Association between Economic Growth and Infant Mortality: Evidence from 132 Demographic and Health Surveys from 36 Developing Countries

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Abstract

Using nationally representative and repeated cross sectional data from 132 Demographic and Health Survey (DHS) from 36 countries carried out during 1990 to 2012 and probit model, this study aims to investigate whether macroeconomic growth (per-head GDP), is associated with reduction in infant mortality in low and middle income countries. Finding suggests that, if a new born died during infancy that child lived in an environment with average per-capita GDP of $2277 compared with $2957 for a child who survived up to first year of life. Result of probit model depicts that, a 10% increase in per-capita GDP is likely to reduce the probability of infant death by 0.001 (95% CI: 0.001-0.0014). Result of two stage probit model also suggests an inverse association between economic growth and infant mortality. These findings are consistent across rural and urban area, poorest wealth quintile, Asia, Latin America, lower-middle income countries and upper-middle income countries.

Key Words: Economic growth, Gross Domestic Product (GDP), Purchasing Power Parity (PPP), Infant Mortality, Instrumental Variable, Two Stage Probit Model

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Introduction

Improving the health outcomes of children has been the central focus of many public health programs in developing countries over last few decades. To date, there have been several international goals such as declaration of Alma Ata (1978), International conference on Population and development (1994) and United Nations Millennium Development Goals (MDG 4) set out to reduce infant mortality across the developing world, although uncertainty remains over how best to achieve this goal. Improvements in medical technology are believed to be long term reduction in mortality (Preston 1980: Cutler et al. 2006). However, in countries with low per head GDP, macroeconomic growth is often considered as key policy instrument for improving health. The premise is that, economic growth will increase the average income of individuals, especially improving the incomes of poor people, which in turn will improve the life quality by providing better qualified consumption of goods, have access to health care services, better housing and sanitation, leads to reduction in infant mortality. However, the success of such a growth mediated strategy for reducing the deaths of young children still controversial. Sarah Baird et al. used data from 59 developing countries carried out during 1986 to 2004 and reported a strong negative association between per capita GDP and infant mortality. On the other hand, study from Latin America has been suggested that expected relationship applied prior to 1920 to 1930 but that thereafter change in mortality become independent of level of income. A lack of relationship was also suggested by Stolnitz in his review of post-war mortality trends in less developed regions.

Earlier studies on the subject were examined the effect of country level income on average infant mortality (Nishiyama, 2011; Preston, 1975). Such ecological analysis assumes that the risk of death during infancy is same for every child within country. The biggest limitation of ecological model is their inability to quantify within country heterogeneity in risk of infant death, which inherently a question of multilevel. Few researchers have tried to establish the

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magnitude of the effect of macroeconomic growth on individual infant mortality. We identified only one study that have analysed the multilevel association between changes in macro level per head GDP with changes in risk of individual child mortality. Daniel et al. reported that changes in country level per-capita GDP was not consistently associated with reduction in under-five mortality in sub Saharan African countries.

Using nationally representative and mutually comparable repeated cross sectional data from 132 surveys in 36 low income to middle income countries, we investigated whether changes in economic growth is associated with reduction in infant mortality.

Data and Methods

Data

We used nationally representative cross sectional data from Demographic and Health Surveys (DHS). The surveys are designed to collect information on household characteristics, women of reproductive age group and their children. Our study includes surveys carried out between 1990 and 2012. The DHS used multistage stratified sampling design. In first stage of data collection each country were devided into regions. Now from these regions population were stratified by rural and urban area of residence. From each stratified area primary sampling unit (PSU) were selected using probability proportion to sample size (PPS). In second stage of selection all household within PSU were listed and about 25 households within each PSU were randomly selected for interview by equal probability systematic sampling.

The micro data on infant mortality are derived from 132 Demographic and Health Surveys covering more than 0.8 million birth from 36 low to middle income countries carried out during 1990 to 2012. This contains information on time and incidence of child death. The measure of infant mortality is an indicator that takes value of one if child died at a reported age of 11 months or younger. To ensure that every child is allowed to full exposure to the risk of infant death, births that occur 11 months preceding the surveys are excluded. The children

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in the sample are born in 1985-2012. An advantage of using individual data on mortality is that we can explore heterogeneity in the effect of GDP by population subgroup.

The data on per capita GDP were used from World Development Indicator (World Bank 2014). The values correspond to real per-capita GDP, adjusted for purchasing power parity (PPP) exchange rate and reported in 2011 International dollars. The adjustment for PPP makes level and growth of per head GDP comparable across countries and over time. Natural logarithmic of per head GDP were used to model a potentially non linear association with infant death.

We merged the individual data on mortality, income and other variables with a 28 year of data on per head gross domestic product by country and year.

The Empirical Model

The baseline model is

$$D_{imct} = \theta_0 + \emptyset_c + \varphi_t + \beta(\ln GDP_{ct}) + \beta_j(X_{imct}) + €_{imct}$$

Subscript i and m denotes the individual child and mother and c and t indicate country and year respectively. ln denotes natural logarithm. The individual data are nested in country year. D is outcome variable measuring the probability of infant death. GDP is per head gross domestic product and β is the parameter of interest. X is a vector of variables observed at the child or mother levels. $\emptyset_c$ and φ_t are country and year fixed effect and $€_{imct}$ is regression error term. X includes sex of child, birth order of child, the mother's age at birth of child, mother's education, household wealth quintile; sex of household head, rural or urban place of residence.

Methods

We used scatter plots to examine bivariate association between per head gross domestic product and infant mortality. We also used scatter plots to examine the association between

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annual average change in per head gross domestic product and annual average change in infant mortality.

A series of probit model were applied for full sample and various subsamples: the richest and poorest wealth quintiles, the rural and urban areas of residence, Asian countries, Latin American countries and sub- Saharan African countries, low income countries, lower middle income countries and upper middle income countries. All reported standard errors are robust and clustered by country and by primary sampling unit.

A potential problem while estimating the effect of macro level economic growth on infant mortality is that of endogeneity. On the one hand, high economic growth affects infant mortality. On the other hand, high infant may affect economic growth of country (Bloom, & Canning 2008). To overcome the problem of endogeneity, we estimated the effect of economic growth on infant mortality using the two-stage probit model. We used investment share of GDP five years previous to the year of birth as an instrument for log of per head GDP to address the issue of potential statistical problems: measurement error in GDP which could bias the result downwards and the endogenous nature of GDP, which could bias the results because of reverse causality between GDP and infant mortality. In the first stage, ordinary least squares was used to predict GDP as a function of investment share of GDP and other explanatory variables. In the second stage, infant mortality were regressed on predicted values of GDP and other variables using the probit model.

Results

Table 1 presents summary statistics of variable (Infant mortality rate and per-head GDP) from most recent Demographic and Health Survey in 36 developing countries. The average annual change in per-head GDP between earliest and latest survey years varied substantially between countries. Armenia had the sharpest increase in per-head GDP (17.6%) between 2000 and 2010. However, Zimbabwe shows a negative growth rate between 1992 and 2010.

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Across countries and over time, a child was born with an average per-capita GDP of $2922. However, if a new born died during infancy that child lived in an environment with average per-capita GDP of $2277 compared with $2957 for a child who survived up to first year of life.

Figure 1 shows the scatter plot of per capita GDP and infant mortality in 36 developing countries. A negative association was found between per capita GDP and infant mortality. The R^2 was of the order of 0.64. The scatter plot of average annual change in per capita GDP and average annual decline in IMR are shown in figure 2. Findings suggest a negative association between change in per capita GDP and change in infant mortality.

Table 2 present the marginal effects of per capita GDP on infant mortality. Findings suggest that a 10% increase in per-capita GDP is likely to reduce the probability of infant death by 0.001 (95% CI: -0.0014, -0.0009). For the different subsamples, I noted several findings. First, null association was found between per-capita GDP and probability of infant death among children from richest wealth quintile. However, children from poorest wealth quintile indicate significant reduction in infant deaths with increase in per-capita GDP. In rural areas, A 10% increase in per capita GDP is likely to reduce the infant death by 0.002 (95% CI: -0.0018,-0.012). These findings are consistent across various subsamples. An increase in per capita GDP significantly reduces the probability of infant deaths in Asia, Latin America, Lower middle income countries and Upper middle income countries. The one year lagged effect of per capita GDP on the probability of infant death was also statistically significant.

In an instrumental variable regression that used the investment share of GDP five year previous to year of birth used in the analysis as an instrument for log of per capita GDP, the association between per capita GDP and probability of infant death still statistically significant (Table 3).

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Discussion

Using nationally representative and cross sectional data from 136 demographic and health surveys from 36 developing countries, this paper has shown that country level economic growth has significant association with reduction in infant mortality after controlling well known determinants of infant mortality such as sex of child, birth order, mother's education, mother's age at birth of child, sex of household head, wealth index and place of residence. A 10% increase in economic growth was likely to reduce the probability of infant death by 0.001. our finding is consistent with earlier study (Ensor, Cooper, Davidson, Fitzmaurice, & Graham, 2010; Erdoğan, Ener, & Arıca, 2013; Nishiyama, 2011). However after splitting 36 countries into three different continents: Asia, Sub-Saharan Africa and Latin America, macroeconomic growth has no more significant effect on infant mortality in Sub-Saharan Africa. This finding is consistent with previous study of Corsi, Daniel had been done in using DHS data from 59 Sub-Saharan countries. Country level economic growth is also associated with reduction in infant mortality among children from poor households, living in rural area and belongs to lower middle income countries and upper middle income countries.

The limitation of our study must be stated. First we were not able control utilization of maternal health care services such as ante-natal check-ups, iron folic tablet and tetanus injection during pregnancy which is well known determinants of child survival in developing countries (Bamji, PV, Williams, & Vardhana Rao, 2008; Gokhale, Rao, & Garole, 2002). Secondly we could not include mother's nutritional status in statistical analysis. The nutritional status was not available for earlier surveys. Third, we could not control for birth weight or birth size, which is a significant predictor of infant mortality in developing countries (Murki et al., 2015).

This study has certain strength. A unique feature of our study is controlling household economic status while examining the impact of economic growth on infant mortality by

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accounting birth and death of infant in preceding three to five year from year of survey. Another unique feature of our study is the use of the two-stage probit regression model. The use of two-stage probit regression model helped us overcome issues related to endogeneity while estimating the effect of economic growth on infant mortality.

Thus our study concludes that economic growth is inversely associated with infant mortality in developing countries and supports the assumption that macroeconomic growth automatically leads to reduction in infant mortality.

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Figure 1: Scatter plot showing association between per capita GDP and IMR in 36 developing countries carried out during 1990 to 2012

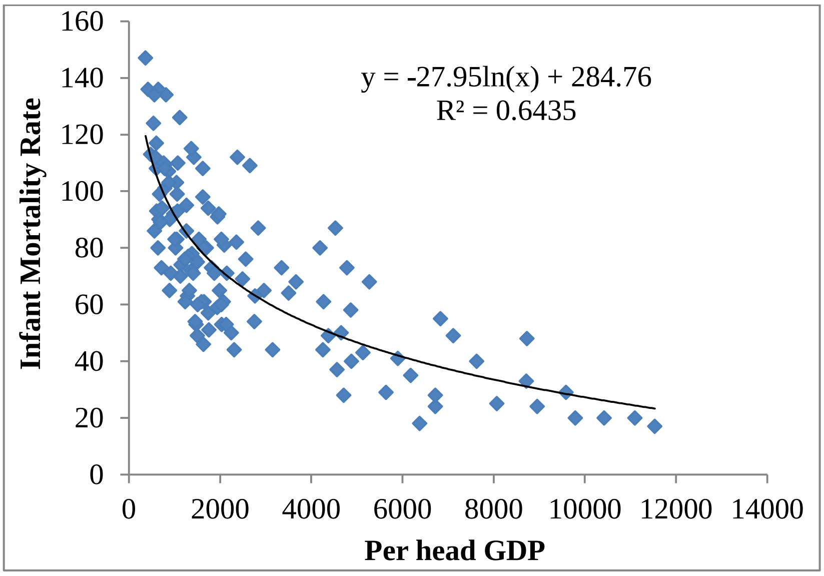
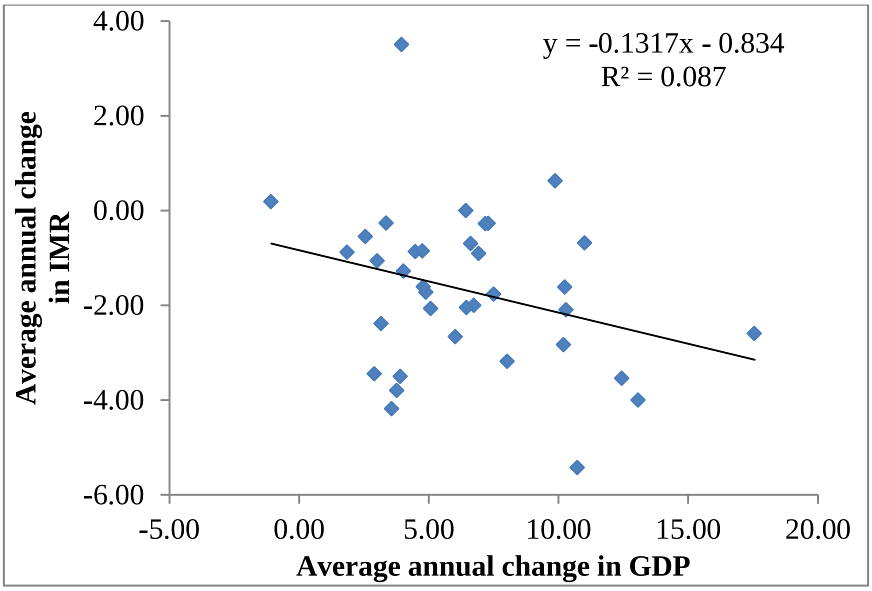


Figure 2: Scatter plot showing association between average annual growth rate in per capita GDP and average annual decline in IMR between DHS.



Note: Data on **i**nfant mortality rate were taken from Demographic and Health Surveys

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Table 1: Infant Mortality rate by country from most recent Demographic and Health Survey

Country	Year	IMR	GDP per head*	GDP growth rate**	Change in IMR¥
Armenia	2010	18	6383	17.56	-2.60
Benin	2011-12	46	1644	3.77	-3.80
Burkina Faso	2010	78	1390	7.51	-1.76
Bangladesh	2011	50	2252	10.21	-2.83
Bolivia	2008	58	4871	5.09	-2.07
Cote d'Ivoire	2011-12	76	2567	1.86	-0.88
Cameroon	2011	69	2502	2.56	-0.55
Colombia	2010	18	10569	4.49	-0.87
Dominican Republic	2007	33	8719	11.01	-0.69
Egypt	2008	29	9596	8.03	-3.19
Ethiopia	2011	74	1150	12.45	-3.55
Ghana	2008	54	2755	6.62	-0.70
Guinea	2012	76	6383	3.16	-2.38
India	2005-06	65	2966	10.25	-1.62
Jordan	2012	17	11539	6.93	-0.91
Kazakhstan	1999	55	6838	3.96	3.50
Kenya	2008-09	59	1941	3.37	-0.27
Lesotho	2009	83	2036	6.44	0.00
Morocco	2003-04	44	4260	4.89	-1.73
Madagascar	2008-09	53	1479	3.57	-4.18
Mali	2006	112	1433	6.75	-2.00
Mozambique	2011	71	926	10.73	-5.43
Malawi	2010	73	723	3.90	-3.50
Namibia	2006-07	49	7121	4.76	-0.86
Niger	2012	65	899	2.91	-3.45
Nigeria	2008	87	4534	7.19	-0.28
Nepal	2011	53	2044	6.03	-2.67
Peru	2012	20	11103	10.30	-2.10
Rwanda	2010	61	885	4.80	-1.61
Senegal	2010-11	53	2140	4.02	-1.28
Chad	2004	115	1375	9.88	0.63
Turkey	1998	48	8734	13.08	-4.00
Tanzania	2010	60	1515	6.46	-2.05
Uganda	2011	65	1334	7.30	-0.27
Zambia	2007	82	2364	3.02	-1.07
Zimbabwe	2010-11	54	1456	-1.08	0.19

GDP- gross domestic product, IMR- Infant Mortality rate, * GDP, adjusted for purchasing power parity (PPP) exchange rate and reported in 2011 International $, ** Average annual growth rate of GDP per head Between DHS, ¥ average annual decline in IMR between DHS.

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Table 2: Marginal Effect for Infant death associated with log of per head GDP for full sample and various subsamples

Variable	N	Marginal effect	95% C.I.
Full sample			
log of per-capita GDP in year of birth	804036	-0.012*	(-0.014, -0.009)
Poorest Wealth Quintile			
log of per-capita GDP in year of birth	196303	-0.023*	(-.028, -0.018)
Richest Wealth Quintile			
log of per-capita GDP in year of birth	125935	-0.002	(-0.007, 0.004)
Rural			
log of per-capita GDP in year of birth	524009	-0.015*	(-0.018, -0.012)
Urban			
log of per-capita GDP in year of birth	280027	-0.004*	(-0.007, -0.0004)
Asia			
log of per-capita GDP in year of birth	148624	-0.018*	(-0.023, -0.013)
Sub-Saharan Africa			
log of per-capita GDP in year of birth	496214	0.001	(-0.003, 0.005)
Latin America			
log of per-capita GDP in year of birth	159198	-0.025*	(-0.029, -0.022)
Low income countries			
log of per-capita GDP in year of birth	349974	0.002	(-0.003, 0.006)
Lower middle income countries			
log of per-capita GDP in year of birth	271264	-0.020*	(-0.025, -0.016)
Upper middle income countries			
log of per-capita GDP in year of birth	182798	-0.016*	(-0.020, -0.013)
Full Sample			
log of per-capita GDP from previous year of birth	772894	-0.012*	(-0.014, -0.009)

Note: standard error are clustered at country and primary sampling unit (not shown in table), * p<0.05, Results are adjusted for sex of child, birth order, mother's education, mother's age at birth of child, sex of household head, wealth index, place of residence and country and birth year fixed effect.

Table 3: Marginal Effect for Infant death associated with log of per head GDP using investment share of GDP 5 year lag as an instrument

Variable	N	Marginal effect	95% C.I.
log of per capita GDP in year of birth	796519	-1.23*	(-1.536, -0.920)

Note: We merged DHS data on infant death, income and other variables with data on GDP using country and birth year. Results are adjusted for sex of child, birth order, mother's education, mother's age at birth of child, sex of household head, wealth index, place of residence , country and birth year fixed effect.

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