IMPACT OF FEMALE EDUCATION ON CHILD MORTALITY RATES IN DEVELOPING COUNTRIES

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ABSTRACT

Despite continuous efforts by government and the international community to reduce child mortality, under-five child mortality rates remain high in developing countries. This policy brief examines the impact of females' primary and secondary education on under-five child mortality. Using evidence from the World Bank, the study finds that secondary school enrollment is negatively associated with child mortality, and that this negative association is statistically significant only for countries with GDP per capita less than $5,000. The relationship between primary school enrollment and child mortality is also negative but not statistically significant when the White robust standard errors are used.

INTRODUCTION

Over the past two decades, developing countries have made great strides in development with increased economic growth rates and lower poverty.[1] Such achievements, however, should not mask a pressing area of concern: under-five child mortality.[2] Children under five years of age are the most vulnerable to illnesses and mortality.[3]

This paper seeks to recommend policies aimed at reducing under-five child mortality. The question of interest is, "What is the impact of females' primary and secondary education on under-five child mortality?" Using evidence from the World Bank, this study finds that secondary school enrollment is negatively associated with child mortality, and that this negative association is statistically significant only for countries with GDP per capita less than $5,000. The relationship between primary school enrollment and child mortality is also negative, but not statistically significant when robust standard errors are used. This analysis contributes to previous research by using a time-serious cross-sectional dataset that includes 128 countries over 40 years.

LITERATURE REVIEW

1. *TRENDS*

Under-five child mortality worldwide has declined drastically in recent years; from 163 deaths for every thousand children born in 1968 to 48 in 2012 (see Figure 1[4]).[5] However, child mortality experiences pronounced regional discrepancies. While North America had the lowest child mortality of all seven regions, reaching 7 in 2012, Sub-Saharan Africa ranked highest with 98 in the same year.[6] South Asia experienced the second highest child mortality over the 1968-2012 period, although the figure went down from 217 in 1968 to 60 in 2012.[7] The trends and rankings of child mortality among regions are mostly consistent over time, except for Middle East and North Africa, whose child mortality decreased substantially from 221 in 1968 to 25.

Despite these downward global and regional trends, some countries have seen their child mortality rates increase.[8] In 1998, India had the highest child mortality with

1 The World Bank, World Development Indicators 2013 (Washington, DC: World Bank, 2013). Numbers in this section have been rounded to the nearest whole number.

2 UNICEF, *The State of the World's Children 2008: Child Survival* (New York: Hatteras Press, 2007): 2. Under-five child mortality indicates children dying before they reach the age of five and is referred to as child mortality in this study.

3 *Ibid.*

4 All Figures & Tables are located in the appendix

5 World Bank, *Indicators*.

6 *Ibid.*

7 *Ibid.*

8 Mariam Claeson *et al.*, "Reducing Child Mortality in India in the New Millennium," *Bulletin of the World Health Organization* (2000), http://www.who.int/bulletin/archives/78%2810%291192.pdf.

2.5 million children dying that year.[9] More than one million of those infants were born to adolescent girls and died before they reached the age of one.[10] Today, in developing countries almost 9,000 infants die during their first month of life each day, mostly from preventable causes such as respiratory or diarrheal affliction.[11]

2. *IMPORTANCE*

A high child mortality rate is significant because it is a crucial indicator of a nation's development.[12] It bespeaks the aggregated impacts of economic, technological, health, and sociocultural advancement.[13] Combating child mortality not only means improving the health of young children, but also indicates an attempt to improve human rights.[14] When children are well fed and taken care of, they are more likely to survive and contribute to society as adults.[15] If parents are confident that their children will survive, they tend to have fewer children and offer them better care and opportunity.[16] Countries thus will have a slower population growth rate with higher quality development.[17]

3. *CAUSES*

This paper focuses on six major factors impacting child mortality rates in the developing world. These factors are interrelated and need to be tackled cooperatively at all levels to maximize efficiency. These factors include education, income, health services, food insecurity, early pregnancy and exclusion of mothers and children, which will be described in further detail below.[18]

3.1. *FEMALE EDUCATION*

A mothers' low rate of literacy can lead to children's poor health outcomes.[19]Over the past 40 years, primary illiteracy rates are rampant among women in developing countries when compared to men.[20] In 2011, roughly 54% of females were literate compared to 69% of males in low-income countries. The gap is narrower in middle-income countries with a literacy rate of 78% among females and 88% among males. In upper-middle income nations, 91% of females were literate, 4 percentage points lower

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9 Claeson *et al.*, "Reducing Child Mortality."

10 Save the Children (STC), "Children Having Children," *State of the World's Mothers* (2004), http://www.savethechildren.org/mothers/report_2004/index.asp.

11 UNICEF, *State: 1.*

12 UNICEF, *State: vi*; Claeson *et al.*, "Reducing Child Mortality."

13 Claeson *et al.*, "Reducing Child Mortality."

14 UNICEF, *State*: vi.

15 UNICEF, *State*: 3.

16 James F. Phillips, Ayaga A. Bawah and Fred N. Binka, "Accelerating Reproductive and Child Health Programme Impact with Community-Based Services: The Navrongo experiment in Ghana," *Bulletin of the World Health Organization* (2006).

17 Phillips *et al.*, "Accelerating Reproductive."

18 UNICEF, "UNICEF Joint Health and Nutrition Strategy for 2006-2015 (E/ICEF/2006/8)," *UN Economic and Social Council* (New York, 2005): 3-4.

19 Helen Ware, "Effects of Maternal Education, Women's Roles and Child Care on Child Mortality," *Population and Development Review* 10, (1984): 191–232.

20 World Bank, *Indicators*.

than males (see Table 1 in the Appendix). This phenomenon results from the gender bias against girls, which prompts parents to underinvest in their daughters' education.[21] Females' enrollment in primary and secondary schools tends to be higher in higher-income countries (see Figures 2 and 3).

Providing education to females can improve their standard of living and improve their health knowledge.[22] Education develops positive behaviors and habits among young mothers who can offer quality care to their children and others in their communities.[23] Increased access to education is the driving force of a trained and highly skilled labor force.[24] Universal basic education alleviates poverty and enhances productivity, thereby boosting growth.[25] More importantly, education develops the positive behaviors and habits among young mothers who can offer quality care to their children and those in their communities.[26]

3.2. *INCOME*

Another determinant of child mortality is income.[27] Countries and households with higher income are more likely to have lower child mortality rates.[28] By using cross-country panel data of childhood mortality by gender, Ueyama finds that income growth is associated with lower female child mortality in most developing countries, including South Asia.[29] Increased income results in higher nutrition intake and healthcare.[30]

There is a large gap in child mortality between low and higher-income countries (see Figure 6 below). When considering data between 1969 and 2012, low-income countries had the highest child mortality rates. However, child mortality rates declined in low-income countries from 236 to 82 during that period. There is a large gap between low- and middle-income countries in terms of child mortality. The gap, however, shrank from

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21 World Bank, *Women's Education in Developing Countries: Barriers, Benefits, and Policies* (Maryland: Johns Hopkins UP, 1993).

22 Bixby Center, *Can Sending Girls to School Help Reduce Maternal Mortality? Highlights of Bixby Center Research in Zaria, Northern Nigeria*, Berkely, CA, 2010, http://bixby.berkeley.edu/can-sending-girls-to-school-help-reduce-maternal-mortality.

23 Ann Veneman, "Education Is Key to Reducing Child Mortality the Link between Maternal Health and Education." *UN Chronicle* (World Health Organization, 2007), http://www.who.int/pmnch/topics/mdgs/2008unchronicle_aveneman.pdf.

24 *Ibid*.

25 *Ibid*.

26 *Ibid*

27 Claeson *et al.* "Reducing Child Mortality."; JBG Tilak, *Socioeconomic Correlates of Infant Mortality in India,* (Washington, DC: The World Bank Group, 1991).

28 Lucia Hanmer, Robert Lensink, and Howard White, *Infant and Child Mortality in Developing Countries: Analyzing the Data for Robust Determinants* (2003), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.194.4950&rep=rep1&type=pdf.; Denisard Alves and Walter Belluzzo, "Child Health and Infant Mortality in Brazil." *Inter-American Development Bank* (2005), http://www.iadb.org/res/publications/pubfiles/pubR-493.pdf.

29 Mika Ueyama, *Income Growth and Gender Bias in Childhood Mortality in Developing Countries*, (Washington, D. C.: International Food Policy Research Institute, 2007).

30 *Ibid*.

78 in 1969 to 37 in 2012. High-income countries experienced the lowest child mortality during the 1969-2012 time period, which reached an all-time low of 6 in 2012. Income levels, therefore, appear to be inversely associated with child mortality.

3.3. *INADEQUATE HEALTHCARE SERVICES*

Studies show a correlation between the health of the mother and that of the child.[31] Research on Bolivia, Brazil, and Jamaica shows the importance of enhancing antenatal and delivery care in the developing world to reduce child mortality.[32] In India, the mother's poor health, nutrition, antenatal care, obstetric and other health services, and inadequate deliveries are found to lead to the child's low birth weight and prematurity.[33] Healthcare accessibility can often be difficult for newborns and their mothers in developing countries. The World Bank reports that immunization and vitamin A are two of the most cost-effective interventions to bolster infants' immune system and lower their likelihood of death.[34]

3.4. *FOOD INSECURITY*

Malnutrition is one of the primary reasons for slow physical and mental development of children.[35] A basic minimum amount of food supply is needed to ensure sufficient nutrients for children's development.[36] Nutrition can be measured directly by assessing the amount of food before consumption.[37] Malnutrition accounts for an estimated 54% of child mortality worldwide.[38] India is an example of a country with a high under-five child mortality rate, and over half of under-four-year-olds in India are malnourished and 30% of infants are considerably underweight.[39]

3.5. *EARLY PREGNANCY*

Infants who are born to adolescent girls between the ages of 15 and 19 experience increased complications from pregnancy and higher rates of death during childbirth.[40] Each year, one in every ten births is to a mother aged 14 and under.[41] Thirty three percent of women have children before they reach the age of 20 in developing countries, ranging from 10% in East Asia to 55% in West Africa.[42] Women in these age groups in

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31 Claeson *et al.*, "Reducing Child Mortality."

32 *Ibid.*

33 Ware, "Effects of Maternal Education."

34 World Health Organization and United Nations Children's Fund, *Integration of Vitamin A Supplementation with Immunization: Policy and Programme implications, Meeting report (WHO/EPI/GEN/98.07)*, (Geneva: WHO, 1998): 4-12.

35 A. Measham and M. Chatterjee, *India Wasting Away: The Crisis of Malnutrition in India*, (Washington, DC: The World Bank Group, 1998).

36 Mosley and Chen, "An Analytical Framework."

37 *Ibid.*

38 Claeson *et al.*, "Reducing Child Mortality."

39 K. Subbarao. *Improving Nutrition in India: Policies and Programs and Their Impact*. Washington, DC: The World Bank Group (1989).

40 STC, "Children Having Children."

41 *Ibid.*

42 Anne Boyd, *The World's Youth 2000*,(Washington, DC: Population Reference Bureau, 2000).

third world countries are particularly vulnerable to problems arising from pregnancy and childbirth due to the lack of healthcare and education.[43] Their infants tend to be delivered prematurely, have low birth weight, die during the first month, and not receive quality healthcare and nutrition.[44] Early pregnancy, therefore, is a crucial determinant of child mortality.

3.6. *EXCLUSION OF MOTHERS AND CHILDREN*

Social exclusion is a phrase used to describe a situation where a society fails to include all groups and individuals in the process of fulfilling their potential.[45] It is defined as the inequalities that result from limited entitlement and restricted access to resources that "compounds vulnerability, restricts prospects for upward mobility, and increases the probability of inter-generational chronic poverty."[46] Indicators of social exclusion include economic capability, gender, age, caste, and religion.[47] In India, caste serves as an indicator of social exclusion.[48] Socially marginalized groups are more inclined to live in poverty and dire conditions.[49] They tend to have worse health status and health services than the average population.[50]

DATA

1. *DATA DESCRIPTION*

The dataset used in this study is the World Development Indicators developed by the World Bank. This dataset was chosen due to its extensive coverage of various indicators gathered from officially-acknowledged international sources available from 1968 to 2013 for 214 countries.[51] It presents the most updated and accurate worldwide development data and encompasses national, regional, and global estimates.[52]

Based on the analysis of the causes of child mortality above, the policy memo includes data on five variables. The dependent variable is under-five child mortality (Mor-

43 STC, "Children Having Children."

44 STC, "Children Having Children."

45 K.R. Nayar, "India's Country Experience in Addressing Social Exclusion in Maternal and Child Health Addressing Social Exclusion in Maternal and Child Health." *World Conference on Social Determinants of Health*, (World Health Organization, 2011), http://www.who.int/sdhconference/resources/draft_background_paper8_india.pdf.

46 Janet Gardener and Ramya Subrahmanian, "Tackling Social Exclusion in Health and Education: Case Studies from Asia." *Eldis* (2006) http://www.eldis.org/fulltext/tackling-social-exclusion.pdf.

47 Gardener and Subrahmanian, "Tackling Social Exclusion."

48 Nidhi Sadana "Dalit Children in Rural India: Issues Related to Exclusion and Deprivation." *Indian Institute of Dalit Studies* (2009), http://www.dalitstudies.org.in/wp/0905.pdf.

49 Nayar, "India's Country Experience."

50 Sadana, "Dalit Children in Rural India."

51 World Bank, *Indicators*.

52 World Bank, *Indicators*.

tality).[53] The variables of interest are primary and secondary school enrollment for females[54] (Primary_enroll and Secondary_enroll). The two control variables are GDP per capita (GDPpct)[55] and fertility rates (Fertility).[56] Health services are not included due to its high correlation with GDP per capita. Data on food insecurity and exclusion of mothers and children is not available. These variables thus are excluded from the study. The initial hypothesis based on the reviewed literature is that primary and secondary school enrollment and GDP per capita have a positive relationship with child mortality. Fertility, on the other hand, has a negative association with child mortality. Eighty-six observations were deleted due to missing data, leaving the dataset with 128 observations.

The summary statistics for the sample are presented in Table 2 in the Appendix. A perusal of the data reveals that there is a wide range of data on the variables. Mortality rates range from 3 to 198, while GDP per capita goes from $185 to $153,042. Primary school enrollment among females is higher than secondary school enrollment, indicating a high rate of dropouts at secondary schools. The distributions of the data on five variables are shown in Figure 5 in the Appendix. The distribution of GDP per capita is heavily skewed to the right, suggesting that it is helpful to log the data to make the distribution normal. This transformation allows for the use of linear regression, which assumes that the dependent variable is normally distributed over the explanatory variable (Classical Assumption I).

Child mortality and GDP per capita has a negative relationship (see Figure 6 and Table 3 below). At low levels of GDP per capita, child mortality tends to be considerably high. As the income level increases, child mortality rates are likely to decline. When GDP per capita exceeds $60,000, child mortality is relatively rare. For countries with GDP per capita less than $2,000, the average number of deaths per 1,000 children is 86. In countries where GDP per capita ranges from $2,000 to $5,000, the average number of deaths per 1,000 children declines to 32. For upper middle-income countries with GDP from $5,000 and $10,000, the figure remains low at 17 deaths per 1,000 children. Wealthy nations with GDP higher than $10,000 have 7 deaths per 1,000 children.

The scatterplots in Figure 9 show that female primary and secondary school enrollment are inversely associated with child mortality (see Appendix). Bivariate regression results indicate that the coefficients of both independent variables are statistically and substantively significant (see Table 1 below). First, as more women enroll in prima-

53 It is "the probability per 1,000 that a newborn baby will die before reaching age five" (World Bank, *Indicators*).

54 "Percentage of female students in gross enrollment ratio which is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown" (World Bank, *Indicators*).

55 "GDP per capita is gross domestic product divided by midyear population" (World Bank, *Indicators*).

56 "Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates" (World Bank, *Indicators*).

ry schools, child mortality in a country goes down. The bivariate regression results confirm this preliminary observation. The coefficient of Primary_enroll is (-0.79), indicating that a one percent increase in primary school enrollment among females is associated with a decrease of 0.79 under-five child deaths per 1,000 children.

Second, countries where more women enroll in secondary schools have lower child mortality rates. The downward relationship between secondary education and child mortality is more pronounced and stronger than that of primary education and child mortality. The bivariate regression findings demonstrate that a one percent decrease in secondary school enrollment among females leads to a declined in 1.21 under-five child deaths per 1,000 children. The impact of secondary education, as also shown in Figure 6, is stronger than that of primary education.

$$Mortality_i = \beta_0 + \beta_1 Primary\_enroll_i + \varepsilon_i$$
$$Mortality_i = \beta_0 + \beta_1 Secondary\_enroll_i + \varepsilon_i$$

2. *ISSUES WITH DATA*

There are three main issues with the data that need to be taken into consideration when the estimates of the model are examined.

2.1. *OMITTED VARIABLE BIAS*

One should take precaution when interpreting the bivariate relationships between mortality and school enrollment rates due to the potential for omitted variable bias. This specification error occurs when one fails to include all the pertinent independent variables.[57] An omitted variable is defined as a crucial independent variable that is excluded from a regression equation. The omitted variable(s) not only prevents an estimate of the coefficients of primary and secondary education, but also creates bias in other variables in the equation. In other words, omitted variable bias can cause the expected value of the estimated coefficients of primary and secondary school enrollment among women to be significantly different from the true value of the population coefficients.

If there is omitted variable bias, the estimated coefficients are not unbiased, do not have minimum variance, or both.[58] Potential omitted variables in this study are the presence of conflict in a country, food insecurity, and the level of exclusion of mothers and children. If the omitted variable's impact on the outcome and its relationship with the included independent variables are in the same direction, it will cause an upward bias in the coefficients of education and a downward bias otherwise. The previously mentioned potential variables, however, are not included in the model due to the lack of data.

2.2. *MULTICOLLINEARITY*

Including too many variables in the model to avoid the omitted variable bias can

57 A.H. Studenmund, *Using Econometrics: A Practical Guide*, (Boston, MA: Addison Wesley, 2001).

58 *Ibid*.

cause another problem with the data: perfect collinearity between two explanatory variables. This issue occurs when two independent variables are "the same variable, or that one if a multiple of the other, and/or that a constant has been added to one of the variables."[59] Since the two variables move at the same time, the OLS estimation will fail to distinguish one variable from the other. This violates Classical Assumption VI, which assumes no perfect multicollinearity. Even when the explanatory variables are not perfectly multicollinear but are very highly correlated, the standard errors of the estimates will increase, causing t-scores to be lower. The collinearity problem is more severe among the explanatory variables in model 2 than in model 1 (see Tables 3 and 4).

2.3. *HETEROSKEDASTICITY*

The residuals are regressed on the explanatory variables to check for heteroskedasticity. The results demonstrate evidence of heteroskedasticity. At different levels of primary and secondary school enrollment, logged GDP per capita, and fertility, the dispersion of the residuals changes (see Figures 10 and 11). Data points are more concentrated at the lower end of school enrollment. This indicates that more countries have low primary and secondary school enrollment rates among women than those with high enrollment rates. Heteroskedasticity violates Classical Assumption V, which assumes a constant variance in the error term.[60] The White test is used to examine whether heteroskedasticity exists. The White test detects heteroskedasticity by regressing the squared residuals as the dependent variable on the explanatory variables.[61] The p-values are less than 0.01, indicating that we cannot reject the null hypothesis that there is no heteroskedasticity in the data at the 1 percent significance level. In other words, the data sample has the heteroskedasticity problem. Nevertheless, it is still useful to use OLS with robust standard errors to estimate the predictive power of the independent variables.

Methods

This study uses ordinary least squared regression to test the theory that countries where more women are more highly educated have less child mortality. The memo examines whether primary and secondary school enrollment for females is statistically and substantively significant. The conservative significance level of 5 percent is used due to the long-term importance of educational policy that might result from this study. The 5 percent level of significance is widely used to test hypotheses in research.[62] The t-statistic (with 124 degrees of freedom in each model) is used since population standard deviations are unknown.

Two pairs of hypotheses were generated. The first null hypothesis is that primary school enrollment for females aged 15 and above has no relationship with under-five child mortality (H_0: $\beta_{Primary} = 0$). The alternative hypothesis is that primary school enroll-

59 *Ibid.*

60 *Ibid.*

61 *Ibid.*

62 *Ibid.*

ment for females aged 15 and above is negatively associated with child mortality (H_a: $\beta_{Secondary} < 0$). The second null hypothesis is that secondary school enrollment for females aged 15 and above has no relationship with child mortality (H_0: $\beta_{Secondary} = 0$). The alternative hypothesis is that primary school enrollment for females aged 15 and above is negatively associated with child mortality (H_a: $\beta_{Secondary} < 0$). Primary and secondary school enrollment are estimated in two separate models since they are relatively highly correlated with a score of 0.189, which can overestimate standard errors of the estimates and lower the t-value, thereby underestimating the significance of the estimates. The models are shown below:

$$Mortality_i = \beta_0 + \beta_1 Primary\_enroll_i + \beta_2 \ln(GDPpct_i) + + \beta_3 Fertility_i + \varepsilon_i \quad (1)$$

$$Mortality_i = \beta_0 + \beta_1 Secondary\_enroll_i + \beta_2 \ln(GDPpct_i) + + \beta_3 Fertility_i + \varepsilon_i \quad (2)$$

RESULTS

With the above model specification, Ordinary Least Squared regression is used to estimate the coefficients. Robust standard errors are also included to correct for heteroskedasticity. The bivariate and multivariate regression findings are presented below:

RESULTS 1: BIVARIATE AND MULTIVARIATE REGRESSION RESULTS FOR MODEL (1)

Bivariate model				
	Coefficient	Std. Error	t-value	p-value
Primary enrollment	-0.79	0.26	-3.02	< 0.01
Adj-R_2	0.06			
N	128			
Multivariate model (OLS standard errors)				
	Coefficient	Std. Error	t-value	p-value
Primary enrollment	-0.26	0.12	-2.19	0.03
Log of GDP per capita	-6.72	1.64	-4.10	< 0.01
Fertility	18.33	1.65	11.06	< 0.01
Intercept	68.94	23.35	2.95	< 0.01
Adj-R_2	0.81			
N	128			
Multivariate model (White robust standard errors)				
	Coefficient	Std. Error	t-value	p-value
Primary enrollment	-0.26	0.19	-1.36	0.17
Log of GDP per capita	-6.72	2.25	-2.99	< 0.01
Fertility	18.33	2.82	6.48	< 0.01
Intercept	68.94	40.44	1.70	0.09
Adj-R_2	0.81			
N	128			

In model 1, all three independent variables are significant at the 5% significance level when the ordinary least squares (OLS) standard errors are used. When robust standard errors are used, however, the standard errors increase, reducing the magnitude of the t-values. The coefficient of primary school enrollment loses its statistical significance, whereas those of logged GDP per capita and fertility remain statistically significant at the 5% significance level. The magnitudes of the coefficients of all variables stay the same.

This study focuses on the results that use robust standard errors. The intercept is 68.94, which is the value of mortality rates when the variables included in the equation take on a value of zero. This scenario is highly unlikely and not helpful for the analysis. Primary school enrollment has a coefficient of (-0.26), indicating that a 1% increase in primary school enrollment is associated with a decrease of 0.26 child deaths per 1,000, holding other factors constant. This result, however, is not statistically significant at the 5% significance level. The magnitude of this coefficient is smaller than that in the bivariate regression which is (-0.79). This explains that there was indeed omitted variable bias in the bivariate model which attributed part of the negative impact of GDP per capita to primary school enrollment. The adjusted R_2 increased dramatically from 0.05 to 0.81, indicating that the multivariate model has more predictive power. It explains 81% of the variation in child mortality. The coefficient of logged GDP per capita is (-6.72), meaning that a 1% increase in GDP per capita is associated with a decrease of 0.0672 child deaths per 1,000 children, holding other factors constant. The coefficient of fertility is 18.33, suggesting that a decrease in 1 childbirth to a woman during her child-bearing years is associated with a decline in 18.33 deaths per 1,000 children, holding other factors constant. This result is particularly substantially significant considering the magnitude of the decrease.

RESULTS 2: BIVARIATE AND MULTIVARIATE REGRESSION RESULTS FOR MODEL (2)

Bivariate model				
	Coefficient	Std. Error	t-value	p-value
Secondary enrollment	-1.21	0.06	-20.14	< 0.01
Adj-R_2	0.76			
N	128			
Multivariate model (OLS standard errors)				
	Coefficient	Std. Error	t-value	p-value
Secondary enrollment	-0.57	0.10	-5.36	< 0.01
Log of GDP per capita	-1.04	1.78	-0.58	0.56
Fertility	13.83	1.78	7.75	< 0.01
Intercept	51.99	16.42	3.17	< 0.01
Adj-R_2	0.84			
N	128			
Multivariate model (White robust standard errors)				
	Coefficient	Std. Error	t-value	p-value
Secondary enrollment	-0.57	0.12	-4.46	< 0.01

Log of GDP per capita	-1.04	2.27	-0.46	0.64
Fertility	13.83	2.17	6.37	< 0.01
Intercept	51.99	19.55	2.66	< 0.01
Adj-R_2	0.84			
N	128			

In model 2), secondary school enrollment and fertility rates are statistically significant at the 1% significance level, but logged GDP per capita is not in the models using OLS and robust standard errors. This paper focuses on the results using the robust standard errors. The coefficient of secondary school enrollment is (- 0.57), which indicates a more powerful predictive power than primary school enrollment (-0.26). It means that a 1% increase in the number of women enrolling in secondary school leads to a decrease of 0.57 child death per 1,000, holding other factors constant. The magnitude of the coefficient of secondary school enrollment in the multivariate model (-0.57) is still smaller than that in the bivariate model (-1.21). This suggests that the omitted variable bias in the bivariate model caused a downward bias in the coefficient of secondary school enrollment. The Adj-R_2 of the multivariate regression is 0.84, meaning that it can explain 84% if the variation in child mortality, which is better than the Adj-R_2 of 0.81 in the bivariate regression. What is puzzling here is the lack of significance of logged GDP per capita. This may be due to the fact that secondary school enrollment is highly correlated with GDP per capita with a Pierson score of 0.83. This highlights the problem of severe multicollinearity in the data sample. The correlation score between primary school enrollment and GDP per capita is 0.09 in model (1) where logged GDP per capita is statistically significant.

This analysis uses OLS regressions with robust standard errors examine the relationship of education and mortality at different levels of GDP per capita. Countries are divided into four groups corresponding to four levels of GDP per capita: (1) less than $2,000, (2) $2,000 to $5,000, (3) $5,000 to $10,000, and (4) more than $10,000. The results are presented below. The relationship of primary school enrollment and child mortality is statistically insignificant at the 5% significance level at different levels of income. The negative association between secondary school enrollment and child mortality is statistically significant at the 5% significance level only for countries with GDP per capita less than $5,000 and not for nations where GDP per capita exceeds $5,000. For countries whose GDP per capita is less than $2,000, a 1% increase in female school enrollment is associated with a decrease of 0.64 deaths per 1,000 children. In nations where GDP per capita ranges between $2,000 and $5,000, a 1% increase in female school enrollment is associated with a decline of 0.81 deaths per 1,000 children. The relationship of secondary school enrollments for females and child mortality, therefore, is strongest for lower middle countries with GDP per capita from $2,000 and $5,000.

RESULTS 3: RELATIONSHIP OF FEMALES' PRIMARY SCHOOL ENROLLMENT AND CHILD MORTALITY AT DIFFERENT LEVELS OF GDP PER CAPITA (WHITE ROBUST STANDARD ERRORS)

GDP per capita	Coefficient	Std. Error	t-value	p-value
Less than $2,000	-0.28	0.24	-1.15	0.25
$2,000 – $5,000	-0.37	0.38	-0.97	0.34
$5,000 – $10,000	-0.46	0.26	-1.74	0.09
More than $10,000	0.22	0.15	1.41	0.16

RESULTS 4: RELATIONSHIP OF FEMALES' SECONDARY SCHOLL ENROLLMENT AND CHIL MORTALITY AT DIFFERENT LEVELS OF GDP PER CAPITA (WHITE ROBUST STANDARD ERRORS)

GDP per capita	Coefficient	Std. Error	t-value	p-value
Less than $2,000	-0.64	0.23	-2.79	< 0.01
$2,000 – $5,000	-0.81	0.27	-2.96	< 0.01
$5,000 – $10,000	-0.07	0.12	-0.59	0.56
More than $10,000	-0.05	0.04	-1.22	0.23

DISCUSSION

The findings respond to the policy question by highlighting the significance of promoting education, especially secondary education, among girls in order to lower under-five mortality. Based on the results presented in this paper, policymakers should encourage women to pursue secondary education since it is beneficial not only to themselves but also to the future generation of their countries. A focus on secondary education will enhance the quality of human resources that are conducive to sustainable growth. The women and under five children that will benefit the most from this policy recommendation are those in low- and lower-middle-income countries in high-risk regions such as Sub-Saharan Africa and South Asia.

However, further research is warranted to more adequately assess the findings of this policy study and allow for more effective new programs. The study has four main limitations. First, this research looks at GDP per capita as an explanatory variable that helps explain child mortality. However, child mortality can also explain GDP per capita. In other words, countries that have high rates of child mortality tend to be less developed. There is a pressing need to establish the causal relationship between GDP per capita and child mortality. Second, GDP per capita can be a strong predictor of all of the potential causes of child mortality such as education, health services, nutrition, and mother/child exclusion. A better dataset would contain times-series cross-sectional data on all of the relevant explanatory variables of child mortality such as nutrition levels and the mother/child exclusion. One needs to parse out the separate effects of GDP per capita and other explanatory variables to sufficiently assess the predictive power of education. Third, the data in the study has the issues of omitted variable bias, heteroskedasticity, and high correlation among explanatory variables. Lastly, the study has yet to establish the causal relationship of females' secondary school enrollment and child mortality. Future research needs to address these limitations to more accurately estimate the effects of education on under-five child mortality.

CONCLUSION

This paper presents a cross-sectional analysis of the relationship of primary and secondary school enrollment and under-five child mortality. This research shows that secondary education is negatively associated with lower child mortality and should be encouraged among women, particularly those in high-risk developing countries. The memo recommends new programs that promote secondary education among women that includes health training for pregnant women and young mothers. However, due to the limitations of the study, further research is needed for policymakers to design and implement effective policies that have long-term effects on mothers and their children. Further investigations should consider factors that may affect child mortality rates that have yet to be addressed in this policy memo. These factors include the number and quality of health facilities regardless of income levels, access to immunization, and religious beliefs about the effectiveness of healthcare on preventing child mortality. The causal relationship between secondary education and child mortality also needs to be established to determine the potential impact of increasing secondary school enrollment for females on child mortality.

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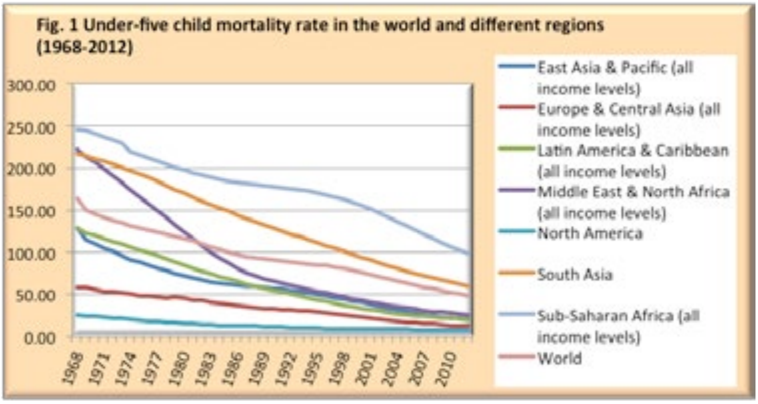
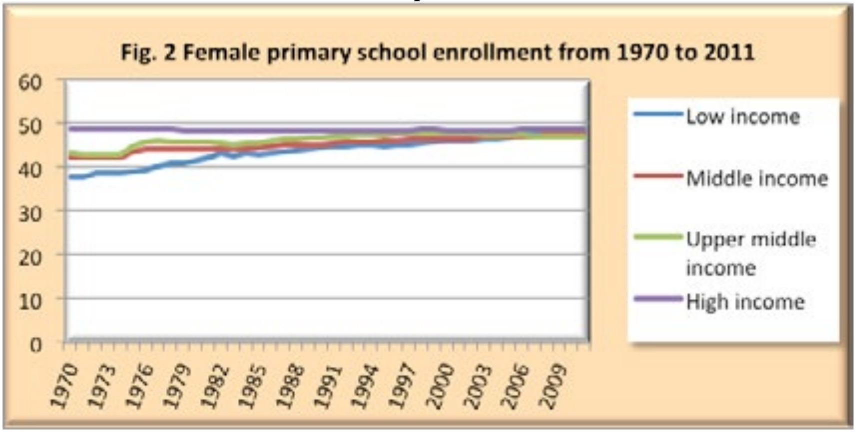
APPENDIX



Source: World Development Indicators (2013)



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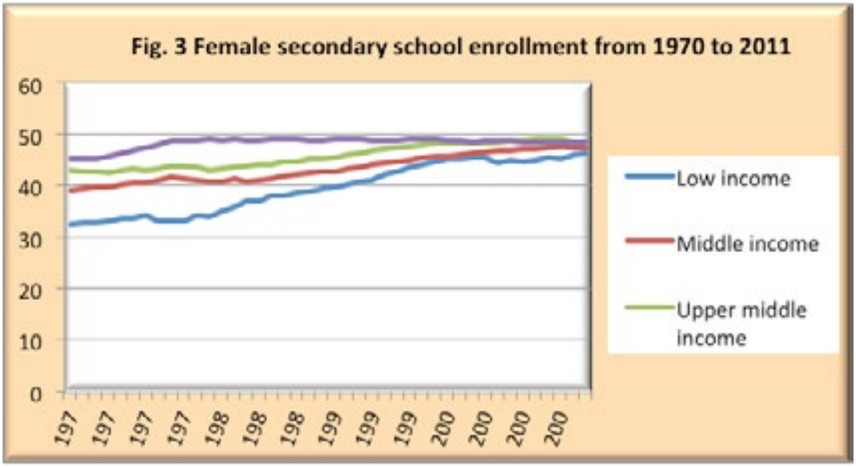
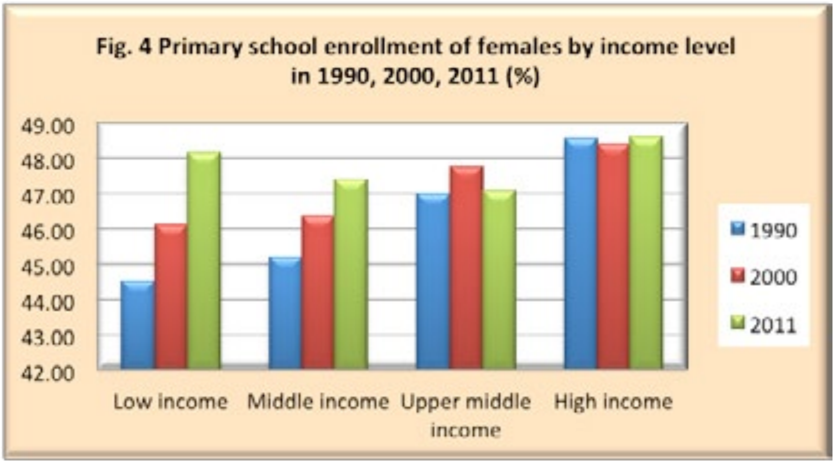


Source: World Development Indicators (2013)

TABLE 1: LITERACY RATES BY INCOME LEVEL IN 1990, 2000, 2011

Income level	Literacy rate (% of persons ages 15 and above)	1990	2000	2011
Low income	Female	41.45	49.42	53.99
	Male	60.29	65.99	68.79
Middle income	Female	62.03	74.45	77.72
	Male	78.80	86.33	88.17
Upper middle income	Female	73.28	87.54	91.39
	Male	87.35	94.04	95.80
High income	Female	NA	NA	NA
	Male	NA	NA	NA

Source: World Development Indicators (20



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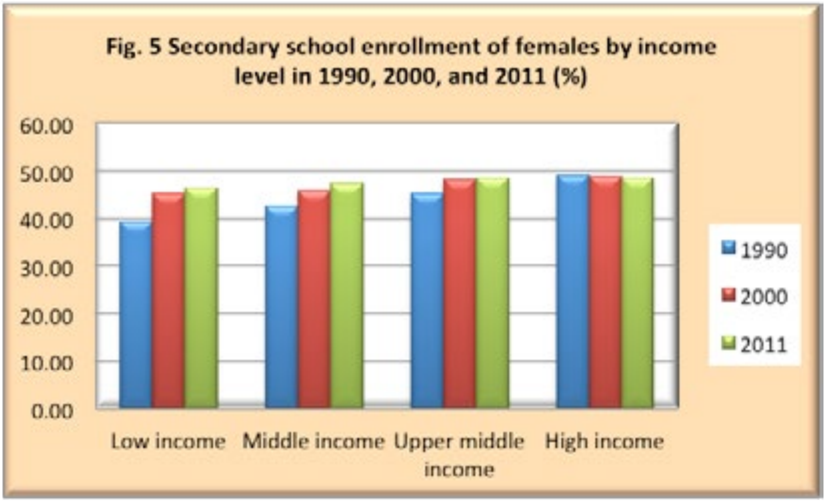
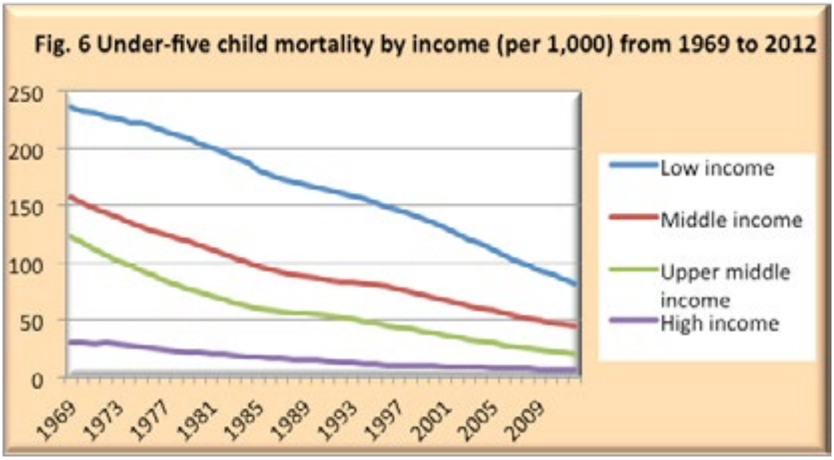


Source: World Development Indicators (2013)



Source: World Development Indicators (2013)

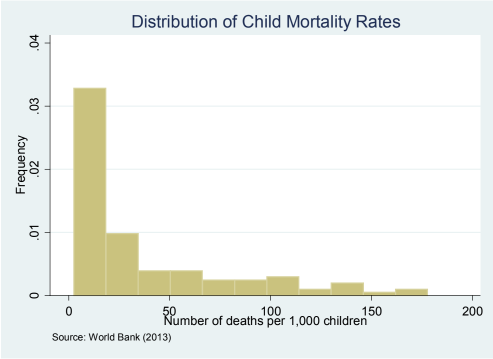
TABLE 2: SUMMARY STATISTICS

Variable	N	Mean	Std. Dev.	Min	Max
Mortality	128	36.53	41.80	2.6	177.9
Primary_enroll	128	102.48	13.63	40.01	148.24
Secondary_ Enroll	128	79.48	29.97	9.10	126.41
GDPpct	128	12,181.76	15,991.64	185.23	78,457.42
Fertility	128	2.82	1.54	1.14	7.58

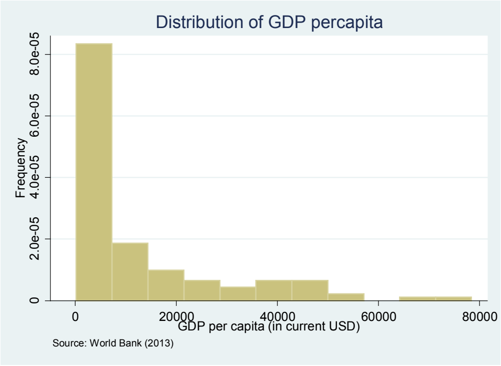
Source: Data from the World Bank (2013)

FIGURE 7: DISTRIBUTION OF DEPENDENT AND INDEPENDENT VARIABLES

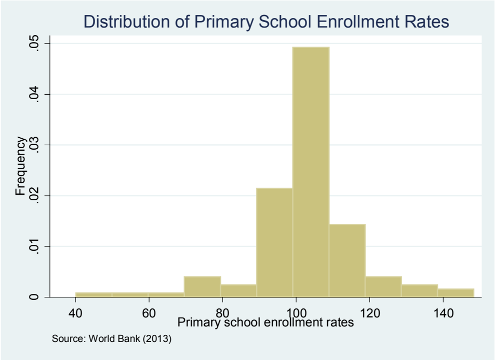
7a.



7b.



7c.



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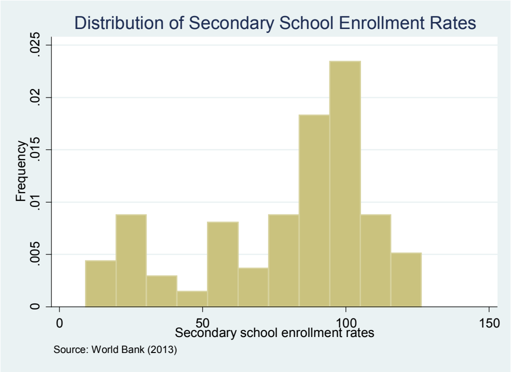
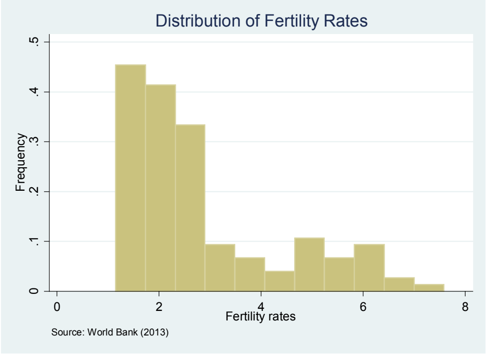


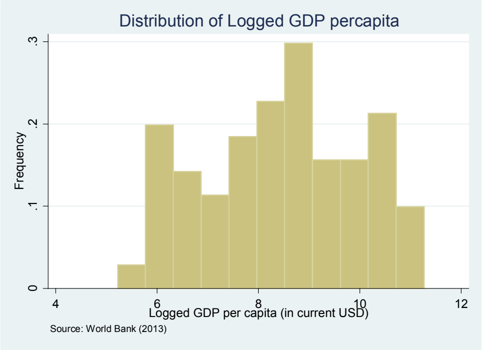
Distribution of Secondary School Enrollment Rates
Frequency
0
.005
.01
.015
.02
.025
0
50
100
150
Secondary school enrollment rates
Source: World Bank (2013)

7e.



Distribution of Fertility Rates
Frequency
0
.1
.2
.3
.4
.5
0
2
4
6
8
Fertility rates
Source: World Bank (2013)

7f.



Distribution of Logged GDP percapita
Frequency
0
.1
.2
.3
4
6
8
10
12
Logged GDP per capita (in current USD)
Source: World Bank (2013)

FIGURE 8: SCATTERPLOT OF CHILD MORTALITY AND GDP PER CAPITA

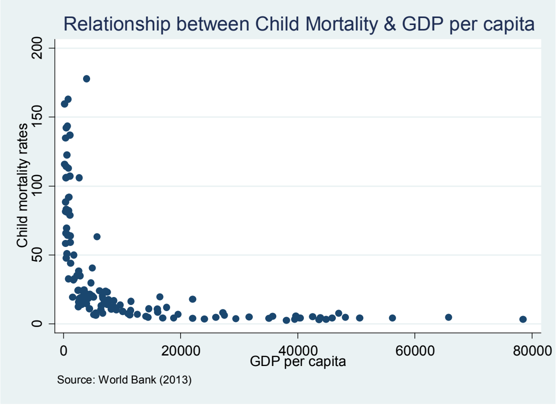


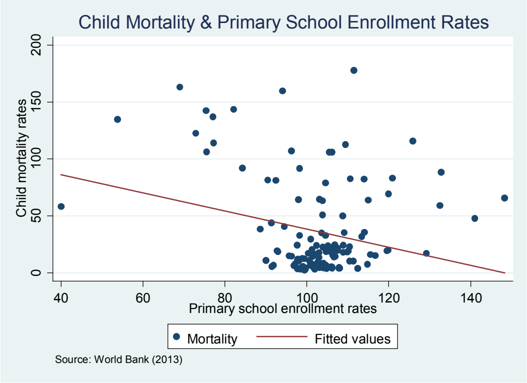
TABLE 3: CHILD MORTALITY AT DIFFERENT LEVELS OF GDP PER CAPITA

GDP per Capita	# of Observations	Mean	Std. Dev.	Min	Max
Less than $2,000	37	85.95	37.41	19.4	163.1
$2,000 – $5,000	26	32.16	34.84	10.9	177.9
$5,000 – $10,000	23	16.73	11.39	6.2	63.1
More than $10,000	42	6.54	3.95	2.6	19.6

Source: World Bank (2013)

FIGURE 9: SCATTERPLOT OF CHILD MORTALITY AND SCHOOL ENROLLMENT RATES

9a.



9b.

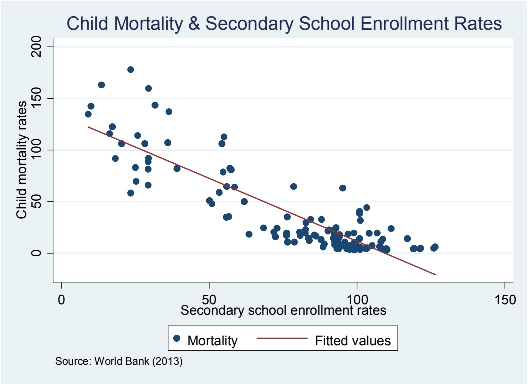
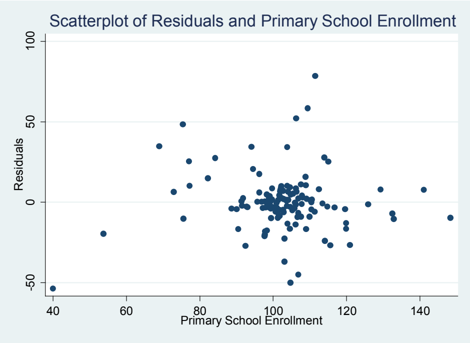


TABLE 4: CORRELATION OF RESIDUALS AND EXPLANATORY VARIABLES IN MODEL 1

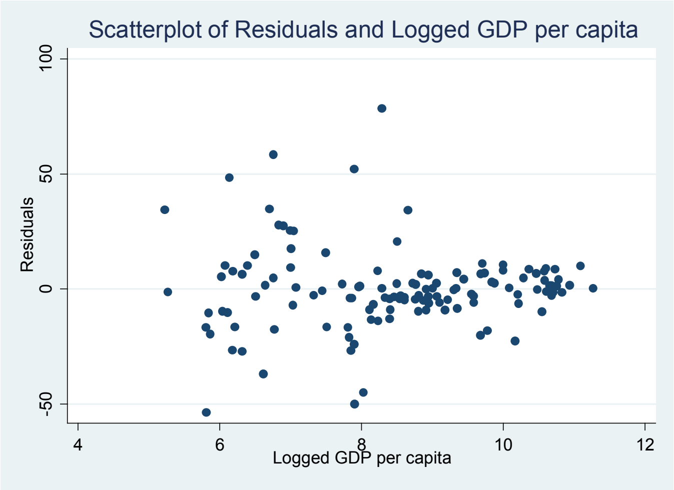
Model 1	Residuals	Primary school enrollment	Logged GDP per capita	Fertility rates
Residuals	1.00			
Primary school enrollment	0.00	1.00		
Logged GDP per capita	0.00	0.08	1.00	
Fertility rates	0.00	-0.22	-0.76	1.00

FIGURE 10: SCATTERPLOT OF RESIDUALS AND EXPLANATORY VARIABLES IN MODEL 1

10a.

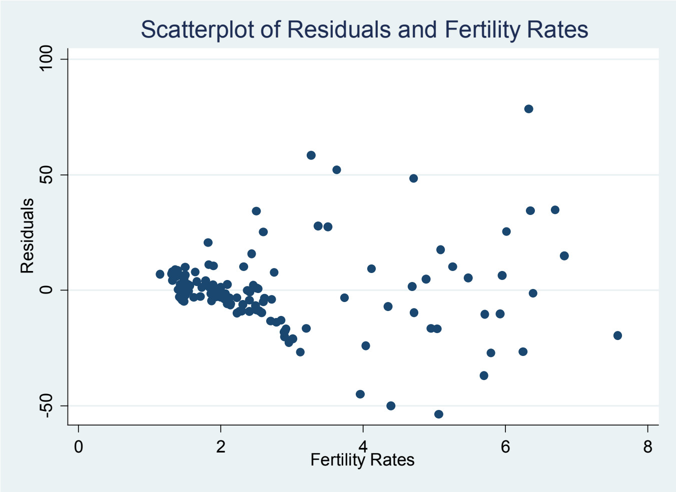


10b.



Scatterplot of Residuals and Logged GDP per capita
Residuals
-50
0
50
100
4
6
8
10
12
Logged GDP per capita

10c.



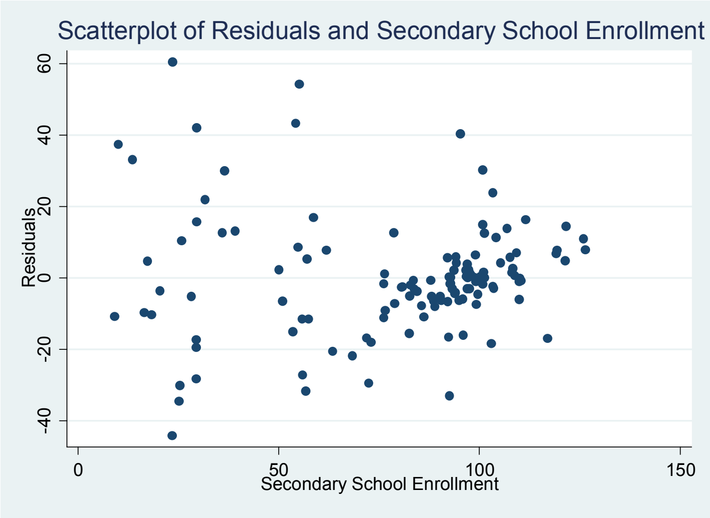
Scatterplot of Residuals and Fertility Rates
Residuals
-50
0
50
100
0
2
4
6
8
Fertility Rates

TABLE 5: CORRELATION OF RESIDUALS AND EXPLANATORY VARIABLES IN MODEL 2

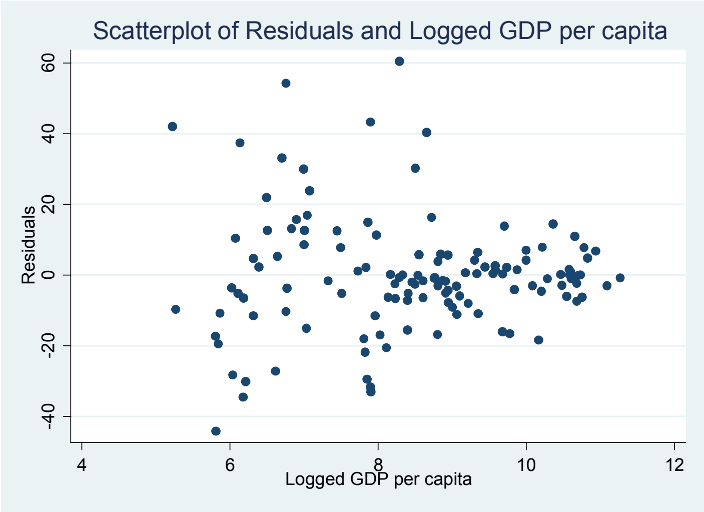
Model 1	Residuals	Secondary school enrollment	Logged GDP per capita
Residuals	1.00		
Secondary school enrollment	0.00	1.00	
Logged GDP per capita	0.00	0.83	1.00
Fertility rates	0.00	-0.83	-0.76

FIGURE 11: SCATTERPLOT AND EXPLANATORY VARIABLES IN MODEL 2

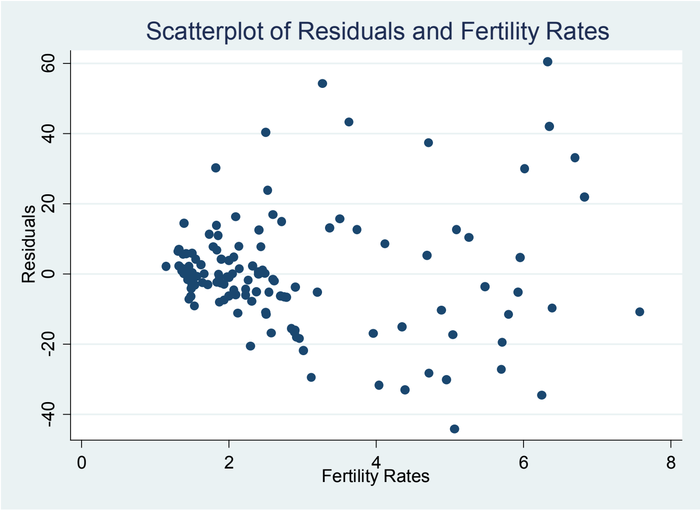
11a.



11b.



11c.



Scatterplot of Residuals and Fertility Rates
Residuals
60
40
20
0
-20
-40
0
2
4
6
8
Fertility Rates