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INFANT MORTALITY AND PUBLIC HEALTH EXPENDITURE IN NIGERIA: EMPIRICAL EXPLANATION OF THE NEXUS

Joseph DAVID[1]

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This study employs Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration and Granger causality technique to empirically examines the nature of relationship between infant mortality and public expenditure on health in Nigeria from 1980 – 2016. In addition, the study considers the roles of immunization, private health expenditure and external health resources on infant mortality in Nigeria. Among other things, the empirical results indicate the presence of significant con-integrating (long-run) relationship between infant mortality and government health expenditure (and private health expenditure, immunization and external health resources), coupled with the existence of bi-directional causal relationship between infant mortality and government health expenditure. In addition, the results also demonstrate that, government health expenditure, private health expenditure, immunization, and external health resources significantly influence infant mortality negatively both in the long and short term. Although, private health spending is shown as the major determinant of the reduction of infant mortality rate in Nigeria, due to the size of the coefficient of private health expenditure. In essence, the total overhaul of the Nigerian health sector, so as to improve the efficiency of the sector, as well curb the incidents of fund mismanagement which has plagued the sector overtime, coupled with the intensifying of immunization programs and activities are however recommended.

Keywords: **Infant Mortality, Public Expenditure, Health Expenditure, Nigeria, ARDL Bound Testing Technique**

JEL Classification: **H51, I12, I18, C22**

[1] *Economics Department, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria*

1. Introduction

Over the time, the nature of relationship between government expenditure on health and infant mortality have generated a lot of debate among economic scholars, policy makers and health economists (Byaro & Musonda, 2016; Farahani, Subramanian, & Canning, 2010; Ude & Ekesiobi, 2014). In Nigeria, with the increase in government's health expenditure from N15.22 billion in 2000 and N179.99 billion in 2013 to N257.72 billion in 2015, accounting for 3.30%, 5.60% and 6.73% respectively of the total recurrent expenditure (Central Bank Nigeria [CBN], 2016), infant and child mortality has remained seemingly high in Nigeria. In 2015, about 9% deaths of new-born babies in the world occurred in Nigeria, thus placing Nigeria as the third country with highest infant mortality aside India and Pakistan (Owoseye, 2017), as it records 69.4% death rate per 1,000 infants, although this rates are higher in rural areas compared to their urban counterparts. In most developing economies like Nigeria, increase in budgetary allocation to social services, like health expenditure is highly desirable, though the increase by itself is not sufficient to guarantee enhancement in service delivery (Yaqub, Ojapinwa & Yussuff, 2013), even with the advancement in medicine and technology which have aided the identification and fight against major childhood diseases.

Although there is a broad consensus that economic growth can definitely lead to improvement in health (Babatunde, 2011), the growth of Nigeria's economy in term of its GDP have not made the health condition in the country any better with continuous increase in infant mortality and even under-5, neonatal and maternal mortality. A cross-country study on infant mortality-public health expenditure nexus usually shows income as the major determinant of a population's health status (Farahani et al., 2010), which is likely due to inefficiency, funds mismanagement and absence of professionals which characterized the public health sector of most developing economies like Nigeria, compared to its private counterpart which is perceived to be unaffordable by the citizens as a result of the high incidence of poverty. Generally, countries with high incidence of corruption have high tendency of experiencing high level of child and infant mortality rates (Yaqub et al., 2013).

The lack of access to basic health facilities and resources due to environmental and social barriers (such as the isolation of those in rural areas, the absence of health facilities in rural areas and poverty) contributes immensely to the increase in infant mortality. In the world, about 99% of the incidence of infant deaths occurs in developing countries, and 86% of these deaths are due to infections, premature births, complications during delivery, and pre-natal asphyxia and birth injuries (Andrews, Brouillette & Brouillette, 2008). Other leading causes of infant mortality are neonatal infection, diarrhea, malaria, measles, malnutrition (Women

and Children First, n.d.), birth asphyxia, pneumonia, term birth complications such as abnormal presentation of the fetus umbilical cord prolapse, or prolonged labor (WebMD, n.d.), and smoking during pregnancy which is a preventable cause of infant mortality (Hall, Venkatesh & Greenberg, 2016). Although factors such as the mother's level of education, environmental conditions, political and medical infrastructure of a country also contribute to infant mortality (Genowska et al., 2015), the improvement in sanitation, access to clean drinking water, immunization against infectious diseases, and other public health measures can help reduce high rates of infant mortality.

On this background this study investigates the nature of relationship between government expenditure on health and the outcome in term of infant mortality in Nigeria. Apart from this introductory section, this paper is structured in five sections, vis-à-vis; literature review; method; result presentation and discussion; and conclusion and policy implications

2. Literature Review

On the one hand, infant mortality refers to deaths of young children, typically those younger than one year of age, and it is measured by the infant mortality rate (IMR), which is the number of deaths of children under one year of age per 1000 live births (Carpenter, n.d.). In a given region, the IMR is the number of children dying under one year of age, divided by the number of live births during the year, multiplied by 1,000 (Andrews et al., 2008); while public health expenditure on health entails the expenditures or expenses incurred by the government of a country or region, especially in monetary terms in the provision of social goods in the health sector of the country. Public health expenditure as well covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.

Both in developing and developed economies, several studies have been raised with the aim of ascertaining the nature of relationship between government's health expenditure and the health outcome. Some of the studies were carried out from the economic point of view within same continents, regions or economic unions. For instance, Nikoloski and Amendah (2017) examined the probability of increased health expenditure on health leading to a better health outcome on the populace in 14 African countries from 2002 to 2014, focusing on infant mortality, neonatal mortality, under-five mortality, and life expectancy at birth. The study employed descriptive and multivariate analyses, and their finding revealed that public health expenditure reduces infant, neonatal and under-5 mortality, while increasing the life

expectancy at birth significantly in the 14 African countries. Similarly, in the study of the public health expenditure and public health outcome nexus in 17 OECD countries from 1973 to 2000, Kim and Lane (2013) used infant mortality rate and life expectancy at birth as indicators of public health indicator. The result indicates that while public health expenditure significantly influences infant mortality negatively, life expectancy at birth is positively influenced. Anyanwu and Erhijakpor (2007) as well examined the relationship between government's health expenditure and health outcomes in 47 African countries, with special reference to infant mortality and under-5 mortality rates from 1999 to 2004. The study used panel regression analysis, and found a significant negative relationship between public health expenditure and health outcomes (infant and under-5 mortality) in the 47 African countries examined.

In Asian countries, A. Shetty and S. Shetty (2014) studied the correlation between health expenditure and infant mortality rate using the data from 34 Asian countries. Their study found a significant inverse relationship between health expenditure and infant mortality rate. Finally, from the perspective of economies in the same regions, Novignon, Olakojo and Nonvignon (2012) investigated the effects of public and private health care expenditure on health status in sub-Saharan Africa. They used panel data on 44 Sub-Saharan African countries from 1995 to 2010, and employed fixed and random effect panel regression analysis. The result obtained shows both public and private expenditure on health as significant decreasing effect of infant mortality rate in the 44 Sub-Saharan African countries. Accordingly, the health expenditures (public and private) also act as significant increasing factor of life expectancy at birth as well as a decreasing factor of crude death rate.

In the same vein, some studies were conducted at a country-specific level. For example, Farahani, Subramanian, and Canning (2010) studied the Effects of State-level Public Spending on Health on the mortality Probability in India using the data from second National Family Health Survey (NFHS-2) of India. Thus using the Probit MLE model, the study shows the existence of 2% decrease in the probability of death in the country for 10% increase in public spending on health in India. Similarly, Byaro and Musonda (2016) investigated the Impact of Public Health Expenditure on health outcomes, specifically on Infant and Under-five Mortality in Tanzania from 1995-2013. Using full Bayesian time series approach based on Markov Chain Monte Carlo (MCMC), the study shows the presence of significant positive relationship between government health expenditure and infant (and under-5) mortality in Tanzania. Alike, Kumar, Ram and Singh (2013) examined the link between Public health spending and infant and child mortality in India from 1980 – 2006. Hence, using data from the first, second, and third National Family Health Survey (NFHS) of India to create a birth cohort for the years under study and the fixed effect Probit model to empirical ascertain the nature of the nexus, the study shows the existence of negative relationship between public health expenditure and infant (and under-5) mortality. As such, the educational status of the

mother and age of the child at birth also significantly influence infant (and under-5) mortality in India. Equally, Bhalotra (2007) analyses the relationship between state health expenditure and infant mortality in India. Using micro-data of about 120,000 rural births from 1970-1998 across the fifteen major Indian states, the study discovers the presence of long-run negative relationship between the pairs. And finally Barenberg, Basu and Soylu (2015) examined the Effect of Public Health Expenditure on Infant Mortality in Indian states during the period 1983-1984 and 2011-2012. Using panel data set of Indian states, the study shows that public expenditure on health care reduces infant mortality. Accordingly, female literacy and urbanization also contributes to the decline of infant mortality rate in Indian states.

In Nigeria, certain scholars also examined the relationship between government's health expenditure and the corresponding health outcome specifically on infant mortality. For instance, Bashir (2016) assessed the Impact of Government Expenditure on Infrastructures in the performance of Nigerian health sector from 2000 to 2013. Hence using data on infant mortality and life expectancy as proxy by performance of the Nigerian health sector, the Pearson's moment correlation to analyze nature of its relationship with government expenditure on health, the study discovers the presence of strong and significant inverse relationship between government health expenditure and infant mortality, and weak positive association between public health spending and life expectancy. Similarly, Ude and Ekesiobi (2014) used multiple regression analysis to empirically analyze the effect of per capita health expenditure on child mortality proxy by infant, under-5 and neonatal mortality rates, the result obtained in the study revealed the presence of inverse relationship between per capita health expenditure and child mortalities, hence denoting the decline in child mortalities as per capita income and per capita expenditure on health increase. Likewise, Yaqub, Ojapinwa and Yussuff (2013) studied the impact of governance with special reference to public health expenditure and resultant health outcomes in Nigeria. They used Ordinary Least Square (OLS) and Two-Stage Least Square (2-SLS) techniques to analyze the data from 1980 – 2008, the study found an inverse relationship between government health expenditure and infant mortality (and under-5 mortality) with the inclusion of governance indicators. Edeme, Emecheta and Omeje (2017) also examined the link between Public Health Expenditure and Health Outcomes in Nigeria from 1981-2014. The study applied OLS and found that public health expenditure on health and per capita income poses as decreasing function of infant mortality in Nigeria during the period under study.

3. Method

This study uses annual data from 1980 to 2016 to examine the influence of public health expenditure on infant mortality in Nigeria. The data for public expenditure on health (proxy by the percentage of total government expenditure on health) was collected from the Central Bank of Nigeria (CBN) statistical bulletin. The data on infant mortality, immunization (measured by the percentage of children under one year immunized against diseases and infections), external health resources and private health expenditure (measured by the percentage private health expenditure of total health expenditure) were collected from the World Bank Development Indicators (WDI).

To ascertain the nature of relationship between public health expenditure and infant mortality, we develop a functional relationship as:

$$IMR = f(PHEXP) \tag{1}$$

Where IMR denotes the infant mortality rate which is measured by the number of children under one year of age that died, divided by the number of live births during the year, multiplied by 1,000; and PHEXP is government's health expenditure. According to the literature, apart from government's expenditure on health, factors such as, household income; availability of physicians; the educational status of the mother; expenditure of the private sector on health; External resources for health (funds or services in kind that are provided by entities from other region or countries); and immunization also influence the infant mortality rate. Therefore, considering and including some of the factors into the model, we have:

$$IMR = f(PHEXP, IMMUN, EHRES, PrEXP) \tag{2}$$

Where; IMMUN is the percentage of children under the age of one immunized against certain diseases and infections; EHRES denotes external health resources; PrEXP is private health expenditure; other identities as previously stated. To measure and ascertain the size and signs of these factors empirically, the model to be estimated is specified as follows:

$$IMR_t = a_0 - b_1 PHEXP_t - b_2 IMMUN_t - b_3 EHRES_t - b_4 PrEXP_t + \mu_t \quad (3)$$

Where; a_0 is the intercept; $b_1 - b_4$are the slope coefficients; t denotes the number of time series observations; and μ is the error term. As a pre-test we employ one of the unit root test technique to check for the stationarity, so we won't be generating a spurious regression result. Accordingly, the Stationarity and order of integration of the series will determine the estimation technique to be employed. For instance, when all the series are stationary at level (I(0)), Equation (3)will be estimated using the Ordinary Least Square (OLS) technique, and this technique won't generate any spurious regression result. Consequently, if the series are stationary at first difference (I(1)), the residual-based (Engle & Granger, 1987) Error Correction Mechanism (ECM) will be used to estimate Equation (3) to capture the short-run dynamics while the OLS technique will be used for long-run dynamics if the presence of cointegration is been confirmed by the maximum likelihood test (Johansen, 1988, 1991; Johansen & Juselius, 1990). The short-run ECM model is specified as follows:

$$\Delta IMR_t = a_0 - b_1 \Delta PHEXP_t - b_2 \Delta IMMUN_t - b_3 \Delta EHRES_t - b_4 \Delta PrEXP_t + \theta(IMR_t - a_0 + b_1 GHEXP_t + b_2 IMMUN_t + b_3 EHRES_t + b_4 PHEXP_t) + \mu_t \quad (4)$$

Or:

$$\Delta IMR_t = a_0 - b_1 \Delta PHEXP_t - b_2 \Delta IMMUN_t - b_3 \Delta EHRES_t - b_4 \Delta PrEXP_t + \theta \varepsilon_{t-1} + \mu_t \quad (5)$$

Where; θ is the coefficient of error correction term lagged by one periodε_{t-1} which captures the speed of adjustment of the series towards long-run equilibrium; Δ denotes the difference identity.Furthermore, we estimate the Autoregressive Distributed Lagged (ARDL) Model if the stationarity of the series are mixture of I(0) and I(1).Relative to the residual-based technique (Engle & Granger, 1987) and the maximum likelihood test (Johansen, 1988, 1991; Johansen & Juselius, 1990), the ARDL method and its bound testing approach (Pesaran, Shin & Smith, 2001) can be used to examine cointegration relationships regardless of the sample size and order of integration of the series (I(0), I(1) or a mixture of both). Similarly, the method uses different optimal lags and a single reduced form equation to simultaneously estimate the long run and short run parameters of the model (Abu, 2017) which is not so in the conventional methods.

The ARDL bound testing procedure is based on the comparison of the f-statistics obtained from equating the coefficient of the un-differenced variables in the conditional ECM with the

critical values provided by Pesaran et al. (2001), which is hence used to test the null hypothesis that no cointegration exist against the alternative hypothesis that cointegration exists among the series. When the f-statistics is greater than the upper bound (I(1)), we reject the null hypothesis that no cointegration exists among the series. If the f-statistics is less than the lower bound (I(0)), we fail to reject the null hypothesis that no cointegration exist among the series. Accordingly, if the F-statistic falls between I(0) and I(1), our inference would be inconclusive. The conditional ECM is specified as follows;

$$IMR_t = a_0 + b_1 \sum_{i=0}^{n} \Delta IMR_{t-i} - b_2 \sum_{i=0}^{n} \Delta PHEXP_{t-i} - \cdots - b_5 \sum_{i=0}^{n} \Delta PrEXP_{t-i} + \partial_1 IMR_{t-1} - \partial_2 PHEXP_{t-1} - \cdots - \partial_5 PrEXP_{t-1} + \mu_t \quad (6)$$

Where; $\partial_1 - \partial_5$ are the coefficient of the un-differenced variables in the model to be used in obtaining the test statistics for comparison with the upper and lower bound. When there exist cointegration (long-run relationship) between the series, Equation (3) will be estimated to capture the long-run dynamics of the series, while the short-run dynamics will be captured by the ARDL model specified below;

$$IMR_t = a_0 + b_1 \sum_{i=0}^{n} \Delta IMR_{t-i} - b_2 \sum_{i=0}^{n} \Delta PHEXP_{t-i} - b_3 \sum_{i=0}^{n} \Delta IMMUN_{t-i} - b_4 \sum_{i=0}^{n} \Delta EHRES_{t-i} - b_5 \sum_{i=0}^{n} \Delta PrEXP_{t-i} + \mu_t \quad (7)$$

Apparently, of all the accessible studies conducted to examine the link between public health expenditure and its corresponding effect on infant mortality in Nigeria, aside employing inappropriate estimation technique (see Bashir, 2016; Edeme, Emecheta & Omeje, 2017; Ude & Ekesiobi, 2014; Yaqub et al., 2013), the studies ignore the stability test and important post-estimation diagnostics such as tests for autocorrelation, heteroscedasticity, normality, model stability, etc. (see Bashir, 2016; Byaro & Musonda, 2016; Edeme et al., 2017; Farahani et al., 2010; Ude & Ekesiobi, 2014; Yaqub et al., 2013), thus therefore leading to the presentation of spurious and misleading empirical result, since the data used in the study were not subjected to any sort of stationarity test or post-estimation diagnostics which would have aid in ensuring the goodness and stability of the result/model. Hence, the variables entering the model for this study will undergo critical stationarity test to avoid and cover the lapse of previous studies, as well serve as a pre-test and indicator of the estimation technique to be employed. Accordingly, post-estimation tests and diagnostics will be performed and the study will extend its reach to 2016 since most of the studies stopped in 2014.

4. Result and Discussion

Stationarity Test

To ascertain the stationarity of the series/data entering the model, the popular Augmented Dickey-Fuller (ADF) unit root test procedure was employed. Under the ADF unit root test, the null hypothesis that a series have a unit root (non-stationary) is being rejected when the ADF statistics is greater than the critical values at 1%, 5% or 10%. We fail to reject the null hypothesis that a series is not stationary if the ADF statistics is less than the critical values. Though, a series can be differenced once (or twice), to make stationary. As shown in Table 1, the series (*IMR*, *PHEXP*, *IMMUN*, *EHRES*, and *PrEXP*) are found to be a mixture of I(0) and I(1). While *IMR*, *EHRES* and *PrEXP* are stationary at levels, *PHEXP* and *IMMUN* were made stationary after first differencing. Since the series are a mixture I(0) and I(1), we employ the ARDL bound testing approach to ascertain the presence of cointegration (long-run relationship) among the series.

Table 1. Result of Unit Root Test

Variables	ADF	5% Critical Value	Order of Integration
IMR	-3.621293	-2.948404	I(0)
$PHEXP$	-8.724834	-2.948404	I(1)
$IMMUN$	-5.560045	-2.948404	I(1)
$EHRES$	-4.457804	-3.029970	I(0)
$PrEXP$	-3.307444	-3.012363	I(0)

Source: Author(s) Computations Using E-Views 10-SV

ARDL Approach to Co-Integration

From the presented ARDL bound testing output in Table 2, the computed F-statistics (36.14619) is greater than the upper bound (I(1)) at both 1%, 2.5%, 5% and 10% . Therefore, the null hypothesis of no cointegration among the series is rejected. This result thus implies that a cointegration (long-run relationship) exists among the series (IMR, PHEXP, IMMUN, EHRES and PrEXP). With the presence of co-integration among the series established, Equation (3) and Equation (7) will hence be estimated as the long-run and short-run estimates respectively.

Table 2. Result from Bound Test

Dependent Variable	Function			K-1	F-Statistics
IMR	$f(IMR/PHEXP, IMMUN, EHRES, PrEXP)$			4	36.14619
Asymptotic critical value bounds for the F-statistic (Pesaran et al (2001) Case II)					
1%		5%		10%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.45	3.52	2.86	4.01	3.74	5.06

Source: Author(s) Computations Using E-Views 10-SV

Causality Test

Since correlations between series do not necessarily denote the presence of causality, Granger causality technique was therefore employed to ascertain the presence of causal relationship between infant mortality and public health expenditure. From the result of the Granger causality test presented in Table 3, the null hypothesis that there exist no causal relationship between infant mortality and public health expenditure was rejected, due to the significance of the bi-directions causality models on a percent and 5 percent significance level. This therefore indicates the presence of a bi-directional causality running from public health expenditure to infant mortality, and vice versa.

Table 3. Pairwise Granger Causality Tests

Null Hypothesis:	Lags	Obs.	F-Statistic	Prob.
PHEXP does not Granger Cause IMR	1	29	1.78217	0.1910
IMR does not Granger Cause PHEXP			14.2642	0.0006

Source: Author(s) Computations Using E-Views 10-SV

Discussion of Long-Run Estimates

Since the ARDL bound test procedure for cointegration testing suggests the existence of long-run equilibrating relationship between the series in the model, and the Granger causality test also suggest the presence of causal relationship between infant mortality and government health expenditure, the long-run and short-run model is therefore estimated to obtain the long-run and short-run estimates of the model. The result of the long-run estimates presented in Table 4 is analogous to the long-run model specified in Equation (3).

From the long-run estimates in Table 4, government health expenditure and infant mortality exhibits an inverse long-run relationship. A percent change in the fraction of health expenditure to the total government expenditure will cause infant mortality to decline by 7.298. Furthermore, the immunization of children below age one has a negative and significant long-run relationship with infant mortality. On average, a percent increase in the number of children under the age of one immunized against diseases and infection will cause the mortality rate of children under this age to decline by 1.900. Accordingly, external health resources (from international organizations, NGOs, countries and private individuals) and private health expenditure both poses a significant and long-run relationship with infant mortality. When the ratio of external health aids and private health expenditure to the total health expenditure in Nigeria increases by a percent, it tends to result into decline in infant mortality by 0.8897 and 20.091 respectively.

Table 4. Long-Run Estimates

Dependent Variable: IMR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GHEXP	-7.298082	0.877401	-8.317845	0.0000
IMMUN	-1.900800	0.283946	-6.694234	0.0000
EHRES	-0.889752	0.265210	-3.354891	0.0064
PHEXP	-20.09127	3.295476	-6.096623	0.0001

Source: Author(s) Computations Using E-Views 10-SV

Discussion of Short-Run Estimates

Consequently, the long-run estimates presented in Table 4 above correspond with Equation (7). The short-run model is estimated using the ARDL technique, with optimum lag length indicated by SIC as (0,1,1,1,1). To test the plausibility of the ARDL model, it was subjected to post estimation diagnostics such as the test for autocorrelation, homoscedasticity, normality and the stability of the model. As presented in Table 6, the diagnostics shows that the model is free from autocorrelation, heteroscedasticity and the error terms are normally distributed.

From the short-run dynamics in Table 5, akin to the long-run estimates, public health expenditure and infant mortality exhibits a significant negative relationship. And this implies that a percent increase in public expenditure on health will lead to 19%decrease in infant mortality rate in Nigeria. The negative sign of the coefficient of public health expenditure lends supports to the findings of previous studies (see Anyanwu and Erhijakpor, 2007; Bashir, 2016; Byaro and Musonda, 2016; Farahani et al., 2010; Muthaka, 2013; Nikoloski and Amendah, 2017; Novignon et al., 2012) that the expenditure of the government on health aid in reducing infant mortality in a country. Similarly, verifying the empirical findings of Byaro

and Musonda (2016), immunization of children below a year old significantly influence infant mortality negatively. From the short-run estimates, a percent increase in immunization of children under the age of one will result to decline in infant mortality by 0.55%. Similar to the scenario of polio, when the pace at which children under the ages of one are immunized against known infections and diseases, the rate at which children at that age die will decline drastically.

Furthermore, Special aid and resources from international organizations, private individuals, government of advanced economies and NGOs such as UNICEF, WHO, Bill Gates Foundation, Mark Zuckerberg foundation, USA, Britain, etc. also act as a decreasing function of infant mortality rate in Nigeria. A percent increase in aids and resources from institutions and organizations will cause infant mortality rate to decline by 0.25%. Equally, private health expenditure poses a strong and significant negative effect on infant mortality in Nigeria. From the short-run estimates in Table 5, it happens to be the factor which has the largest decreasing effect on infant mortality in the country, as a percent increase in private health expenditure will likely cause infant mortality rate to decline by 38%. The negative coefficient of private health expenditure and its high significance corroborates with the empirical findings of Anyanwu and Erhijakpor (2007), Farahani et al. (2010), Muthaka (2013), Nikoloski and Amendah (2017), Ude and Ekesiobi (2014) and Novignon et al. (2012).

The coefficient of the error correction term lagged by one period(ε_{t-1}) is rightly stated as it is negative, less than 1 and highly statistically significant, and therefore meets our expectations. The sign of the coefficient indicates a relatively low speed of adjustment to equilibrium after a shock and indicates that approximately 0.41% of the deviations or disequilibrium in infant mortality will be corrected within one year.

Table 5. Short-Run Estimates

Dependent Variable: IMR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$Constant$	9.356145	0.768137	12.18030	0.0000
$\Delta GHEXP$	-0.190114	0.031039	-6.124927	0.0001
$\Delta IMMUN$	-0.053526	0.010540	-5.078440	0.0004
$\Delta EHRES$	-0.024912	0.007849	-3.174051	0.0089
$\Delta PHEXP$	-0.380625	0.073689	-5.165266	0.0003
ε_{t-1}	-0.040706	0.002593	-15.69877	0.0000
R2 =0.95, Adj. R2 =0.93, F-statistic =52.69572, Prob. (F-statistic) = 0.000000, Durbin-Watson stat = 2.015842				

Source: Author(s) Computations Using E-Views 10-SV

Results of Diagnostics Tests

The results reported in Table 6 reveal that the ARDL model employed passes the diagnostic tests including serial correlation (with 2-lags), heteroscedasticity, normality and functional form (Ramsey RESET test), which indicates the absence of autocorrelation and heteroscedasticity (unstable variance), as well as the stability and normality of the model. In addition, the plots of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMQ) (Figure 1 and Figure 1) are within the 5 percent significance lines or boundaries, which suggests that the residual variance of the model is somewhat stable, hence also confirming the stability of the model.

Table 6. Diagnostic Tests

Test Statistics	Result
Autocorrelation: Chi-Sqr(1)	0.7880094 (0.3747)
Heteroscedasticity: Chi-Sqr(3)	12.73593 (0.1749)
Normality: Jaque-Bera	0.689121 (0.708532)
Functional Form: Ramsey RESET F-stat(1,10)	0.397195 (0.5427)

Source: Author(s) Computations Using E-Views 10-SV

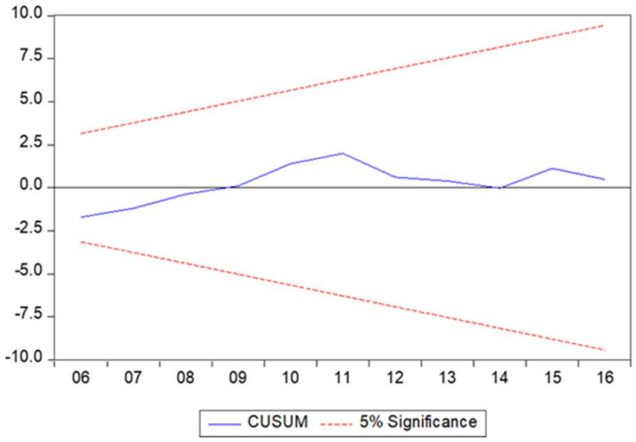

Figure 1. Plots Of The Cumulative Sum Of Recursive Residuals (CUSUM)

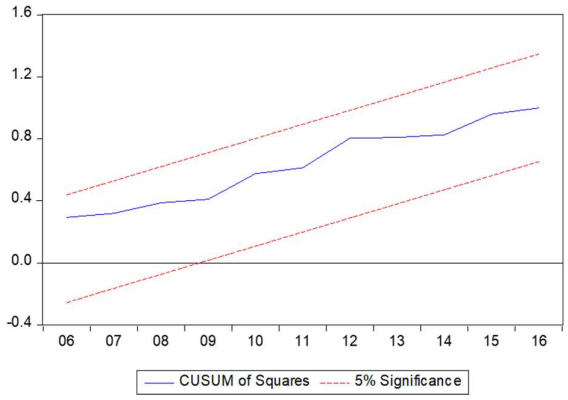

Figure 2. Plots Of The Cumulative Sum Of Squares Of Recursive Residuals (CUSUM of Sqr.)

6. Conclusion and Policy Implications

This study utilizes the ARDL bounds testing technique to examine the nature of relationship between government's health expenditure and infant mortality in Nigeria from 1980 to 2016, and considers the effect of immunization, external health resources and private expenditure on health in Nigeria. The results indicate the presence of cointegrating (long-run) relationship between infant mortality, government health expenditure, immunization, external health resources and private health expenditure, and causal relationship (Granger causality) between infant mortality and government health expenditure. The results revealed that government health expenditure has a long term as well as short-term significant negative influence on infant mortality, in addition to significant negative short-run and long-run relationship between infant mortality and private health expenditure, immunization and external health resources.

Based on the findings, it is clear that even with the increase in government health spending in Nigeria, it still poses little impact on infant mortality rate as compared to the effect of private health expenditure of reducing infant mortality in the country. furthermore, the claims of fund mismanagement can however be upheld since the fund injected into the health sector by the private sector which is more effective in combating infant mortality is way more lesser than the expenditure of the public sector.

In essence, it is recommended that the public health sector be overhauled and purged, in order to improve transparency, efficiency and accountability in the sector. In addition, full-fledged probe and prosecution of officers responsible for fund diversion and mismanagement in the public health sector should be undertaken so as to purge out the bad eggs in the sector and set an antecedent for other erring officers.

Furthermore, measures such as work measurement and incentive plans should be enacted in public health centers, as it will act as an indicator for workers efficiency and morale boaster for the efficient workers. Finally, the intensity of immunization exercises for infants is recommended, as it tends to act as a proactive measure in curbing infant and under-five mortality, hence enhancing the life expectancy at birth.

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