An Empirical Analysis of Exchange Rate Volatility on Export Trade
In a Developing Economy

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Abstract
This paper investigates the impact of exchange rate volatility on export in Nigeria. The paper employed three models, viz: Ordinary Least Square (OLS); Granger causality test; and ARCH and GARCH techniques and also Augmented Dickey-Fuller technique was used in testing the presence of unit root. The results of unit root suggested that all the variables in the model are stationary at first difference, while causality test revealed that there is causation between export and exchange rate in the country, but the causation flows from exchange rate to export. Thus, exchange rate causes export. Furthermore, ARCH and GARCH results suggested that the exchange rate is volatile nevertheless export is found to be non-volatile. The study further showed that exchange rate is impacting positively on export, as shown by the regression results. The elasticity results revealed that, the demand for Nigerian products in the World market is fairly elastic. Therefore, for export to improve and foreign exchange earnings increase, the country should depreciate its currency, thereby reducing the price of its products so as to increase demand, which is changing from import-led to export-led economy. Consequently, in order to improve exports, efficient delivery services are needed, such as; power supply, energy resources and infrastructure. The significance of this paper is that, it stands to be a guide to policy makers. It has also pushed forward empirical discourse and provided literature to future research. Finally, this research recommends the pursuance of a stable and sustainable exchange rate policy and to put in place measures that will promote greater exchange rate stability and improve terms of trade, promote greater openness in order to augment non-oil exports. Hence, these measures could greatly promote export trade.

Keywords: exchange rate, volatility, export, ARCH and GARCH

INTRODUCTION
Ever since the breakdown of the Bretton Woods System in the early 1970s, when previously fixed exchange rates among major currencies were allowed to float, researches have been interested in the effects of greater exchange rate volatility on exports. There has been significant disagreement throughout the years with evidence on both positive and negative impacts of volatility on nation’s exports. Most of the earlier studies such as Thursby & Thursby (1987) found large negative impacts of the exchange rate volatility on trade. Later work, on the other hand, found both small negative (e.g. Frankel and Wei, 1993; Eichengreen and Irwin, 1995; Frankel, 1997) and positive effects (Klein, 1990). Research related to exchange rate management still remains of interest to economists, especially in developing countries, despite a relatively enormous body of literature in the area. This is largely because the exchange rate in whatever conceptualization, is not only an important relative price, which connects domestic and world markets for goods and assets, but it also signals the competitiveness of a country’s exchange power vis-a-vis the rest of the world in a pure market. Besides, it also serves as an anchor which supports sustainable internal and external macroeconomic balances over the medium-to-long term. There is, however, no simple answer to what determine the equilibrium exchange rate, and estimating equilibrium exchange rates and the degree of exchange rate misalignment remains one of the most challenging empirical problems in open-economy macroeconomics (Williamson, 1994). The fundamental difficulty is that the equilibrium value of the exchange rate is not observable. While the exchange rate misalignment refers to a situation in which a country’s actual exchange rate deviates from such an unobservable equilibrium, an exchange rate is said to be “undervalued” when it depreciates more than its equilibrium, and “overvalued” when it appreciates more than its equilibrium. The issue is, unless the “equilibrium” is explicitly specified, the concept of exchange rate misalignment remains subjective. The problem of subjectivity is, especially so, according to Chang and David (2005) because exchange rate equilibrium or misalignment is measured over
different time horizons. Notwithstanding, Edwards (1989) states that the equilibrium real exchange rate (RER) prevails when given sustainable values for other relevant variables, such as terms of trade, capital and aid flows, and technology, the economy achieves both internal and external equilibrium.

Exchange rate is a prominent determinant of world trade, receiving much attention in the context of global imbalances. Past decades witnessed disputes on trade and exchange rate issues. Recent disputes on trade surplus and deficit between the United States of America (USA) and China is believed to be resolvable through adjustments to exchange rate by China. Disparity in China’s Yuan exchange rate to the US dollar, favour China’s trade surplus with the US. Oguro, et al (2008) observed that the Marshal-Lerner condition, requiring the sum of the absolute values of price elasticities of imports and exports to exceed one for an appreciation of the result in a deterioration of a country’s balance of trade, is the focus of new studies at explaining the effect of exchange rate on trade balances.

Hooper et al (1998) and Chinn (2004; 2005) found that dollar trade flows are significantly affected by real exchange rates. In his study, Thorbecke (2006) noted that though the above is true, exchange rate elasticities for trade between the US and Asia are not large enough to lend confidence that the depreciation of the US $ will improve the US trade balance with Asia. Comparing this with the multilateral trade balance approach, Oguro et al (2008) observed that aggregate bias problems are reduced in bilateral trade analysis. In their study of trade between the US and Japan, Breuer and Clements (2003) concluded that trade between the two countries are affected by exchange rate elasticities. Commenting, Oguro, et al (2008) opined that sensitivity of export trade to exchange rate changes is dependent on certain conditions. Using a six-industry-panel data to investigate 48 industries, specific sensitivity of exports to exchange rates for 38 trading pairs including China, USA and Japan, they concluded that higher inter-industry trade reduces the export sensitivity to exchange rates due to lower elasticity of substitution among differentiated products; but where inter-industry trade does not exist, exchange rate changes affect export trade. The existence of these conditions according to Cui and Syed (2007), does not eliminate the dependence of export trade on exchange rate volatility; insisting that China’s trade growth with the US is hinged on favourable exchange rate of China’s Yuan to the US$. Like in China, the Central Bank of Nigeria allow a market determination of her naira to other foreign currencies; intervening intermittently to redirect and stabilize it. As in other economies, such actions are to achieve overall economic growth. Moreover, WDI (2006) stated that Nigeria’s non-oil export volume grew by 1.9% on the average between 1990-2004; while non-oil export value grew by 5.2% within the same period, reversing a decline of -4.4% and -20.8% of export volume and value respectively in the 1980-1990 period.

Nigeria’s tariff and trade policies has been characterized by uncertainty and counter policies; to which the government established a market determined nominal exchange rate using the inter-bank foreign exchange market (IFEM), the autonomous foreign exchange market (AFEM), and the Dutch auction system (DAS) at different times to avoid overvaluation of the Naira exchange rate and boost non-oil export. At the foreign exchange market, the naira depreciated consistently against major foreign currencies which in theory should improve export performance as witnessed in China. Findings by Caballero and Corbo (1989) of the effect of individual European Union country currency depreciation on individual country export trade, support this thought; national currency depreciation affecting export trade positively. In addition, Chukwu (2007) observed the instability exchange rate as a determinant of trade in Nigeria: having a positive influence on the dependent variable, export trade; and at other times a negative influence. This suggests an erratic change in its value having a long-run effect on export and economic growth. Studies conducted by (Osuntogun et al., 1993); and Obadan, (1994) on the naira exchange rate impact on export trade focused on the effect of stable exchange rate on Nigeria’s export performance.

**THE PROBLEM**

There is growing agreement in the literature that prolonged and substantial exchange rate misalignment can create severe macroeconomic disequilibria and the correction of external balance will require both exchange rate devaluation and demand management policies. The main intuition behind this is that an increase in exchange rate volatility leads to uncertainty which might have a negative impact on trade flows. According to Anderton and Skudely (2001) the economic logic underpinning the negative link is the aversion of firms to engage in a risky activity, namely trade. Thus, Baldwin, Skudelný and Taglioni (2005) discovered that the effect of exchange rate uncertainty on trade in the European Union (EU) countries is negative; trade increases as volatility falls and gets progressively larger as volatility approaches zero. However, numerous studies were conducted on the extent of Naira exchange rate and its misalignment in Nigeria (see Soludo and Adenikinju, 1997; Obaseki, 2001; CBN, 2005; CBN, 2008; CBN, 2009), assessment of the impact of exchange rate volatility on export has in the recent past been nonexistent. It is against this background, that this work seeks to quantitatively measure the impact of
exchange rate volatility on non-oil export trade in Nigeria from 1970 to 2009. On practical front, exchange rate in Nigeria has been highly volatile and favoured foreign currencies such as Dollars, Euro, Pounds etc. which is detrimental to the growth of export trade as well as the growth of the economy as a whole.

**Contribution of the Paper to Knowledge**

Contribution of the paper on policy formulation is that the findings of the research present an important ground for formulating trade policy, i.e. export-led economy. On empirical front, the paper also pushes forward empirical discourse and provided literature to future research.

**LITERATURE REVIEW**

**Theoretical Framework**

Export income is a function of export price and volume of goods, and the exchange rate of the local currency to the international currency. Production volume for export been fairly stable (Adubi & Okummadewa, 1999; and Chukwu, 2007) suggest export drive as based on export price (itself fairly stable) and the fluctuations in the exchange rate. Fluctuations, positive or negative, influence export: increasing export when depreciation occurs and decreasing export when exchange rate appreciations occur. The traditionalist view on the impact of currency depreciation on trade indicates that it leads to an expansion in trade via lower export prices. The structuralist school, however, stresses some contractionary effects, Meade (1951). Hirschman (1949) points out that currency depreciation from an initial trade deficit reduces real national income and may lead to a fall in aggregate demand. Kandil and Mirzaie (2002) argued that currency depreciation gives with one hand, by lowering export prices and takes away with the other hand, by raising import prices. They observed that if trade is in balance and terms of trade remain unchanged, these price changes offset each other, especially when the famous Marshall-Lerner condition is not satisfied. If imports exceed exports, the end result is a reduction in real income within a country. See Krugman & Taylor (1978) and Edward (1988 and 1989).

It is a widely accepted tenet that chronic misalignment in the real exchange rate has been a major source of slow growth in Africa and Latin America, while prudent macroeconomic, trade and exchange rate policies have fostered growth in Asia (World Bank, 1984; Edwards, 1988; Ghura & Grennes, 1993; and Yotopoulos, 1996). Yotopoulos & Sawada (2005), systematic deviations of nominal exchange rate (NER) from their purchasing power parity (PPP) levels may engender serious instabilities of the international macroeconomic system. According to Baldwin, Taglioni (2002), disequilibrium exchange rate values have been conclusively shown to have negative link with trade (see inter alia, European Commission, 1995). Some authors, however, argued that under the existence of forward exchange markets, exchange rate uncertainty can be completely covered so that there is no impact of exchange rate uncertainty on trade (Baron, 1976). Conversely, Viaene & de Vries (1992) argued that even under the forward exchange markets there may be an indirect effect of exchange rate volatility on trade if hedging is costly.

**Determinants of Nigeria’s Foreign Exchange Rate Volatility**

Exchange rate movements and exchange rate uncertainty are important determinants of international transactions. In Nigeria, these fluctuations according to Omojimite & Akpokodje (2010) have been influenced by changing pattern of international trade, institutional changes in the economy and structural shifts in production. Additionally, Ogunleye (2010) noted that the real exchange rate in Nigeria has been principally influenced by external shocks resulting from the vagaries of world price of agricultural commodities and oil price; both are main sources of Nigerian export and foreign exchange earnings. When the economy depended on agricultural exports, real exchange rate volatility was less pronounced given the fact that these products were subject to less volatility and that there were more trading partners’ currencies involved in the calculation of the country’s real exchange rate. This to Ogunleye minimally affected the real exchange rate fluctuating by only 0.14% between 1970 and 1977. The increased dependence of the country on oil, resulted in severe trade shocks from global oil price stocks fluctuating the naira exchange rate by 10% between 1978-1985 (Ogunleye, 2010).

To Iyoha and Oriakhi (2002), movements in real exchange rate during this period were nominal stocks resulting from fiscal deficits. Similarly, Ogunleye (2008) earlier wrote that the oil windfall resulted in excessive fiscal expenditure in ambitious development projects; and when the windfall ended, the government resorted to financing its expenditures through money creation. Thus, this expansionary monetary fiscal policy according to him exerted upward pressure on inflation, aggravated sharp movements in real exchange rate movements. From 1986, the adoption of the structural adjustment program (SAP) became a contributory factor in shaping the dynamics of real exchange rate in Nigeria. One of the cardinal points of this policy was floating nominal exchange rate policy. As the naira was allowed to float, the nominal exchange rate movement became more pronounced, contributing to stronger movements in exchange rate during this period. While, between 1986 and 1992, Ogunleye (2010) observed that the mean annual charge in real
exchange rate in the country increased to 25%. This subsequently reduced to 4.5% between 2000 and 2006. Therefore, favourable terms of trade, less fiscal dominance, effective monetary policy induced by more independent and transparent central bank and well managed nominal exchange rate policy contributed to this decline in foreign exchange rate volatility.

**Foreign Exchange Rate Volatility, Export Performance and Economic Growth**

Foreign exchange fluctuations whether positive or negative are not desirable to producers of export products as it has been found to increase risk and uncertainty in international transactions which discourages trade (Adubi and Okunmadewa, 1999). Findings by the IMF (1984) revealed that these fluctuations induce undesirable macroeconomic phenomena called inflation. Similarly, Caballero and Corbo (1989) observed positive effect of exchange rate fluctuations on export trade in European Union countries. Accordingly, Walsh and Yu (2010) noted that low exchange rate favours the importation of productions machinery, and production and export in periods of high foreign exchange rate. Lama and Medina (2010) opined that different open economies experience different episodes of exchange rate appreciation in response to different types of stocks, contending that an appreciation in exchange rate induces a contraction of the exporting manufacturing sector. Maintenance of export performance to them require the depreciation of the real exchange rate of a country’s currency, the achievable through monetary injections; noting that a policy of exchange rate depreciation can successfully prevent a contraction of export output, having an allocative effect in the economy.

Moreover, Adubi and Okunmadewa (1999) posited that Nigeria, a developing nation, is expected to gain from export conversion price increase as a result of currency devaluation. Findings by Obadan (1994) and Osuntogun, et al (1993) on the effect of stable exchange on export performance showed that exchange rate affect a country’s export performance. In addition, instability in an exchange rate with its attendant risk affect exports earnings, performance and growth which turn out as positive to exporters when devalued. Poor results from the floating exchange regimes of the 1970’s necessitated a change in foreign exchange rate management. The structural adjustment program was introduced in 1986 with the cardinal objective of restructuring the production base of the economy with a positive bias for agricultural export production. This reform facilitated the continued devaluation of the Nigerian naira with the expected increase in domestic prices of agricultural export boasting domestic production.

Thus, Srour (2006) asserted that, diversification of countries export base is one reason given by developing nations for changing foreign exchange rates and regimes. In the same vein, the World Trade Organization (2010) wrote that, diversification increases local production, employment, income and economic growth. In different works, Chukwu (2007) and Adubi & Okunmadewa (1999) concluded that foreign exchange rate is a determinant of export trade and economic growth in Nigeria. Similarly, Lama & Medina (2010) observed a coincidence in exchange rate appreciation with a contraction of 3% in the country’s gross domestic product in the manufacturing sector; with a 2% average decline in manufacturing GDP over a 20 year period characterized foreign exchange rate appreciation. Although, carrying attendant risks, foreign exchange rate movement are monetary policy instruments to achieve export growth, economic growth and development of any nation.

**Empirical Framework**

Empirical studies in the past that applied time series analysis and found no significant relationship between volatility and trade. The few that found a link suggest that the effect was very small (see Koray and Lastrapes (1989), Bini-Smaghi (1991), Meese and Rogoff (1983), in a work which predates the cointegration literature, forecast exchange rates by simply regressing the exchange rate on the macroeconomic fundamentals and then using these parameter estimates and the ex post realized and revised values of the future economic fundamentals to predict the future exchange rate. Cross-sectional studies were also carried out by Hooper et’al (1978), Brada and Méndez (1988), and Eichengreen and Irwin (1995) find evidence of a negative effect of exchange rate uncertainty on export. Again, this effect, in most cases, was relatively small. Some studies employed co-integration analysis, for example, Koray and Lastrapes (1989), Arize (1997, 1998a and b), Fountas and Aristotelous (1999) and Flam and Jansson (2000). A detailed empirical review of this strand of literature is reported in Baldwin, Skudenly and Taglioni (2005). The results of the studies taking into consideration the trend characteristics of the time-series appeared to be more clear-cut and most suggest a significant negative effect of exchange rate uncertainty on the trade variables. For instance, Fountas and Aristotelous (1999) found a significant negative long run effect of exchange rate uncertainty on trade. Wei (1999) found a negative and statistically significant effect for foreign exchange rate volatility on exports taking account of futures and options instruments to hedge risk. Recently, Baum et al (2004) showed evidence of a positive relationship between exchange rate volatility and trade using a poisson flexible lag structure, while Klaassen (2004) did not find evidence of any significant effect of exchange rate
volatility on trade for G7 economies. Caporale and Doroodian (1994) used a generalized autoregressive conditional heteroskedasticity (GARCH) technique to measure the volatility of exchange rate and discovered significant negative effect of volatility on import trade. McKenzie and Brooks (1997) and McKenzie (1999) used ARCH modeling and introduced an exchange rate volatility term into their export trade models for both German-US and Australian trade flows respectively. Their results were statistically significant but, showed positive impact of volatility on trade, while for McKenzie (1999), the results were mixed.

Furthermore, studies that employed panel estimation techniques, according to Anderton and Skudelny (2001) emerge with better results. For example, Abrams (1980), Thursby and Thursby (1987), Dell’Ariccia (1998), Pugh, et al (1999) and Rose (1999), all found significant negative effect of the proxy for exchange rate uncertainty. In particular, while Dell’Ariccia (1998) found that the trade gains resulting from the elimination of exchange rate volatility would have been 10 percent. Anderson and Skudelny (2005) discovered that exchange rate volatility would decrease extra-euro area imports by around 10 percent.

Another strand of empirical studies apply gravity-type trade model to assess the impact of exchange rate volatility on bilateral trade. Pugh, et al (1999) use 16 OECD countries and showed that volatility leads to a once and for all decrease in the level of trade by around 8 percent and Rose (2000) estimated a gravity trade model for 186 countries using a 5-year moving average of the variance of the nominal exchange rate return and discovers that exchange rate volatility has a significant negative impact on trade (estimates show that zero exchange rate volatility would have resulted in a 13 percent increase in trade). It was this seminal work (Rose (2000)) that started the debate that countries participating in a currency union seemed to trade three times more than expected – even when one controls for the impact of exchange rate volatility. This discovery was christened the Rose effect. Rose and Engel (2002) and Glick and Rose (2002) found empirical evidence in support of the Rose effect. Furthermore, Aliyu (2007) uses a gravitational model for Nigeria-India bilateral trade and discovered that the exchange rate coefficient is theoretically consistent and statistically significant in the import model for the Indian economy but not for the Nigerian economy.

A number of empirical studies on Nigeria were carried out by Ojo, et al (1978), Osagie (1985), and all downplayed the role of exchange rate in the import-export trade in the country. This was largely possible in view of the system of exchange rate regime prior to the introduction of structural adjustment programme in Nigeria in July 1986. However, Omolola (1992), Akanji (1992), Ihimodu (1993) Osuntogun, et al (1993) World Bank (1994), Aliyu (1994 & 2001) discovered that exchange rate depreciation caused significant changes in the structure and volume of Nigeria’s agricultural exports. Egwaikhde (1999) in his dynamic specification model of import determinants in Nigeria from 1953 to 1989 discovered that short run changes in the availability of foreign exchange earnings, relative prices, and real output (income), significantly explained the growth in total imports in Nigeria. On exchange rate instability, Nnanna (2002) links exchange rate instability in Nigeria to adverse monetary policy outcome, inflation, interest rate and growth in money supply; and the failure of monetary policy was linked to fiscal dominance in the economy. Aliyu (2007b) showed that exchange rate significantly affects imports more than exports due largely to the monocultural nature of Nigeria’s exports and inexhaustible and multifarious nature of its imports. According to a study by the CBN (2008) using fundamental variables; TOT, nominal effective exchange rate (NEER) and lagged real exchange rate; findings suggest that the three variables accounted for 22, 55 and 99 percent of variations in the dependent variable, respectively.

Theoretically, the volatility-trade link is ambiguous according to Baldwin, Skudelny and Taglioni (2005). Dornbusch (1987) observed that the effect of an appreciated exchange rate on trade would be to make production of tradable unprofitable and non-tradable goods more profitable. In other words, imports will be high, while exports will tend to be discouraged. Cottani, et al (1990) found that misalignment was strongly related to lower per capita GDP growth, and to low productivity, slow export growth and slow agricultural growth.

It is evident from the above review that studies on the impact of exchange rate volatility on trade have no dominant approach. The choice of a particular approach or methodology and expected outcomes depend on a particular economy and nature and availability of data. Gala and Claudio (2006) state that two main methods of dealing with exchange rate misalignment are the purchasing power parity (PPP) approach and fundamental analysis. The PPP approach, on one hand, is based on relative prices and considers high international price levels as proxy for exchange rate overvaluation for a given GDP per capita level. Fundamental analysis, on the other hand, considers economic fundamentals in modeling exchange rate misalignment. These include terms of trade (TOT), balance of payments (BOP) financing condition, fiscal policy stance (surplus or deficit spending), degree of openness (OPN), GDP per capita, etc. It has also been established in the literature that a drop in exchange rate volatility can
increase the volume of trade in two not mutually exclusive ways – by producing more exports, and by increasing the number of firms that are engaged in exporting. It is this theorization that accounts for a negative volatility-trade link, Baldwin, Skudelny and Tagliioni (2005). Generally, the transmission mechanism through which exchange rate volatility affects non-oil exports in Nigeria could be both from the supply and demand channels. The supply side effects are related to the fact that exchange rate volatility could affect input prices. This induces some producers to lower output and in the face of volatile exchange rate, makes the exports less competitive. Exchange rate volatility could also affect consumer confidence in importing countries and thus lowers demand. It also adversely affects investment indirectly by increasing producers’ cost. Against this background, this paper seeks to assess the link between exchange rate and export trade performance in Nigeria. Empirical findings by Osuntogun, et al (1993), Himodu (1993) reveal changes in both structure and volume of Nigeria’s trade as a result of the devaluation of naira.

**METHODOLOGY**

This research will make use of econometric procedure in estimating the relationship between the variables in question. The ordinary Least Square (OLS) technique will be employed in obtaining the numerical estimates of the coefficients of the equation, Argumented Dicky-Fuller (ADF) test of stationarity would be adopted after which Granger causality test can be used to determine the causation between export and exchange rate, afterward ARCH and GARCH techniques can be applied to test the volatility of the data. In demonstrating the application of ordinary least square method, the simple linear regression analysis is used with the export and exchange rate, as the relevant variables. The independent variable is exchange rate while the export is the dependent variable. Justification for the selection of these methods is that the data is a time series data and all-time series data exhibit a random walk.

**Model Specification**

The export demand function which on apriori grounds is influenced by a number of factors such as relative prices is presented as follows:

**Model I (OLS)**

\[
\text{EXPORT} = a_0 + a_1 \text{EXCR} + e_i
\]

**Model II (ARCH and GARCH)**

\[
\begin{align*}
\text{EXPORT}_t &= a_0 + a_1 \text{EXCR}_{t-1} + e_i \\
\text{EXCR}_t &= a_2 + a_3 \text{EXCR}_{t-1} + e_i \\
\sigma_t^2 &= \text{ARCH}_t \\
\sigma_t^2 &= \text{GARCH}_t
\end{align*}
\]

\[
\begin{align*}
\text{ARCH}_t &= \alpha_0 + \alpha_1 e_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \\
\text{GARCH}_t &= \beta_0 e_{t-1}^2 + \beta_1 \sigma_{t-1}^2
\end{align*}
\]

Where; \(\alpha_0, \alpha_1, \beta_0, \beta_1\) as ARCH and GARCH coefficients, \(\beta_3\) is ARCH term, \(\beta_2\) is GARCH term. It is expected that \(\beta_1 + \beta_2 < 1\) and \(\beta_3 > 1\). The export is expected to be stable and not volatile on apriori grounds, while exchange rate is expected to be volatile.

**Model III (CAUSALITY)**

The model of causality test is thus specified as follows:

\[
\begin{align*}
\text{EXCR} &= \sum \phi_i \text{EXCR}_{t-i} + \sum \theta_i \text{EXCR}_{t-i} + \mu_i \\
\text{EXCR} &= \sum \alpha_i \text{EXCR}_{t-i} + \sum \beta_i \text{EXCR}_{t-i} + \mu_i
\end{align*}
\]

From model III, it is expected that \(\phi_i = 0, \theta_i = 0, \alpha_i = 0\) and \(\beta_i \neq 0\). \(\phi_i\) and \(\alpha_i\) are expected to be statistically insignificant whereas \(\theta_i\) and \(\beta_i\) are expected to be statistically significant. However, if the estimates of the parameter turn up with signs or size not conforming to economic theory, they should be rejected, unless there is a good reason to believe that in the particular instance, the principles of economic theory do not hold.

**RESULTS AND DISCUSSION**

The results of model I, is presented in Table 1, which contains bivariate regression results for the relationship between export and exchange rate. The results indicated that the coefficient of exchange rate is statistically significant. Precisely, the coefficient of exchange rate is found to be statistically significant at 1 percent level as indicated by its probability value 0.0000 and rightly signed (positive). This therefore, implies that 1 unit increase in exchange rate would increase by 44361.49 units. The constant term is found to be statistically significant, indicated by its high probability value 0.5615, which implies that the constant is not significant at 56 percent. The F-statistics value 96.4260, which is the measure of the joint significance of the parameters, is found to be statistically significant at 1 percent level as indicated by the corresponding probability value 0.000000. Though export of a country does not only depends on the exchange rate along but to some extent on the elasticity of demand for a country’s export in the world market. Given the regression equation:

\[
\text{EXCR} = -172637.7 + 294739.1\text{EXCR}
\]

The mean of export is 1535304 and the mean of exchange rate is 38.5005. The regression result revealed that, the elasticity of demand for Nigeria’s export is \((294739.1 / 38.5005) = 7.3911\). This indicated that, the elasticity of demand for the Nigerian product in
the world market is fairly elastic; therefore depreciation in naira value (reduction) in the prices of Nigeria’s product. The $R^2$ square value 0.71 which implies that 71 percent total variation in export is explained by the regression equation. Coincidentally, the goodness of fit of the regression remained high after adjusting for degree of freedom as indicated by the adjusted $R^2$ square is 70. Durbin Watson statistic is 0.347156 in Table 1, is found to be less than $R^2$ value 0.71 indicating that the model is spurious. Durbin Watson statistic is very low indicating the presence of autocorrelation; therefore, the unit root test became important to make the data to be stationary.

The results of unit root test are contained in Table 2, and 3 in the Appendix. The results revealed that all the variables of the model are found to be stationary at both 1 percent, 5 percent and 10 percent level with first difference (d(1)), which is indicated by ADF results at all levels less than the critical values in negative direction. The ADF value for EXPORT is -4.1602 and the critical values are -3.6156, -2.9412 and -2.6091 at 1, 5, and 10 percent respectively. The ADF value for EXCR is -5.2430 and the critical values are -3.6156, -2.9412, and -2.6091.

The results of causality are contained in Table 4 in the Appendix. The results revealed that EXPORT does not granger causes EXCR, the null hypothesis is accepted at 92 percent indicated by the high probability value 0.9212. The results also revealed that EXCR Granger causes EXPORT, the null hypothesis is rejected at 1 percent indicated by the probability value 0.0002 and this is confirmed by the F-statistics value 17.0752. This result therefore, indicates one-way causation flowing from EXCR (exchange rate) to EXPORT (volume of export). This results shows that exchange rate causes export and not the other way round.

The ARCH and GARCH results contain in Table 5, 6, and 7 in the Appendix which reveals that the time series data under consideration is volatile. This is indicated by the sum of the ARCH and GARCH coefficient in Table 5 (2.404933 -- 0.847271 = 1.5577). This result shows that there is high volatility clustering in the data. The ARCH and GARCH results for EXPORT is contain in Table 6; this result indicated that export data in Nigeria is not volatile as in indicated by the sum of the ARCH and GARCH coefficient (1.506505 - 0.995383 = 0.511122). The ARCH and GARCH results for EXCR is contain in Table 7; the result indicated that exchange rate in Nigeria is highly volatile as indicated by the sum of the ARCH and GARCH coefficient (2.208021 - 0.034864 = 2.173157). The autoregressive conditional heteroscedasticity and generalized autoregressive conditional heteroscedasticity results above revealed that exchange rate in Nigeria is highly volatile and is impacting positively on the export of the country.

**CONCLUDING REMARKS**

This paper investigates the impact of exchange rate volatility on export in Nigeria from 1970-2009 using the applied of ADF technique in testing the unit root property of the series, the Granger causality test for causation was conducted, ARCH and GARCH techniques were tested to see the presence of volatility in the series. The results of unit root suggested that all the variables in the model are stationary at first difference, the results of causality showed that there is causation between export and exchange rate in Nigeria, but the causation flows from exchange rate to export (i.e. exchange rate granger causes export), and ARCH and GARCH results revealed that the data is volatile, especially the exchange rate is volatile nevertheless export is found to be non-volatile. The results also discovered that when exchange rate is increased by 1 unit export increase by 44361.49 units. Thus, exchange rate is impacting positively on export trade in Nigeria as shown by the regression results.

The elasticity results indicated that, the demand for the Nigerian products in the World market is fairly elastic. Consequently, for export to improve and foreign exchange earnings to increase, the country should change the course of export drive from import-led to export-led economy so as to devalue its currency appropriately, thereby reducing the price of its products and increasing demand.

The paper recommends the pursuance of a stable and sustainable exchange rate policy and to put in place, measures that will promote greater exchange rate stability and improve conditions of terms of trade, promote greater openness of the economy in order to enhance non-oil exports. There is the need for the government to devalue its currency after changing the courses of trade export volume, other vital factors are; efficient delivery of services, infrastructure, power supply and other energy resources. It is hoped that coming up with the above measures could greatly promote more export trade.

Lastly, the paper is not without limitations, therefore the shortcomings of the methodologies and sources of data are in a way the research limitations. It is important to assert that a major limitation to this study is the extent of accuracy of information and data that documents the manifestations of export trade and exchange rate in Nigeria.

**REFERENCES**


APPENDIX

### TABLE 1: REGRESSION RESULTS
Dependent Variable: EXPORT
Method: Least Squares
Date: 06/17/12 Time: 14:07
Sample: 1970 2009
Included observations: 40

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-172637.7</td>
<td>294739.1</td>
<td>-0.585731</td>
<td>0.5615</td>
</tr>
<tr>
<td>EXCR</td>
<td>44361.49</td>
<td>4517.614</td>
<td>9.819673</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.717317
Mean dependent var: 1535304.
S.E. of regression: 1717431.
Sum squared resid: 8.61E+13
Log likelihood: 96.42597
AIC: -8.61E+12
S.D. dependent var: 172637.7
Mean dependent var: 1535304.
S.E. of regression: 1717431.
Sum squared resid: 8.61E+13
Log likelihood: 96.42597
AIC: -8.61E+12

### TABLE 2: UNIT ROOT TEST FOR EXPORT
Null Hypothesis: D(EXPORT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-4.160231</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.615588</td>
</tr>
<tr>
<td>5% level</td>
<td>-2.941145</td>
</tr>
<tr>
<td>10% level</td>
<td>-2.609066</td>
</tr>
</tbody>
</table>

### TABLE 3: UNIT ROOT TEST FOR EXCR
Null Hypothesis: D(EXCR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=1)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-5.242948</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.615588</td>
</tr>
<tr>
<td>5% level</td>
<td>-2.941145</td>
</tr>
<tr>
<td>10% level</td>
<td>-2.609066</td>
</tr>
</tbody>
</table>

### TABLE 4: GRANGER CAUSALITY TEST
Pairwise Granger Causality Tests
Date: 06/17/12 Time: 14:17
Sample: 1970 2009
Lags: 1

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPORT does not Granger Cause</td>
<td>39</td>
<td>17.0752</td>
<td>0.0002</td>
</tr>
<tr>
<td>EXPORT does not Granger Cause EXCR</td>
<td>0.00093</td>
<td>0.9212</td>
<td></td>
</tr>
</tbody>
</table>


### TABLE 5: ARCH/GARCH RESULTS
Dependent Variable: EXPORT
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/17/12 Time: 14:23
Sample: 1970 2009
Included observations: 40
Convergence achieved after 297 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-58136.64</td>
<td>272361.9</td>
<td>-0.213454</td>
<td>0.8310</td>
</tr>
<tr>
<td>EXCR</td>
<td>55607.08</td>
<td>2928.957</td>
<td>18.98527</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Variance Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.40E+12</td>
<td>5.90E+11</td>
<td>2.369229</td>
<td>0.0178</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>2.404933</td>
<td>0.685793</td>
<td>3.506791</td>
<td>0.0005</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>-0.847271</td>
<td>0.035510</td>
<td>-23.86037</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.631842
Mean dependent var: 1535304.
S.E. of regression: 1717431.
Sum squared resid: 1.12E+14
Log likelihood: -606.5872
Durbin-Watson stat: 0.330580


#### TABLE 6: ARCH/GARCH FOR EXPORT
Dependent Variable: EXPORT
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/17/12 Time: 14:27
Sample: 1970 2009
Included observations: 40

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>6.48E+12</td>
<td>3.31E+12</td>
<td>1.955077</td>
<td>0.0506</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>1.506505</td>
<td>0.847894</td>
<td>1.776761</td>
<td>0.0756</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>-0.995383</td>
<td>0.002863</td>
<td>-347.7060</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.309700
Mean dependent var: 1535304.
S.E. of regression: 3157256.
Sum squared resid: 31.99E+14

Variance Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.40E+12</td>
<td>5.90E+11</td>
<td>2.369229</td>
<td>0.0178</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>2.404933</td>
<td>0.685793</td>
<td>3.506791</td>
<td>0.0005</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>-0.847271</td>
<td>0.035510</td>
<td>-23.86037</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.631842
Mean dependent var: 1535304.
# TABLE 7: ARCH/GARCH RESULTS FOR EXCR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.409812</td>
<td>0.925481</td>
<td>-0.442810</td>
<td>0.6579</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>2.208021</td>
<td>3.129450</td>
<td>0.705562</td>
<td>0.4805</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>-0.034864</td>
<td>1.506335</td>
<td>-0.023145</td>
<td>0.9815</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>-0.534303</td>
<td></td>
<td></td>
<td>38.5054</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>-0.495945</td>
<td></td>
<td></td>
<td>53.3422</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>65.24222</td>
<td></td>
<td></td>
<td>7.138150</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>170261.9</td>
<td></td>
<td></td>
<td>7.264816</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-139.7630</td>
<td></td>
<td></td>
<td>7.183949</td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>0.037929</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

resid
Log likelihood: -617.8479  Hannan-Quinn criter. 31.08819
Durbin-Watson stat: 0.043889