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THE IMPACT OF HOUSEHOLD WEALTH ON CHILD SURVIVAL IN GHANA

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ABSTRACT

This paper pools four waves of data from Demographic and Health Surveys (from 1993 to 2008) to examine the impact of household wealth status on child survival in Ghana. The Weibull hazard model with gamma frailty was used to estimate the general wealth effect, as well as the trend of wealth effect on child's survival probability. We find that household wealth status has a negative and significant effect on the hazard rate. Thus a child is more likely to survive when he/she is from a household with high wealth status. Even though wealth effect declined over the years, the risk of death for children from the poorest households was about 1.7 times higher than those from the richest households. Among other factors, birth spacing and parental education are found to be highly significant to increase a child's survival probability.

Keywords: *Child survival, wealth, Weibull hazard model, Gamma frailty, Ghana*

1. Introduction

Efforts to improve child health in the developing world have recently become one of the major targets of national governments and international organizations, since countries will give a definite account of their efforts to achieve the Millennium Development Goals (MDGs) by 2015 (Smith and Haddad, 2015). Throughout the past two decades, a number of strategies were proposed and implemented in order to reduce child mortality and improve child health in developing nations. Some of these strategies include improving health care financing, improving access to healthcare, increasing educational level, and most importantly, efforts to reduce poverty. Despite all these efforts, under-five and infant mortality rates still remain high in many developing nations.

Among the strategies listed, economic development and poverty reduction are deemed as major strategies that affect child health outcomes. For example, Pritchett & Summers (1996) found that more than half a million child deaths, which occurred in developing world in 1990 alone, could be attributed to poor economic performance in the 1980s. Thus economic development would contribute to child survival in a major way. If the state of the economy is better, it would increase the average income of the population, which would then increase capital for further investments (Boyles et al, 2006), and also improve infrastructure, which would then positively affect individuals in the population.

In Ghana, the question as to what extent does economic circumstances of households reduces infant and child mortality still remain largely unanswered. Thus, the purpose of this study is to investigate the extent to which wealth affects the survival of under-five children, using data from the Demographic and Health Survey (DHS) of Ghana. We infer that households' wealth reduces under-five mortality rate, since children from wealthier households may be exposed to less health shocks than children from poor backgrounds, given that rich parents are able to provide nutritious food, clean water and a safe environment (amongst other factors) for their children. In this sense, we expect the household wealth to be substitute to publicly offered child health care and public infrastructure in general. Given that public health care and infrastructure have improved in the decades, we also expect that the wealth effects might be reduced over time. Thus, we additionally investigate if the effects of wealth on under-five mortality have reduced overtime.

Mostly due to data limitation, different studies used "socioeconomic status" of the household to study this relationship. Most of these studies found a positive relationship between socioeconomic effect and child health (Khanam, Nghiem and Connelly, 2014, Khanam, Nghiem and Connelly, 2009, Cameron & Williams, 2009; Currie & Stabile, 2003; and Case, Lubotsky & Paxson, 2002). The most common variable used as a proxy for socioeconomic status of the household in recent past has been maternal educational status (Basu & Stephenson, 2005; Cleland & Van Ginniken, 1988; Caldwell & McDonald, 1982; Cochrane, Leslie & O'Hara, 1982). Unlike these studies, other studies have the perspective that data on income would give a better picture of socioeconomic effect on child mortality and survival (Pritchett & Summers, 1996; Casterline, Cooksey & Ismail, 1989). However, in the absence of income, consumption or expenditure data, various studies have suggested that household assets and characteristics when weighted appropriately using the Principal

Component Analysis could be used as proxy for the household wealth (Gwatkin, Rutstein, Johnson, Pande & Wagstaff, 2000; Filmer & Pritchett, 2001; Rutstein & Johnson, 2004; Reinbold, 2011; Chalasani 2012; Chalasani and Rutstein, 2014).

This paper uses this strategy and makes several contributions to the literature. First, to the best of our knowledge, this is the first study in Ghana that combines four cross sectional data sets from DHS to study a policy-relevant question. Further, we use Principal Component Analysis (PCA) to measure wealth status of the households in the absence of data on income, consumption and expenditure in DHS. As we use information on household's assets and characteristics from four data sets from DHS for the years of 1993-2008 to construct wealth index, therefore, the wealth index we use serves as a long-term robust measure of household's economic situation compared to income and expenditure. Second, we extend Standard Weibull hazard model into Weibull hazard model with gamma frailty, which gives us a more accurate estimation of the effect of wealth status on child survival. Finally, the findings of this study are of interest not only because they provide insights into the determinants of child health in Ghana and other developing countries, but they also suggest policies beyond the scope of health. This requires policy makers to collaborate with sectors outside of health in order to maximize the health of children.

2. Econometric Model

2.1 Duration Analysis using Weibull Hazard Model

Duration analysis was employed to determine the effect of wealth and other variables on the risk of death. Data used to examine this relationship is a cross-section survey data with retrospective question on the state of children who are 5 years or below. In the DHS dataset, we observe either the age of the child at the survey date or age of death; indicating that the data consist of both completed durations and right censored durations.

The major advantage of using this model is its ability to account for the sequential nature of the data; its ability to handle censoring and also its ability to incorporate time varying covariates. In this case, using a proportional hazard model makes it possible to estimate age pattern mortality. This is done through the estimation of hazard rate which refers to the chances of making a transition from the current state at each instant conditioned on survival up to that point. The major difference between the various duration models is determined by the distribution that the function follows (Jenkins, 2005).

It is widely believed that the conditional probability of a child's survival increases as he/she progresses in age; thus child survival is subject to "negative duration dependence". Substantial policy interventions have been carried out in Ghana that promised an increase in child survival on the assumption that negative duration dependence is a pervasive phenomenon. This study estimates the duration dependence effects using the Weibull Hazard Model. The model adopted for this duration analysis is a flexible parameterization which is useful when the relationship we observe monotonically increases or decreases or it is flat with respect to time; it permits the baseline hazard to change with time, thus, capturing duration dependency.[1] We estimate a simple child survival function that is a function of socioeconomic and proximate factors:

$$\lambda(x_i;\alpha,\beta,\theta_i) = \alpha t^{1-\alpha} \exp(x'\beta)\theta_i$$

Where x_i is a vector of socioeconomic and proximate determinants respectively for the *i*th child. Since we use a repeated cross section data, the covariates do not change with the survival time, and therefore the covariates do not have the time subscript. By assuming that all the covariates are exogenous, we rule out other selective factors or policy initiatives which improve for example the chances of survival of a child from a poor household. The term, θ i, represents unobserved heterogeneity, or frailty, associated with child survival which is assumed to be uncorrelated with the determinants in the survival function. We assume θ i, follows gamma distribution.

3. Data, Variables and Summary Statistics

3.1 Data description

The study uses data from the Demographic and Health Survey (DHS) which is the most detailed dataset on households and demographic characteristics in Ghana. It is a repeated cross sectional data. The surveys collect information on a wide set of variables at the individual, household and community levels and are conducted every five years. The

[1] Box-Steffensmeier and Jones (2004) described this using political science data. Similar model was used by Hong et al (2007). Choe (1981) also used it to study infant and childhood mortality. Model is further explained by Lancaster (1985). Also refer to Gutierrez (2008) on how to handle survey for survival analysis.

sample for the survey covers about 6,000 households in each round. Data was obtained by distributing questionnaires to women of reproductive age between 15 and 49 years, which asked, among other things, their birth history information. DHS dataset is divided into the following groups; birth, couple, household, individual, children, male, household member, verbal autopsy and geographic datasets. We use the children dataset which contains detailed child information as well as those of mother and the household.

In Ghana there have been five rounds of collection; but only four rounds of datasets from 1993, 1998, 2003 and 2008 were used in this analysis. 1988 datasets were not used since some key variables, such as categorical regional data, were missing from it. There were 2,204 observations in the 1993 wave, 3,298 in the 1998 wave, 3,844 in the 2003 wave and 2,992 observations in 2008 wave. After eliminating observations with incomplete information, our final sample contained 12,002 child year observations.

3.2 Variable description

Table 1 shows a description of the main variables used for our hazard function estimation. The selection of explanatory variables mostly follows prior literature, especially those suggested by Mosley and Chen (1984). Duration of survival for children was the main health indicator which ranges between 0-59 months because the questionnaire asks about children whose ages were 5 years or less from the date of the interview.

Wealth index was the main explanatory variable. It is constructed using the Principal Component Analysis (PCA) since the dataset does not contain household income or consumption or expenditure variable. (See Appendix I for the details of the computation of the wealth index). We identified the following variables that can characterize the household wealth; the household durable assets ownership that includes radio, television, refrigerator, bicycle, motorcycle, television, car; access to utilities such as electricity, having improved sanitation facility and having improved source of drinking water; housing characteristics, such as the type of floor material. The choice of variables was based on prior literature (Gwatkin, et al, 2000; Filmer & Pritchett, 2001; Rutstein & Johnson, 2004; Vyas & Kumaranayake, 2006).

Mother's age will be included in our hazard function analysis. We expect that teenage mothers may lack the experience in child up-bringing and this is likely to affect a child's survival. Both mother's and father's education will be included since parents' education were shown to be a determinant of child survival (Caldwell, 1979; Basu & Stephenson, 2005). Water and sanitation are deemed essential for child health (Smith & Haddad, 2015).[2] Having improved source of drinking water was considered as essential for the survival of children since unimproved sources of drinking water may likely carry organisms which could cause diarrhea, worms among others which could reduce the duration of survival. Having improved sanitary facility is an indicator of clean environment which may also reduce the duration of survival if sanitation is poor.

At the individual level, sex of the child, birth intervals and twin status among others were considered. For example, shorter birth interval can affect mother's health and

[2] Improved source of drinking water is defined as private or public piped water, borehole/tube well, protected dug well/spring and rain collection; and improved sanitary facility is defined as having a flush or pours flush into pipe sewer system, septic tank or pit latrine and ventilated improved latrine (WHO/UNICEF, 2009).

mother's attention for each child will reduce for each child. Mother's attention may further reduce when the children are twins and this might contribute to shorter survival duration.

Table 1: Description of variables used for analysis

Variables	Description
Duration	Age in months of the child at the time of survey. If the child is dead at the time of the survey, it shows child's age in month when the child died.
Household level	
Wealth Index	Continuous variable which represents the long run economic status of household
Poorest	= 1 if household is poorest quantile, 0 otherwise
Poor	= 1 if household is poor quantile, 0 otherwise
Middle	= 1 if household is middle quantile, 0 otherwise
Richer	= 1 if household is richer quantile, 0 otherwise
Richest	= 1 if household is richest quantile, 0 otherwise
Mothers' age (Years)	
Teenage mother	= 1 if mother at the time of birth of the index child was less than 20 years, 0 otherwise
20-29	= 1 if mother at the time of birth of the index child was aged 20 or higher less than 30years, 0 otherwise
30-39	= 1 if mother at the time of birth of the index child was aged 30 or higher less than 40years, 0 otherwise
Over 40	= 1 if mother at the time of birth of the index child was age 40 or above, 0 otherwise
Mothers' Education	
No education	= 1 if mother had never attended school, 0 otherwise
Primary	= 1 if mother had primary education, 0 otherwise
Secondary or Higher	= 1 if mother had either secondary or higher education, 0 otherwise
Fathers' Education	
No Education	= 1 if father had never attended school, 0 otherwise
Primary	= 1 if father had primary education, 0 otherwise
Secondary or Higher	= 1 if father had either secondary or higher education, 0 otherwise
Improved Water	= 1 if household's source of drinking water is approved by WHO/ UNICEF as improved, 0 otherwise
Improved Sanitation	=1 if household uses toilet facility approved by WHO/ UNICEF as improved, 0 otherwise
Individual Level	
Male	= 1 if sex of child is male, 0 otherwise
Birth Order	Indicates the order in which index child was born
Preceding Birth Interval (months)	Indicate the difference in months between the index child and previous child
Below 24	=1 if preceding birth interval is less than 24 months, 0 otherwise
24-36	= 1 if preceding birth interval is between 24-36 months, 0 otherwise
Above 36	=1 if preceding birth interval is above 36 months, 0 otherwise

Table 1 Continued

Variable	Description
#Children aged ≤5	Indicates the number of children in the household who are 5 years and below
Twin	= 1 if child was of multiple birth, 0 otherwise
Community Level	
Urban	= 1if location was classified as urban, 0 otherwise
Regional Distribution	
Southern Belt	= 1 if household is located in Central or Western or Greater Accra Region, 0 otherwise
Eastern-Volta	=1 if household is located in Eastern or Volta Region, 0 otherwise
Ashanti- Brong	= 1 if household is located in Ashanti or Brong-Ahafo Region, 0 otherwise
Northern Belt	=1 if household is located in Northern or Upper-East or Upper-West Region, 0 otherwise
Religion	
No Religion	= 1 if mother did not join any religious group, 0 otherwise
Christianity	=1 if mother was a Christian, 0 otherwise
Muslem	=1 if mother was a Muslim, 0 otherwise
Traditional	= 1 if mother joins any Traditional religious sect , 0 otherwise
Others	=1 if mother joins any other religious group, 0 otherwise

3.3 Summary Statistics

Table 2 shows the summary statistics of our main variables for all years under in the study. The average age of a mother was about 29 years in the 1993 wave. The average birth order is 3.5 in the same wave. This means that the average mother in our dataset must have had 3 to 4 children already. However, in the 2008 the average age of a mother was 30years while the index child may be the third child of the woman. Thus, the average age increased while the number of children decreased at this age. Even though the average number of mothers with some education increased over time, most of these mothers had only primary education. While the average number of households having improved source of water increased over time, households with improved sanitary facilities declined over time.

Table 2:Summary statistics of variables used for analysis

Variables	1993		1998		2003		2008	
	Mean	st-dev	Mean	st-dev	Mean	st-dev	Mean	st-dev
Duration	16.050	(10.745)	27.153	(17.837)	26.751	(17.597)	26.782	(18.088)
Household level								
Wealth Status	2.971	(1.430)	2.940	(1.422)	2.934	(1.402)	2.990	(1.423)
Poorest	0.218	(0.413)	0.214	(0.410)	0.207	(0.405)	0.208	(0.406)
Poor	0.183	(0.387)	0.200	(0.400)	0.202	(0.401)	0.194	(0.395)
Middle	0.208	(0.406)	0.215	(0.411)	0.235	(0.424)	0.199	(0.399)
Richer	0.191	(0.393)	0.170	(0.376)	0.162	(0.368)	0.200	(0.400)
Richest	0.199	(0.399)	0.199	(0.399)	0.194	(0.396)	0.200	(0.400)
Mothers' age (Years)	28.651	(6.783)	30.083	(7.150)	30.498	(7.140)	30.084	(7.019)
Teenage mother	0.127	(0.333)	0.072	(0.259)	0.069	(0.254)	0.071	(0.257)
20-29	0.495	(0.500)	0.478	(0.500)	0.447	(0.497)	0.470	(0.499)
30-39	0.351	(0.477)	0.359	(0.480)	0.395	(0.489)	0.375	(0.484)
Over 40	0.084	(0.278)	0.131	(0.338)	0.124	(0.330)	0.115	(0.319)
Mothers' Education								
No education	0.397	(0.489)	0.468	(0.499)	0.475	(0.499)	0.378	(0.485)
Primary	0.547	(0.498)	0.181	(0.385)	0.214	(0.410)	0.241	(0.428)
Secondary or Higher	0.055	(0.229)	0.351	(0.477)	0.311	(0.463)	0.380	(0.486)
Fathers' Education								
No Education	0.367	(0.482)	0.402	(0.490)	0.459	(0.498)	0.388	(0.487)
Primary	0.463	(0.499)	0.080	(0.272)	0.083	(0.276)	0.087	(0.282)
Secondary or Higher	0.170	(0.375)	0.517	(0.500)	0.457	(0.498)	0.525	(0.499)
Improved Water	0.508	(0.500)	0.544	(0.498)	0.594	(0.491)	0.768	(0.422)
Improved Sanitation	0.653	(0.476)	0.589	(0.492)	0.587	(0.493)	0.531	(0.499)
Individual Level								
Male	0.514	(0.500)	0.492	(0.500)	0.507	(0.500)	0.510	(0.500)
Birth Order	3.543	(2.254)	3.573	(2.370)	3.612	(2.341)	3.382	(2.216)

Table 2 continued

Variables	1993		1998		2003		2008	
	Mean	st-dev	Mean	st-dev	Mean	st-dev	Mean	st-dev
Individual Level								
Preceding Birth Interval (months)								
Below 24	0.096	(0.294)	0.104	(0.306)	0.104	(0.305)	0.106	(0.308)
24-36	0.278	(0.448)	0.260	(0.439)	0.257	(0.437)	0.236	(0.425)
Above 36	0.420	(0.494)	0.408	(0.492)	0.418	(0.493)	0.429	(0.495)
#Children aged ≤5	1.837	(0.962)	1.764	(0.992)	1.779	(0.941)	1.783	(0.981)
Twin	0.047	(0.211)	0.043	(0.204)	0.040	(0.196)	0.044	(0.205)
Community Level								
Urban	0.279	(0.448)	0.216	(0.411)	0.271	(0.445)	0.334	(0.472)
Rural	0.721	(0.448)	0.784	(0.411)	0.729	(0.445)	0.666	(0.472)
Regional Distribution								
Southern Belt	0.289	(0.453)	0.288	(0.453)	0.242	(0.429)	0.259	(0.438)
Eastern-Volta	0.216	(0.412)	0.197	(0.398)	0.153	(0.361)	0.169	(0.375)
Ashanti- Brong	0.277	(0.448)	0.204	(0.403)	0.270	(0.444)	0.236	(0.424)
Northern Belt	0.218	(0.413)	0.310	(0.463)	0.334	(0.472)	0.336	(0.472)
Religion								
No Religion	0.149	(0.356)	0.099	(0.299)	0.078	(0.268)	0.050	(0.218)
Christianity	0.672	(0.470)	0.636	(0.481)	0.657	(0.475)	0.661	(0.474)
Moslem	0.127	(0.332)	0.141	(0.348)	0.207	(0.405)	0.201	(0.401)
Traditional	0.051	(0.221)	0.097	(0.296)	0.057	(0.232)	0.086	(0.280)
Others	0.002	(0.048)	0.027	(0.162)	0.001	(0.032)	0.002	(0.048)

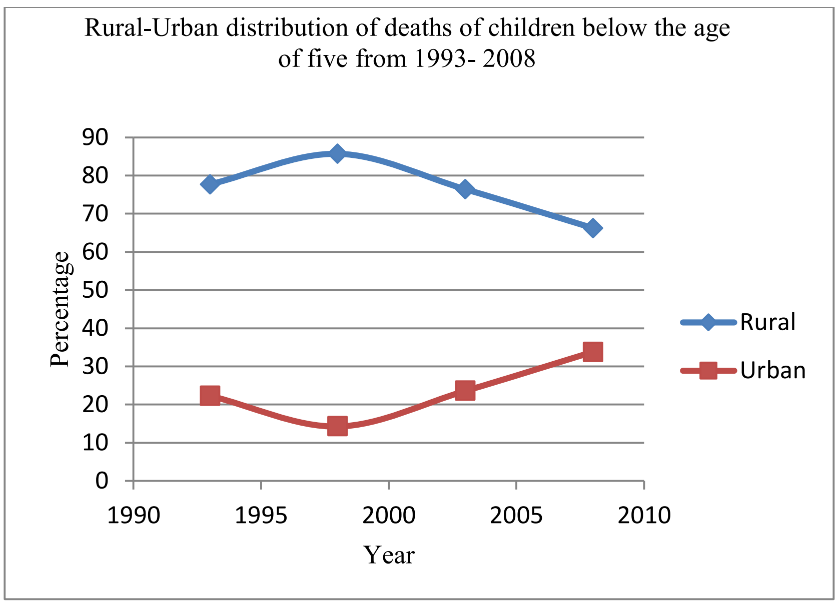
3.4 Rural-Urban distribution of mortality among children below age five

The number of deaths in our sample as well as under-five mortality rates[3] are illustrated in Figure 1. The mortality rate is measured as number of deaths per 1,000 live births. Figure 1 shows the trend in the number of deaths separately for urban and rural areas.

[3] Data source for mortality rates is from Ghana Demographic and Health Survey report (2008)

The figure indicates that under-five mortality is higher in the rural areas compared to the urban areas, but it also shows that under-five mortality in the rural areas is reducing over time while that of urban areas is increasing over the same period[4]. This may be due to the fact that the population in the urban areas was increasing which may have led to increased pressure on the health facilities in the urban areas; and therefore quality of health care for children in these areas may have deteriorated.

Figure 1: Rural-Urban Distribution of mortality among children below age five from 1993 to 2008



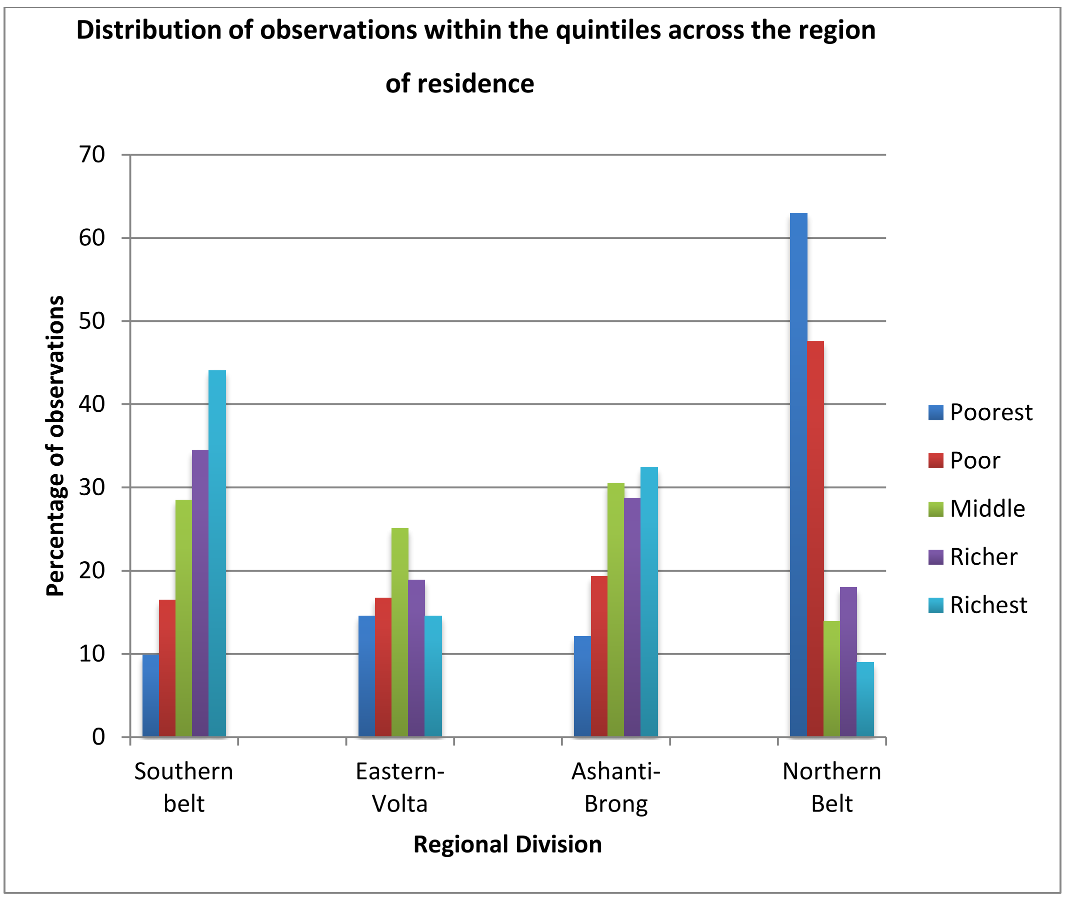
3.5 Distribution of wealth across regions

Figure 2 shows the distribution of observations (where one observation represents one child) across different levels of wealth (in quintile), separately for different regions.

[4] The percentage of deaths in the rural area was 77.7%, 85.7%, 76.4% and 66.2% in 1993, 1998, 2003 and 2008 respectively while in the urban areas it was 22.3%, 14.3%, 23.6% and in 1993, 1998, 2003 and 2008 respectively.

Sixty-three percent of children from poorest households are located in the Northern belt and in the same region only 9% of children are from richest households. This is the exact opposite for children who are located in the Southern belt. Forty-four percent of children in the Southern belt are from the richest household while 9% are from the poorest household.

Figure 2: Distribution of observations within the quintiles across the region of residence



4. Empirical Results and Discussion

4.1 Kaplan-Meier

Our main analysis is a hazard function analysis. Before we present the results from hazard function analysis, however, it is useful to first present Kaplan-Meier (K-M) graphs. Figure 3 shows the K-M survival estimate for all children under the age of five years. The graph suggests that about 6% of children die before they turn five years. Figure 4 shows the K-M survival estimate for infants only, and it also suggests that about 3% of children die before their first birthday.

Figure 3: Kaplan-Meier survival estimate for under-fives

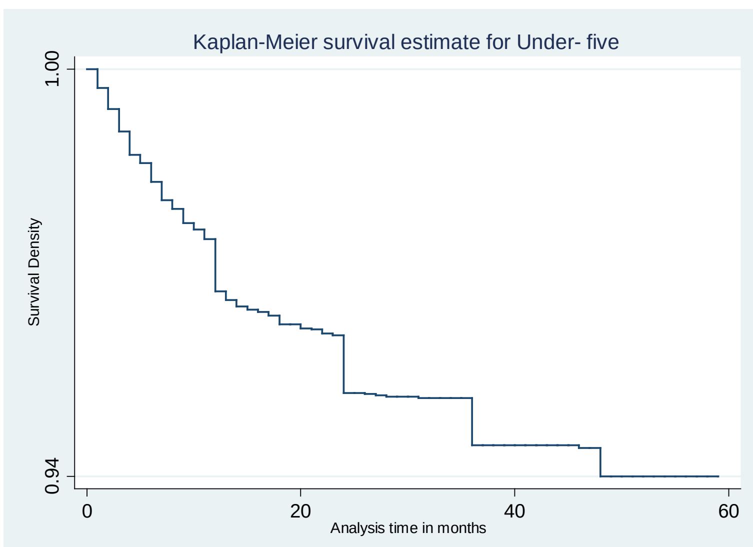
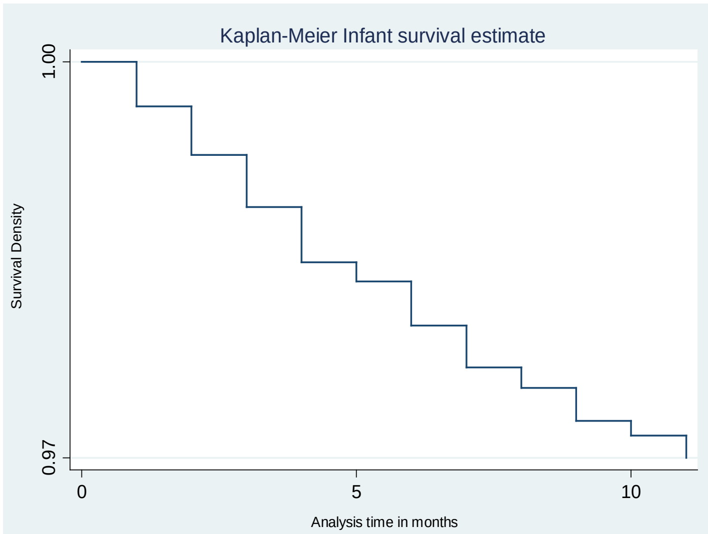


Figure 4: Kaplan-Meier survival estimate for Infants



4.2 Hazard Function Analysis

We used the standard Weibull hazard model with gamma frailty to estimate hazard function. We present the estimations from standard Weibull model in the Appendix in Table 3 for comparison with the standard Weibull model with gamma frailty. Before presenting the results, we briefly discuss some identification issues. The major identification problem which could lead to biased estimations and for which we are concerned with is reverse causality. In the study of the effects of income on health, income can affect health and inversely, health can affect income since one might not be able to work due to poor health, causing a reverse causality problem. However, the main subjects of this study are children below the age of five years. These children are less likely to contribute directly to the wealth of the household. Therefore reverse causality may be considered to be much less of a problem in this study. In addition to the fact that our subjects are children below age five, some studies, such as that of Acemoglu and Johnson (2007) showed in their study of the effect of life expectancy on economic growth that there was no evidence that increase in life expectancy which was mainly driven by child mortality, led to a faster growth of income per capita or output per worker. Thus, reverse causality does not substantially bias our estimate. Two other identification problems which could lead to biased estimations are how to account for unobserved heterogeneity and dependence[5] among observations. To account for these, we include a gamma frailty term in our model[6] (Box-Steffensmeier & Jones, 2004; Gutierrez, 2002, Klein and Moeschberger, 1997; Omariba, Beaujot & Rajulton, 2007). Thus the hazard function becomes a function of both the observed covariates and unobserved frailties associated with the individual.

Wealth Effect

Now, we turn to our results. Model 1 in Table 3 shows the estimates of effect of household wealth on the survival of all children under the age five. Household wealth status has a negative and significant effect on the hazard rate. Thus a child is more likely to survive when he/she is from a household with high wealth status. To understand the

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[5] An important assumption of the hazard model is that the observations are independent. However, data on children are collected from mothers who may have more than one child; therefore children may not be independent observations. Refer to Klein and Moeschberger, (1997) for detailed explanation.

[6] Model described by Box-Steffensmeier and Jones (2004) similar model used by Box-Steffensmeier, Linn & Smidt.(2013) Model also proposed by Hougaard (1995)

magnitude of the wealth effects more clearly, we computed the survival probability for the top and the bottom wealth quintiles, while holding others factors constant. Figure 5 shows the results, which suggests that the top wealth quantile households had about 3.5% child mortality while bottom quantile had child mortality of 5.5%. So the difference is 2% which is relatively high. Thus, the survival probability is lower for poorest but relatively high for the richest.

The findings of significant wealth effect on child mortality are consistent with of other studies (Chalasani and Rutstein, 2014; Chalasani 2012; Cameron & Williams, 2009; Currie & Stabile, 2003; Case, Lubotsky & Paxson, 2002). What then could be the source of these wealth effects in the Ghanaian situation? In Ghana, there is qualitatively significant difference between the rich and the poor. The rich are able to provide at least the basic needs of their households including nutritious food, safe water, enough sleeping rooms, safe environment and also pay extra medical bills among others. These basic needs are not met for poorest/ poor households. Thus children from low income families are more likely to be subject to more health shocks.

Table 3: Effect of wealth and other factors on risk of death among children in Ghana-Estimated with Gamma Frailty

Variables	All under-fives			Infants
	Model 1	Model 2	Model 3	Model 4
		Coefficient (s. e.)		
Household level				
Wealth Status	**-0.116****		-0.272**	**-0.095**
	(0.054)		(0.111)	**(0.072)**
Poorest		**0.523****		
		(0.234)		
Poor		**0.405***		
		(0.212)		
Middle		**0.298**		
		(0.195)		
Richer		**0.245**		
		(0.189)		
Mothers' age (Years)				
20-29	0.241	0.246	0.238	0.197
	(0.289)	(0.289)	(0.289)	(0.358)
30-39	0.087	0.093	0.070	0.126
	(0.315)	(0.316)	(0.316)	(0.399)
Over 40	-0.278	-0.269	-0.305	-0.389
	(0.389)	(0.370)	(0.371)	(0.485)
Mothers' Education				
Primary	0.0001	-0.002	0.009	0.128
	(0.139)	(0.139)	(0.139)	(0.889)
Secondary or Higher	-0.437***	-0.432***	-0.457***	-0.118
	(0.163)	(0.163)	(0.164)	(0.216)
Fathers' Education				
Primary	-0.195	-0.195	-0.184	-0.509**
	(0.173)	(0.173)	(0.174)	(0.248)
Secondary or Higher	-0.405***	-0.403***	-0.410***	-0.367*
	(0.137)	(0.137)	(0.137)	(0.183)
Improved Water	0.012	0.013	0.048	0.024
	(0.116)	(0.119)	(0.119)	(0.157)
Improved Sanitation	0.187	0.186	0.144	0.082
	(0.146)	(0.149)	(0.147)	(0.191)

- * Indicates significance at 10% level, ** Indicates significance at 5% and *** Indicates 1% significance level

Table 3: Continued

Variables	All under-fives			Infants
	Model 1	Model 2	Model 3	Model 4
	Coefficient (s. e.)			
Individual Level				
Male	-0.025	-.025	-0.028	0.016
	(0.099)	(0.099)	(0.099)	(0.133)
Birth Order	0.073**	0.072**	0.076**	0.065
	(0.033)	(0.033)	(0.033)	(0.046)
Preceding Birth Interval (months)				
Below 24	0.517***	0.514***	0.524***	0.711***
	(0.164)	(0.164)	(0.165)	(0.208)
Above 36	-0.499***	-0.501***	-0.502***	-0.493***
	(0.120)	(0.120)	(0.121)	(0.167)
# Children aged ≤5	-1.268***	-1.266***	-1.270***	-1.042***
	(0.075)	(0.075)	(0.075)	(0.098)
Twin	1.90***	1.810***	1.899***	2.047***
	(0.299)	(0.229)	(0.231)	(0.308)
Community Level				
Urban	-0.126	-0.114	-.0141	-0.206
	(0.143)	(0.147)	(0.145)	(0.194)
Regional Distribution				
Southern Belt	-0.357***	-0.362**	-0.350**	-0.417*
	(0.170)	(0.170)	(0.170)	(0.230)
Ashanti- Brong	-0.496***	-0.500***	-0.486***	-0.598**
	(0.179)	(0.179)	(0.180)	(0.244)
Eastern-Volta	-0.599***	-0.606***	-0.585***	-0.587**
	(0.197)	(0.199)	(0.198)	(0.259)
Religion				
No religion (Excluded category)				
Christianity	-0.167	-0.169	-0.131	-0.122
	(0.189)	(0.189)	(0.190)	(0.264)
Muslim	-0.577*	-0.584*	-0.559*	-0.357
	(0.297)	(0.298)	(0.299)	(0.382)
Traditional	-0.221	-0.222	-0.217	0.041
	(0.219)	(0.220)	(0.221)	(0.300)
Others	-0.098	-0.100	-0.063	-0.037
	(0.193)	(0.193)	(0.195)	(0.272)

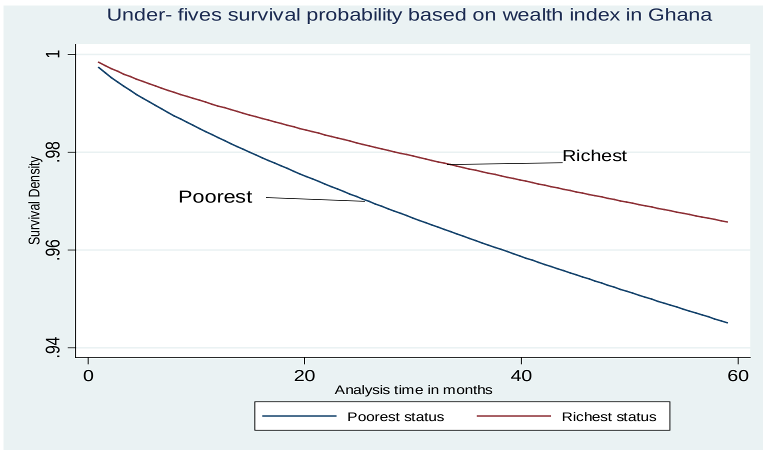
Table 3: Continued

Variables[7]	**All under-fives**			**Infants**
	Model 1	**Model 2**	**Model 3**	**Model 4**
	Coefficient (s. e.)			
Community Level				
Period				
Year 1998	0.338*	0.334*	-0.016	0.219
	(0.195)	(0.195)	(0.352)	(0.247)
Year 2003	0.126	0.123	-0.350	-0.122
	(0.195)	(0.195)	(0.374)	(0.250)
Year 2008	0.03	0.023	-0.721*	-0.026
	(0.206)	(0.206)	(0.412)	(0.261)
(Wealth) x (year 1993)			**-0.272****	
			(0.111)	
(Wealth) x (year 1998)			**0.135**	
			(0.121)	
(Wealth) x (year 2003)			**0.181**	
			(0.126)	
(Wealth) x (year 2008)			**0.277****	
			(0.135)	
Log α (Shape Parameter)	-0.226***	-0.227***	-0.224**	0.095
	(0.050)	(0.05)	(0.051)	(0.072)
Log Likelihood	-2290	-2290	-2287	-1388
Prob>Chi-Square	0.000	0.000	0.000	0.000
Theta, θ	1.305**	1.310**	1.374**	3.001*
	(0.669)	(0.669)	(0.695)	(2.427)
Prob>Chi-Square for θ	0.005	0.004	0.004	0.057

* Indicates significance at 10% level, ** Indicates significance at 5% and *** Indicates 1% significance level

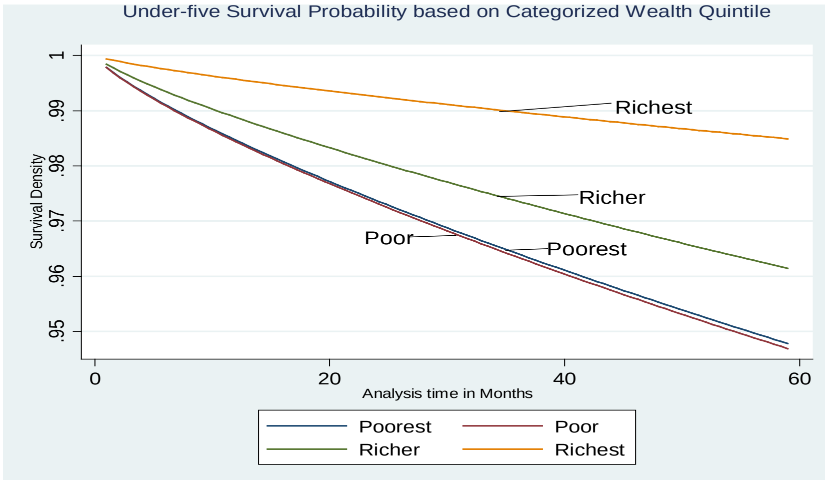
[7] Reference groups are as follows: Richest for wealth classes; below 20years for mothers age; no education for both mother's and father's education; unimproved water; unimproved sanitation; female; 24-36 months for preceding birth intervals; single birth for twin; rural for urban; northern belt regional distribution; no religion for Religion and year 1993 for the year categories.

Figure 5: Graph of Weibull survival rate by poorest and richest classes for under-fives



Model 2 controls for wealth as categorical dummies to capture possible non-linear effect, where wealth index is divided into wealth quintile dummies. In column 2, we found that the hazard of death was twice for a child from the poorest household compared to a child from a richest household. Holding all other factors constant, we computed the survival probability for all the quintiles. This is shown in Figure 6, which suggests that the richest class would have child mortality of 1.5% while the poorest has 5.5% by the 59th month; so the difference is 4%. From the graph, the survival probability for the poorest and the poor were almost the same and so is the difference between the richest and the poor. The difference is relatively higher compared to the earlier estimation which considered the coefficient of wealth status to be constant for all categories. The difference may be attributed to reasons as already discussed.

Figure 6: Graph of Survival Probabilities Based on Model 2



Model 3 examines if wealth effects have changed over time. In the past 20 years, Ghana has considerably improved its provision of reproductive and child health services. If the public health service is a substitute for household wealth, we would expect that wealth effect must decline over time. Thus model 3 includes interaction between wealth and year dummies to estimate this effect. As shown in Table 3 the effect of wealth in 1993 is negative and significant. However, the interactive coefficients are all positive and monotonically increasing over time, and therefore the wealth effects becomes gradually less negative over time. In fact in 1998, it is close to zero. Thus, the effect of wealth reduced over time. This is consistent with our expectation. The trend may be attributed to gradual strengthening of public health systems to support child health care over the years. For example vaccination trend has increased from 55% in1993 to 79% in 2008; household bed net use increased from 4% in 2003 to 39% in 2008; and between 1993 and 2008, health facilities including CHPS compounds increase by about 30% across Ghana[8] and National Health Insurance Scheme was introduced in 2003. However, the result of this study indicates that these efforts by Government will not be enough to improve under-fives' survival if it is not complemented with an increase in household wealth.

Other Determinants of Child mortality

Other variables which are also of interest are discussed below using the results mainly from Model 1. First, the risk of childhood mortality was significantly high for children born less than two years after a previous sibling whiles it was significantly low for children born more than three years after a previous sibling. A child born less than two years after a previous sibling was 1.7 [Exp(0.517)=17] times more likely to die whiles the risk reduced by a multiplicative factor of 61% among children born more than three years after a previous sibling. This may be due to many reasons; common among these are (1) competition for parents' limited time and resources; (2) the inability to allot enough time for a child if his/her birth was earlier than desired; and (3) most importantly the transmission of diseases among closely spaced siblings (DaVanzo, et al, 2004). Our results reaffirmed the importance of child spacing.

Furthermore, Children born to mothers who had at least secondary education had their risk of death reduced. This finding is consistent with Blunch (2013)'s finding on rural

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[8] Ghana Statistical Service (GSS) (2012): Multiple indicator cluster survey (MICS)

Ghana. Father's level of education was also highly statistically significant. Children born to fathers who have at least secondary education have their risk of death reduced. Whereas we find both parents education almost equally counted in determining child mortality, some studies (See for example, Chalasani and Rutstein (2014), Chalasani (2012), Caldwell, 1979) found mothers' education had a relatively higher impact on child mortality than fathers' education and any other socioeconomic factors. Breierova and Dufflo (2004) in their program evaluation in Indonesia similarly found that increase in both parents' education had a strong causal effect on the reduction of child mortality. The trend may be due to the changing socialization circumstances in Ghana where men have increasingly become more concern about child care; and it may further be due to the current nature of ante-natal health education which is gradually involving husbands of pregnant women.

Childhood risk of death reduced by a multiplicative factor of about 28% [Exp(-1.268)= 28%] when the number of children who were less than five years in a household reduced by one. Also, if the index child is a twin, hazard of death would increase by about 7 times compared to a child of single birth. The risk of children who are twin may be attributed to the same reasons as found in literature for birth intervals. However, the risk is seen to be very high for the twin child due to the fact that competition for parents' time occurs at the same time period and so handling twins becomes challenging for parents.

Improved water and improved sanitation did not have significant coefficients. This is perhaps due to the fact that those variables were used to construct wealth index. Thus, it could be that the effects of these variables were mostly captured by the wealth status. Also, urban dummy variable had negative but insignificant coefficient. This may appear contradict the Figure 1 that shows that urban areas generally had lower mortality rate throughout our sample period. The insignificant estimate may be due to the fact that most of the urban areas are concentrated in the Southern belt and Ashanti-Brong regions. Thus the regional dummies especially southern belt dummy may mostly capture the effect of urban area.

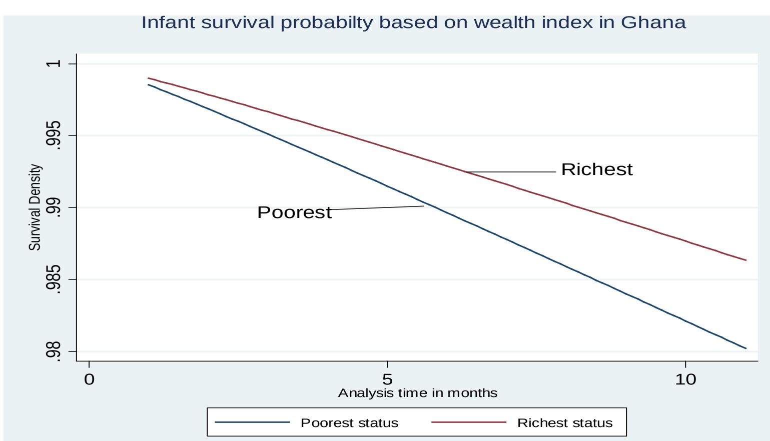
Even though it had weak significance, children born to Muslims households were less likely to die before reaching their fifth birthday than those born into households who had no religion. Furthermore, the risk of childhood mortality significantly reduced in relations to regional location of the household. The risk of dying for children born in households located in the Southern belt, Ashanti-Brong and Eastern-Volta reduced by a multiplicative factor of 70%, 61% and 55% respectively compared to those born within households in the Northern belt. Thus, a child faces a high hazard of death when he/she is located in a household in the Northern Belt.

The findings on regional location using child survival as a major indicator of household's economic status and by extension, the economic development of the region, are supported by findings by Overseas Development Institute and Centre for Policy Analysis (2005) of Ghana. They indicated that the three northern regions of Ghana which is captured as Northern belt in this study are persistently the poorest; and unfortunately, the stable economic growth which has been experienced in Ghana since the early 1990s has not extended to the north. Generally, the risk of child mortality reduced over the historic period under the study. The shape of the hazard rate, α is 0.59, which is less than 1, indicating that there is negative duration dependence. Thus, if children were alive for a longer period, they were less likely to die.

3.3 Robustness Check: Infant Survival

As shown in Table 3, model 4 shows a model restricted to the duration 0-11 months, as a robustness check. As can be seen, the sign of coefficients were un-altered, though the main explanatory variable was not statistically significant. The difference in survival between infants from poorest and richest households is illustrated in Figure 7 which shows that the poorest are less likely to survive compared to the richest over the same period. The insignificant estimate suggests that wealth status of the household is not a major determinant survival in infancy. The results is not out of place since it is theoretically known that at the early stages of life, biological and genetic factors mediate more in mortality; and income effect is expected to be stronger after infancy.

Figure 7: Graph of Weibull hazard rate by poorest and richest classes for Infants



4. Conclusion and Recommendation

Empirical evidence of the consequence of households' wealth status on child survival is scarce in developing countries, particularly in Sub-Saharan Africa. We use four waves of data from DHS for the historic years of 1993-2008 to study a policy-relevant question which has not been studied with Ghanaian data. Thus we estimate the effect of wealth on child survival in Ghana.

We found that household wealth status had a negative and significant effect on the hazard rate. Thus a child is more likely to survive when he/she is from a household with high wealth status. An upward move into the next highest class in wealth quintile by a household reduced the risk of child death by a multiplicative factor of 89%. Before reaching their fifth birthday, the risk of dying if a child is from the poorest household was about two times higher than one of the same age from richest household. This could be an indication that high under-fives' mortality rates experienced over the years have its sources rooted in the circumstances of the poorest/ poor households. However, we found that such disparity in survival rates by wealth status gradually reduced overtime. This may be due to an increased healthcare system in Ghana during this period.

Many reasons may account for the high risk seen among children in the poorest/poor households, thus household, health systems and program level mediators could account for this. For example, poor households cannot afford to provide basic needs of the children; they are unable to pay for extra medical bills aside what the National Health Insurance Scheme provides; and there could also be unequal access to health services; low human and material resources in facilities that serve the poor; low or sometimes the lack of technical quality of health care for the poor; and universality nature of programs which should alleviate poverty. It is known that a lot of efforts have been made to improve child survival in many developing countries including Ghana. However, due to the multi-facetted nature of the solution to reducing child mortality as observed in literature, there is the need to work much harder as we approach the end of 2015 when all countries will need to fully account for how far they have met the MDG 4, linking the achievements and failures to the Sustainable Development Goals (SDGs).

Improving universal access to health is important. However, various studies over the years and current studies have provided evidence that the risk of child mortality is highest among the poor; therefore there is an increasing need to appropriately target the poor. This could be done by making services more accessible to the poor, increase the availability of human and material resources in facilities that serve the poor; make available and increase technical quality of health care services to the poor (see, for example, literature review by Wagstaff, et al, 2004); and implementing policies which alleviate poverty and sustain wealth in deprived areas targeting such disadvantaged groups. However, the cost-effectiveness of such policy strategies is beyond this study and is recommended for future research. The study further recommends that as a developing country, Ghana needs to conduct studies that will help it appropriately target the poor before implementing the various pro-poor programs.

Other than wealth effect, we found the following results, which should also be emphasized. Estimates of this study suggest that preceding birth interval which is commonly known as "child spacing" had a significant effect on both infant and child survival. These finding are similar with studies by Rutstein (2008) and DaVanzo, et al (2004). Based on our findings, we recommend that policy makers should make it as part of their message when educating parents about family planning to wait at least 24 months after birth to conceive the next child in order to reduce the risk of death among children below the age of five. Common approaches to prolong child spacing are through the use of family planning methods and also effective parental education.

Another important finding of this study is the high risk of death in childhood when the index child is a twin. This may have similar reasons as those of child spacing, but in addition, competition for parent's limited time occurs at the same time and this is a formidable challenge for parents. This finding is similar to that of Uthman, Uthman and Yahaya (2008) and Hong (2006). The evidence suggests that it is important to have a considerable number of screening programs at the community level in order to identify high risk pregnancies and to refer them appropriately in order to reduce the risk. It is also important that once such high risk pregnancies are identified, the parents are given enough education on how to handle the children when they are born.

We found that an increase in both maternal and paternal education reduced the risk of death especially among children. This may be because educated parents become more capable to take steps to protect their children from diseases. Findings are similar to those of Breierova and Dufflo (2004). Thus educating both females and males is essential for child survival in Ghana.

We also find that survival in all children below age five years vary with the region of residence, when other variables are held constant. As already shown in the results section, children in the Northern belt had the highest risk of death. This is not to underscore the risk of deaths in households in the other regions; however this does suggest that it is only necessary that poverty reduction and wealth sustenance initiatives targeted the deprived regions, reduce and if possible totally mute regional disparities in order to improve the wealth status of households and in so doing, reduce the risk of dying among children below the age of five years in Ghana.

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Appendix I

Wealth index construction

We develop a proxy for the household economic status using the Principal Component Analysis. Research has shown that the use of PCA in the construction of the wealth index based on household assets and housing characteristics is robust, valid and correctly represents the long-run household economic status (Gwatkin, et al, 2000; Filmer & Pritchett, 2001; Rutstein & Johnson, 2004; Vyas & Kumaranayake, 2006; Chalasani 2012; Chalasani and Rutstein, 2014). PCA is a multivariate technique used to extract from a set of variables the few orthogonal linear combinations of the variables that capture the common information most successfully. In this, a number of variables in the data set are reduced into a smaller number of dimensions. First, the asset variables used are changed into indicator variables which are separately entered in a linear multivariate regression equation that will create weights on the variables; and so each principal component is a weighted linear combination of the original variable. From the set of correlated variables, the PCA extracts a set of uncorrelated principal components.

Supposed there are n correlated variables, X_1-X_n representing the number of assets in each household *i,* each variable is normalized by using its own mean and standard deviation.

$X_1 =(x_1 - x_1^*)/ S_1^*$, where x_1^* is the mean of all values of the first variable and S_1^* is its standard deviation. Given a set of variables from X_1 through to Xn, the principal components are expressed as:

$$PC_1 = \alpha_{11}X_1 + \alpha_{12}X_2 + \ldots + \alpha_{1n}X_n$$

$$\vdots$$

$$PC_m = \alpha_{m1}X_1 + \alpha_{m2}X_2 + \ldots + \alpha_{mn}X_n$$

Where,

α_{mn} is the coefficient or weight or the factor score for the *mth* principal component and the *nth* variable.

When PCA is used, the variance for each principal component (PC) is given by the eigenvalue of the corresponding eigenvector. Each principal component is the sum of each variable multiplied by its weight; weight is different for each variable in each principal component and is effectively defined by a factor score. The components are ordered such that the first principal component (PC_1) explains the largest part of variation in the original data and corresponds to the largest eigenvalue of the correlation matrix of X, subject to the constraint that the sum of the squared weights is equal to one $\left(a_{11}{}^2 + a_{12}{}^2 + \ldots + a_{1n}{}^2\right)$. PC_1 is uncorrelated to the second component and the other components which give additional variations; and PC_1 is assumed to represent the economic status.

It is important to note that the number of households in each wealth group is based on the factor scores obtained from the principal component analysis. Higher positive scores are assigned to variables that are more likely to be associated with the richer households while the negative scores are to those variables that are more likely to be associated with the poorer households. The higher the resulting score, the higher the contribution of that variable to the wealth index. Appendix Table 1 shows the principal components and Table 2 shows the scoring coefficients constrained on the fact that the sum of squares is equals to 1.

Table 1: Principal Components/Correlation for 1993, 1998, 2003 and 2008

Components	Eigenvalues			
	1993	**1998**	**2003**	**2008**
1	3.222	3.171	3.279	3.086
2	1.819	1.968	1.793	1.803
3	1.421	1.323	1.450	1.511
4	1.000	.985	.992	1.022
5	.895	.934	.910	.924
6	.857	.873	.828	.823
7	.725	.704	.787	.790
8	.663	.702	.688	.698
9	.582	.530	.479	.582
10	.434	.452	.447	.447
11	.383	.355	.348	.316
12	.002	.003	0	0

Table 2: Scoring Coefficients of standardized variables

Constraint: Sum of squares (column Loading) = 1

Variables	1993	1998	2003	2008
Radio	.275	.268	.176	.157
Television	.431	.448	.440	.466
Refrigerator	.436	.430	.433	.415
Bicycle	-.047	-.135	-.169	-.175
Motorcycle	.084	.083	.026	.017
Car	.255	.221	.253	.191
Electricity	.418	.430	.417	.460
Improved Water	.240	.240	.216	.085
Improved Toilet Facility	.068	.176	.254	.346
Cement/tile floor	-.212	-.032	-.170	.047
Wood type floor	.420	.367	.393	.291
Earth/mud floor	-.126	-.242	-.162	-.305

Appendix II

Table 3: Effect of wealth and other factors on child survival in Ghana-Estimated with Standard Weibull

Variables	All under-fives			Infants
	Model 1	Model 2	Model 3	Model 4
		Coefficient (s. e.)		
Household level				
Wealth Status	**-0.120****		-0.257**	**-0.096**
	(0.050)		(0.105)	**(0.067)**
Poorest		**0.523****		
		(0.234)		
Poor		**0.405****		
		(0.212)		
Middle		**0.298**		
		(0.195)		
Richer		**0.245**		
		(0.189)		
Mothers' age (Years)				
20-29	0.225	0.232	0.217	0.226
	(0.272)	(0.273)	(0.272)	(0.336)
30-39	0.136	0.147	0.119	0.197
	(0.295)	(0.296)	(0.295)	(0.369)
Over 40	-0.178	-0.164	-0.201	-0.183
	(0.344)	(0.345)	(0.345)	(0.446)
Mothers' Education				
Primary	(0.0030)	-0.002	0.004	0.155
	(0.127)	(0.127)	(0.127)	(0.173)
Secondary or Higher	-0.384**	-0.377**	-0.399***	-0.094
	(0.152)	(0.152)	(0.152)	(0.201)
Fathers' Education				
Primary	-0.148	-0.149	-0.134	-0.453*
	(0.160)	(0.160)	(0.160)	(0.229)
Secondary or Higher	-0.407***	-0.407***	-0.0409***	-0.374**
	(0.127)	(0.127)	(0.127)	(0.169)
Improved Water	-0.004	-0.009	0.028	0.007
	(0.107)	(0.110)	(0.110)	(0.144)
Improved Sanitation	0.256*	0.254*	0.128	0.128
	(0.133)	(0.135)	(0.134)	(0.177)

* Indicates significance at 10% level, ** Indicates significance at 5% and *** Indicates 1% significance level

Table 3 Continued

Variables	All under-fives			Infants
	Model 1	Model 2	Model 3	Model 3
	Coefficient (s. e.)			
Individual Level				
Male	-0.039	-0.039	-0.042	0.023
	(0.091)	(0.091)	(0.091)	(0.123)
Birth Order	0.059*	0.058*	0.061**	0.049
	(0.030)	(0.030)	0.030	(0.041)
Preceding Birth Interval (months)				
Below 24	0.361**	0.357**	0.362**	0.607***
	(0.141)	(0.141)	(0.141)	(0.180)
Above 36	-0.448***	-0.451***	-0.449***	-0.429***
	(0.110)	(0.110)	(0.111)	(0.150)
#Children aged ≤5	-1.185***	-1.183***	-1.185***	-0.973***
	(0.064)	(0.064)	(0.064)	(0.082)
Twin	1.571***	1.571***	1.566***	1.300***
	(0.175)	(0.175)	(0.175)	(0.211)
Community Level				
Urban	-0.074	-0.060	-0.083	-0.153
	(0.134)	(0.138)	(0.134)	(0.180)
Regional Distribution				
Southern Belt	-0.391**	-0.398**	-0.382**	-0.426**
	(0.155)	(0.156)	(0.155)	(0.209)
Ashanti- Brong	-0.514***	-0.516***	-0.497***	-0.595***
	(0.166)	(0.166)	(0.166)	(0.228)
Eastern-Volta	-0.632***	-0.641***	-0.618***	-0.59**
	(0.183)	(0.185)	(0.183)	(0.241)
Religion				
Christianity	-0.203	-0.205	-0.176	-0.123
	(0.173)	(0.173)	(0.174)	(0.244)
Moslem	-0.567**	-0.569**	-0.557*	-0.325
	(0.280)	(0.280)	(0.281)	(0.358)
Traditional	-0.208	-.0208	-0.207	0.057
	(0.203)	(0.203)	(0.204)	(0.278)
Others	-0.068	-0.069	-0.041	0.001
	(0.177)	(0.177)	(0.177)	(0.270)

* Indicates significance at 10% level, ** Indicates significance at 5% and *** Indicates 1% significance level

Table 3 Continued

Variables[9]	**All under-fives**			**Infants**
	Model 1	**Model 2**	**Model 3**	**Model 4**
		Coefficient (s. e.)		
Community Level				
Period				
Year 1998	0.254	0.249	-0.039	0.195
	(0.181)	(0.181)	(0.337)	(0.228)
Year 2003	0.093	0.087	-0.309	-0.142
	(0.183)	(0183)	(0.348)	(0.233)
Year 2008	0.021	-0.027	-0.682	-0.066
	(0.194)	(0.194)	(0.382)	(0.242)
(Wealth) x (year 1993)			**-0.257****	
			(0.105)	
(Wealth) x (year 1998)			**0.111**	
			(0.114)	
(Wealth) x (year 2003)			**0.155**	
			(0.118)	
(Wealth) x (year 2008)			**0.247****	
			(0.126)	
Log α (Shape Parameter)	-0.292***	-0.292***	-0.292***	0.039
	(0.042)	(0.042)	(0.042)	(0.059)
Log Likelihood	-2293	-2293	-2291	-1389
Prob>Chi-Square	0.000	0.000	0.000	0.000

* Indicates significance at 10% level, ** Indicates significance at 5% and *** Indicates 1% significance level

[9]Reference groups are as follows: Richest for wealth classes; below 20years for mothers age; no education for both mother's and father's education; unimproved water; unimproved sanitation; female; 24-36 months for preceding birth intervals; single birth for twin; rural for urban; northern belt regional distribution; no religion for Religion and year 1993 for the year categories.