

Aliyu et al (2008) examined the degree of ERPT to import and consumer prices in Nigeria utilizing quarterly data for the period 1986 to 2007. The study showed that ERPT was significant in Nigeria, though found to be higher in import prices than in consumer prices during the period. Their results indicated that a one per cent shock to exchange rate resulted in 14.3 and 10.5 per cent pass-through effects to import and consumer prices, respectively, four quarter ahead. They suggested that ERPT in Nigeria declines along the price chain and partly downturns the conservative perception in the literature that

ERPT is always considerably higher in developing economies than developed economies. Oyinlola and Babatunde (2009) also examined the extent of pass-through of exchange rate into import prices for Nigeria between 1980 and 2006, using UECM-Bounds test proposed by Pesaran et al (2001). They also showed that world export prices had a dominant effect compared to exchange rate in explaining changes in Nigeria's import prices in the short and long run.

Utilizing annual data for Nigeria from 1980 – 2010, ESD (2012) found the exchange rate pass through to be incomplete in Nigeria, as the elasticities were 76.0 and 31.0 per cent in the long run and short run, respectively. They indicate that exchange rate changes increase domestic prices for two consecutive periods, and stress the need to ensure exchange rate stability in view of its large impact on domestic prices. They, however, found import price pass-through to be quite low whereas oil price pass-through was more severe than the ERPT.

Adelowokan (2012) considered the interest and inflation rate channels of ERPT in Nigeria applying the ordinary least squares estimation procedure and using annual data for the period 1970 to 2010. The study couldn't find any evidence of ERPT to inflation in Nigeria during the period as neither the exchange rate of the Naira vis-à-vis the US dollar nor its lagged value could influence consumer prices. However, it found evidence of the pass-through effect to interest rates. Adeyemi and Samuel (2013) investigated the ERPT to consumer prices in Nigeria using the VECM approach and data for the period 1970 to 2008. Results from their impulse response functions (IRF) analysis indicated considerable degree of ERPT to consumer prices in Nigeria, amounting to about 83 per cent in the long term. The study showed that the exchange rate was more important in explaining the rising inflation in Nigeria than money supply.

3.0 Research Methodology

Ghosh and Rajan (2009) formulated two equations – the bilateral exchange rate and the Nominal Effective Exchange Rate (NEER) - to estimate pass-through elasticities for Korea and Thailand. Their equations were stated as follows;

$$NER: \ln\left(P^i\right)_t = \alpha_0 + \alpha_1 \ln\left(E_j^i\right)_t + \alpha_2 \ln\left(GDP^i\right)_t + \alpha_3 ln(PPI^j)_t \qquad (2)$$

$$NEER: \ln\left(P^i\right)_t = \beta_0 + \beta_1 \ln(NEER)_t + \beta_2 \ln\left(GDP^i\right)_t + \beta_3 ln(CPI^w)_t \quad (3)$$

where i is Korea or Thailand, j is US or Japan, P^i is import prices or CPI of Korea or Thailand, E_j^i is the bilateral exchange rate of Korea and Thailand per USD or JPY, PPI is the producer price index of the US or Japan, GDP is the gross domestic product of Korea or Thailand and CPI^w is the world CPI. We examine the ERPT into import and consumer prices in Nigeria by applying a modified version of Ghosh and Rajan (2009) methodology stated above. We included the international crude oil prices in our model in view of the importance of crude oil exports in the Nigerian economy. We consider the law of one price in absolute terms as stated previously. Transforming equation (1) yields the following equation:

$$\Delta\ln(P_t^a) = \Delta\ln(EXC_t) + \Delta\ln(P_t^*) \quad (4)$$

where Δ *represents change, while the other variables are as defined previously.*

Equation (4) is augmented with control variables. We apply the bilateral nominal exchange rate of the US dollar to the Nigerian currency (NER) in the baseline model. Jiang and Kim (2013) have shown that using the nominal effective exchange rate (NEER) as a proxy for the exchange rate was more appropriate for two reasons – NEER was a broader measure and had more variations than the nominal exchange rates. Consequently, we used the NEER to proxy EXC in the alternative model. The world import price is proxied by US producer price index (USPPI). Other control variables to be included in the analysis are crude oil prices (OILP) and real output (RGDP). Thus, the pass-through into Nigeria's import and consumer prices is estimated for the US dollar NER and the NEER as follows:

$$In(CPI) = \alpha_0 + \alpha_1 In(NER) + \alpha_2 In(USPPI) + \alpha_3 In(OILP) + \alpha_4 In(RGDP) + \varepsilon_t \quad (5)$$

$$In(CPI) = \alpha_0 + \alpha_1 In(NEER) + \alpha_2 In(USPPI) + \alpha_3 In(OILP) + \alpha_4 In(RGDP) + \varepsilon_t \quad (6)$$

Many empirical studies applied the cointegration and VAR methodology to analyze ERPT in many countries. This study employs the VECM in line with

the works of Aliyu *et al* (2008), Ca' Zorzi *et al* (2007) and McCarthy (2000). The general VAR model from which the VECM evolves is stated as follows:

$$Y_t = c + \sum_{i=1}^{p} \Phi_i Y_{t-1} + \varepsilon_t \quad (7)$$

where Y_t represents a vector of endogenous variables, c is a vector of constants, Φ_i represents a vector of autoregressive coefficients and ε_t is a vector of white noise processes.

The empirical analysis starts by checking the time series properties of the variables using the Augmented Dickey Fuller (ADF), Phillips Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to establish the order of integration of the series, before embarking on Johansen and Juselius (1990) cointegration tests in a multivariate form.

The study used a five-variable VECM model, similar to that in Aliyu et al (2008), Ca' Zorzi et al (2007) and McCarthy (2000). However, Aliyu et al (2008) measured exchange rate only in nominal terms, while this study utilized two measures of the exchange rates – NER and NEER. The baseline model includes oil prices (OILP), real output (RGDP), exchange rates (NER), import prices (USPPI) and consumer price index (CPI). The alternative model dropped NER and includes NEER. The exchange rates and the two variables of import and consumer prices are the key variables in the analysis. Higher oil prices increase oil receipts which may lead to reserves accretion and subsequent appreciation in the naira exchange rates, leading to a decline in inflation. Higher import and consumer prices all lead to depreciation of the exchange rate and increased inflation. Thus, the a priori expectations of the vector coefficients of the two exchange rate variables and crude oil prices will be negative, while import prices and real output will be positive.

Ca' Zorzi et al (2007) indicated that identification of the structural shocks is achieved by appropriate ordering of the variables of interest and applying Cholesky decomposition to the variance-covariance matrix of the reduced form residuals, ε_t. Thus, we order the most exogenous variable, the crude oil price (OILP) first, as its shocks may affect all other variables contemporaneously, but are not themselves affected by any of the other

shocks. The next variables are real output and the exchange rates, with the import price ordered last.

The study utilizes quarterly time series data from 1995Q1 to 2015Q1. The exchange rate is measured as the amount of US dollars per unit of the Nigerian naira, such that depreciation of the naira appears as a decline in the nominal exchange rate series. The second proxy is the NEER, which also falls as the nominal value of the exchange rate depreciates. The USPPI is used to proxy import prices, as the US is Nigeria's biggest trading partner. Output is measured by real GDP, while consumer price index is measured by composite CPI (November 2009 = 100). Crude oil prices were obtained from the World Bank Commodity price data (the pink sheet), while USPPI and Nigeria NEER were sourced from the International Financial Statistics (IFS). Other series were obtained from the Central Bank of Nigeria's (CBN) statistics database. All variables were seasonally adjusted.

4.0 Empirical Results

This section presents the results of the analysis including unit root tests, cointegration analysis and the vector error correction results. Two versions of the specified model are estimated – the baseline model, which define exchange rates in terms of the amount of US dollars per one Nigeria Naira, and the alternative model, which proxy exchange rates using the nominal effective exchange rates (NEER). Impulse response functions (IRF) and variance decomposition (VDC) analysis are also carried out.

4.1 Unit Root Tests

We begin by testing for the presence of unit root in all the variables, using the Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Empirical results from the ADF and PP tests as indicated in table 1 shows that the null hypothesis of a unit root cannot be rejected at the 5 per cent levels for all the variables. Similarly, the KPSS tests for all the variables show that the null hypothesis of stationarity under KPSS is rejected at the 5 per cent level.

ADF and PP tests on the first difference of the variables, however, result in a strong rejection of the null hypothesis, while the KPSS null is accepted. Consequently, all the variables are found to be non-stationary at level, but can

be made stationary with first differencing, and can be tested for cointegration in the Johansen sense.

Table 1: Unit Root Tests

	Level			*First Difference*		
Variable	ADF	PP	KPSS	ADF	PP	KPSS
lnCPI	-2.34	-2.23	1.27	-5.81*	-8.57*	0.30*
lnOILP	-1.62	-1.29	1.16	-5.31*	-5.30*	0.19*
lnRGDP	2.77	1.56	1.25	-9.95*	-9.56*	0.31*
lnUSPPI	-1.06	-0.73	1.21	-5.06*	-4.58*	0.11*
lnNER	-1.8	-1.8	0.89	-8.52*	-8.52*	0.19*
lnNEER	-1.65	-1.66	0.98	-8.58*	-8.58*	0.14*

** and ** indicate significance at 1 and 5 per cent levels.*
The MacKinnon critical values were -3.52 and -2.90 at 1 and 5 per cent levels for both ADF and PP Tests. The KPSS critical values were 0.74 and 0.46 at 1 and 5 per cent levels, respectively.
The null hypothesis of KPSS tests assumed the series to be trend-stationary while that of ADF and PP tests the null hypothesis of a unit root.
Source: Researchers' computations

4.2 Cointegration Tests

Empirical results from the Johansen cointegration analysis are presented in table 2. The Johansen's test is aimed at determining whether a long-term relationship exists between the series, and start with the null hypothesis that there is no cointegrating relation. If this hypothesis is rejected, we then test that there is at most one cointegrating equation. Since there are five variables in each of the model, we then test whether the number of cointegrating equations is zero, one, two, three or four.

The results indicate the presence of two cointegrating equations on both the trace and maximum eigenvalue statistics, at the 5 per cent level for both the baseline and alternative specifications. This confirms the presence of a long-run stable relationship among the variables in the models.

Table 2: Cointegration Analysis

Hypothesized No. of CE(s)	Trace Statistics	0.05 Critical Value	Max-Eigen Statistics	0.05 Critical Value
Baseline Model				
None	101.62*	69.82	48.67*	33.88
At Most 1	52.95*	47.86	29.12*	27.58
At Most 2	23.83	29.8	14.8	21.13
At Most 3	9.03	15.49	8.06	14.26
At Most 4	0.96	3.84	0.96	3.84
Alternative Model				
None	104.70*	69.82	50.52*	33.88
At Most 1	54.18*	47.86	29.67*	27.58
At Most 2	24.51	29.8	15.19	21.13
At Most 3	9.32	15.49	8.24	14.26
At Most 4	1.08	3.84	1.08	3.84

The series used were CPI, OILP, RGDP, USPPI and NER for the baseline model while the alternative model excluded NER but included NEER.
Lag lengths were determined in line with AIC.
Source: Researchers' computations.

4.3 VECM Estimates of the Pass-through Effects

In view of the presence of a cointegrating vector among the variables as evidenced by the cointegration tests, the long-run pass-through effect from exchange rates to domestic prices is estimated using the vector error correction methodology (VECM). Table 3 provides a summary of the cointegration equation results for both the baseline and alternative models. Empirical results from both models indicate that all variables have their anticipated signs. Real output is, however, found to be statistically insignificant. Changes in import prices are found to have greater impact on the exchange rates in the long-run.

Table 3: Normalized Cointegrating Coefficients

Baseline Model

lnCPI	lnOILP	lnRGDP	lnNER	lnNEER	lnUSPPI	c
1.000000	-0.91*	0.30	-0.24*		4.82*	-16.39
	(-2.69)	(0.56)	(-3.18)		(2.61)	
Alternative Model						
1.000000	-0.89*	0.39		-0.30*	4.43*	-12.58
	(-2.80)	(0.83)		(-3.55)	(2.70)	

** and ** denotes significance at 1 and 5 per cent levels.*
t-statistics in parentheses

We find the long-run ERPT elasticity into Nigeria's CPI inflation for the sample period to be 0.24, when the US dollar bilateral exchange rates is used to proxy the exchange rate in the baseline model. The elasticity is 0.30 when the nominal effective exchange rates (NEER) is utilized in the alternative model, and both coefficients are found to be significant at 1 per cent level. This implies that 1 per cent depreciation in the Nigerian naira – US dollar exchange rates will lead to a 0.24 and 0.30 per cent increase in Nigeria's CPI inflation. Import price elasticities indicate that a 1 per cent change in import prices will lead to a 4.82 and 4.43 per cent change in CPI. Thus, the pass-through effects is found to be higher in import than consumer prices, suggesting that pass-through declines along the pricing chain in Nigeria, which is in line with the findings of previous empirical studies on the subject (Aliyu et al, 2008).

Table 4: Short-run VECM Coefficients

Baseline Model

Lags	ΔlnCPI	ΔlnOILP	ΔlnRGDP	ΔlnNER	ΔlnNEER	ΔlnUSPPI	*ECM*
1	0.30*	-0.02	-0.63*	-0.05*		-0.00	-0.09*
	(2.45)	(-0.44)	(-4.77)	(-3.34)		(-0.00)	(-4.68)
2	-0.29*	-0.05	-0.49*	-0.07*		0.24	
	(-2.47)	(-1.56)	(-3.65)	(-4.29)		(1.14)	
Alternative Model							
1	0.29*	-0.01	-0.62		-0.06*	-0.05	-0.10*
	(2.41)	(-0.40)	(-4.76)		(-3.51)	(-0.25)	(-4.84)
2	-0.26*	-0.06	-0.48*		-0.07*	0.21	
	(-2.40)	(-1.61)	(-3.65)		(-4.30)	(1.01)	

** and ** denotes significance at 1 and 5 per cent levels.*
t-statistics in parentheses

The short-run dynamics of the models are presented in Table 4 above. The coefficients of the error correction term are 0.09 for the baseline and 0.10 for the alternative model, and are significant at the 1 per cent level. This suggests that any deviation from the long-run equilibrium relationship is adjusted by about 9 to 10 per cent in a quarter, respectively, for the two specifications. Thus, it will take roughly 11 quarters for CPI inflation to adjust to its long-run equilibrium. The speed of adjustment is quite low, and this can be attributed to the composition of the Nigeria CPI inflation. The short-run ERPT elasticities are found to be 0.05 and 0.07 for the NER and 0.06 and 0.07 for the NEER in the first and second quarters, and are significant at the 1 per cent level. A cursory look at the composition of the CPI basket indicates that about two-

third of goods and services included in the CPI basket were produced in the country, leaving only the balance of about one-third being imported. CPI on food alone constituted about 50 per cent of the total CPI. Consequently, the pass-through effect impacted mainly on those commodities imported, as foreign exchange is required to import them. However, we did not find any statistically significant import price pass-through to inflation in the short-run.

Diagnostic tests are utilized for checking the validity of a fitted model. Consequently, the VECM-based diagnostic tests are conducted. A preliminary investigation of the nature of correlation of the VECM residuals reveals that most of the off-diagonal elements from the two models are less significant or close to zero, indicating that no contemporaneous correlations are being ignored by the models. To investigate white noise errors, residual serial correlation LM tests, White's heteroskedasticity and normality tests are carried out on the models. The results indicate that there is no serial correlation in the residuals in both models and the residuals are homoskedastic.

4.4 Impulse Response Functions and Variance Decompositions

Impulse response functions trace the effect of a shock emanating from an endogenous variable to other variables in the VECM. The response of import and consumer prices to a one per cent shock in both the NER and NEER are indicated in figures 1 and 2. Results from impulse responses indicate that CPI reacted negatively to the shocks in exchange rates for the first four quarters, and became positive after the fifth quarter. The response continues to increase slightly up to twelve quarters. However, the response of USPPI was negative throughout the period and continues to increase up to twelve quarters. The alternative model also showed similar results, as the response of CPI dies out and became positive at the fourth quarter, while US PPI was also negative throughout. This further supports the view that pass-through was higher in import than in consumer prices in Nigeria.

The results also indicate that the pass-through effect to exchange rate itself is high, persistent and significant, implying that exchange rate depreciation leads to further depreciation as established by Aliyu *et al* (2008).

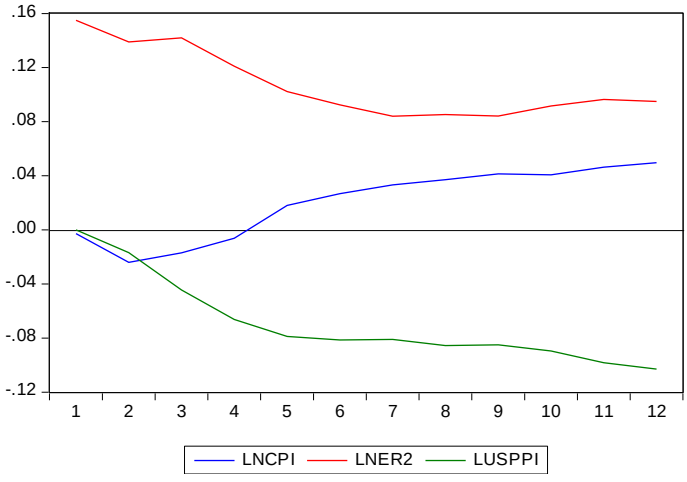

Figure 1: Response of Price Indices and Exchange Rates to an Exchange Rate Shock (Baseline Model)

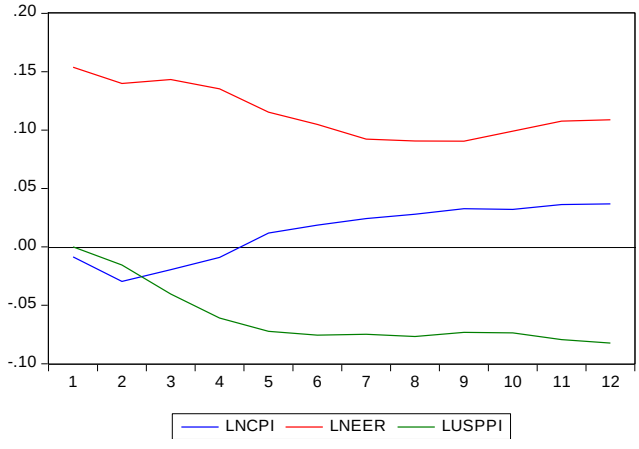

Figure 2: Response of Price Indices and Exchange Rates to an Exchange Rate Shock (Alternative Model)

Results from variance decomposition presented in table 5 show that CPI inflation accounts for 100 per cent of its own variance, but declines to 74.5 and 54.2 per cent during the second and fourth quarter, respectively, in the baseline model. The influence of the exchange rates in CPI inflation increases from 5.0 per cent in the second quarter to 15.8 and 16.9 per cent respectively, in four and six quarters.

Variance decompositions from the alternative model are found to be similar to those in the baseline model. These results suggest that CPI inflation in Nigeria is being significantly influenced by inertia and exchange rate fluctuations.

Table 5: Variance Decomposition

Baseline Model				
	2 quarters	4 quarters	6 quarters	8 quarters
CPI	74.45	54.17	51.83	52.28
USPPI	2.56	2.06	1.48	1.05
NER	4.97	15.79	16.89	13.91
Alternative Model				
	2 quarters	4 quarters	6 quarters	8 quarters
CPI	74.81	54.83	52.58	52.98
USPPI	3.35	3.15	2.30	1.62
NEER	3.88	13.57	14.70	11.99

The magnitude of the pass-through effects in Nigeria indicates that the impact of exchange rate fluctuations on trade balance may be quite large. Similarly, the external sector driven nature of the economy suggests that shocks from global markets may have profound implications on inflation and other economic activities. Consequently, the monetary authority may need to gauge appropriate monetary policy responses to pass through effects by ensuring exchange rate stability, anchoring inflation expectations and minimizing fluctuations in economic activities.

5.0 Concluding Remarks

Large price increases resulting from exchange rate depreciation could spill over to other sectors of an economy, raise the overall domestic production costs and might lead to an inflationary spiral. Consequently, the need to gauge an appropriate monetary policy response to such pass-through effects by a central bank and make the external sector competitive through appropriate exchange rate adjustment has made a study of ERPT in Nigeria imperative. This paper examined the magnitude of ERPT to import and consumer prices in Nigeria.

The paper started by testing for the presence of unit root in the series to avoid incidences of spurious models. Results from the tests conducted using the ADF, PP and KPSS unit root tests indicate that all the variables are stationary at the first difference. The Johansen approach to cointegration tests, for both the baseline and alternative specifications, show that the null hypothesis of no

cointegration cannot be accepted. The study finds the long-run ERPT elasticity into Nigeria's CPI inflation to be incomplete, as the pass-through elasticities are 0.24 and 0.30 for the baseline and alternative models, respectively. Both coefficients are found to be significant at the one per cent levels. ERPT was also found to be higher in import than in consumer prices, implying that the pass-through effects decline along the pricing chain.

The findings of the paper are relevant to Central Bank of Nigeria given its task of achieving a stable exchange rate, through appropriate policies and interventions in the foreign exchange market and efficient management of foreign reserves. Furthermore, price stability being one of the cardinal objectives of the bank could be achieved, if the pattern of ERPT is clearly and correctly identified.

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