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Determinant of Infant Mortality Rate: A Panel Data Analysis of African Countries

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Abstract
This study examines the factors that affect the rate of mortality among infants under one year of age using panel data sets from the World Bank's World Development Indicator database from the year 2000 to 2009 from 53 African countries. Using a random effect model in a 2SLS analytical method, results obtained after correcting for endogeneity showed that fertility rate significantly affect infant mortality rate in a positive way. Similarly, GDP per capita as a proxy for income, public health expenditure as a percentage of GDP, Prevalence of HIV and the participation of adult female in the labour force significantly affect infant mortality rate. Furthermore, of all the explanatory variables used in the analysis, fertility rate and GDP per capita had the most impact on infant mortality rate respectively. This study also confirms Chowdhury's (1988) postulation that there is a dual causality between infant mortality rate and fertility rate.
Keywords: Infant mortality; Fertility rate; Health; Population; Africa

INTRODUCTION

Infant mortality is the number of deaths of infants under one year of age per 1,000 live births. The infant mortality rate is an important measure of the well-being of infants, children, and pregnant women. It is related to a variety of factors, including health status of women, the quality of and access to medical care services, socio-economic conditions, and public health practices in any given geographical location. High infant mortality signify the lack of proper childcare owing to poverty, lack of education, and societal preferences (such as the affinity for a male child), among others (Zakir and Wunnava, 1999). Household decisions shape health, but these decisions are also inhibited by the income and education of household members.
This study therefore intend to contribute to the quantitative assessment of the interlinking factors that affect the rate of mortality among infants under one year of age which is one determinant of the health status of any nation (Nwabu, 1997).

Pritchett and Summers (1996) explore a causal relationship between the the phenomena of health and wealth and conclude that wealthier nations are healthier nations. These observations are not far-fetched because in principle, it implies that wealthier nations are in a stronger position to provide better health to the population. Better health in turn increases labor productivity, thereby enhancing wealth (Nwabu, 1997). Apart from being both a constituent part of human welfare and a factor of production, good health as measured from infancy through to progression to adulthood contributes directly to enjoyment of life. In this respect, it is in the same category as other goods and services such as housing and education that fulfil this function (ibid). High infant mortality rates could reflect improper childcare. 'A population with diseased and unhealthy infants who grow up to form sickly adults prone to disease, dampen economic progress in many ways: it decreases worker productivity; it does not allow utilization of natural resources that would otherwise be accessible under good health conditions; it harms the next generation by decreasing enrolment of children in school, and finally, it increases medical-care expenditure, rendering inefficient allocation of resources (World Bank, 1993).

This study therefore aims at assessing factors from earlier studies on the determinant of infant mortality and to test the validity of these factors that affect infant mortality using panel data from the World Bank's World Development Indicator database from the year 2000 to 2009, covering one decade. Other sections of this study is organised as follows: a review of some literature and justification for the study is followed by a detailed methodology for the study and the accompanying empirical analysis. The results and discussion on the findings of the research are described afterwards. Finally, the conclusion and implication for research and policy is highlighted.

THEORETICAL FRAMEWORK

Classical demographic transition theory implies that fertility decline is preceded by mortality decline. For this reason, the interrelationship between mortality and fertility have been a keen concern to demographers as well as policy-makers (Park et al., 1996). Several studies on health had substantiated a positive relationship between fertility rate and infant mortality rate. For example, Zakir and Wunnava (1999) observed a strong positive impact between fertility rate and infant mortality in a cross-sectional data analysis of 117 countries. However, other studies have put great emphasis on the causal link from high infant mortality to high desired fertility. The reason being that parents in Africa and other parts of the world do not know whether their children will survive, therefore they respond by having large families (McCord et al., 2010).The original model of the demographic transition, indeed, was driven almost solely by infant mortality rates. Exogenous changes to infant mortality (e.g., the advent of public health, safe drinking water, immunizations, improved nutrition) were seen as the primary precursor to reduced fertility rates—albeit with a lag of one or more generations (ibid). In this instance, the argument has been that at least some of the powerful correlation of high infant mortality and high fertility represents increased infant mortality due to higher fertility which is due in part to increasing strain on household resources and decreased parental care and supervision with the addition of more children.

The relative income-health hypothesis postulates that income distribution is one of the key determinants of population health (Torre and Myrskyla, 2011). One may not expect a direct linear relationship between infant mortality and income per head to exist, because national income is simply a measure of the rate of production of new goods and services. However, income is likely to influence the level of mortality indirectly through its effects on the rate of consumption of items affecting health, such as food, housing, sanitation, medical care and education (Flegg, 1982). Similarly, other studies have strongly suggested the income inequality-health hypothesis (Lynch et al 2004)[1].

There are many other possible determinants of infant mortality besides fertility rate and income. Unfortunately, due to the limitation of access to adequate data, only few additional explanatory variables will be considered here. These variables could include maternal education (proxy by literacy rate of adult female as a percentage of females ages 15 and above), expenditure on health care as a percentage of GDP, percentage of women in the labour force, prevalence of HIV, measure of income inequality (Gini index) etc. A case for the importance of maternal education as a determinant of child mortality was made by Caldwell (1979). He concluded that maternal education was the most important single determinant of mortality in childhood in the area of study. Similarly, Zakir and Wunnava (1999) in their analysis of infant mortality suggest a significant coefficient for both maternal labour force participation and literacy rate in their study of 117 countries. Similarly, the World Development Report of 1993 argued that a limited package of public health measures and essential clinical interventions is a top priority for government finance; some governments may wish, after covering the minimum for everyone, to define their national essential package more broadly. Government expenditure on health care services as it relates to infant and maternal health will be a crucial determinant of infant mortality rate. This study is therefore aimed at examining the effect of some of these factors on infant mortality rate among Africa countries.

METHOD AND EMPIRICAL MODEL SPECIFICATION

This research report uses a panel data set for the empirical analysis. The observations are 53 African countries covering ten-year period from 2000 to 2009. The dependent variable is Infant Mortality rate (IMR) while the explanatory variables are fertility rate (births per woman), GDP per capita (PPP, constant 2005 international $), public health expenditure (percentage of GDP), prevalence of HIV (percentage of population ages 15-49), and female labour force participation (percentage of total labour force). Undoubtedly, a substantial body of knowledge have shown that other variables such as the measure of income inequality (measured by Gini index), maternal literacy rate etc has strong influence on infant mortality (Deaton 2003; Lynch et al, 2004; Gonzalez and Tseng, 2009; Torre and Myrskyla, 2011). However, these variables were not included in this analysis due to unavailability of adequate data from the World Bank's World Development Indicator database for the case study. In choosing an appropriate specification model that produces efficient and consistent estimates, a test of simultaneity is important. Gujarati (2004) noted that the OLS estimators produce consistent and efficient estimators if there is no simultaneity problem. On the other hand, if there is evidence for simultaneity, the OLS estimators are not even consistent. Similarly, Abrevaya et al (2010) opined that failure to correct for endogeneity can result in incorrect inference and that with the availability of appropriate instruments, two-stage least squares (2SLS) yields consistent estimates in linear models without the need for making parametric assumptions on the error disturbances. In view of this, Chowdhury (1988) has suggested that there is a dual causality between infant mortality rates and fertility rates. He argued that when a woman has multiple pregnancies, the chances of her child's survival are significantly reduced. A woman may therefore, decide to bear more children in the hope that some will survive. Other studies have affirmed the endogeneity of infant mortality and fertility rate (Benefo and Schultz, 1996; Schultz, 1997; Galloway et al, 1998; Dreze and Murthi, 2001). From these studies therefore, a test for endogeneity between infant mortality and fertility is expedient for this study and this was subsequently tested for.

[1] For a detailed review of this literature on income inequality and health, see Deaton (2003) and Lynch et al. (2004).

After performing a simultaneity test using Hausman (1978) Specification Tests, fertility rate was found to be endogenous. The predicted value of fertility rate from the OLS regression of fertility rate on the instrumental variable (population density) from the reduced form equation (2) was added as an extra regressor to the model in equation (3) in order to correct for the problem of endogeneity. The empirical specification therefore for the 2SLS regresion analysis, is given below:

$I_{it} = \beta_{0i} + \beta_1 E_{it} + \beta_2 G_{it} + \beta_3 H_{it} + \beta_4 HI_{it} + \beta_5 L_{it} + \mu_{it}$ ---------------(1)

Instrument: Population density (P_{it}) for Fertility rate, E_{it}

STAGE 1

$E_{it} = \alpha_0 + \alpha_1 P_{it} + \nu_{it}$ ---(2)

STAGE 2

$I_{it} = \beta_{0i} + \beta_1 \hat{E}_{it} + \beta_2 G_{it} + \beta_3 H_{it} + \beta_4 HI_{it} + \beta_5 L_{it} + \omega_{it}$-------------(3)

$\beta_{0i} = \beta_0 + e_i \qquad i = 1, 2, ..., 53$

e_i = random error term

$\omega_{it} = e_i + \mu_{it}$

Where i = 1, 2, 3, . . ., 53; t = 2000, 2006, . . , 2009;
I = Infant Mortality Rate (per 1,000 live births)
E = Fertility Rate (births per woman)
G = Natural logarithm of GDP per capita (PPP, constant 2005 international $)
H = Public Health Expenditure (percentage of GDP)
HI = Prevalence of HIV (percentage of population ages 15-49)
P = Population density (people per sq. km of land area)
L = Female labour force participation (percentage of total labour force)
μ, ν and ω= error term

Hausman specification test was conducted to select between fixed effect and random effect regression model. According to the result from the test, the null hypothesis for selection of fixed effect was rejected at the 5 percent level of significance. Therefore, random effect model was used for this analysis in the second stage of regression.

RESULTS AND DISCUSSION

Before delving into the econometric analysis, a brief overview of the description of the data used will suffice. Table 1 therefore, shows a descriptive statistics of the data that was used for the analysis. The table revealed that for all the observations (Africa countries), the mean infant mortality in Africa between the year 2000 to 2009 is 71.9779 and the maximum is 141.9. The average fertility rate for the sampled African countries is 4.7507.

As highlighted above, the a priori expectation is that fertility rate affects infant mortality rate in a positive way; the variable parameter β_1 is therefore expected to be positive. The variable *G* (the natural logarithm of GDP per capita) is used to capture a diminishing effect of GDP on infant mortality. The coefficient β_2 therefore, is expected to be negative implying that an increase in income decreases infant mortality at a decreasing rate. β_3 is expected to be negative, implying that an increase in government expenditure in the health sector, will ultimately lead to better and improve access to health care services, which will therefore reduce infant mortality rate. The prevalence of HIV was chosen because a country where HIV is prevalent especially among reproductive females could exacerbate the rate of infant of mortality. Therefore, β_4 is expected to carry a positive sign. Similarly, the a priori expectation is that female participation in the labour force could increase infant mortality (Zakir and Wunnava, 1999). Accordingly, β_5 should have a positive sign. Table 2 shows the results of selected ordinary least square (OLS) regression estimation with infant mortality as the dependent variable while ignoring the possibility of simultaneity between infant mortality and fertility.

The value of R^2 for the first regression of Table 2 indicates that the explanatory variable, fertility rate, contribute substantially to the explanation of inter-country differences in infant mortality rate in Africa; moreover, this variable is also significant at the 1 per cent level of significance. Similarly, it is worth noting that a comparison of the results in the first and last regression shows that fertility rate has a strong impact on infant mortality in Africa with the R^2 value drastically reduced after exclusion of the effect of fertility rate in the last regression model. It is equally worth noting that most of the explanatory variables are significant at the one per cent level in the regression results.

Correcting for the problem of endogeneity, the second stage regression estimation results using the Random Effect Model are shown in table 3 below:

An analysis of the results in the study shows that all the explanatory variables are significant at the one per cent level. However, the coefficient estimate of fertility rate after correcting for the problem of endogeneity was found to be very high as shown in table 3. This may suggest that fertility rate has a strong impact on the rate of death of infants within Africa countries. Similarly, GDP per capita and government expenditure in health also have strong impact on infant mortality rate as shown in the estimates of -14.291 and -5.536 respectively. This seems to imply that as the economy grows and the government place more priority in the provision of health care services, African countries could achieve a rapid fall in their infant mortality rate. Similarly, the result in table 3 also shows that the participation of adult female in the labour force and the prevalence of HIV both have positive impact on infant mortality. However, the estimates show that the impact of these variables is rather low compared to other variables.

CONCLUSION

This empirical research examined the determinants of infant mortality in Africa using a panel data from the World Bank's World Development Indicator database covering ten years from 2000 to 2009. The results from 53 African countries after correcting for endogeneity showed that fertility rate significantly affect infant mortality rate in a positive way. Similarly, GDP per capita as a proxy for income, public health expenditure as a percentage of GDP, Prevalence of HIV and the participation of adult female in the labour force significantly affect infant mortality rate in the area of study. Furthermore, of all the explanatory variables used in the analysis, fertility rate and GDP per capita had the most impact on infant mortality rate respectively. This study also confirms Chowdhury's (1988) postulation that there is a dual causality between infant mortality rate and fertility rate.

However, it is pertinent also to note certain limitations of the analysis. First, there are the challenges inherent in drawing inferences from results, regarding the likely changes over time in the infant mortality rates of particular countries or sets of countries (Flegg, 1982). Secondly, finding an appropriate Instrumental Variable for fertility rate to correct the problem of simultaneity was a daunting challenge in arriving at an appropriate model specification. Thirdly, limitations of data meant that many potentially important explanatory variables had to be neglected. For instance, the measure of income inequality measured by Gini indext and the literacy rate of adult female that are both important indicators for infant mortality rate were not included in the analysis.

Despite the limitations highlighted above, the results presented here in this study seems to suggest that African countries whose government place low priority on individual family health (e.g. appropriate family planning measures), achieving economic growth, and provision of adequate health care services are unlikely to accomplish a rather rapid fall in their infant mortality rates.

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TABLE 1: Mean and Standard Deviation of Variables in the Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Year	530	2004.5	2.8749	2000	2009
Infant Mortality Rate	530	71.9779	28.3535	11.5	141.9
Fertility Rate	530	4.7507	1.3523	1.5	7.503
GDP	509	3440.829	4835.954	247.9451	31738.23
Public Health Exp.	512	2.5518	1.2107	0.0031	8.1991
Prevalence of HIV	470	5.4657	6.9301	0.1	26.3
Female Labour Force Participation	520	41.9691	7.7312	21.7928	53.1525
Population Density	530	79.0402	108.1542	2.3027	628.2379

TABLE 2: Selected Ordinary Least Squares (OLS) Regression Estimation Result with Infant Mortality as the Dependent Variable.

E	G	H	HI	L	R^2	$\bar{R}^2$
17.041*** (32.06)	-	-	-	-	0.6607	0.6600
14.742*** (19.07)	-3.983*** (-4.10)	-	-	-	0.6631	0.6618
14.381*** (18.17)	-4.162*** (-4.28)	-1.259** (-2.01)	-	-	0.6658	0.6638
13.775*** (17.38)	-3.826*** (-3.73)	-3.533*** (-4.85)	0.922*** (7.02)	-	0.6267	0.6233
13.578*** (17.04)	-2.848** (-2.50)	-3.691*** (-5.05)	0.810*** (5.67)	0.253* (1.94)	0.6298	0.6256
-	-13.045*** (-10.48)	-5.815*** (-6.28)	0.661*** (3.61)	0.537*** (3.23)	0.3876	0.3821

Note: t-statistics in parentheses. The level of statistical significance of the estimates is indicated by ***, ** and * for the one, five and ten per cent level of significance.

TABLE 3: Random Effect Model Regression Estimation Result with Infant Mortality as the Dependent Variable.

Explanatory Variables	Estimated Coefficient	Standard Error	p-value	$R^2 = 0.4431$
Ê	50.070***	7.527	0.000	
G	-14.291***	1.203	0.000	
H	-5.536***	0.885	0.000	
HI	0.476***	0.177	0.007	
L	0.568***	0.158	0.000	

Note: The level of statistical significance of the estimated coefficients is indicated by ***, ** and * for the one, five and ten per cent level of significance.