

## **Exchange Rate Movement and Import Price of Machineries in Nigeria: A Bound Testing Approach.**

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### **Abstract**

This paper examines the driving factors of import price of machineries and their pass-through in dynamics route. An assessment of the short-run and long-run between price of machineries and its driving indicators between 1981 and 2014 is carried out with a view to determining its pass-through, given the need to save domestic price against future exigencies. It makes use of unrestricted error correction mechanism and the bound testing approach to co integration in an autoregressive distributed lag framework proposed by Pesaran et al. (2001). The empirical estimates reveal that one lag variability of import price, exchange rate, foreign cost, domestic competitors price and demand pressure proxied by GDP impact it in the long-run. However, the ECM coefficient is properly signed with -0.549. By implication, approximately 54% of the discrepancy from long run equilibrium in the previous year is adjusted for by the current year. The findings suggest that The implication of these results is that government should effectively fight inflationary pressure by implementing appropriate macroeconomic policies that can considerably tame down the level of inflation to non accelerated inflation rate of unemployment, a very sound exchange rate management tends to complement this as there may be case of exchange rate pass-through and this level of inflation is tolerated as it is not inimical to working system of the economy.

**Keywords:** Import price of machineries, Exchange rate, Inflation and Bounds test

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## **1.0 Introduction**

An upswing interest of international finance to investigate and measure the extent to which exchange rate changes are reflected in domestic prices of goods and services, culminate from the breakdown of Bretton Woods system in 1973. Exchange rate pass-through refers to the effect of a change in the exchange rate to domestic prices. In other words, it is the change in domestic prices that can be attributed to a prior change in the nominal exchange rate. Balance-of-payments models normally assume a one-for-one response of import prices to exchange rates, which is known as complete exchange rate pass-through (Peter 2003). A one-to-one response of import prices to exchange rate changes is known as complete ERPT while a less than one-to-one response is known as partial or incomplete ERPT. The rate of ERPT has important implications for the effect of monetary policy on domestic prices as well as for the transmission of macroeconomic shocks and the volatility of the real exchange rate.

According to An (2006) understanding of exchange rate pass-through is of extreme importance for three key reasons: first, the knowledge of the degree and timing of pass-through are essential for the proper assessment of monetary policy transmission on prices as well as for inflation forecasting. Second, the adoption of inflation targeting requires knowledge of the size and speed of exchange rate pass-through into inflations. Finally, the degree of exchange rate pass-through has important implication for “expenditure-switching” effects from the exchange rate. In other words, a low degree of exchange rate pass-through would make it possible for trade flows to remain relatively insensitive to changes in exchange rates, though demand might be highly elastic. Nigeria as one of developing economies, has historically been reluctant to permit more than a moderate degree of exchange rate flexibility due to the fear that such variations might feed into domestic prices.

The potential vulnerability of small and open economies to exchange rate pass-through into domestic prices is high and this arises from the high share of tradable goods, high import content of domestic production and exports, as well as generally high degree of integration with the global trading system. In Nigeria, the emphasis on knowing the exchange rate pass-through is underpinned by the fact that the Nigerian economy is external sector driven such that shocks from global commodity markets have serious implications on the economy. In addition, the need to make the external sector competitive through appropriate exchange rate adjustment has made the study of exchange rate pass-through in Nigeria imperative. Recent developments in the external sector of the Nigerian economy revealed that the naira exchange rate depreciated by 24.0 percent between October 2008 and February 2009 and the pressure is still on as crude oil receipts continue to dwindle due to both demand and supply factors.

Concerns are what would be the implications of these developments on inflation or the extent of exchange rate pass-through on domestic and import prices. Although empirical evidences have shown that the transmission is not unitary, the main objective of the paper is to determine the degree and extent of exchange rate pass-through on import price of machinery and transport equipment in Nigeria on the basis of Autoregressive Distributed Lag model using annually time series from 1981 to 2014. The rest of the paper is divided into five sections. Following the introduction is section two which presents review of related literature on exchange rate pass-through in Nigeria. Section three focuses on methodology of the paper while the penultimate section analyses the empirical results.

There is a vast literature on the subject matter (see Goldberg and Knetter (1997); McCarthy (2000); Kim (1998); Goldfajn and Werlang (2000); Oyinlola (2011); Oyinlola and Egwaikhide (2011); Oriavwote and Omojimate (2012); Oladipo (2012); etc). However, some of these studies carried out for Nigeria are limited as they have been based on descriptive analysis, Ordinary least Square method (OLS), the Johansen (1988) and Johansen and Juselius (1990) co-integration test, Vector Autoregressive Model (VAR) and Vector Error Correction Model (VECM). These approaches may not be appropriate, especially when a small sample size is considered (see, Narayan and Smyth 2005). In this regard, we propose to use the bound testing approach within an autoregressive distributed lag framework proposed by Pesaran et al. (2001) to estimate the exchange rate movement and import price of machineries in Nigeria. Furthermore, it is evident that none of the studies have taken into consideration, the pass-through of exchange rate to import price of machineries which become centre focus of this study.

## **2.0 A Skeletal View of the Literature**

Exchange rate pass-through to import price of goods is originally developed as one component of the investigation of a specific macroeconomic problem. Goldberg and Knetter (1997) ERPT is defined as “the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries.” In the traditional open- macroeconomic models, under the purchasing power parity (PPP) assumption, ERPT to domestic prices is always immediate and complete. On the other hand, the incomplete ERPT is exhibited by firms who want to maintain their market share by adjusting mark-up instead of fully passing the exchange rate movement to prices. However, two channels of ERPT are distinguished; a direct and an indirect channel.

The direct channel of pass-through runs via the external sector of a country, i.e through the price of imports. The channel hinges on the conjecture of Purchasing Power Parity (PPP) and it forms the benchmark of the theory of ERPT, which state that pass through of exchange rate on domestic prices ought to be complete and no arbitrage opportunities may exist in the long run, formally:

$$P = EP^*$$

Where  $P$  is domestic price level,  $P^*$  is foreign price level (assumed to be exogenous), Exchange rate, measured in units of the domestic currency per unit of the foreign currency, then  $EP^*$  represents the domestic-currency price of the imported good. If  $P^*$  remains fixed and  $E$  depreciates (rises) then the domestic-currency price of the imported good will rise in proportion. The result is called the pass-through from the exchange rate to import prices. However, pass-through is only complete (100 percent) if (a) markups of prices over costs are constant and (b) marginal costs are constant (Goldberg and Knetter, 1997). The change in import prices is also likely to translate into changes in the producer and consumer prices of an economy if producers raise their prices in line with the increase in import prices

The indirect channel of ERPT refers to the competitiveness of goods on international markets. A depreciation of the exchange rate makes domestic products relatively cheaper for foreign buyers, and as a consequence, exports and aggregate demand will rise and induce an increase in the domestic price level. However, the reality shows that Exchange rate deviates

from complete pass through to domestic prices of import. Goldberg and Knetter (1997) stated that import prices in the U.S. only reflected about 50% of exchange rate changes (Although, the responsiveness of prices to exchange rate varies across the countries).

McCarthy (2000) presents a comprehensive study of exchange rate pass-through on the aggregate level for a number of industrialized countries. He estimates a VAR model using import, producer and consumer-price data from 1976 up until 1998. In most of the countries analyzed, the exchange rate pass-through to consumer prices is found to be modest. The rate of pass-through is, furthermore, shown to be positively correlated with the openness of the country and with the persistence of and exchange rate change, and negatively correlated with the volatility of the exchange rate.

Kim (1998) investigated exchange rate pass-through in the United States using a framework of multivariate cointegration. This study relates changes in producer prices to changes in the trade weighted nominal effective exchange rate, money supply, aggregate income and interest rates. The exchange rate is found to contribute significantly to producer prices. Similarly, Goldfajn and Werlang (2000) presented a study of 71 countries, where exchange rate pass-through into consumer prices is investigated using panel estimation methods on data from 1980 up until 1998. Both developed and emerging market economies are included in their study. They reported that the pass-through effects on consumer prices increase over time and reach a maximum after 12 months. The degree of pass-through is, furthermore, found to be substantially higher in emerging market economies than in developed economies.

Oyinlola (2011) uses the impact of exchange rate movements on prices of disaggregated imports in Nigeria (1980-2006) by taking trade policy into consideration. The outcome of the study reveals that exchange rate exhibits positive and more-than-complete pass-through to import prices of consumer and capital product groups, with mixed interpretations for intermediate products. Hence, depreciation of exchange rate outstrips the impact of tariff reduction on prices of some products.

Oyinlola and Egwaikhide (2011) examine exchange rate pass-through to different measures of domestic price in Nigeria using vector error correction model. This study, by employing data of 1980 – 2008, reveals that long run relationship exists between exchange rate and domestic price level. In addition, it was shown that short run variations in exchange rate might be anticipated and thus has its impact dampened.

Oriavwote and Omojimate (2012), in their study, establish the strength and length of the relationship between exchange rate pass-through and domestic prices in Nigeria using the Vector Error Correction Model. Applying data covering 1970 to 2009, they find that exchange rate volatility induces domestic inflation in Nigeria, and thus recommend that exchange rate volatility should be given important consideration when implementing domestic inflation management policies.

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Oladipo (2012), evaluates sectoral exchange rate pass-through effects, reveal that sectoral dependence on imports varies across sectors and show evidence of incomplete pass-through at varying degrees across sectors. As a result, when adjustment in relative prices is dampened, it reduces considerably the incentive for consumers to switch expenditure from foreign to domestic goods. The implication is that exchange rate policy may not be the most appropriate instrument to be used in dealing with external imbalances.

### **3.0 Methodology**

#### *Theoretical Framework*

The study is hinged on the adopted Hooper and Mann (1987) and Menon(1993) models, theoretical framework between exchange rate and import price of goods is provided as follow. ERPT is broadly defined as the percentage in importer currency import prices as a result of one percent change in the exchange rate between exporting and importing countries. This basic relationship follows the law of one price in the purchasing power parity (PPP).

$$P_t = E_t P_t^* \quad (1)$$

Where  $P_t$  is domestic price level,  $P_t^*$  is foreign price level assumed to be exogenous,  $E_t$  is exchange rate, measured in units of the domestic currency per unit of the foreign currency, then  $E_t P_t^*$  represents the domestic-currency price of the imported manufactured goods. However, the assumptions underlying purchasing power parity (PPP) hinges on perfect competitive structure which deviates from reality facts.

However, Nigerian economy is characterised by imperfect competition where forces of demand and supply fail to regulate market price, neither efficiently nor effectively. So, Models of Pricing-to-Market are based on imperfect competition where producers can exercise market power by changing prices above the marginal cost by a mark-up that may differ between customers. The model assumes a profit maximizing behaviour of the firm with some degree of controls over the price of its export in N destination markets. The profit equation is expressed as:

$$\pi_t = \sum_{i=1}^N (Q_{it} P_{it}^*) - C_t \quad (2)$$

The relationship between exporter's cost in her own currency  $C_t$  and the total quantity demanded in the destination markets,  $Q_{it}$ , wage rate,  $W_t$  and the price of raw material inputs ( $E_t R_t$ ) can be expressed as:

$$C_t = C \left[ \sum_{i=1}^N Q_{it}, W_t, \sum_{i=1}^N (E_{it} R_{it}) \right] \quad (3)$$

The first order condition for profit maximization implies that the firm equates marginal revenue from sales in each market to common marginal cost:

$$\frac{\delta \pi_t}{\delta Q_{it}} = \frac{\delta (Q_{it} P_{it}^*)}{\delta Q_{it}} - C_t' = 0 \quad (4)$$

Where  $C_t'$  is the marginal cost of production in period t. Rearranging gives:

$$P_{it}^* + Q_{it} \frac{\delta}{\delta Q_{it}} = C' \quad \text{OR} \quad P_{it}^* \left[ 1 + \frac{Q_{it} \delta P_{it}^*}{P_{it}^* \delta Q_{it}} \right] = C' \quad (5)$$

The absolute value of the elasticity of demand ( $\eta_{it}$ ) with respect to foreign price level in market i is recalled as:

$$\eta_{it} = - \left( \frac{\delta Q_{it}}{\delta P_{it}^*} \right) \left( \frac{P_{it}^*}{Q_{it}} \right) \quad (6)$$

Substituting equation (6) into (5):

$$P_{it}^* \left( 1 - \frac{1}{\eta_{it}} \right) = C'_t \quad (7)$$

$$P_{it}^* = PX_t = C'_t \left( \frac{\eta_{it}}{\eta_{it}-1} \right) \equiv C_t^* \lambda_t \quad (8)$$

Where,  $\lambda_t = \frac{\eta_{it}}{\eta_{it}-1}$  is the mark-up,  $C'_t$  denotes the marginal cost of production denominated in exporter's currency, now represented as  $C_t^*$  and  $P_{it}^*$  represents the export prices ( $PX_t$ ) in the destination market. This is equal to the product of mark-up  $\lambda_t$  and production cost of foreign exporter ( $C_t^*$ ), with the markup determined by the price elasticity of demand in the market ( $\eta_{it}$ ). We assume that the foreign exporter set the price of its exports to Nigeria,  $PX_t$ , at a mark-up,  $\lambda_t$ , over its marginal cost of production,  $C_t^*$ .

The import price can then be obtained by multiplying the export price  $PX_t$  by the exchange rate  $E_t$  of the importing country: recall,  $PX_t = C_t^* \lambda_t$

$$PM_t = PX_t E_t = C_t^* \lambda_t E_t \quad (9)$$

Hooper and Mann (1989) argued in their model that the mark-up ( $\lambda_t$ ) would be inversely dependent on competitive pressures in the destination market, and directly dependent on demand pressures ( $Y_t$ ) in all market combined. Competitive pressure in the importing country is measured by the gap between the competitors prices in the importing country market ( $P_t$ ) and the production cost of exporting firm  $C_t^*$ . The mark-up can therefore be written as :

$$\lambda_t = \left[ \frac{P_t}{E_t C_t^*} \right]^\alpha Y_t^\beta, \quad 0 < \alpha < 1, \text{ and } 0 < \beta < 1. \quad (10)$$

Substituting equation (10) into (9) and rearranging, we obtain:

$$PM_t = (E_t C_t^*)^{1-\alpha} (P_t)^\alpha Y_t^\beta \quad (11)$$

In logarithmic form, equation (11) can be expressed as

$$pmm_t = (1 - \alpha)e_t + (1 - \alpha)c_t^* + \alpha p d_t + \beta y_t \quad (12)$$

Equation (12) defines the real pass through of exchange rate to import price of goods. ERPT in equation (12) shows that complete pass through is not always possible in real life situation

but partial as a result of market imperfections in economy. ERPT is defined as the partial elasticity of import price to exchange rate, is  $(1-\alpha)$ .

With special consideration to import price of machinery equipment and exchange rate shock only, which is the center focus of the study, we have

$$\frac{\delta pmm_t}{\delta e_t} = 1 - \alpha. \quad (13)$$

This forms the theoretical basis on which the empirical model specification is derived and hinged.

### *The Empirical Model Specification*

Based on the outcome of research theoretical framework that attempts to examine the changes in import price of machines and machineries  $pmm_t$ , as a result of changes in exchange rate  $e_t$ , along with production cost  $c_t^*$ , domestic competitors' price  $Pdc_t$ , and demand pressure  $y_t$ , in the adopted model of Hooper and Mann (1987) and Menon(1993).

It is pertinent for our estimation that we relax the restrictions earlier mentioned and consider the following long run equation from equation (12)

$$pmm_t = \alpha + \delta_1 e_t + \delta_2 c_t^* + \delta_3 Pdc_t + \delta_4 y_t \varepsilon_t \quad (14)$$

Where  $pm_t$  represents price of goods,  $e_t$  is nominal exchange rate,  $c_t^*$  is production cost,  $P_t$  is competitors' price, and  $y_t$  denotes demand pressure.

Having considered Aggregate approach to import price and disaggregated approach such as import price of manufactured goods by different authors, Our approach considers only pass through into import price of Machinery and transport equipment in Nigeria. The import price approach is pursued, because it is the more relevant dependent variable in the debate on the current inflation consequences of exchange rate movement in Nigeria as far as president Mohammad Buhari administration is concerned.

In this paper, test of cointegration are carried out using the autoregressive distributive lag model (ARDL) approach due to Pesaran et al. (2001) where we estimate five unrestricted error correction considering each variable as dependent variable. It follows the ARDL bound testing approach to cointegration developed by Pesaran and Pesaran (1997); Pesaran *et al.* (2000) and later on by Pesaran et al. (2001). Thus estimates obtained from the ARDL method of cointegration analysis are unbiased and efficient, since they avoid the problems that may arise in the presence of serial correlation and endogeneity.

A two- step procedure is used in estimating the long-run relationship. In the first step, we investigate the existence of a long-run relationship predicted by theory among the variables in question. The short and long run parameters are estimated in the second stage, when if the long run relationship is established in the first step.

Suppose that at the first stage, theory predicts that there is a long-run relationship among  $pmm_t, e_t, c_t^*, Pd_t$  and  $y_t$ . Without having any prior information about the direction of the long-run relationship among the variables, the following unrestricted error correction (UEC) regressions are estimated:

$$\Delta \ln pm_t = \alpha_0 + \sum_{i=1}^p \beta_i \Delta \ln pm_{t-i} + \sum_{i=0}^p \gamma_i \Delta \ln exc_{t-i} + \sum_{i=0}^p \delta_i \Delta \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \Delta \ln pdc_{t-i} + \sum_{i=0}^p \theta_i \Delta \ln y_{t-i} + \psi_1 \ln pm_{t-1} + \psi_2 \ln exc_{t-1} + \psi_3 \ln c_{t-1}^* + \psi_4 \ln pdc_{t-1} + \psi_5 \ln y_{t-1} + \varepsilon_t \quad (15)$$

Note that we log our model to address the likely problem of heteroscedasticity. The above equation shows the unrestricted version of ARDL specification. F statistic is used for testing the existence of long-run relationships. The null hypothesis for testing the nonexistence of the first long-run relationship (i.e.  $H_0: \psi_1 = \psi_2 = \psi_3 = \psi_4 = \psi_5 = 0$ ). The F test has a nonstandard distribution which depends upon: (i) whether variables included in the ARDL model are to be I (0) or I (1), (ii) the number of regressors, and (iii) whether the ARDL model contains an intercept and/or a trend. Two sets of critical values are reported in Pesaran et al. (2001): one set is calculated assuming that all variables included in the ARDL model are I (1) and the other is estimated considering the variables are I (0). If the computed F values fall outside the inclusive band, a conclusive decision could be drawn without knowing the order of integration of the variables.

If a stable long-run relationship is supported by the first step, then in the second stage, the augmented ARDL (m, n, o, p, q) model is estimated using the following

$$\ln pm_t = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots (16)$$

More explicitly, ARDL (m, n, o, p, q) bound testing is considered in VAR as follow

$$\ln pm_t = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots \dots (17)$$

$$\ln exc_t = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots \dots (18)$$

$$\ln c_t^* = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots \dots (19)$$

$$\ln pdc_t = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots \dots (20)$$

$$\ln y_t = \alpha_0 + \sum_{i=1}^m \beta_i \ln pm_{t-i} + \sum_{i=0}^n \gamma_i \ln exc_{t-i} + \sum_{i=0}^o \delta_i \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \ln pdc_{t-i} + \sum_{i=0}^q \theta_i \ln y_{t-1} + u_t \dots \dots \dots (21)$$

Again the maximum of lags ( $\rho$ ) in Eq. 1 must retain to determine the numbers of lags (m, n, o, p, q) in Eq. 2 selected by the Akaike Information Criterion (AIC) or Schwartz Bayesian Information Criterion (SBIC) to determine the optimal structure for the ARDL specification.

After the estimation of the ARDL (m, n, o, p, q) specification and the calculation of the associated long-run multipliers, the final step is the estimation of the short-run dynamic coefficients via the following error correction model:

We estimate residuals from equation 14 and tagged as Error Correction Term i.e ECT

$$\Delta \ln pm_t = \alpha_0 + \sum_{i=1}^p \beta_i \Delta \ln pm_{t-i} + \sum_{i=0}^p \gamma_i \Delta \ln s_{t-i} + \sum_{i=0}^p \delta_i \Delta \ln c_{t-i}^* + \sum_{i=0}^p \eta_i \Delta \ln Pd_{t-i} + \sum_{i=0}^p \theta_i \Delta \ln y_{t-i} + \lambda ECT_{t-1} \dots \dots \dots (22)$$

Where  $ECT_{t-1}$ , is the error correction term resulting from the verified long-run equilibrium relationship and  $\lambda$  is a parameter indicating the speed of adjustment to the equilibrium level after a shock. The sign of the  $ECT_{t-1}$  must be negative and significant to ensure convergence of the dynamics to the long-run equilibrium. The value of the coefficient,  $\lambda$ , which signifies the speed of convergence to the equilibrium process, usually ranges from -1 and 0. -1 signifies perfect and instantaneous convergence while 0 means no convergence after a shock in process.

Moreover, Pesaran and Pesaran (1997) argued that it is extremely important to ascertain the constancy of the long-run multipliers by testing the above error-correction model for the stability of its parameters. The commonly used tests for this purpose are the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ), both of which have been introduced by Brown et al. (1975).

**4.0 Empirical Analysis and Discussion of Results**

**Summary of variable description**

Table 1 reveals the summary statistics for the dataset used. Variables are expected to have normal distribution before they are used in any parametric statistical method. Skewness and kurtosis give indications as to the nature of distribution of variables. Skewness measures symmetry, or more precisely, the lack of symmetry. The skewness for a normal distribution is zero, and any symmetric data should have skewness equal or near zero. Skewness values for most of the variables in the table are nearly zero with all variables having negative signs indicating negative skewness. Kurtosis measures whether the dataset are peaked or flat relative to a normal distribution with expected value of 3. None satisfies this condition. The Jarque-Bera (JB) test is used to check hypothesis about the fact that a given sample  $xS$  is a sample of normal random variable with unknown mean and dispersion. JB test has the null hypothesis of normal residuals; hence, its rejection requires low probability, that is, the probability that a Jarque-Bera statistic exceeds the observed value. Probability value of all variables are high, hence, we do not reject the normal distribution for all variables indicating a normality of their unconditional distributions. In addition, the mean to median ratio of each variable is within the unit proximity. The standard deviations of the data set shows very slight and small variability because they are quietly low.

**Table 1: Descriptive statistics of variables**

	LogCPI(Pdc)	LogEXCr	LogPMM	LogRGDP(Y)	LogFCOST(C*)
Mean	2.971474	3.168960	4.755937	7.958588	3.899711
Median	3.696986	3.089606	5.316537	8.321185	4.255474
Maximum	5.187012	5.059422	8.232868	11.39688	4.790079
Minimum	-0.226711	-0.494255	0.823210	4.546746	2.206343
Std. Dev.	1.888381	1.932336	2.395194	2.240559	0.853830
Skewness	-0.451375	-0.684331	-0.255631	-0.121095	-0.683134
Kurtosis	1.646864	2.117568	1.787434	1.733123	1.975210
Jarque-Bera	3.748408	3.756888	2.453247	2.356815	4.132249
Probability	0.153477	0.152828	0.293281	0.307768	0.126676
Sum	101.0301	107.7447	161.7019	270.5920	132.5902
Sum Sq. Dev.	117.6774	123.2194	189.3195	165.6634	24.05783
Observations	34	34	34	34	34

**Unit root Testing**

Although the ARDL cointegration approach does not require unit root tests, nevertheless we need to conduct this test to ensure that none of the variables are the integrated of order 2, i.e., I (2), because, in case of I (2) variables, ARDL procedures makes no sense. If a variable is found to be I(2), then the computed F-statistics, as produced by Pesaran et al. (2001) and Narayan (2005) can no longer be valid. The time series property of dataset is examined, considering the Augmented Dickey Fuller and Phillips Perron is employed as confirmatory test.

**Table 2: Unit root tests**

Variables	Level		First Difference	
	ADF	P.P	ADF	P.P
lnExc	-2.056183	-2.206182	-4.823471***	-4.823471***
lnC*	-4.850860***	-3.489723***	----	----
lnP	-1.890121	-1.781845	-2.771219*	-2.744240*
lnY	-0.197626	-0.183326	-5.378235****	-5.393858***
lnPmm	-0.514810	-0.360528	-6.978849****	-7.010523***

Source: Author’s computation.

N.B: \*, \*\* and \*\*\* denote 10%, 5% and 1% level of significance respectively. The values are given in the cells are calculated values of the regressions. The null hypothesis is the series has a unit root which is tested against Mackinnon Critical values.

**Cointegration Test**

The cointegration relationship between the variables *Pmm, Exc, C\*, P and Y* is examined using the newly developed ARDL bound testing procedure. Two steps are used in this procedure in a stepwise fashion. In the first step, the order of lags on the first differenced variables in Equations 16 – 20 are obtained from the unrestricted VAR models by using the Akaike Information Criterion (AIC) or the Schwartz-Bayesian Criterion (SBC). Table 3 shows the lag-length selection of the 1st differenced of the variables. It shows that according to AIC, SC and HQ, the maximum lag-length for the estimation of equation is 1. After determining the lag-length, we proceed to the cointegration test. As our model is unrestricted, we omit the trend term in equations.

**Table 3: Lag length selection of the first differenced of the variables**

Lag	LL	LR	FPE	AIC	SC	HQ
0	-67.28427	NA	6.31e-05	4.517767	4.746788	4.593681
1	104.4057	278.9963*	6.73e-09*	-4.650359*	-3.276231*	-4.194874*
2	125.8564	28.15404	9.50e-09	-4.428527	-1.909293	-3.593472

N.B \* indicates the lowest value under each criteria

**Table 4: Cointegration Test (Based on AIC and SC)  
Autoregressive Distributed Lag (Bound Testing) in Vector Autoregressive Model(VAR)**

Models	LHS Variables	Forcing Variables	F- Statistics	95% lower	95% upper	90% lower	90% Upper	Cointegration
$F_{pmm}$	<i>Pmm</i>	<i>Excr,fcost,Pdc, Y</i>	3.57**	2.86	4.01	2.45	3.52	present
$F_{excr}$	<i>Excr</i>	<i>Pmm,fcost,pdc, Y</i>	2.09	2.86	4.01	2.45	3.52	No cointegration
$F_{fcost}$	<i>F cost</i>	<i>Pmm,exc,pd, Y</i>	2.29	2.86	4.01	2.45	3.52	No cointegration
$F_{pdc}$	<i>Pdc</i>	<i>Pmm,exc,fcost, Y</i>	4.21*	2.86	4.01	2.45	3.52	Present
$F_y$	<i>Y</i>	<i>Pmm,exc, pd,fcos</i>	0.67	2.86	4.01	2.45	3.52	No cointegration

Table 4 represents the F statistics of estimation of equation (1) using AIC. As earlier stated that we would perform the test using each of the variables as dependent variables, so, all-in-one we would get 5 equations. We performed F test for each of the model and Table 4 shows those results. After deciding on lag-length, the issue on the selection of critical values (CVs) becomes imperative. The CVs of the F test depends on the sample sizes. Narayan (2005) argues that CVs of Pesaran et al (2001) that is generated for larger sample size should not be used for smaller sample size. Narayan (2005) presents CVs of the F test for smaller sample sizes with 30-80 observations. With 34 observations in our sample, we report both the 95% and 90% critical values from Narayan (2005) in Table 4. The long-run relationship is clearly identified for models  $F_{pmm}$  and  $F_{pd}$ . As we give importance on model  $F_{pmm}$ , It passes both at only 10% level of significance as the value of F-statistics is higher than critical value. Model  $F_{pmm}$  and  $F_{pd}$  represent the long-run relationship but other models show no cointegration as their calculated F statistics fall below the bounds (lower and upper) at both levels 5% and 10%.

**Table 5: Augmented ARDL bound test (Long Run) Optimal lag ordering (1,1,1,1,1)**

Variable	Coefficient	T- Stat	Prob.
C	-5.395687	-1.990703	0.0567
PMM(-1)	0.547212	-2.788409	0.0096*
EXCR(-1)	0.112954	0.659620	0.0151*
FCOST(-1)	1.573198	1.870621	0.0723***
INFL(-1)	-0.679588	-1.419282	0.1673
RGDP(-1)	0.466373	1.775046	0.0872***
$R^2$	0.408720		
Adj. $R^2$	0.299223		
DW Stat.	2.462082		
F-statistic	3.732722		
Prob(F-statistic)	0.010687		

Source: E- views output. Note: pmm is the dependent variable

The coefficients of long-run impacts are as detailed in Table 5 above. Essentially, the estimates indicate that exchange rate-pass-through to import price of machinery at one period lag is positively related with 0.11 coefficient and incomplete. The one-period lag of exchange rate is significantly positively related to import price of machines in Nigeria with 0.11 coefficient and 0.01 probability value. However, one period lag of Other variables of the model such as import price of machines and machineries, foreign cost and demand pressure proxied by real GDP are all significant except domestic competitors price.

**Table 6: Estimates of Short-run Coefficients Using ARDL (1,1,1,1,1)**

Variable	Coefficient	T- Stat	Prob.
C	0.099020	0.632960	0.0325
$\Delta$ PMM(-1)	0.001703	0.006590	0.0948
$\Delta$ EXCR(-1)	0.173784	0.644873	0.0249
$\Delta$ FCOST(-1)	0.629592	0.418143	0.0794
$\Delta$ INFL(-1)	0.423605	0.578922	0.0678
$\Delta$ RGDP(-1)	-0.260735	-0.470221	0.0423
$\Delta$ ECT(-1)	-0.549313	-1.674775	0.0064
$R^2$	0.208631		
Adj. $R^2$	0.018702		
DW Stat.	2.028187		
F-statistic	1.098470		
Prob(F-statistic)	0.390749		

Source: E-views output. Note: pmm is the dependent variable

Tables above detailed the Error Correction Models (ECM) within the Autoregressive Distributed Lag (ARDL) framework for the Model. These estimates are optimal as they were based on the optimal values of Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) selected amidst series of scenario analyses computed. For the Model, the ECM coefficient is properly signed with -0.549 and significant too with absolute T-statistics values of 1.675 with probability value of 0.006. These estimates confirm the long-run equilibrium conditions evident among the variables of interest and further indicate that all disequilibrium conditions in PMM are barely recovered on every 2 quarters (half) of the year to a tune of 54%. In other words, This means that approximately 54% of the discrepancy from long run equilibrium in the previous year is adjusted for by the current year.

### Diagnostic and Robustness Checks

#### Residual tests

For robustness of results and the reliability of the estimates obtained, it becomes imperative that we conduct some tests on the estimates obtained. Essentially, four of these tests stand out. These include Reset test ( $x^2_{RESET}$ ), Jaquebera test ( $x^2_{NORMAL}$ ), Breusch-Godfrey LM test ( $x^2_{SERIA}$ ), and Arch test ( $x^2_{ARCH}$ ),

**Table 7: Robustness of Results**

S/N	TEST STATISTICS	MODEL
1	$x^2_{SERIA}$	0.2169 (0.6465)
2	$x^2_{ARCH}$	14.246 (0.1621)

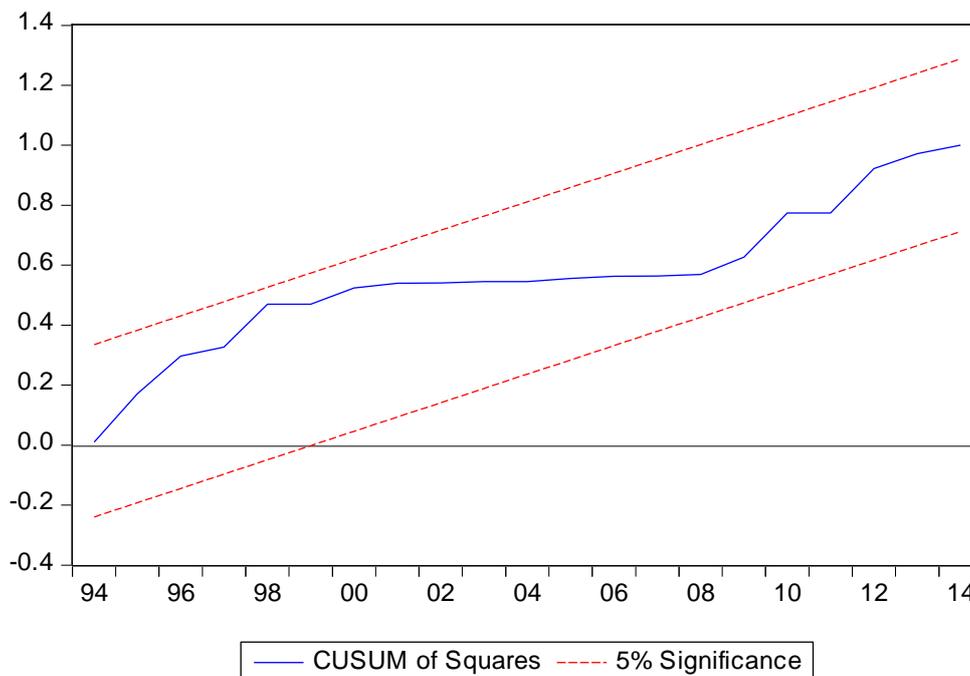
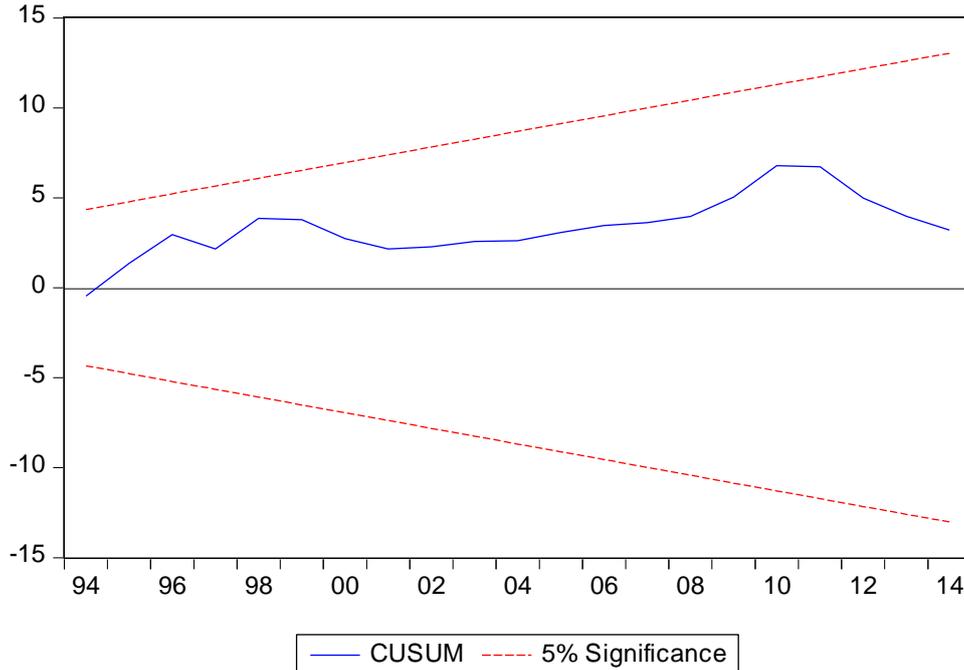
Source: E-Views Output. Note: Figures in parentheses are the probabilities of significance. Specifically, the null hypotheses for these tests are that

- (1) Ho: the residuals are serially uncorrelated
- (2) Ho: there is absence of autoregressive conditional heteroscedasticity

In line with these null hypotheses, these estimates suggest that these null hypotheses should all be accepted at the 5 percent of significance since the probability values for these tests are all above 0.05.

**Stability test**

In ascertaining the reliability level of estimates obtained, stability tests of CUSUM and the CUSUM sum of squared were conducted on the error correction estimates obtained. These tests are considered more apt than the Chow test as it depicts how the estimates depart or converge to their consistent level. As depicted in figures 2 and 3 below, the estimates lie within the confidence interval at the 5 percent level of significance; thus, our estimated model is stable.



## **5.0 Conclusion**

This paper examined the long-run and short-run determinants of import price of machineries in Nigeria with special reference to exchange rate movement. Based on theoretical linkages, variables like variability of exchange rate (excr), foreign cost (fcost), domestic competitors price (pdc) and real GDP were considered between 1981 and 2014. The study makes use of error correction mechanism and bounds testing approach to cointegration within an ARDL framework. The result reveals that in the long-run; one period lagged value of import price of machineries, variability of exchange rate, foreign cost, domestic price and demand pressure (real GDP) were positive and statistically significant while domestic competitors price was negatively related to import price of machineries but not significant. In the short-run, the one-period lagged value of variability of exchange rate (excr), foreign cost (fcost), domestic competitors price (pdc) and real GDP were positively related to import price of machineries and statistically significant. The implication of these results is that government should effectively fight inflationary pressure by implementing appropriate macroeconomic policies that can considerably tame down the level of inflation to non accelerated inflation rate of unemployment, a very sound exchange rate management tends to complement this as there may be case of exchange rate pass-through and this level of inflation is tolerated as it is not inimical to working system of the economy. Evidently, policies based on short term boost of GDP is not optimal for the economy. Hence, there is need to increase aggregate demand i.e develop a very sound and effective macroeconomic policies that will shift demand pressure upward in the long run.

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