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AN EMPIRICAL INVESTIGATION ON EXCHANGE RATE VOLATILITY AND MATERNAL MORTALITY: A SIMULTANEOUS MODEL APPROACH FOCUSING ON NIGERIA

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Abstract

Purpose: The issue of exchange rate volatility and maternal mortality rate has rarely been considered in a single study by research scholars and economists over the years as very few, if any empirical studies have been carried out to explain the relationship between these two variables. Consequently, this study used an empirical examination to ascertain if there exists a relationship between exchange rate volatility and maternal mortality rate.

Findings: The results indicated that exchange rate and maternal mortality rate both have negative impacts on each other which is statistically significant. Also, the female education enrolment reduces maternal mortality rate while the recurrent health expenditure causes it to rise, albeit not statistically significant.

Contributions to theory, policy and practice: The study therefore recommends that the foreign exchange control policies must prioritize both foreign sector and domestic balance of the economy. The government should also focus on capital health expenditure as well as encouraging policies that will encourage female education enrolment in Nigeria.

Keywords: *Exchange Rate, Exchange Rate Volatility, Maternal Mortality Rate, Health*

1.0 INTRODUCTION

Introduction of exchange rate policies in oil-producing developing countries is often sensitive and controversial. This could be because of the type of structural transformation required, such as cutting the volume of imports or increasing the volume of non-oil exports, which invariably implies a depreciation of the nominal exchange rate. Such domestic adjustments, owing to their short-run effect on prices and demand, are seen as damaging to the economy (Benson and Victor, 2012). Atypically, the distortions intrinsic in an overvalued exchange rate regime is hardly an issue of argument in developing economies that depend on imports for production and consumption. As explained by Dornbusch, (2014) and David, Umeh and Ameh, (2016), the success of currency depreciation in stimulating trade balance depends heavily on substituting demand in the right direction and volume as well as on the capacity of the domestic economy to meet the extra demand by supplying more goods. Generally, exchange rate fluctuations are likely, in turn, to influence some economic development variables. Thus, it is necessary to evaluate the effects of exchange rate fluctuations on maternal mortality in Nigeria. According to the World Health Organization (WHO) (2008) factsheet, an estimated 1500 women die as a result of pregnancy or pregnancy-related complications daily. Most of these deaths happen in developing countries, and most are avoidable. Of all the health statistics compiled by the World Health Organization, the biggest divergence between developed and developing countries occurred in maternal mortality.

Over the years, maternal mortality has remained a severe issue in Nigeria, particularly in the northern states of the country as well as the rural south. In 2005, the projected total of global maternal mortality recorded was 536,000; over 99 percent or 533,000 of the recorded maternal deaths are accounted for by developing countries like Nigeria (WHO 2007). By having just 2 percent of the world's total population, Nigeria accounted for 10 percent of the world's total maternal deaths in 2010. Nigeria's maternal mortality rate exceeds 1000 deaths per 100,000 live births and is much higher than the African continent average of 800 deaths per 100,000 live births (Zozulya, 2010).

The haphazard nature of economic policies and lack of continuity in exchange rate policies has led to the unsteady nature of the naira rate. Aliyu, (2015) and Benson and Victor, (2012) noted that despite various efforts by the government to sustain a stable exchange rate, the naira has depreciated throughout the 1980's to date.

In light of the foregoing, this paper intends to provide an empirical investigation of the concept of exchange rate, exchange rate volatility and its possible relationships with maternal mortality rate (MMR) in Nigeria.

This study contributes to the literature in two major ways. First, most of the previous or related studies in Nigeria usually look at exchange rate volatility and its impact on economic growth, but this study looks at exchange rate volatility and its effect on a development determinant, the maternal mortality rate. Second, to the best of our knowledge, there are few studies in this subject area with comprehensive analysis such as ours, as we employ data from 1981 to 2017 (37 years).

The remainder of this paper is prearranged as follows: Section two provides a literature review of related studies and the hypotheses of the research. Section three presents the research methodology. Section four discusses the empirical findings and policy implications. Finally, conclusions and recommendations are made in section five.

2.0 LITERATURE REVIEW

This study will review relevant theoretical and empirical literatures in this section. Exchange rate is the price of one country's currency in relation to that of another country. Additionally, it is the necessary amount of units of a currency that can buy another quantity of units of another currency (David, Umeh and Ameh, 2016). However, Exchange rate volatility refers to the tendency for foreign currencies to appreciate or depreciate in an unstable manner or unpredictably, thus disturbing the profitability of foreign exchange trades. The volatility measures the extent that these rates change and the regularity of those changes.

As expounded in Shah and Say (2007), a maternal death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, regardless of the period and site of the pregnancy, from any cause connected to or provoked by the pregnancy or its management but not from accidental or incidental causes. Worldwide, the projected number of maternal deaths in 2005 was 536,000 up from 529,000 in 2000.

Theoretical Literature

The theoretical foundation for the determination of exchange rate behaviour is entrenched in both monetary and macroeconomic theories. The monetary theory adopts the integration of goods and capital markets. The theory buttresses the assertion of purchasing power parity (PPP) principle which was introduced by Gustav Cassel in 1970 to determine the exchange rate between the currencies of two countries (Jhingan, 2008). Purchasing power parity maintains that the rate of exchange between two currencies must be equal to the ratio of total price levels between both countries (Asab, Abdullah, Nawaz, Shakoor & Arshad, 2015).

The second theory that underpins exchange rate determination is the macroeconomic (real) theory. This theory centres its attention on the role played by macroeconomic fundamentals (variables) in determining exchange rate behaviour (Villavicencio and Bara, 2008). This approach is divided into two – The Balassa-Samuelsson approach and the balance of payments approach. The Balassa-Samuelson doctrine was introduced in 1964.This approach focuses on the balance amongst tradable and non-tradable sectors (Jhingan, 2008). Conversely, the balance of payments approach was presented by Nurkse in 1945. According to this theory, the exchange rate of a nation is determined by its balance of payment. A positive balance of payment overvalues the exchange rate, while a negative balance of payments undervalues exchange rate of the said nation (Asab, *et al.*, 2015).

Lastly, we consider the Marshall-Lerner Condition; this theory aids in the verifiability of whether a foreign exchange market is stable or prone to volatility. This theory is based on the shapes of the curves of demand for imports and exports in a country. According to the theory, a foreign exchange market is stable if the sum of the price elasticity of the demand for imports and exports are greater than one in absolute terms. A country is in a great position if these two elasticity are greater than one by a significant amount since the current account will then improve more in a case where depreciation occurs. Alternatively, if the price elasticity sum up to less than one in absolute terms, such a foreign exchange market is unstable or volatile. Lastly, the current account will remain unaffected by a change in the exchange rate if the elasticities sum up to one (Salvatore, 2004).

The theory relevant to this study in terms of maternal mortality is Eager's theory, that is, the importance of social movements and the construction of risk. In her discussion of the construction of risk, Nathanson (1996) notes that there are three elements which are critical to credible construction of risk. Credible refers to the degree to which the construction fits with cultural frameworks in the society. The first element is basically Eager's "transformative actors," though Nathanson (1996) simply refers to groups or individuals who have the "authority to define and describe the danger that threatens". The second element is the construction of a believable causal chain explaining the cause of the health risk. Finally, there is a need to identify designated victims of the risk.

Furthermore, Nathanson (1996) examined her theory by comparing France and the U.S. in terms of two policies: maternal and infant health, and tobacco control public health policies. She attempted to explain the changes in policies that led to a decline in these areas in her case studies, using her hypotheses as a framework. In France, the decline in infant mortality was more successful than the U.S. because the former saw the death of pregnant mothers and infants as a national tragedy.

The credible construction of risk in France involved framing mothers as a national asset who reproduce on behalf of the state by giving birth to healthy babies to preserve the existence of the nation. Nathanson (1996) acknowledged that even though social movements are powerful actors that bring about changes in policies, she noted that the social construction of risk should not be left entirely to the social movement groups. Other actors including political and economic players should be part of the risk construction process.

Empirical Literature

Owing to the somewhat uniqueness of this paper, we consider related studies which have been carried out on both exchange rate and maternal mortality as follows;

Asher, (2012) examined the impact of exchange rate fluctuation on the Nigeria economic growth for period of 1980 – 2010. The result showed that real exchange rate has a positive effect on the economic growth. In a similar study, Aliyu, (2015) examined foreign exchange market and economic growth in a developing oil-based economy like Nigeria from 1970-2003. He discovered that positive relationship exists between exchange rate and economic growth. Obansa, Okoroafor, Aluko and Millicent, (2013) also studied the relationship between exchange rate and economic growth in Nigeria between 1970 and 2010. The result revealed that exchange rate has a strong effect on economic growth. They resolved that exchange rate liberalization is good to Nigerian economy as it promotes economic growth. Azeez, Kolapo and Ajayi, (2012) also considered the effect of exchange rate volatility on macroeconomic performance in Nigeria from 1986 – 2010. They discovered that exchange rate is positively correlated to economic development.

There are numerous factors that play into the link between maternal health and poverty level. The most direct link is that women are not able to pay for the antenatal care they need during their pregnancy. However, there are also a host of indirect factors caused by poverty, such as psychological stress, gender dynamics, social standing, self-esteem, ethnicity, and race that also have an effect on the rates of maternal mortality in a community (Ronsman, 2006 & Dayal, 2013). Tuberculosis, malaria, syphilis, worm infestations, Chlamydia, gonorrhea and HIV are challenging problems in Nigeria that lead to high maternal mortality (Okereke *et al.*, 2005). These infections account for 27 percent of the total maternal deaths in Nigeria.

In light of thee, the first hypothesis of the study in its null form is given thus;

H_{01}: Thre is no relationship between exchange rate volatility and maternal mortality rate in Nigeria

Adewuyi and Akpokodje, (2013) using error correction model argued on the contrary that trade liberalization promoted growth in the Nigerian industrial sector and stabilized the exchange rate market between 1970 and 2006. Their findings suggest there is a positive and significant relationship between the index of industrial production and real export. A one percent increase in real export increases the index of industrial production by 12.2 percent. By inference, it means that the policy of deregulation has a positive impact on export through exchange rate depreciation. David, Umeh and Ameh, (2016) also studied the effect of exchange rate fluctuations on the Nigerian manufacturing industry. They used multiple regression econometric tools which showed a negative relationship between exchange rate volatility and manufacturing sector performance. Azeez, Kolapo and Ajayi, (2012) found a similar outcome, as they opined that the negative effect of real exchange rate volatility on economic growth diminishes in countries with higher or advanced levels of financial development. Opoku (2007) investigated the utilization of maternal care services in Ghana by region and discovered that half the births occurring in the 2 years prior to the Multiple Indicator Cluster Survey (MICS) were delivered by skilled personnel. This percentage was highest in the Greater Accra Region (83 %) and Ashanti Region (60%) with seven of the regions below 50 % (Western, Central, Volta, Eastern, Northern, Upper East and Upper West). The Upper West shows the lowest percentage of any skilled attendance (29.1%).

According to Anthony (2013), maternal education is a vital pointer of how women view healthcare, whether they follow treatment regimens, whether they make significant decisions in their households, and several other factors. In a cross-sectional WHO global study, it was

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discovered that lack of maternal education is related to maternal mortality and leads to a greater possibility of negative pregnancy outcomes (Karlsen, 2011).

Consequent upon mixed results by extant literature discussed above, we hypothesize without indicating any direction as follows;

H_{02}: There is no relationship between health expenditure, female education and maternal mortality Theoretical Framework

This section will consider the empirical model to be used for the study as well as the methodology. The theories influencing the model and variables used are the Marshall-Lerner condition and Eager's theory.

We collected data for a period of 37 years from 1981 to 2017. They were sourced from the Central Bank of Nigeria's Statistical Bulletin (2018) and the World Bank's data page.

3.0 METHODOLOGY

This study adopts an econometric research design using the exchange rate, maternal mortality rate, health expenditure and female education enrolment as variables. The first difference of the exchange rate variable was used to capture the exchange rate volatility. The logarithm of the variables will be taken in order to take care of the extremes in the data. Descriptive statistics was used to show data behaviour over the period of study. The econometric model adopted in this study is the Two-stage least squares (2SLS) model, which aims at determining the interrelationship between the set of *the four* variables used in this study. The conventional ordinary least square (OLS) regression is invalid because of endogeneity issues, both exchange rate volatility and maternal mortality itself can be influenced by a host of other factors. Therefore, the endogeneity problem with respect to both variables is to be resolved by the use of instrumental variables. Vital tests such as Johansen Co-integration and granger causality will also be used.

The four-variable 2SLS model is specified below in its functional form as:

$$\mathbf{Z_t = \mathit{f}\,(EXRV, MMR, HEXP, FENR)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \mathbf{1}$$

Same 2SLS model is expressed in its compact form as:

$$\boldsymbol{Z_t = \sum_{i=1}^{4} \beta_{it}\, Z_{t-1} + \mu_{it}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots.. \mathbf{2}$$

When the compact model above is expanded using the four variables in the study, it will yield series of interrelationships. However, the focus of the study is mainly on exchange rate volatility and the maternal mortality rate.

Therefore, the models are explicitly represented as:

$$\mathbf{MMR_t = \beta_{01} + \sum \beta_{11}\Delta EXR_t + \sum \beta_{12}HEXP_t + \sum \beta_{13}FENR_t + \mu_{1t}} \quad \ldots\ldots.. \mathbf{3}$$

$$\mathbf{\Delta EXR_t = \alpha_{02} + \sum \alpha_{21}MMR_t + \sum \alpha_{22}HEXP_t + \sum \alpha_{23}FENR_t + \mu_{2t}} \ldots\ldots.... \mathbf{4}$$

Including the instrumental variables, the system specification is given thus; lmmr=c(1) + c(2)*lexr + c(3)*lhexp + c(4)*lfenr @ lmmr(-1) lexr(-1) lhexp(-1) lfenr(-1 to -2)

lexr = c(5) + c(6)*lmmr + c(7)*lhexp + c(8)*lfenr @ lexr(-1) lmmr(-1) lhexp(-1) lfenr(-1 to 2)

Where;

MMR – Maternal Mortality Rate

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ΔEXR – Exchange Rate (Differenced to capture fluctuations or volatility)

HEXP – Recurrent Health Expenditure

FENR – Female Education Enrolment Rate

4.0 FINDINGS

In this section, we perform the analysis that forms the basis for the empirical evaluation of the study. This is done through the presentation and analysis of the estimated results based on the model specified in the previous section. Table 1 presents the statistics summary of our study.

Table 1: Descriptive Statistics

	EXR	MMR	FENR	HEXP
Mean	91.56515	1467.000	27.58538	59.0559 7
Median	92.52838	1170.000	23.14896	15.2180 8
Maximum	306.0000	5230.000	47.69855	257.700 0
Minimum	0.636900	805.0000	11.55227	0.04131 5
Std. Dev.	81.32074	1050.175	9.699170	82.9850 4
Skewness	0.748394	2.343375	0.572295	1.26928 0
Kurtosis	3.370786	7.621492	2.229332	3.13338 9
Jarque-Bera	3.665864	66.79089	2.935361	9.96236 6
Probability	0.159944	0.000000	0.230459	0.00686 6
Sum	3387.910	54279.00	1020.659	2185.07 1
Sum Sq. Dev.	238070.2	39703226	3386.660	247914. 6
Observations	37	37	37	37

Source: Author's Computation

From the above table, during the 1995 to 2016 period, the average exchange rate was N91.56515, with a standard deviation of 81.32074 which gives an early indication of the kind of volatility exhibited by the variable the graph (in the appendix section paints a clearer picture). Maternal mortality rate has a mean of 1467 and a relatively high standard deviation of 1050.175. Considering the standard deviations of health expenditure as well as female enrolment to their respective means, the use of logarithm to reduce the extremes of the variables is justified. Also, we see that the variables have also had some series of fluctuations over the years. This is made clearer by their graphs in the appendix section. Next we consider the granger causality test below.

Table 2 Granger Causality Test

Sample: 1981 2017

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
MMR does not Granger Cause EXR	35	0.12224	0.8854

EXR does not Granger Cause MMR		1.64523	0.2099
FENR does not Granger Cause EXR	35	0.91072	0.4131
EXR does not Granger Cause FENR		2.89484	0.0709
HEXP does not Granger Cause EXR	35	3.24232	0.0531
EXR does not Granger Cause HEXP		1.94117	0.1611
FENR does not Granger Cause MMR	35	2.72644	0.0817
MMR does not Granger Cause FENR		0.50766	0.6070
HEXP does not Granger Cause MMR	35	0.52695	0.5958
MMR does not Granger Cause HEXP		0.38307	0.6850
HEXP does not Granger Cause FENR	35	2.15620	0.1334
FENR does not Granger Cause HEXP		6.03544	0.0063

Source: Author's Computation

The table 2 above presents the granger causality test results. With the established null hypotheses, at 10% level of significance, it can be seen that MMR and EXR do not have any causal relationship as the p-value of the F-statistics is greater than 10%. There is a onedirectional granger causality relationship between exchange rate and female relationship as exchange rate granger causes female enrolment, this is because the p-value of 0.0709 is lower than 10% level of significance, so we reject the null hypothesis. Similarly, health expenditure granger causes exchange rate.

Female enrolment granger causes both maternal mortality rate and health expenditure at 10% level of significance. Having seen the granger causality test results above, we proceed to the co-integration test results below;

Johansen Co-integration Test

Table 3: Johansen's Co-integration Test

Series: **MMR EXRV HEXP FENR**		
Unrestricted Cointegration Rank Test (Trace)		

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Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.747178	65.89418	47.85613	0.0004
At most 1	0.257191	17.76671	29.79707	0.5834
At most 2	0.113424	7.360654	15.49471	0.5361
At most 3	0.085992	3.147058	3.841466	0.0761

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

integration Rank Test (Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.747178	48.12747	27.58434	0.0000
At most 1	0.257191	10.40606	21.13162	0.7059
At most 2	0.113424	4.213595	14.26460	0.8362
At most 3	0.085992	3.147058	3.841466	0.0761

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Computation

This co-integration is based on the null hypothesis that there is no co-integrating equation and from the results in table 3 above, both tests (Trace test and Max-eigenvalue test) show a rejection of the null hypothesis that "there is no co-integrating equation" at the 5% level. The

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Trace and Max-eigenvalue tests indicates that there is one co-integrating equation at the 5% significance level implying that there is a long-term equilibrium relationship between the variables. Essentially, these equations tell us that there is a stable relationship between the variables in the long term and shows the nature of the relationship between these variables in the long-run.

Finally, the econometric model of the study which is estimated using the two-stage least squares is presented in the table below;

Table 4: Two Stage Least Squares Estimation

System: TWOSTAGE
Estimation Method: Two-Stage Least Squar

Sample: 1983 2017

Included observations: 35

Total system (balanced) observations 70

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	9.472650	1.561896	6.064839	0.0000
C(2)	-0.234633	0.123945	-1.893046	0.0630
C(3)	0.068863	0.108995	0.631806	0.5298
C(4)	-0.501536	0.444838	-1.127457	0.2639
C(5)	18.70308	6.399943	2.922382	0.0048
C(6)	-1.357307	0.762840	-1.779281	0.0801
C(7)	0.645732	0.142459	4.532745	0.0000
C(8)	-2.028905	0.950230	-2.135173	0.0367

Determinant residual covariance 0.018047

Equation 1: LMMR=C(1) + C(2)*LEXRV + C(3)*LHEXP + C(4)*LFENR
Instruments: LMMR(-1) LEXRV(-1) LHEXP(-1) LFENR(-1 TO -2) C
Observations: 35

R-squared	0.605059	Mean dependent var	7.080036
Adjusted R-squared	0.566839	S.D. dependent var	0.437820
S.E. of regression	0.288151	Sum squared resid	2.573969
Durbin-Watson stat	2.505309		

Equation 2: LEXRV = C(5) + C(6)*LMMR + C(7)*LHEXP + C(8)*LFENR
Instruments: LEXRV(-1) LMMR(-1) LHEXP(- 1) LFENR(-1 TO -2) C
Observations: 35

R-squared	0.838102	Mean dependent var	3.771845
Adjusted R-squared	0.822435	S.D. dependent var	1.749857
S.E. of regression	0.737363	Sum squared resid	16.85483
Durbin-Watson stat	1.392593		

Source: Computed using E-views 9

From the above table, both equations have been estimated simultaneously and results presented. It can be seen that from estimates of the first equation (C1 to C4), exchange rate volatility has a negative and significant impact on maternal mortality rate at 10% level of significance as a percentage increase in exchange rate will cause maternal mortality rate to fall by 0.23%. Health expenditure impacts maternal mortality positively while female education enrolment impacts it negatively, albeit both variables are not statistically significant. The Rsquared shows that 60.5% of the systematic variations in maternal mortality can be explained by exchange rate, health expenditure and female education enrolment.

From the second equation (C5 to C8), maternal mortality has a negative impact on exchange rate volatility and is statistically significant at the 10% level. Health expenditure impacts positively on exchange rate volatility while female education enrolment has a negative impact on female enrolment. Here, the R-squared shows that 83.8% of the systematic variations in exchange rate volatility can be explained by maternal mortality rate, health expenditure and female education enrolment.

Residual Diagnostics

Overall, the model is good and to a very large extent free from autocorrelation. The DurbinWatson statistic in both equations fall in the grey region using the rule-of-thumb, however residual diagnostics, particularly the System Residual Portmanteau Tests for Autocorrelations (full results in appendix) shows that there are no autocorrelations up to a 10 period lag at 10% level of significance. This is because the p-values of the adjusted Q-statistic are below the 10% significance level so the null hypothesis that there is no residual autocorrelation cannot be rejected. Furthermore, the correlogram shows that there is no autocorrelation in the model.

The residuals are also normally distributed, as the p-value of the Jarque-Bera statistic is lower than 10%, thus the null hypothesis which says that the residuals are multivariate normal cannot be rejected.

5.0: CONCLUSION AND RECOMMENDATION

The results obtained in the empirical analysis in the previous section are quite interesting and suggest certain policy direction issues.

Firstly, exchange rate volatility and maternal mortality rate both impact negatively on each other and both statistically significant, this implies that disturbances from both the domestic and external sector which could cause exchange rate to fluctuate has negative impact on maternal mortality. This slightly goes against the findings of Benson and Victor (2012) and David et al (2016) who found that usually, external disturbances that affect exchange rate do have a positive effect for economic development variables. External agencies like the World Health Organization as well as the World Bank has however contributed to maternal mortality rate reduction in Nigeria (Eto, 2016).

Secondly, a positive impact of health expenditure on maternal mortality suggests that a unit increase in health expenditure causes an increase in maternal mortality. This goes against health economics theories and this is largely due to the fact that the expenditure here is recurrent in nature and therefore not adequate enough. This is in line with (Mojekwu, 2012) who asserted that government policies are not adequate to combat maternal mortality in a study he did which focused on Lagos state, Nigeria.

Thirdly, female education enrolment has a negative impact on maternal mortality which suggests that a more educated female population will go a long way in reducing maternal mortality, this is in line with Karlsen (2011). Education in form of awareness campaigns can also help to reduce maternal mortality (Eto, 2016).

Finally, female education enrolment also reduces exchange rate volatility, a well-educated population is preferred over a lesser educated one as this suggests a larger skilled labour force which will contribute their quota to making the economy of the nation prosperous.

Recommendations

In light of the results and findings, the following policy recommendations are proffered; There is the need for proper management of the Nigeria's foreign policy to encourage entry of foreign aid bodies whose aim is to reduce the trend of maternal mortality in developing countries over the world.

The government should invest more in capital health expenditure so as to be able to provide enough centres and facilities for pregnant and nursing women so that maternal mortality can be curbed to a greater extent.

Lastly, the significance of female education or education of the girl-child in Nigeria cannot be over-emphasized. The government should put policies in place to encourage, if possible, free education for children up to the secondary school level so as to encourage more enrolment, particularly female enrolment.

Conclusion

The study has examined exchange rate volatility and maternal mortality rate in Nigeria seeking for a link or possible relationship and some of the results generated has been enlightening. While some of the findings have been in line with health economics and international economics theories, others have had contradictory outcomes.

This suggests that more research should be done in this subject matter so as to contribute more to existing knowledge.

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Appendix

Graph of Variables

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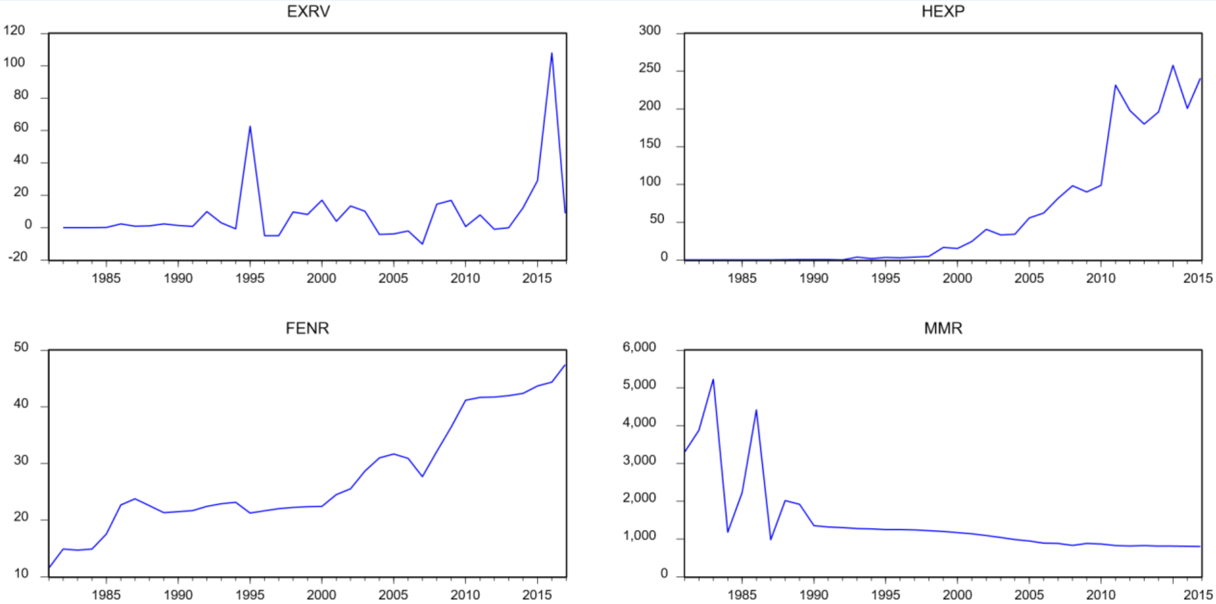

Co-integration

Date: 07/25/19 Time: 08:24
Sample (adjusted): 1983 2017
Included observations: 35 after adjustments Trend assumption: Linear deterministic trend
Series: EXR MMR FENR HEXP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.747178	65.89418	47.85613	0.0004
At most 1	0.257191	17.76671	29.79707	0.5834
At most 2	0.113424	7.360654	15.49471	0.5361
At most 3	0.085992	3.147058	3.841466	0.0761

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.747178	48.12747	27.58434	0.0000
At most 1	0.257191	10.40606	21.13162	0.7059
At most 2	0.113424	4.213595	14.26460	0.8362
At most 3	0.085992	3.147058	3.841466	0.0761

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EXR	MMR	FENR	HEXP
-0.006806	-0.001746	-0.388974	0.039787
-0.004735	-0.000673	0.196659	-0.016746
0.001739	0.000478	-0.020041	0.017782
0.033792	0.000328	-0.151939	-0.004382

Unrestricted Adjustment Coefficients (alpha):

D(EXR)	6.124253	0.954303	5.513092	-2.555381
D(MMR)	585.5023	248.6701	-110.4667	-13.57446
D(FENR)	0.778064	-0.191915	0.087689	0.393631
D(HEXP)	-10.42370	10.39523	1.078041	3.182260

1 Cointegrating Equation(s): Log likelihood -648.6918

Normalized cointegrating coefficients (standard error in parentheses)

EXR	MMR	FENR	HEXP

1.000000	0.256582	57.14835	-5.845470
	(0.02856)	(7.16160)	(0.73077)

Adjustment coefficients (standard error in paren theses)

D(EXR)	-0.041684	(0.02399)
D(MMR)	-3.985159	(0.86295)
D(FENR)	-0.005296	(0.00188)
D(HEXP)	0.070948	(0.03057)

2 Cointegrating Equation(s): Log likelihood -643.4887

Normalized cointegrating coefficients (standard error in parentheses)

EXR	MMR	FENR	HEXP
1.000000	0.000000	-164.0171	15.18183
		(48.8927)	(5.86396)
0.000000	1.000000	861.9664	-81.95143
		(194.200)	(23.2914)

Adjustment coefficients (stan dard error in parentheses)

D(EXR)	-0.046202	-0.011337
	(0.02918)	(0.00659)
D(MMR)	-5.162528	-1.189820
	(0.97900)	(0.22098)
D(FENR)	-0.004387	-0.001230
	(0.00227)	(0.00051)
D(HEXP)	0.021730	0.011210
	(0.03362)	(0.00759)

3 Cointegrating Equation(s): Log likelihood -641.3819

Normalized cointegrating coefficients (standard error in parentheses)

EXR	MMR	FENR	HEXP
1.000000	0.000000	0.000000	-18.93211
			(9.04919)

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0.000000	1.000000	0.000000	97.32908 (46.9724)
0.000000	0.000000	1.000000	-0.207990 (0.05398)

Adjustment coefficients (stan dard error in parentheses)

D(EXR)	-0.036617 (0.02853)	-0.008702 (0.00650)	-2.304991 (1.46925)
D(MMR)	-5.354591	-1.242631	-176.6283
	(0.98508)	(0.22461)	(50.7361)
D(FENR)	-0.004235	-0.001188	-0.342146
	(0.00232)	(0.00053)	(0.11944)
D(HEXP)	0.023604	0.011726	6.077257
	(0.03431)	(0.00782)	(1.76718)

Two Stage Least Squares Estimation

System: TWOSTAGE
Estimation Method: Two-Stage Least Squares
Date: 07/25/19 Time: 08:54
Sample: 1983 2017
Included observations: 35
Total system (balanced) observations 70

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	9.472650	1.561896	6.064839	0.0000
C(2)	-0.234633	0.123945	-1.893046	0.0630
C(3)	0.068863	0.108995	0.631806	0.5298
C(4)	-0.501536	0.444838	-1.127457	0.2639
C(5)	18.70308	6.399943	2.922382	0.0048
C(6)	-1.357307	0.762840	-1.779281	0.0801
C(7)	0.645732	0.142459	4.532745	0.0000
C(8)	-2.028905	0.950230	-2.135173	0.0367
Determinant residual covariance		0.018047		

Equation: LMMR=C(1) + C(2)*LEXR + C(3)*LHEXP + C(4)*LFENR
Instruments: LMMR(-1) LEXR(-1) LHEXP(-1) LFENR(-1 TO -2) C
Observations: 35

R-squared	0.605059	Mean dependent var	7.080036
Adjusted R-squared	0.566839	S.D. dependent var	0.437820
S.E. of regression	0.288151	Sum squared resid	2.573969
Durbin-Watson stat	2.505309		

Equation: LEXR = C(5) + C(6)*LMMR +*LHEXP + C(8)*LFENR
C(7)
LFENR(-1 TO -2) C
Instruments: LEXR(-1) LMMR(-1)
LHEXP(-1) Observations: 35

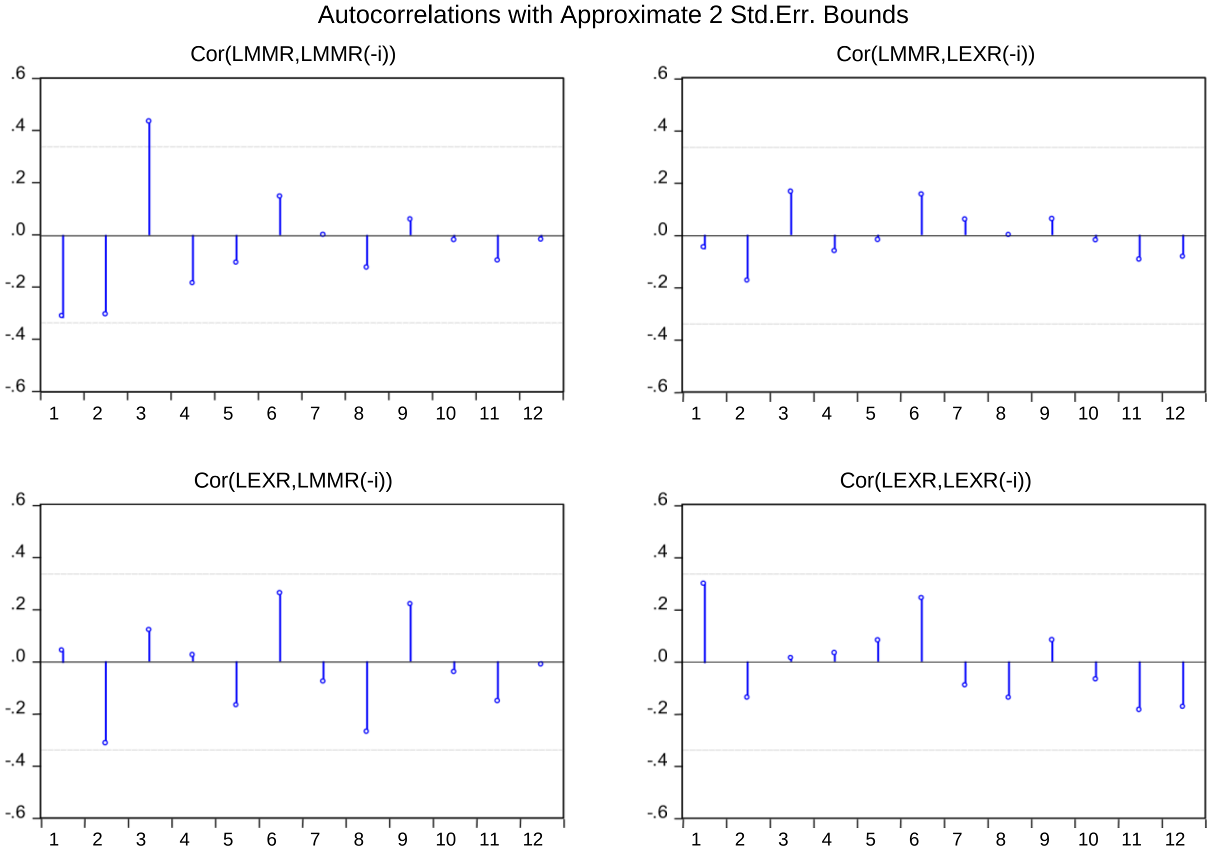
R-squared	0.838102	Mean dependent var	3.771845
Adjusted R-squared	0.822435	S.D. dependent var	1.749857
S.E. of regression	0.737363	Sum squared resid	16.85483
Durbin-Watson stat	1.392593		

System Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h
Date: 07/25/19 Time: 11:05
Sample: 1983 2017
Included observations: 35

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	13.00021	0.0113	13.38257	0.0096	4
2	17.47036	0.0256	18.12364	0.0203	8
3	27.91686	0.0057	29.54950	0.0033	12
4	31.20074	0.0127	33.25710	0.0068	16
5	35.92972	0.0157	38.77425	0.0071	20
6	38.63043	0.0298	42.03372	0.0128	24
7	40.12646	0.0644	43.90376	0.0284	28
8	43.51412	0.0843	48.29517	0.0323	32
9	46.78155	0.1077	52.69364	0.0358	36
10	47.02508	0.2069	53.03458	0.0813	40
11	48.41056	0.2995	55.05507	0.1226	44
12	50.55747	0.3728	58.32211	0.1461	48

*The test is valid only for lags larger than the System lag order. df is degrees of freedom for (approximate) chi-square distribution



System Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 07/25/19 Time: 11:08
Sample: 1983 2017
Included observations: 35

Component	Skewness	Chi-sq	df	Prob.
1	-0.029948	0.005232	1	0.9423
2	0.621504	2.253227	1	0.1333
Joint		2.258459	2	0.3233

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Component	Kurtosis	Chi-sq	df	Prob.
1	8.352341	41.77768	1	0.0000
2	5.096555	6.410168	1	0.0113
Joint		48.18785	2	0.0000

Component	Jarque-Bera	df	Prob.
1	41.78291	2	0.0000
2	8.663395	2	0.0131
Joint	50.44631	4	0.0000