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A BOUND TESTING ANALYSIS OF EXCHANGE RATE PASS-THROUGH TO AGGREGATE IMPORT PRICES IN NIGERIA: 1980-2006

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This paper examines the extent of pass-through of exchange rate into import prices for Nigeria between 1980 and 2006 using the recently developed UECM-Bounds test proposed by Pesaran *et al*. (2001). Empirical evidence reveals that world export prices has a dominant effect compared to exchange rate in explaining changes in Nigeria's import prices in the short and long run. The major implication for our study therefore is that exogenous factors such as world export prices appeared to be more important determinants of domestic import prices than a country's exchange rate policies.

Keywords: Aggregate Import Price, World Export Price, Bound Testing, Nigeria
JEL classification: C22, F31

1. INTRODUCTION

For a small open economy trading in a much larger international market, one would expect a change in exchange rate to result into an equal amount of change in import prices (i.e., complete pass-through). The assumptions of perfect market and free entry for open macroeconomic models ensure that movement in exchange rate is fully transmitted to the prices of traded goods. Such models have relied on the assumption of the purchasing power parity (PPP) which ensures the complete pass-through and therefore appropriate impetus for the expected balance of payments adjustment.[1] It was

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[1] Pass- through is the percentage changes in local currency import prices resulting from a one-percent change in the exchange rate, that is, the change in domestic prices that can be attributed to a prior change in the nominal exchange rate. One-to-one response of import prices to exchange rates is referred to as "full" or "complete" exchange rate pass-through while less than one-to-one response of import prices to exchange rates is referred to as limited, incomplete or partial exchange rate pass-through (Kiptui *et al.* (2005)). However, researchers have expressed fear that external account imbalance of major trading nations, notably, the United States of America (USA), were not responding as expected to significant exchange rate movement.

assumed that the delay in adjustment was due to transient price rigidities in a perfectly competitive market. However, several studies in developed as well as developing economies have documented the existence of incomplete pass-through. Investigation to the reason for less-than-complete in the long-run has led to the development of models based on the imperfectly competitive market structures, the result of which have demonstrated that incomplete pass-through appears to be a widespread phenomenon.[2]

The rapid movements in exchange rate became apparent in Nigeria after the Structural Adjustment Programme (SAP) was introduced. From 1986, there was a significant shift in exchange rate and trade policy direction towards greater liberalization. This informed the fall in the nominal effective exchange rate between 1985 and 1989 at an average of 41% annually as well as an average depreciation of 71% annually of the official exchange rate. The parallel exchange rate market was even worse; it depreciated by an average of 114% annually between 1986 and 1993. In recent years, measures like the Dutch Auction System (DAS)[3] mechanism of determining exchange rate that later metamorphosed into the Wholesale Dutch Auction System (WDAS) in February 20, 2006[4], are directed towards moving the economy further into liberalization. The resulting impacts are evident on the continued appreciation and stability of the exchange rate since its commencement.

In addition, other efforts are directed towards moving the domestic price closer to international prices. These events occurred in line with the period of average annual increase in the consumer price index (CPI) of about 78% between 1985 and 1989. This statistics however does not reveal the volatility of changes in CPI as the period entails years of rapid fall and increase in inflation. It was found that annual change in inflation actually rose well above 300% in 1988 relative to the previous year. This volatility has significant implications for the appropriate conduct of monetary policy in an open economy and hence the management of consumer price inflation and balance of payment which are affected by exchange rate movement, through its effect on prices of import.

[2] The coefficients obtained from these studies not only vary for countries and products, but also vary for different studies conducted for same countries (especially US). This has been attributed to different proxies for variables and methodology used in the studies. While some studies rely on Vector Autoregressive models (VAR), others have applied cointegration analysis with error correction models.

[3] The DAS is a method of exchange rate determination through auction where bidders pay according to their bid rates and where the ruling rate is arrived at with the last bid rate that clears the market.

[4] The exchange rate has been stable since the commencement of DAS particularly in the year 2004. Year 2004 opened with a rate of N137.00/$1 and closed with an exchange rate of N132.85/$1, indicating an appreciation of N4.15 (or 3.03%). There was further improvement in 2005 as the naira appreciated by 2% from N132.00/$1 to N129/$1 as at end December, 2005. The exchange rate under the new WDAS has also stabilized and continued to improve the operations of the foreign exchange market. As at March 20, 2006 the exchange was N128/$1. The naira further appreciated in 2007 closing at N116/$1 in December, 2007.

It is therefore imperative to examine the extent of pass-through of exchange rate to the import price. Such investigation will assist in understanding the process of price determination in Nigeria and consequently ensure a robust formulation of monetary policy aimed at curbing inflation. Thus, the significance of this study lies in the argument that the knowledge of the extent of pass-through to import prices could influence monetary authorities' forecasts of the future path of inflation, which is a key element in the conduct of monetary policy. Indeed, the successful implementation of monetary policy presupposes that monetary authorities have not only a good understanding of price determination, but that they are also relatively successful at predicting the future path of inflation.

The critical role played by other key factors in price determination cannot be underestimated. If inflation forecasts are based on estimates of exchange rate pass-through that do not take other factors such as tariff into account, these forecasts could be overestimating the effects of changes in the exchange rate on domestic price. Moreover, the conduct of an optimal monetary policy aimed at price stability depends on the extent, source and the duration of price shock. Hence, the design of an optimal monetary policy should differ across countries and products group depending on the extent of exchange rate pass-through. The determination of the extent of pass-through is therefore crucial for the formulation of an optimal monetary policy.

Furthermore, there is still a paucity of research on the empirical estimates of pass-through for small open and developing economy. Most of the studies have focused on the U.S, Germany, Canada, Belgium, Italy, Austria, Switzerland, Ireland (Baldwin (1988), Hooper and Mann (1989), Feenstra (1989), Kim (1990), Kenny and MacGettigan (1996), Hänninen (1998)), Asia (Athukorala and Menon (1994), Mallick & Marques (2007)) and Latin America (Garcia & Restrepo (2001)) leaving a glaring gap for developing countries. Although, there are few empirical studies on some SSA countries (Bhundia (2002) for South Africa, Kiptui *et al.* (2005) for Kenya, and Oladipo (2007) for Nigeria) but these cannot be generalized for all SSA countries because of their peculiar problems and economic conditions which are countries specific and therefore responsible for the heterogeneous nature of pass-through estimates as obtained in the study by Barhoumi (2005) on few developing countries. Thus, the need for more country specific studies on the subject matter so as to further contribute to the debate and assist in the formulation of appropriate monetary policies is crucial especially for Nigeria where studies in this area are scarce. Finally, many of the previous studies have either ignored the need for testing the time-series properties of the variables entering the import function or have used the Engle and Granger (1987) or Johansen (1988, 1991) cointegration methods, both of which presuppose that all the series contain a unit root.

For example, Oladipo (2007) applied the Johansen (1988) cointegration technique to sectoral data using the mark-up model that sets export prices as a mark-up on production costs of the foreign exporters and established the existence of incomplete pass-through for Nigeria. The study, however, suffers from one major empirical issue. This is because there are limitations to this technique. For example, while the most obvious advantage of

the Johansen method is that it allows estimation of multiple cointegrating vectors where they exist, researchers fail to recognize that the application of the Johansen technique presupposes that the underlying regressors are all integrated of order one (Pesaran *et al*. (2001)).

This is necessary because in the presence of a mixture of stationary series and series containing a unit root, standard statistical inference based on conventional likelihood ratio tests is no longer valid. Harris (1995), for example, notes that the trace and maximum eigen-value tests from the Johansen procedure may lead to erroneous inferences when I(0) variables are present in the system since stationary series are likely to generate spurious cointegrating relations with other variables in the model (De Vita *et al*. (2005)). This study therefore applies a price decomposition method used by Sharma (2003) to investigate the extent of pass-through in Nigeria in a bound testing error correction model serving as our contribution in the study of pass-through in Nigeria. A merit of the ARDL bounds testing approach (Pesaran and Shin (1999), Pesaran *et al.* (2001)) that we employ, is that it allows testing for cointegration when it is not known with certainty whether the regressors are purely I(0), I(1) or cointegrated.

The study covers a period of twenty-seven years. This is between 1980 and 2006. The choice of the period is guided by data availability considerations. The sequence of this study is clear. Section 2 discusses the analytical framework. Estimation issues and sources of data are the pre-occupation of Section 3. Empirical results are discussed in Section 4 while Section 5 rounds off the study with concluding summary.

2. ANALYTICAL FRAMEWORK

The theoretical foundation on which the relationship between prices and exchange rate is based evolve 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 cost. The understanding of the background knowledge of price determination in Nigeria informs the specification of the model. The basic relationship linking the domestic price to exchange rate follows from the Law of One Price (LOOP) which states that at equilibrium, the price of tradable goods in two markets cannot differ when expressed in the same currency and thus, guaranteeing a complete pass-through. The price of tradables is sub-divided into prices of importable and exportable. The focus of this study is on the importable side and we therefore specify the traded price as import price. Following Rangasamy (2003), the purchasing power parity doctrine with no transport costs and tariffs is stated as:

$$P_t^m = EXR_t \cdot P_t^*, \tag{1}$$

Where P_t^m is import price at time *t*, P_t^* is the world price of the import and EXR_t is

exchange rate, measured in units of the domestic currency per unit of the foreign currency, thereafter $EXR \cdot P_t^*$ represents the domestic-currency price of the imported good.

Empirical studies however show that there is incomplete pass-through and hence, LOOP fails to hold. Possible explanations to the failure of the law of one price are, according to Dwyer and Lam (1994) departures from the law occur when for a given world price of an import, proportional changes in its domestic price are not identical to those in the exchange rate. First stage pass-through is the elasticity of the domestic over-the-docks import price with respect to the exchange rate. Adopting the argument of Kenny and McGettigan (1996) and Kiptui *et al.* (2005) we assume that producers abroad set their foreign currency export price (P^*) as a mark-up (δ^*) on their cost of production in foreign currency terms (WEXP):

$$P^* = \delta^* \cdot WEXP \,. \tag{2}$$

The domestic currency import price can therefore be expressed as:

$$P_t^m = E_t \cdot P_t^* = \delta^* \cdot WEXP \cdot EXR_t \,. \tag{3}$$

The implication of Equation (3) is that the domestic currency import price is assumed to be influenced by foreign costs of production, mark-up of foreign producers and the exchange rate. Simultaneously, the mark-up of foreign producers is assumed to depend on competitive pressures in the domestic market and the exchange rate. In this model, the competitive pressure is represented by the price of import-competing goods (PICG) and the exporter's production cost.

$$\delta^* = [PICG / P^* \cdot EXR_t]^{\alpha} \,. \tag{4}$$

Allowing the substitution of Equation (4) into Equation (3):

$$P_t^m = [PICG / WEXP \cdot EXR_t]^{\alpha} \cdot WEXP \cdot EXR_t = [PICG]^{\alpha} \cdot [WEXP \cdot EXR_t]^{1-\alpha} \,. \tag{5}$$

The long run relationship can be estimated from a log-linear transformation of Equation (5) and is expressed as:

$$\ln P_t^m = \alpha \ln PICG_t + (1-\alpha) \ln EXR_t + (1-\alpha) \ln WEXP_t \,. \tag{6}$$

Allowing the representation in Equation (6) to have a constant term:

$$\ln P_t^m = \beta_0 + \beta_1 \ln PICG_t + \beta_2 \ln EXR_t + \beta_3 \ln WEXP_t + \mu, \quad (7)$$

where μ is the stochastic term; β_1 is the elasticity of the domestic competing product price; β_2 and β_3 represent the pass-through for exchange rate and world prices to domestic import prices. The stochastic error term is represented by μ. Import prices (P^m) is measured as aggregate import price, exchange rate (*EXR*) is measured as official exchange rate of the Naira to the US dollar, *WEXP* is the export price index of foreign producers of Nigeria's imports. This is a weighted mean of export price indexes for China, U.K., U.S., Netherlands, France, Germany and Italy. Finally, *PICG* is measured as the domestic competing product price proxied by manufacturing output prices. This is obtained by taking manufacturing output measured at current prices, divided by price of manufacturing output at constant prices. All the data series are transformed into their logarithmic form in order to achieve stationarity in variance.

3. ESTIMATION TECHNIQUE

In this study, we use the bounds test proposed by Pesaran *et al.* (2001) which is based on the unrestricted error correction model (UECM). This is because the Pesaran *et al.*'s approach has certain advantages over the common practice of univariate and multivariate cointegration analysis (Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990)). One, endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger (1987) method are avoided. Two, the long and short-run parameters of the model are estimated simultaneously. Three, all variables are assumed to be endogenous. Four, the econometric methodology is relieved of the burden of establishing the order of integration amongst the variables and of pre-testing for unit roots. In fact, whereas all other methods require that the variables in a time-series regression equation are integrated of order one, i.e., the variables are I(1), only that of Pesaran *et al*. (2001) could be implemented regardless of whether the underlying variables are I(0), I(1), or fractionally integrated. Finally, the methodology can be applied to studies that have a small sample size, such as the present study.

The bounds test is a Wald Test (or *F*-test) in which the joint significance of coefficients for lagged variables is tested with *F*-statistics calculated under the null. The distribution of the test statistics under the null is non-standard, in which critical values depend on the order of integration of variables involved.[5] For a given significance level

[5] Utilizing Monte Carlo simulation experiments, Pesaran *et al.* (2001) tabulate asymptotic critical values, depending on whether or not drift and/or time trend terms are included as well as the number of independent variables.

of β, if the *F*-statistic falls outside the critical bound, a conclusive inference can be made without considering the order of integration of the underlying regressors. By way of illustration, if the *F*-statistic is lower (higher) than the lower (upper) critical bound, then the null hypothesis of no cointegration is rejected (accepted). In cases where the *F*-statistic falls inside the lower and upper bounds, a conclusive inference cannot be made. Here, the order of integration for the underlying explanatory variables must be known before any conclusion can be drawn. The cointegration relationship for the import price function for Nigeria is estimated based on the following unrestricted error correction model (UECM):

$$\begin{aligned}\Delta \ln P_t^m = {} & \alpha_0 + \sum_{i=1}^{q} \alpha_{1i} \Delta \ln P_{t-i}^m + \sum_{i=0}^{q} \alpha_{2i} \Delta \ln WEXP_{t-i} + \sum_{i=0}^{q} \alpha_{3i} \Delta \ln EXR_{t-i} \\ & + \sum_{i=0}^{q} \alpha_{4i} \Delta \ln PICG_{t-i} + \alpha_{5i} \ln P_{t-1}^m + \alpha_{6i} \ln WEXP_{t-1} \\ & + \alpha_{7i} \ln EXR_{t-1} + \alpha_{8i} \ln PICG_{t-1} + \varepsilon_t,\end{aligned} \tag{8}$$

Where $\Delta \ln P_t^m$, $\Delta \ln WEXP_t$, $\Delta \ln EXR_t$, $\Delta \ln PICG_t$ are the first differences of the logarithms of the price of imports, foreign price level, exchange rate and manufacturing output prices respectively. Through the estimated UECM, the long-run elasticities are the coefficients of the explanatory variables lagged one period (multiplied by a negative sign) divided by the coefficient of the dependent variable also lagged one period (Bardsen (1989)). Thus, the long-run foreign price elasticity, exchange rate elasticity and manufacturing output prices elasticity are $-(\alpha_6 / \alpha_5)$, $-(\alpha_7 / \alpha_5)$, and $-(\alpha_8 / \alpha_5)$, respectively. The short-run effects will be captured by the coefficients of the first differenced variables in the UECM model.

Bahmani-Oskooee and Brooks (1999) however argued that the existence of a cointegration derived from Equation (8) does not necessarily imply that the estimated coefficients are stable. Consequently, cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) stability tests based on the recursive regression residuals are carried out. The two tests incorporate the short-run dynamics to the long-run through residuals. The statistics of the two tests are updated recursively and plotted against the break points of the model. Providing that the plot of these statistics fall inside the critical bounds of 5% significance, one assumes that the coefficients of a given regression are stable. The outputs of the two tests are usually presented in graphical form.

4. DATA AND EMPIRICAL ANALYSIS

Annual time series data were collected on import prices, exchange rate, and tariff rate and price index of Nigerian trading partners for Nigeria. The annual data covers the period 1980 to 2006. The choice of this period was guided by data availability considerations. The data were obtained from the Central Bank of Nigeria Statistical Bulletin (2005), Annual Report and Statement of Accounts (2006), National Bureau of Statistics Annual Abstract of Statistics and International Monetary Fund International Financial Statistics.[6]

The bounds test results are reported in Table 1.[7] The computed F-Statistic of 5.7150 was found to exceed the upper bounds critical value of 4.35 for a 5% significance level and the upper bounds critical value of 5.61 for a 1% significance level. This implies that import prices and its determinants; exchange rate, world export prices and manufacturing output prices are cointegrated or co-moving. Table 2 gives the estimates of the aggregate import price function.

Table 1. Bounds Testing for Cointegration Analysis

Computed *F*-statistic: 5.7150	(lag structure, $k = 2$)
Critical bound's value at 1%	Lower: 3.23 and Upper: 4.35
Critical bound's value at 5%	Lower: 4.29 and Upper: 5.61

Notes: Three regressors and no trends in the model. Pesaran *et al*. (2000), p. T.2, Table Cl. iii: Case III.

We examine the effect of exchange rate shocks, world export prices and manufacturing output prices on import prices by estimating an unrestricted error correction model. We find that exchange rate shocks have a positive effect on import prices, implying that depreciation increases import prices. In the short-run, 1% depreciation leads to 0.09% increase in import prices, so that it can be said that some of the exchange rate shocks are passed on to import prices. World export prices in the immediate past period also have significant positive effects on import prices. A 1% increase in world export prices results in 0.24% increase in import prices, suggesting that suppliers pass on additional costs by selling their products at higher prices.

An increase in the price of an import competing good (manufacturing output prices in this case) was expected to reduce competitive pressure, induce suppliers of imports to increase their mark-up and sell their products (imports) at higher prices. This is supported by the estimation, but occurred with lags, as only the coefficient of

[6] A detailed explanation of the sources of data are presented in appendix 1.

[7] The lag length k=2 was selected based on the Schwarz criterion (SC)

manufacturing output prices of the past second period has a significant negative effect on the current import prices for Nigeria.

The estimated long run exchange rate elasticity, world export price elasticity and manufacturing output prices elasticity are 0.121, 4.46 and 0.02 respectively. For example, the implication is that a 1% depreciation of the exchange rate translates to 0.121% increase in import prices while a 1% increase in the world export prices translates to about 4.46% increase in import prices in Nigeria. The import of this finding is that in the long run the world export price is more important than the exchange rate in determining the magnitude of the import price in Nigeria.

Table 2. The Estimated UECM for the Nigerian Import Price Function

Variable	Coefficient	*t*-statistics
Constant	-4.125***	-2.071
$\Delta WEXP$	-2.729	-1.147
$\Delta WEXP_{t-1}$	0.240**	2.156
$\Delta WEXP_{t-2}$	-2.489	-1.072
ΔEXR	0.085***	1.928
ΔEXR_{t-1}	0.044	0.470
ΔEXR_{t-2}	0.098	1.716
$\Delta PICG$	-0.107	-0.899
$\Delta PICG_{t-1}$	-0.060	-0.608
$\Delta PICG_{t-2}$	-0.272**	-2.377
ΔIMP_{t-1}	-0.464	-1.217
ΔIMP_{t-2}	-0.486	-1.666
IMP_{t-1}	-0.590	-0.989
$EXPT_{t-1}$	2.632*	2.956
$PICG_{t-1}$	-0.009	-0.073
EXR_{t-1}	0.068	0.510

Notes: *, **, and *** denote significant at 1%, 5%, 10% respectively. Dependent Variable is ΔIMP. Sample: 1980 to 2006. Included observations: 27. R-squared: 0.81059; Durbin-Watson: 2.77. LM= 6.2077[.042]; RESET: 3.3464[.110]. Jaque-Bera: 1.5112[.470]

In addition, Table 2 presents diagnostic tests of our model and suggests an absence of major diagnostic problems such as serial correlation, non-normality and specification errors. These results indicate that our estimated import price model is well specified. Thereafter, it is necessary to check for the stability of the import price function. This is because of the importance of the stability of the import price function for an effective

trade policy. This therefore makes it necessary to test whether the estimated import price equation has shifted over time as an important part of this empirical study. As can be observed from Figures 1 and 2, the CUSUM and CUSUM Square tests of parameter stability indicate that the parameters are stable during the sample period.

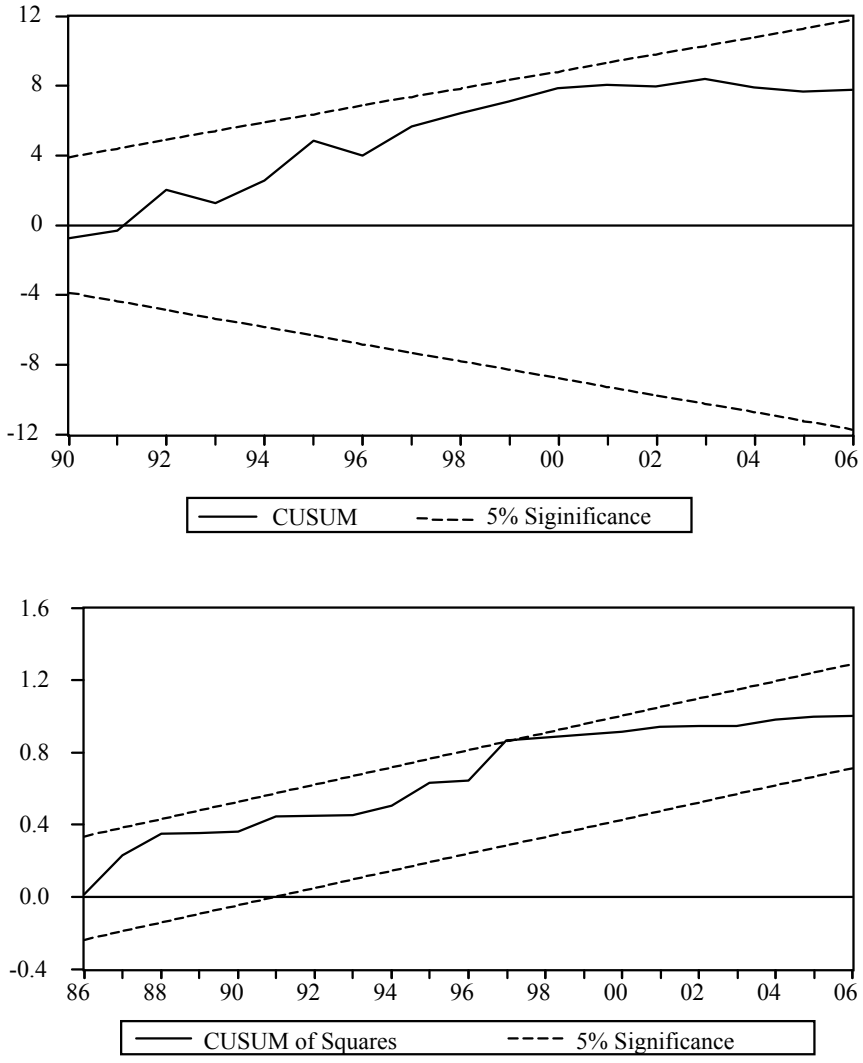

Figure 1. CUSUM and CUSUM of Squares

It is interesting to see how the estimates obtained in this study compare with other published elasticity estimates of exchange rate pass through. In comparison to past studies, we found similar results with the studies of Athukorala and Menon (1994) for Japan; Kenny and MacGettigan (1996) for Ireland; Lee (1997) for Korea; Kiptui, *et al*., (2005) for Kenya; Oladipo (2007) for Nigeria; and Mallick and Marques (2007) for India. Adopting the mark-up model, the studies found out that pass-through is incomplete. The result from this study therefore confirms the outcome of other studies on exchange rate pass through**.** However, we believe our empirical results are more reliable due to the use of more advanced econometric techniques.

5. CONCLUDING SUMMARY

The objective of the study was to estimate the level of exchange rate pass-through for Nigeria, using the recently developed UECM-Bounds test proposed by Pesaran *et al*. (2001), between 1980 and 2006. Our empirical results show that import price, world export prices and manufacturing output prices are cointegrated. The estimated long-run (short-run) elasticities of import prices with respect to exchange rate, world export prices and manufacturing output prices are 0.09 (0.121), 0.24 (4.46), and 0.107 (0.02) respectively. The major implication of all these for our study is that although depreciation increase aggregate import prices in Nigeria, the world export price greatly influence the movement of import prices in Nigeria in the long-run.

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