The Impact of Infant Mortality on Population Growth: An Empirical Evidence of West Africa

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Abstract
The study examined the impact of infant mortality on the population in West Africa from 2004 to 2015 with panel data methodologies. The study used fully modified ordinary least square method to analysis the data to make its statistical inference. The results report negative and statistical significance impact of infant mortality and population growth in West Africa. Further, the study found out that human development contributes a lot to the mitigation of infant mortality hence, improvement in governments' effectiveness and regulation quality will translate into good quality of life, which then increases population growth. The study recommends that governments' should formulate proactive policies and ensure their implementation to help mitigate infant mortality which in the long run affects population growth negatively

Keywords: *Infant mortality; population growth; fully modified ordinary least square, government effectiveness; regulation quality; Human development index*

1. Introduction

It is estimated that more than 10 million children under the age of 5 years die in a year worldwide; over 90% happen in the developing countries due to conditions that are preventable with accessibility to basic and affordable interventions. Existing and previous studies affirm that six countries account for 50% of deaths worldwide of children younger than 5 years and 42 countries account for 90% (Kabagenyi and Rutaremwa, 2013; Miller and Goldman, 2011; Black et al., 2003; Jones et al., 2003; Bryce et al., 2003). Four (4) million out of the 10 million infant deaths annually occur with the first month of life, with approximately 40% comprising under 5 years of mortality and more than 50% of infant mortality globally. Researches into this area have identified socio-economic, maternal, cultural, household, environmental, biological and health care services as the factors that contribute to infant mortality (Hobcraft et al., 1984; Agha, 2000; Casey et al., 2001). Infectious diseases like meningitis and HIV/AIDS are among the causes of high rate of infant mortality in the Sub-saharan Africa. The infant mortality rate is used widely as the overall index of population health based on the information about the distribution, causes, and time trends in many countries (Kabagenyi and Rutaremwa, 2013; Dube et al., 2013). Most importantly, high infant mortality rate has the tendency to reduce the population growth a country as well as the labour force. Therefore, infant mortality rate has an economic and social impact on countries' development.

There is an assumption about world population growth and reduction in infant mortality rate which is mostly misunderstood; the assumption is that any reduction in infant mortality rates must automatically increase population and population growth rates. Also any reduction in the number of children dying each year would increase the total world population, now and in the future. But the opposite is the case; directives that extend child and maternal health services and also expand educational opportunities for girls and women help to reduce infant mortality and reduce fertility; decreasing population growth rates in the longer run. Consequently, when combined with direct family planning efforts, directives to reduce infant mortality are likely to decrease population growth and therefore, the earlier attainment of a stable and lower world population than would be the case if family planning or infant mortality reduction measures were taken independently of each other (Unicef Report, 1990). Astronomical increase in population growth has economic effect which reduces per capita access to subsistence and can also crippled governments' ability to provide basic needs such as employment, housing, electricity, water, good sanitation, implementation of laws and regulations (Buhaug and Urdal, 2013; Homer-Dixon, 1999; Homer-Dixon and Blitt, 1998).

The study draws motivation from the above literature to assess the impact of infant mortality on population growth and intends to contribute to literature on the subject matter for policy direction as well as academic perusal. The study employs panel data methodologies to conduct the research and in the end make statistical inference. The study is divided into section 1. Thus the introduction, section 2 which consists of data and methodology; section 3 reports the results and discussion whiles section 4, concludes the study.

2. Data and Methodology

2.1 Data

The study uses panel data of 10 West African countries from 2004 to 2015 and considered five variables. The variables are as follows:

1. Infant mortality rate (INFMORT): Mortality rate, infant (per 1,000 live births)
2. Human development index (HDI): The Human Development Index is a statistic composite index of life expectancy, education, and per capita income indicators, which are used to rank countries into four tiers of human development.
3. Population growth (POPG): the annual growth rate of the population of a country
4. Regulation quality (REGQTY): Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
5. Government effectiveness (GOVEFF): reflects perceptions of the qualities, the quality of policy formulation and implementation and the credibility of the government's commitment to such policies.
6. Countries sampled for the study; Ghana, Nigeria, Cote d'lvoire, Benin, Burkina Faso, The Gambia, Guinea, Senegal, Mali and Niger.

The data were sourced from World Bank Development Indicators, United Nations Development Programmes (UNDP) Database and Worldwide Governance Indicators.

Infant mortality and population growth were transformed into a natural logarithm.

The econometric model for the study is written as;

Equation 1

$$popg_{it} = f(\inf mort_{it}, goveff_{it}, regqty_{it}, hdi_{it})$$

In the equation (1), popg refers to population growth, infmort refers to infant mortality rate, goveff refers to government effectiveness, regqty refers to the regulation quality and hdi refers to human development index. The study subsequently takes natural logarithm of population growth and infant mortality rate; the resulting equation is represented as:

Equation 2

$$\log(popg)_{\text{it}} = \beta 0 + \beta_1 \log(\inf mort)_{\text{it}} + \beta_2 (goveff)_{\text{it}} + \beta_3 (regqty)_{\text{it}} + \beta_4 (hdi)_{\text{it}} + \mu_{\text{it}}$$

In equation (2), β_0 is the intercept, $_i$ =1 …. I represent the cross-section of the countries, t =1……t represents the time period and μ represents error term (disturbances and other factors that were not considered).

2.2 Methodology

The study employs panel cointegration regression methodology thus fully modified ordinary least square to analysis the data to examine the impact of infant mortality on population growth. Firstly, the study conducted a unit root test to find whether the variables are stationary or not. In spite of this, the following tests are used to test for unit root in the variables; Levin-Lin Chu (LLC) Levin et al. (2002), Im-Pesaran Shim (IPS) Im et al. (2003), Fisher Augmented Dickey-Fuller (ADF) and Fisher Philips-Perron (PP) tests (Maddala and Wu, 1999) to test for heterogeneity in the variables. Afterward, when it is ascertained that there is no unit root in the variables then the co-integration test is performed to establish the long run relationship among the variables with Kao (1999) proposed test. Also correlation matrix is computed to ascertain whether the variables are free from multicollinearity. The long run estimation is then computed with fully modified ordinary least square method on equation (3); Fully modified ordinary least square (FMOLS) estimates long run correlation and endogeneity by using nonparametric correction term to correct the problems that may be detected (Kao, 2000).

Equation 3

$$\ln(popg)_{it} = \gamma_{it} + \delta_{it} + \pi_{1i}\ln(\inf mort)_{it} + \pi_{2i}(goveff)_{it} + \pi_{3i}(regqty)_{it} + \pi_{4i}(hdi)_{it} + \mu_{it}$$

In the equation (3), $i = 1,\ldots, N$ represents the cross sectional observation, $t = 1,\ldots\ldots,T$ represents the time period, popg refers to population growth, infmort represents infant mortality, goveff termed from government effectiveness and regqty refers to regulation quality. The symbol π represents the elasticities that will be estimated, y_{it} and ∂_{it} enables the specific effects and deterministic trend effects for each country. The error term is expected to be normally and identically distributed with zero mean and constant variance, therefore, the symbol μ_{it} represents the error term.

Lastly, the granger causality test is performed to establish the direction at which the variables cause each other. The null hypothesis states that there is no granger causality among the variables.

3. Results and discussion

3.1 Descriptive statistics

Table 1 depicts the results of the descriptive and summary statistics of the variables employed for the study. From the results, it can be realized that the mean and the median are closely related; the standard deviation is homogenous in nature. Moreover, the Skewness and Kurtosis, as well as Jarque-Bera tests, attest that the variables are normally related or in a normal distribution, except lninfmort.

Table 1 Descriptive statistics

	lnpopg	lninfmort	hdi	goveff	regqty
Mean	1.025	4.166	0.432	-0.708	-0.507
Median	1.032	4.235	0.436	-0.680	-0.456
Maximum	1.346	4.599	0.585	0.160	0.128
Minimum	0.579	3.552	0.274	-1.323	-1.352
Std. Dev.	0.168	0.248	0.068	0.342	0.327
Skewness	-0.220	-0.495	-0.084	0.263	-0.345
Kurtosis	2.933	2.385	2.791	2.675	2.641
Jarque-Bera	0.991	6.791	0.359	1.917	3.028
Probability	0.609	0.034**	0.836	0.383	0.220

Note: ** indicates 5% significance

3.2 Panel unit root test

In order to ensure that the variables do not have unit root and are stationary, the study utilized the panel unit root approach Levin, Lin and Chi, Fisher –PP, Fisher –ADF and Im Pearson Shim. Table 2 displays the results, at level form lninfmort and lnpopg showed significant in the four tests. Meanwhile, goveff showed significance with IPS, ADF-fisher and PP-Fisher, regqty showed significance with LLC, ADF-Fisher and PP-Fisher at level form. At the same level form, hdi showed significance with LLC and PP-Fisher. The first difference approach was taken subsequently to concretize the stationarity of the variables; all the variables showed significance with the four tests except lninfmort, which showed insignificance with IPS and ADF-Fisher as well lnpopg which also showed insignificance with PP-Fisher. In a nutshell, the study can conclude that it is evidenced that the variables have not unit root and are stationary hence, the null hypothesis that there is unit root in the variables is rejected.

Table 2 Panel unit root tests

	lninfmort	lnpopg	goveff	regqty	hdi
level					
LLC	-15.544***	-5.118***	-0.247	-2.115**	-4.126***
IPS	-11.050***	-2.312**	-1.531*	-0.776	1.030
ADF-Fisher	80.394***	44.629***	38.169**	33.080**	17.375
PP-Fisher	99.338***	46.231***	40.349**	39.187**	53.109***
First difference					
LLC	-3.769***	-7.264***	-15.843***	-13.117***	-8.626***
IPS	-0.874	-3.993***	-10.988***	-8.196***	-5.053***
ADF-Fisher	28.225	75.033***	91.365***	85.829***	60.462***
PP-Fisher	52.131***	6.817	104.718***	80.220***	45.352***

Note: *** indicates 1% significance, ** indicates 5% significance, * indicates 10% significance

3.3 Correlation Matrix

It is imperative to check for multicollinearity. Hence, the study used a correlation matrix to check for multicollinearity among the independent variables. Table 3 exhibits the results and it can be clearly seen that there is no multicollinearity among the variables. The rule of thumb states that two of the independent variables should not be highly correlated with the dependent variable at coefficient of -/+0.70. From the table, the highest coefficient is -0.457; therefore, the variables are free from multicollinearity.

Table 3 Correlation Matrix

	lnpopg	lninfmort	hdi	goveff	regqty
lnpopg	1				
lninfmort	-0.170	1			
hdi	-0.457	-0.374	1		
goveff	0.305	-0.580	0.302	1	
regqty	0.408	-0.590	0.245	0.855	1

3.4 Kao cointegration test

Table 4 shows the result of the cointegration test performed to ascertain the long run equilibrium or relationship among the variables. According to the result, the variables are co-integrated at 10% significance level.

Table 4 Kao Co-integration test

	t-Statistic	Prob.
ADF	-1.530	0.063*
Residual variance		0.000298
HAC variance		0.000665

Note: * indicates 10% significance

3.5 Results of the impact of infant mortality on population growth

To examine the impact of infant mortality on population growth, the study adopted cointegration regression method, thus fully modified ordinary least squares to compute the coefficient at which the independent variable affects the dependent variable. Table 5 depicts the results and from the results, infant mortality (lninfmort) has negative and 1% statistical significance impact on population growth (lnpopg) at coefficient of -0.210. The factors that could affect infant mortality to have an effect on population growth were used as control variables to check the impact they have on population growth. From the results, government effectiveness index (goveff) has positive impact on population growth (lnpopg) as a result of enhancing policies that could affect infant mortality rate with coefficient of 0.168. Furthermore, the quality of government regulations has a positive impact on population growth, which on the other hand would help in the reduction of infant mortality. At coefficient of 0.100, regqty has positive and 1% significant statistical impact on population growth. The human development index as a control measure of population growth has negative and 1% significant statistical impact on population growth with coefficient of -0.699. In conclusion, a percentage increase in lninfmort, goveff, regqty and hdi will affect lnpop at -0.21%, 0.17%, 0.10% and -0.70% respectively.

Table 5 Result of the impact of infant mortality on population growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Sig.
LNINFMORT	-0.210	0.042	-4.969	0.000	***
GOVEFF	0.168	0.012	13.962	0.000	***
REGQTY	0.100	0.014	7.368	0.000	***
HDI	-0.699	0.207	-3.385	0.001	***
R-squared	0.939	Mean dependent var		1.028	
Adjusted R-squared	0.931	S.D. dependent var		0.163	
S.E. of regression	0.043	Sum squared resid		0.176	
Durbin-Watson stat	0.457	Long-run variance		0.000	

Note: *** indicates 1% significance

3.6 Pairwise Granger causality test

To establish the direction at which the variables cause each other, pairwise granger causality test was used; the null hypothesis is that none of the variables granger causes another. Table 6 shows the results and it is evidenced that there is an existence of unidirectional linkage from hdi→lnpopg, goveff→lninfmort, regqty→lninfmort, hdi→lninfmort and regqty→goveff. In spite of this, the null hypothesis is rejected because there is an evidence of granger causality.

Table 6 Pairwise Granger causality test

Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.	sig.
lninfmort does not granger cause lnpopg	100	0.161	0.852	
lnpopg does not granger cause lninfmort		0.958	0.388	
goveff does not granger cause lnpopg	100	3.198	0.045	
lnpopg does not granger cause goveff		0.736	0.482	
regqty does not granger cause lnpopg	100	1.951	0.148	
lnpopg does not granger cause regqty		0.678	0.510	
hdi does not granger cause lnpopg	100	4.471	0.014	**
lnpopg does not granger cause hdi		0.426	0.654	
goveff does not granger cause lninfmort	100	3.244	0.043	**
lninfmort does not granger cause goveff		1.159	0.318	
regqty does not granger cause lninfmort	100	2.392	0.097	*
lninfmort does not granger cause regqty		0.369	0.692	
hdi does not granger cause lninfmort	100	3.446	0.036	**
lninfmort does not granger cause hdi		0.553	0.577	
regqty does not granger cause goveff	100	2.878	0.061	**
goveff does not granger cause regqty		1.130	0.327	
hdi does not granger cause goveff	100	0.128	0.880	
goveff does not granger cause hdi		1.813	0.169	
hdi does not granger cause regqty	100	0.569	0.568	
regqty does not granger cause hdi		2.250	0.111	

Note: ** indicates 5% significance

4. Conclusion and recommendation

The study used panel data methodologies to examine the impact of infant mortality on population growth in West Africa with a panel of 10 countries from 2004 to 2015. The following panel data methodologies were employed for the study; panel unit root tests, panel co-integration test, correlation matrix, panel fully modified ordinary least square and granger causality test.

The study concludes that infant mortality rate has a negative impact on population growth hence governments should ensure strong and effective policies to mitigate this canker. The study found out that government effectiveness and the quality of their regulations enhance population growth. This confirms the positive impact of government effectiveness and regulation quality on population growth. Moreover, human development index which combines a lot of factors to portray the average level of development in the lives of the populace in a country showed negative impact on population growth. The quality of life of the population enhances their fertility rate, standard of living, health care, education, etc. due to this, the human development index of West Africa. The human development index measures the poverty level of a country since it showed negative impact on population; it can be concluded that the quality of life in West Africa affects its population growth. Poor health care, poor sanitation, poor nutrition, poor education, etc. causes infant mortality rate; all these headaches are a result of poverty.

The study recommends that governments should be proactive in the formulation of policies and their implementation as well as ensure to improve the human development index of their country to help mitigate infant mortality.

The study proposes further research due to its small sample limitation.

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