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Per Capita Income and Child Infant Mortality Rate in Nigeria: A Vector Error Correction Model Analysis

[1]Chris U. Kalu, & [2]Chidinma Okafor
[1&2]Department of Economics,
Nnamdi Azikiwe University, Awka

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Abstract

Nigeria with a high level of infant and child mortality rate has been classified as among the 30 countries with the highest early mortality rate in the world given, given that the majority of deaths in Nigeria occur among infant and youth in Nigeria. This paper examined the impact of per capita income on child infant mortality in Nigeria from 1986-2022 employing the vector error correction model. The variables of this paper include energy consumption, climate change, infrastructure, institutional framework, and educational attainment. The data for these variables were sourced from the Ministry of Health database and World Development Indicator (WDI).

Keywords: *Child infant mortality, Health outcome, Per capita income, Nigeria, Vector error correction model*

Corresponding Author: *Chris U. Kalu*

Background to the Study

There are several reasons why research attention has focused on child mortality in both developed and developing countries. Significantly, one of such goals deals with the reduction of child mortality, while the others have to do with the evidence of association between mortality reduction and demographic transition (Belli, Bustreo & Preker, 2005; Atsiya, 2021). Accordingly, ostensible reductions in child mortality can reduce fertility, and the dependency ratio in the long-run, and can ultimately enhance economic growth.

Child mortality can be used as a more equitable index for resource allocation compared with the gross national income (GNI) per capita. Hence, the child mortality rate indicates that childhood environment is better than income per head index. Moreover, it has been used as an index of accessibility to critical infrastructure in an economy. Child health has also been considered as an 'outcome measure' of the development process of a country's health system (Reidpath & Allotey, 2003).

In strictly economic terms, development has traditionally meant achieving sustained rates of growth of income per capita to enable a nation to expand its output at a faster rate than the growth rate of its population. Real per capita gross national income (GNI) is used to measure the overall economic well-being of a population –how much of real goods and services is available to the average citizen for consumption and investment.

The following research questions formed the focus of this paper.

i. What is the impact of per capita income shock on child infant mortality in Nigeria?
ii. What is the dynamic causal interaction between per capita income and child infant mortality in Nigeria?

The rest of this paper is organized as follows: Section 2 reviews relevant literature while section 3 dwells on the theoretical framework and methodology. Section 4 presents the results and discusses the findings and section 5deals with the conclusion and policy implications. The scope of this paper is from 1986 to 2021.

Empirical Literature

There exists a plethora of studies on per capita income- child infant mortality nexus. Some existing literature reported a positive relation while others show a negative relationship. In Nigeria Kehinde Kabir and Opeloyeru (2020) investigated the macroeconomic determinants of under-five mortality rate in Nigeria between 1980 and 2017. The variables of the study included government expenditure, immunization initiatives and under-five mortality rate. The study employed the autoregressive distributed lag (ARDL) bound test estimation technique. The influences of government health expenditure (GHE) were significant. However, both immunization initiatives (IMI)and health workers (GHE) exerted an insignificant positive influence on the under-five mortality rate (U-5). Thus, the study recommended policies targeted to improve the Nigerian health system in terms of creating an awareness relating to the service delivery and human capital development.

Isaac (2020) examined the effect of health shocks on per capita income in Ado-Ekiti local government area (L.G.A.), Ekiti State, Nigeria. The study used micro analysis involving primary data sourced from respondents across population sampled from the local Government Area. Estimation techniques of descriptive statistics and ordinary least square (OLS) regression method were used. Result of the study showed adverse effect of health imbalances on welfare of households in Ado Ekiti L.G.A. Finding from the study showed that out-of-pocket health expenses exhibits a positive influence on per capita income and statistically significant at 10% level. Based on the findings, it is recommended that government should provide better health care services which in turn improve economic development of Ado-Ekiti L.G.A. and by extension to Nigerian economy at large.

Sanniet (2020), examined the proximate and socio-economic determinants of under-five mortality in Benin. Multivariable hierarchical logistic regression technique was used to analyze the data of 5977 under-five children (U-5) extracted from the 2017 to 2018 Benin Demographic and Health Surveys. The study showed that an under-five mortality rate was shown to be higher in the Plateau region, in rural areas, and among those whose mothers had no postnatal check-up.

Dominic (2020), investigated the impact of public health expenditure and under-five mortality in Nigeria from 1985-2017. The result of the ARDL estimation showed that there is a significant relationship between public health expenditure (PHE) and under-five mortality (U-5) in Nigeria. Therefore, the study concluded by recommending that proper health-fund coordination should be put in place to ensure that budg*et* allocated to the health sector is being spent properly.

Lawal, Isik and Abiodun (2020) investigated the effect of income inequality on the child mortality rate in Nigeria using time series data from 1986 to 2020. The study employed the autoregressive distributed lag (ARDL) model. The results showed that a 36% adjustment of the short-run errors needed to be corrected in the long run annually. However, the estimation also revealed that approximately 99% variance of the explaining variables accounted for the change recorded in the dependent variable. The results of the major finding revealed that income inequality proxied by the Gini coefficient (GINI) has a positive significant association with the mortality of under-5 children. The study recommends that the central government should work collaboratively with states and local administrative councils to fund and supervise the implementation of the already existing intervention programs.

Johan (2020) examined whether increasing the income of the poor - measured as the income of the lowest quintile - is more beneficial in reducing infant and child mortality rates compared with increases in average income. Using a sample of 86 countries from 1995-2014 inclusive, and the instrumental variable fixed affects estimator. The result showed that the elasticity of the income of the lowest quintile never exceeds that of average income. Therefore, if reducing infant and child mortality is a key policy goal, then boosting average income may be preferable to raising incomes at the lower end of the distribution.

Ibrahim (2019) studied the effect of income inequality on health in Quebec using data from the Canadian community health survey of 87 municipals covering the period 2002 and 2013. The results of the generalized method of moments (GMM) revealed that income inequality accounted for a major increase in the child mortality rate of Quebec. The study suggested that current efforts against child labor need to be revisited, at least in low-middle income countries (LMICs). Further studies following a longitudinal design and using common methods to assess the health impact of child labor in different country contexts would inform policy making.
From the reviewed empirical literature, there exist conflicting results about per capita income and infant mortality.

Theoretical Framework and Methodology

Theoretical Framework

The theoretical framework of this study is the Mosley-Chen theory which proposes a new analytical framework for the study of the determinant of child survival in developing countries. The framework is based on the premise that all social and economic determinants of child mortality necessitate operation through a common set of biological mechanism, or proximate determinants, to exert an impact on mortality. The framework is intended to advance research on social policy and medical intervention to improve child survival. The proximate determinants framework of the Mosley-Chen is based on several variables: Income/wealth effects (Through the channels of food, water, clothing/bedding), Fuel/energy, transportation and hygienic/preventive care, Ecological setting (climate, soil, rainfall), Physical infrastructure (roads, electricity, water and telephone) and institutional factors. The channels affect child infant mortality.

Model Specification

Following the framework developed by Mosley-Chen (1984) and adopted by Okafor (2024), the model this study is specified as follows:
Infant Mortality = f(per capita income, energy consumption, Co2 emission, HOSBED, institutional framework) (1)

Similarly, equation (1) can be respecified in it's functional forms:
Infant mortality = f (PCI, ENERCON, CO2 Emission, HOSBED, INFW, ED) (2)

Where, INFM = Infant mortality; PCI = Income; ENERCON = Energy; Co2 emission = Carbon emission, HOSBED = Infrastructure, INFW = Institutional framework and ED = Education.

Expressing equation (2) in translog form to enhance linearity functions, the model becomes:

$$\text{Infant} = \beta_0 + \beta_1 \text{LnENERCON} + \beta_2 \text{LnCO2 Emission} + \beta_3 \text{LnINFR} + \beta_4 \text{LnINFW} + \beta_5 \text{LnPCI} + \beta_6 \text{LnED} + \text{Ut} \quad (3)$$

Estimation Technique and Procedures

This study used the vector error correction model approach (VECM). The VECM approach is taken to investigate dynamic causal interactions among the variables. It is also known as restricted VAR, since the estimated e the long run equation is estimated first, and the estimated parameters are imposed through the error correction unit. In VECM, the variables can be non-stationary but must be integrated (Ezie, 2022). The data for this study was sourced from the Central Bank of Nigeria, World Bank Development Indicator from 1986 to 2022.

Result Presentation and Analysis

Descriptive analysis

Table 1 presents the descriptive statistics of the empirical results.

Table 1: Descriptive Statistics

	INF	PCI	ENERCON	CLM	HOSBED	INFW	ED
Mean	102.9805	1109.812	11.51401	81480.10	1827.153	3.932600	92.29627
Median	106.6000	777.1670	11.14464	90057.10	1751.845	3.491598	90.10355
Maximum	124.3000	2695.913	28.70544	126063.9	2939.792	5.997606	113.0788
Minimum	70.60000	180.0214	1.573876	9646.900	1034.621	2.752909	78.66348
Std. Dev.	19.68717	740.2745	6.173340	33397.26	567.2352	1.081827	8.839018
Skewness	0.246593	0.401122	0.477526	-1.290495	0.351228	0.680880	0.775311
Kurtosis	1.416183	1.749255	2.875631	3.844927	1.933998	1.974988	2.940023
Jarque-Bera	4.700835	3.771926	1.584635	12.59966	2.784250	4.962777	4.113708
Probability	0.095329	0.151683	0.452794	0.001837	0.248547	0.083627	0.127856
Sum	4222.200	45502.31	472.0742	3340684.	74913.29	161.2366	3784.147
Sum Sq. Dev.	15503.38	21920255	1524.405	4.46E+10	12870232	46.81400	3125.129
Observations	41	41	41	41	41	41	41

Source: Researchers' computation using EView12

Table 1 showed the features of the included data set, i.e. the measures of central tendency and measures of dispersion. From the result, it showed that the infant mortality data is positively skewed. Skewedness measures the *degree of distortion* from the symmetrical bell curve or the normal distribution. A symmetrical distribution will have a skewness of 0. A positively skewed data set has its tail extended towards the right. It is an indication that both the mean and the median are greater than the mode of the data set. In short it is the measure of the degree of asymmetry of data round its mean. Kurtosis, in statistics, is a measure of the tailedness of the probability distribution of a real-valued random variable. Like skewness, kurtosis describes the shape of a probability distribution and indicates the nature of degree of extremity of the distributions. The kurtosis of any univariate normal distribution is 3. Distributions with kurtosis less than 3 are said to be platykurtic, while distributions with kurtosis greater than 3 are said to be leptokurtic. When the kurtosis of a distribution is approximately 3, the distribution is described as being mesokurtic. Table 2 presents the Co-integration test.

Table 2: Johansen Co-integration Test

Date: 05/27/23 Time: 04:53
Sample (adjusted): 1983 2021
Included observations: 39 after adjustments
Trend assumption: Linear deterministic trend
Series: INF Y ENER CO2 Emission
HOSBED INFW ED
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 *	0.892893	266.6466	125.6154	0.0000
At most 1 *	0.831656	179.5235	95.75366	0.0000
At most 2 *	0.660048	110.0354	69.81889	0.0000
At most 3 *	0.561536	67.95633	47.85613	0.0002
At most 4 *	0.443304	35.80166	29.79707	0.0090
At most 5	0.248652	12.95799	15.49471	0.1164
At most 6	0.045311	1.808409	3.841466	0.1787

Trace test indicates 5 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 *	0.892893	87.12309	46.23142	0.0000
At most 1 *	0.831656	69.48806	40.07757	0.0000
At most 2 *	0.660048	42.07912	33.87687	0.0042
At most 3 *	0.561536	32.15467	27.58434	0.0120
At most 4 *	0.443304	22.84368	21.13162	0.0284
At most 5	0.248652	11.14958	14.26460	0.1469
At most 6	0.045311	1.808409	3.841466	0.1787

Max-eigenvalue test indicates 5 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: Researchers' computation using EView 12

Table 2 showed the results of the Johansen co-integration test. From the result, there are 5 co integrating vectors for the trace statistics and 5 co-integrating vectors for the Max Eigenvalue.

Impulse - Response Functions

Impulse-response functions show the effect of a standard deviation shock, which occurs in one of the variables in the system, on the current and future values of endogenous variables. In Figure 1; impulse-response functions are given which show the effect of standard deviation shock, which may occur on each variable, on the other variables in the 95% confidence interval. Dashed lines show the confidence intervals for +/- 2 standard error; straight lines show the reaction given in time by the dependent variable against standard deviation shock occurring in the error term of the model. If impulse-response coefficients are within the confidence limits; it indicates that the impulse-response functions are statistically significant. Shock effects approaching zero in time once more confirms the system stability tested before by using unit root test; and it also shows again that the model is stable (Koyuncu, 2014)

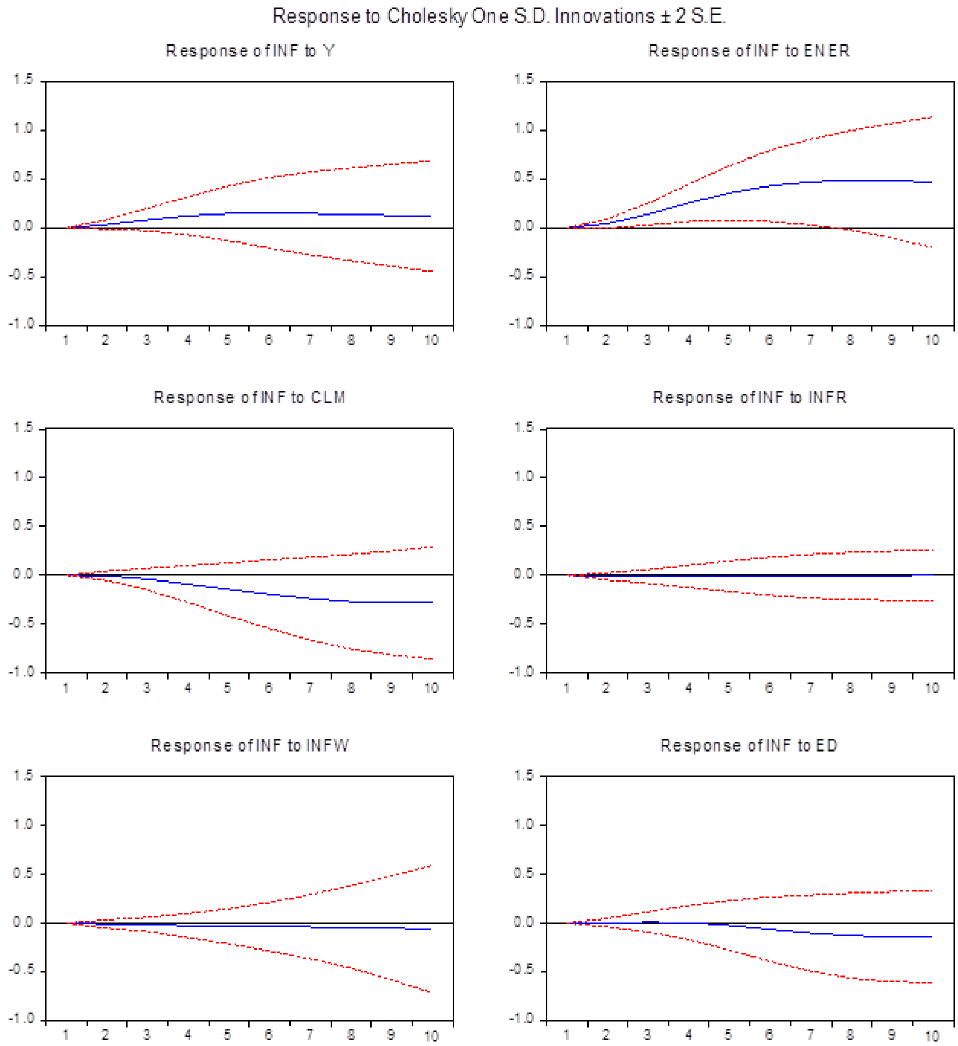

Figure 1: Cholseky Impulse Response Function

The impulse response functions of national income shows that one standard deviation shock given to national income shock will result to an increase in infant mortality (under 5) starting from the sixth period till the tenth period. Similarly, a one standard deviation shock or innovations given to climate change will decrease infant mortality (under 5) and this maintained a decreasing function up to the tenth period. So, the shock on climate change in the short run and long run will have a positive effect on infant mortality (under 5). The impulse response functions of infrastructure shows that one standard deviation shock given to infrastructure will result to a decrease in infant mortality (under 5) up to third period and decline up to the third periods. It later repeated a downward direction up to the tenth period of time. So, the shock on infrastructure has a positive effect on infant mortality both in the short run and long run. Similarly, the impulse response functions of institutional framework as well education shows that one standard deviation shock given to institutional framework and education will result to a decrease in infant mortality up to tenth period. So, the shock on institutional framework as well as education has a positive effect on infant mortality both in the short run and long run.

Variance Decomposition

Variance decomposition is adopted to forecast the error variance effects for each endogenous variable within a system. In a simple linear equation, for any change in x at time (t) there is a corresponding change in y as a dependent variable (Wickremasinghe, 2011). In this study, based on the Monte Carlo procedure and ordering by Cholesky, the forecast is comprised of short-run (two years), medium-term (five years) and long-run (ten years).

Table 3: Variance Decomposition Result

Periods	INF	PCI	ENER	CO2	HOSBED	INFW	ED
Short Term	96.40787	1.242935	2.018463	0.044349	0.140217	0.139202	0.006966
Medium Term	75.54075	3.714734	17.87751	2.569726	0.040165	0.201405	0.055710
Long Term	61.05277	2.852317	26.84446	7.470142	0.014970	0.287845	1.477497

Source: Resaerchers' Computation Using EViews 12

In the short run, impulse or innovation or shock to IFN account for 96.40 percent variation of the fluctuation in INF (Own shock). Shock to per capita income (Y) can cause about 1.24 percent fluctuation in INF, but a shock to energy consumption causes a 2.018 percent variation in the fluctuation in infant mortality. In the medium term, impulse or innovation or shock to INF account for 75.5 percent variation of the fluctuation in INF (Own shock). A shock to per capita income (Y) can cause about 3.17 percent fluctuation in INF, but a shock to energy consumption causes about 17.8 percent variation of the fluctuation in INF. A shock to carbon emission change can cause a 2.56 percent fluctuation in INF in the medium term. In the long run, impulse, innovation, or shock to per capita income (Y) account for 2.85 percent of the variation in INF fluctuations (own shock). A shock to carbon emission can cause about 7.4 percent fluctuation in INF, but a shock to INFW causes about 0.28 percent variation in the fluctuation in INF. This implies that in the long run, per capita income shocks, energy consumption as well as carbon emission can cause an increase in the money supply in Nigeria for the period under investigation.

Conclusion and Policy Recommendation

Conclusion

This paper investigated the impact of per capita income on child infant mortality rate in Nigeria. To analyze the impact of per capita income on child infant mortality rate, this paper utilized the vector autoregressive distributed lag model. The results show that per capita income shock has a positive impact on infant mortality, while carbon emission has a negative impact on infant mortality. Infrastructure, proxy by hospital beds impacted positively to infant mortality in Nigeria. Education which was captured by primary school enrolment impacted negatively on infant mortality. The estimates also showed that changes in per capita income causes changes in infant mortality in Nigeria for the period under examination. More so, the impulse response functions of per capita income showed that one standard deviation shock to per capita income shock will result to an increase in infant mortality (under 5).

Policy Recommendations

In line with the findings of this paper, the following are recommended.

i. As part of healthcare policy measure, the Government and stakeholders should ensure adequate distribution of income, through employment creation and provisions of funds. Furthermore, the Government should strengthen the healthcare intervention programs among other necessities including improved wage rate, social safety net, and free treatment of pregnancies and children under-5 years and school feeding for children. Given proper budgetary funding of primary health care services in Nigeria, income inequality will be gradually reduced and poverty health-related statistics would also improve.

ii. Policy efforts should be geared towards checking the population explosion by instituting a re-strengthening family planning program so as to reduce the population growth rate.

iii. Finally, to ensure adequate health care services for poor rural people, government should make available critical hospitals infrastructure in rural areas and not just in urban regions

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