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Living standards, Household size and Childhood Survival in Africa

Evidence from Census Data

Introduction

Despite twentieth century improvements in medicine and medical knowledge, which have led to unprecedented mortality decline in the developed and in many parts of the developing world, child survival still remains a formidable challenge in much of Africa. Childhood mortality decline witnessed in many African countries after World War II, beginning particularly in the 1960s through much of the 1980s clearly reflected improvement in child health and survival in these countries. The improvement in health culminating in mortality decline was credited to either improvement in public health and medical knowledge brought about by the importation of medical technology from the west or improvement in social and economic conditions, or both (Preston 1980; Caldwell 1986, 1993; Cleland and Ginnekan 1988). However, beginning in the mid-to-late 1980s, as a result of both deteriorating social and economic conditions caused by economic dislocations and the increasing incidence of infectious and viral diseases such as malaria and HIV/AIDS, there has been a considerable decline in child survival in a number African countries, as reflected in rising child hood mortality in a number of African countries (Hill 1993; Caldwell, 1997; Nicoll et al, 1994; Timaeus, 1997, 1999).

This paper examines the relationship between child survival and the social and economic context in which they live (herein referred to as living standards). This is accomplished by using household characteristics such as type of flooring or roofing materials, type of toilet and water facilities, source of cooking or lighting energy as well as other household amenities as indexes of household socioeconomic status, to proxy for living standards (Sastry 1996; Ayad, Barrere and Otto 1997; Montgomery et al. 2000; Filmer and Pritchett 2001). Proxy measures are used to index socioeconomic status or living standards because of the problems associated with measuring directly living standards in developing countries (Todaro 1978; Sen 1985, 1987, 1992; Mazumdar 1999).

Several studies have demonstrated the utility of these socioeconomic status variables in estimation of different demographic outcomes (Filmer and Pritchett 2001; Montgomery et al. 2000; Montgomery et al. (2000) have demonstrated that such proxy variables, however week they may be, are able to provide very useful information whose "power should be acceptable in most demographic applications". They noted among others, "…even weak proxies for consumption are able to detect departures from the null hypothesis. Secondly, demographers are fortunate to have access to relatively large samples, and large size samples further enhances the power of the proxy-based tests" (p. 170). Similarly, Filmer and Pritchett have also demonstrated the utility of such variables in estimation of education outcomes in India.

Household size has also been shown to have an impact on childhood survival or mortality (Manun'ebo et al.1994; Burstrom, Diderichsen and Smedman 1999). We hypothesized that large households may be negatively associated with child survival for two key reasons. First, large households may be associated with crowding which could trigger higher mortality in situations of epidemics, such as measles (Aaby 1984; Burstrom, Diderichsen and Smedman 1999). Second, larger households may also have a draining effect on the households' economic resources because these have to be distributed among a larger number of household members, thus having deleterious effects on children, especially given the current economic situation in most African countries (Farah and Preston 1982).

While the argument that larger households present increased mortality risks or lower survival chances for children, some researchers have found mixed results. For instance, Mahadevan et al. (1985) found household size to be negatively correlated with child mortality among the Harijans, but not with other groups in a district in the south-central region of India in the state of Andhra Pradesh. In fact, some researchers have indicated that larger households sometimes tend to have an augmentation effect (Butz et al. 1982;Locoh 1988). We therefore, propose to examine in addition to the living standard measures, the relationship between household size and childhood mortality among these five countries in Africa.

Living standards and their proxy measures

Measuring standard of living has historically been problematic because of the difficulty of defining an aggregate measure that captures the notion of well-being (Todaro 1978; Sen 1987; Mazumdar 1999). The use of per capita gross national product (GNP) as an indicator of human well-being was discovered in the 1960s to be inadequate, which led to a redefinition of well-being by economists and development theorists to include poverty reduction, inequality and unemployment (Todaro 1978). Sen (1985, 1987, 1992) argued that measures of standard of living must capture happiness, utility and choice; the ultimate objective being to enhance the well-being of people. Sen has particularly been very critical of the undue emphasis on income as a measure of well-being and rather advocated a basic needs approach through social indicators such as freedom of choice, the quality of the physical environment, etc.

The United Nations (UNDP 1990) suggested the use of a Human Development Index (HDI), which in principle also emphasizes the basic human needs approach. In particular, the HDI places emphasis on human longevity as reflected in life expectancy, acquisition of knowledge in terms of level of literacy and access to resources for a decent standard of living (UNDP 1990).

In line with the principles of the basic needs and human well-being approach, various modules have been included in surveys (The World Bank Living Standard Surveys designed purposely for this objective) and some census in developing countries as a way of capturing information that will give an indication of socioeconomic well-being in these countries where there is either no data on income or the data are not reliable. For instance, households equipped with pipe borne water, water closet (WC)/flush toilet within the household, use electricity as a source of cooking or lighting, etc for example, may be considered as high status households compared to those holds which rely or public toilet, use water from public or open wells and other community sources, etc. Having a private tap, flush toilet in the household, living in house constructed with modern building materials or any other such facilities involve a lot financial cost, therefore possessing or not possessing any of these might be an indirect indicator of the level of well-being. Consequently, it is possible to use these variables, either individually or as an aggregate, to differentiate households on the basis of their level of economic well-being -- thus households without any or have just a few of these amenities or characteristics might be considered less well off economically compared to those with most of these facilities.

A number of African censuses have collected information on some of these household level variables, in addition to individual level characteristics. This paper takes advantage of some of this information from the 1991 population census of Botswana, the 1996 Lesotho census and the 1990 census of Zambia, to create a composite index of living standards, which is used to predict child hood survival chances in the three countries. Examples of some of the information collected in these censuses include such individual level information as education and occupation of household members, their gender and household or community level variables such as place of residence, type of building materials, availability of electricity, access to clean water, type of toilet facilities, type of cooking fuel and possession of certain household items such as television, radio and animals (cattle, sheep, goats, etc.) (see table 1 for examples of variables collected in each of the three countries.

Creating a composite index from the individual items listed in table 1 or mentioned earlier elsewhere, presents very daunting challenges for several reasons. For example, the question that often arises is, how best can one deal with the issue of assigning weights when creating a composite index since each of the variables used in creating the index might have different levels of importance, both in terms of the outcome of interest and in different social context. For instance, one question that immediately comes to mind is, to what extent, for instance, is ownership of a television in the household as important as having pipe born water, as a marker of well-being? Or is ownership of cattle, for example, as important as ownership of a motor vehicle? And do these each of the variables command the same weight as a marker of wealth or economic status in both rural and urban areas? Researchers interested in this area have suggested different solutions (Ayad, Barrere and Otto 1997; Montgomery et al 2000; Filmer and Pritchett 2001), but as noted by Filmer and Pritchett, none of these methods can be anointed as "best practice". Duncan (1984) has argued that the problems associated with the creation of a composite index is almost next to impossible to solve, since in his view this has to do with combining "intrinsically heterogeneous components" (using Nicefero's term as cited by Duncan).

In this paper, I created a simple index by assigning a value of 1 for all households that use electricity or gas as a source cooking fuel, have flush toilet within the household, have pipe water, television, radio, tiled flooring or concrete walls, possess animals such as cattle, sheep, etc. I then sum these such that households possessing these characteristics vary between 0 for a household that has none of these, to a maximum of 10 for a household that possess all the indexed items. The highest number of items collected if we consider all three countries is 10. Thus, for each country households can be placed on a continuum of 0 for a household that does not have any of the indexed items, to a maximum of 10 items for one with all items. This variable is then recoded into three categories on the basis of the number of items associated with the household. For instance, households with three or less items are classified as being in the low or poor category, those associated with 4 to 6 items are considered as the middle group and those households with 7 or more are considered as the high category households.

Theoretical Perspective

Social and economic development has historically been recognized to play a role in mortality decline (McKweon and Record 1962; McKweon, Record and Turner 1975; McKweon 1976). In their famous article "An interpretation of the decline of mortality in England and Wales during the twentieth century", McKweon, Record and Turner (1975) attributed the decline to "rising standards of living" (p. 391). Like the case of historical Europe, studies in developing countries have also demonstrated the effect of socioeconomic status variables on childhood mortality (Tabutin and Akoto 1992; Cleland and van Ginneken 1988; Hobcraft, McDonald and Rutstein 1984; United Nations 1985). For instance, in a detailed and elaborate 15-country study the United Nations (1985) demonstrated the positive association between socioeconomic status variables such as income, work status of mothers, characteristics of housing, including toilet and water supply facilities, and child survival in developing countries.

Mosley and Chen (1984) elaborated a conceptual framework articulating the relationship between socioeconomic and biomedical factors on childhood health or mortality. The novelty of the proximate determinants framework suggested by Mosley and Chen is that mortality as an endpoint is influenced by both biomedical and socioeconomic factors, thus suggesting an integrated approach to the study of mortality, or child survival in this case. Unfortunately, examining the effects of the biological or biomedical factors on child health often requires direct measurement of these factors in the field. For example, we can estimate the effects of malnutrition by using anthropometric measures such as taking weights of children, measuring their heights and upper arm circumferences, and in some cases taking blood samples to measure haemoglobin levels in children. On the other hand, in the social sciences it is relatively easier to collect information on the social and economic background of respondents in surveys and censuses. These socioeconomic background variables can serve as proxies for measuring the well-being of the population. In order words, these variables are assumed to measure the background in which children are conceived, born or live.

Our conceptualization in this paper builds on the relationship established by Mosley and Chen (1984). We posit that socioeconomic status information collected in various censuses in Africa serve as proxies for living standards. That is the type of water source used in the household, type of energy source for cooking or lighting, or the type of toilet facility used by members of a household, may be indicative of the economic status of that household. And since economic status has been shown to have a direct relationship to child health, this paper employs these measures and household type, to study child health in Botswana, Lesotho and Zambia.

Data

Data for this paper are from the censuses of Botswana 1991, Lesotho 1996, and Zambia 1990. These three countries were selected based on the suitability of their data for the proposed analysis. For each of the three countries listed, questions were asked of the number of children ever born, those who are dead, and/or those still surviving to women reported in the household. In addition to the basic demographic indices collected in most censuses (age, education, occupation, etc…), additional information on socioeconomic indicators was collected, either at the individual level or at the household level (see table 1). These variables are intended to capture information that can inform on the socioeconomic status of either individuals within households or the status of the households themselves.

Table 1: Proxy variables for living standards

	Country		
Variables	**Botswana** 1991	**Lesotho** 1996	**Zambia** 1990
Source of drinking water	**x**	**x**	**x**
Work status	**x**	**x**	**x**
Occupation of household head	**x**	**x**	**x**
Ownership of animals e.g cattle, donkeys, sheep, goats	**x**	**x**	
Type of dwelling unit	**x**	**x**	**x**
House construction materials	**x**	**x**	**x**
Type of toilet facility	**x**	**x**	**x**
Type of cooking, heating and lighting fuel	**x**	**x**	**x**
Ownership of house	**x**	**x**	**x**
Electricity	**x**	**x**	**x**
Ownership of radio		**x**	**x**

Methods

Given the questions often asked in the census on the survival status of children - number of children ever born to mothers, the number surviving and the number dead, of those ever born, thus a count of the number of events in each case, it is more appropriate to use a model that deals with count data (Agresti 1990; Long 1997; Allison 1999). We use the negative binomial regression model, an extension of the Poisson model that takes into account unobserved heterogeneity. The negative binomial model is based on a poison distribution. Assuming that $\boldsymbol{y}$ is a variable that can only have a nonnegative integer, then the probability that $\boldsymbol{y}$ is equal to $\boldsymbol{r}$ is given by:

$$\Pr(y = r) = \frac{\lambda^r e^{-\lambda}}{r!},$$

where r=0,1,2….n; λ is the expected value of ***y***; and ***r!*** is equal to r (r-1) (r-2)…(1). The parameter λ depends on a set of explanatory variables; therefore, the poison model can be specified as:

$$\log \lambda_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_k x_{ik.}$$

Taking the log of λ ensures that its value is not less than 0 for any of the *x's* or *β's.* A property of the Poisson model is that for any given set of values on the explanatory variables, the variance of the dependent variable is equal to its mean (E(y) = var(y)).

In practice, however, this is often not the case. The variance is often greater than the mean. Secondly, the Poisson regression does not take into consideration the effects of unobserved heterogeneity so that the combined effects of these problems often cause a problem called overdispersion. The problem of overdispersion tends to underestimate the standard errors thereby inflating the test statistics making the estimates inefficient (although they may be consistent) (Long 1997). This problem can be corrected using the negative binomial model, which incorporates an error term in the model to account for unobserved heterogeneity specified as:

$$\log \lambda_i = \log(\tau)\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_k x_{ik} + \sigma\varepsilon_i$$

The assumption here is that the dependant variable y_i has a Poisson distribution with expected value λ_i conditional on ε_i, ε_i having a standard gamma distribution (Agresti

1990; Long 1997; Allison 1999). The idea for the inclusion of ε_i is that this captures the effects of unobserved variables excluded from the model (Long 1997). To adjust for exposure, another term ($\log(\tau)$) is included an offset term, whose coefficient is constrained to 1. The variable used as an offset in this paper is children ever born (ceb), which is to account for the effect of fertility and duration of exposure. The dependant variable is a count of the children surviving, and the independent variables include the LSI measure, household size and a set of individual attributes of women such as educational level of mothers, age, and their work status as well as the occupation of the head of household. This model can be efficiently estimated using maximum likelihood.

FINDINGS

Households are categorized into one of three categories according to the LSI; low if the household has less than a total of three of the indexed items, medium if the household has between a total of 4-6 and high if the household has 7 or more of the indexed items. We classify households also according to size – small if the household has 5 or less members, medium if it has between 6 and 10 members and large if more than 10 members reside in the household. It should be noted from the outset that the intension is not to compare across countries on the basis of the LSI, but to see how poverty is distributed within each country, and how that influences childhood survival. It is not possible to compare countries because each country collected information on different household characteristic different household the questionnaires are not comparable across countries. However, we will from time to time draw attention to peculiar situations within each country that make it stand out strikingly different from the others.

Tables 2 and 3 present distributions of the population within households in the three countries according to the LSI, average household size and selected characteristics of the households by rural and urban residence. Before discussing the table however, a broad presentation of the distribution of each country's total population by the SLI and household size is considered. In Botswana, 70.5 percent of the population falls in the low LSI category, 26.0 percent in the middle and only 3.6 percent in the high category. In Lesotho, 72.0 percent fall in the low category, 27.0 percent in the middle and only about 1.0 percent in the high category. In Zambia on the other hand, 78 percent of the population within households fall in the low category, 13.1 percent in the middle and 8.3 percent in the high category.

Since there is usually large differences between urban and rural areas in most Africa countries, it is much more prudent to examine these characteristics by rural and urban residence. Results shown in tables 2 and 3 show marked differences in terms of the distribution of the population on the SLI, size of the household, and the distribution of water and toilet facilities. For example, while 81 percent of the population in the rural areas in Botswana falls in the low LSI category, the corresponding figure for urban areas is about 62 percent. At the other end, about 6 percent of the population in urban areas falls in the high category as opposed to less than 1 percent for the rural areas. Similar patterns are observed for both Lesotho and Zambia. Zambia presents a particularly interesting picture, where close to the entire population in the rural areas falls in the low category (97 percent), but the distribution is less so skewed in the urban areas. In fact, it seems the distribution in the urban areas is relatively less skewed in terms of the SLI in Zambia than is the case in Lesotho and Botswana.

In terms of distribution of toilet facilities and water sources, a similar pattern of distribution is observed for all countries-- the urban areas are better served with modern and hygienic types of toilet facilities and water sources. This pattern is not unexpected considering the fact that development in most of the countries in Africa is lopsided -- with rural areas often disproportionately advantaged in terms of basic infrastructure in most countries.

We regards to household size, large households tend to be more associated generally with rural than urban areas, which is not unexpected as well since rural areas in general tend to be associated with not only pronatalism, but also associated with extended familial relations.

[Tables 2 and 3 about here]

With this background in mind, we now proceed to estimate effect of the LSI, household size and child survival in the three countries using multivariate negative binomial regression model. The outcome of interest is child survival; therefore the dependent variable is a count of number of children surviving. Three models have been estimated for each country; the first model only include the two main variables of interest -- LSI and household size variables, and the second and third models introduce controls first for the background characteristics of the mother and head of household, and ultimately, controlling for rural and urban residence and region or province of residence. Table 4 presents the results for each of the three countries. In all three countries, the chances of child survival improve as one moves from the low to the high LSI category.

For instance, the chances of survival for children in households in the high LSI category is about 37 percent more than children living in households in the low LSI category in Botswana. A similar pattern is observed for Lesotho and Zambia, as depicted in table 4.

[Table 4 about here]

With regards to household size, children living in larger households have low chances of survival than their counterparts living in smaller households. This is true for all three countries, even when other factors have been controlled. For instance, in Botswana the chances of survival for a child living in a household with more than 11 members reduces by about 11 percent compared to one who lives in a household with five or less members. This relationship is also true for both Lesotho and Zambia, and persist even after controlling for other factors, including place and province of residence. This relationship is however, not linear, as depicted in table 4 in some cases the survival chances for children living in households with between 6-10 members is not different from those living in households with more than 10 members.

With regards to the other variables, children of women who reported that they were not working at the time of the census had lower chances of surviving than children of working mothers. As expected, children of educated mothers have higher chances of survival than those of non-educated mothers. A surprising finding in all three countries relates to marital status. Children born to women who have never been married seem to have better chances of survival than children of married mothers, contrary to expectation.

However, as expected the survival chances of children living in rural areas is less than their counterparts in urban areas.

In Zambia where the country is divided into provinces, I controlled for province of residence in my third model. Compared to Lusaka province (where the capital city is located), it is only the southern province, which has higher chances of child survival than Lusaka province. The northern region has the lowest chances of child survival when we compare all the regions to Lusaka province.

DISCUSSION AND CONCLUSION

This paper used a simple living standards index created from household socioeconomic status variables, quality of housing and household possessions to estimate child survival in conjunction with household size, in three southern African countries-- Botswana, Lesotho and Zambia. All three countries share one common feature -- they are all landlocked countries. However, they have their distinct differences; Botswana is by far the most urbanized of the three countries, with a more vibrant economy and a high proportion of the population never marrying (Baker, Zitha and Ettienne 2001); Lesotho, engulfed by South Africa, is mainly dependant on South Africa as majority of its population work in Africa; and Zambia is a large country with a mixed economy, with copper mining constituting the mainstay of the economy.

The results show that children living in households that fall under the higher LSI category have better chances of survival than those who live in households that fall within the middle and lower categories. This suggests that that possession or having access to some of the items used in constructing the index makes a lot of difference in terms of child health and survival. It should be noted that some of the variables used in the construction of the index either have direct or indirect influence on mortality. For instance variables such as water sources and toilet type have direct impact on child survival, because they directly relate to contamination and disease infection. On the other hand, other variables such as television, radio and electricity have indirect impact on child health and survival in the sense that they either provide information, which is useful in terms of better child health management or provide opportunities for advancement. However, it is difficult to disaggregate the direct and indirect effects.

The effect of household size presents an interesting picture. While the results suggest that the chances of child survival are lower in larger households, compared to those in smaller households, this relationship does not seem to be linear. It seems that children who live in very large households do better than in medium-size households, which seem to support the augmentation hypothesis (Butz et al. 1982;Locoh 1988).

It should be recognized at this point that although we have modeled the effect of the LSI and household size on child survival, realistically, it is difficult to make substantive claims of the direction of causation because we do not know exactly the timing of the events. In other words, we have implicitly assumed that the living standards situation as captured at the time of the census pertained either before or the time of the event.

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Table 2: Percentage of households according LSI, household size and selected household characteristics by country
Rural Residence

	LSI			Household Size			Source of Water				Type of Toilet facility		
Country	Low	Medium	High	1 < 5	6 – 10	11+	Tap inside	Tab Outside	Well	Other	Flush WC	Pit	Other
Botswana	81.1	18.0	0.7	38.7	42.3	19.0	9.8	50.2	20.4	19.6	2.8	23.0	74.2
Lesotho	71.7	27.9	0.4	43.1	46.6	10.3	3.5	37.1	35.5*	23.9	1.2	33.2	65.6
Zambia	97.0	2.3	0.7	44.2	39.2	16.4	1.4	5.7	51.2	41.7	1.7♠	53.8♠	44.5♠

Table 3: Percentage of households according LSI, household size and selected household characteristics by country
Urban Residence

	LSI			Household Size			Source of Water				Type of Toilet facility		
Country	Low	Medium	High	1<5	6 –10	11+	Tap Inside	Tab Outside	Well	Other	Flush WC	Pit	Other
Botswana	62.2	32.0	5.8	51.4	35.8	12.8	40.1	59.4	----	----	21.8	58.7	19.5
Lesotho	73.1	23.6	3.3	68.6	27.6	3.8	35.0	45.3	5.8*	13.9	7.7	77.2	15.1
Zambia	51.6	28.8	19.5	37.2	48.7	14.1	27.6	59.6	10.8	2.0	43.6♠	51.5♠	4.9♠

*Spring

♠ Note that these percentages represent those who reported type of toilet facility available to their household members, but do not tell us the location of such facilities. However, there is another question on location of toilet facility. I used the two questions (type and location of facility) to compute percentages of household with flush or WC located within the household according to rural and urban residence. For rural areas, the percentage of households with flush toilet within the household is 1.0, while the corresponding figure for urban areas is 26.5 percent.

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Table 4: Negative Binomial Regression Results showing the effect of SL and Household size on child survival in Botswana, Lesotho and Zambia

	Botswana			Lesotho			Zambia		
Variable	**Model I** Risk Ratios	**Model II** Risk Ratios	**Model III** Risk Ratios	**Model I** Risk Ratios	**Model II** Risk Ratios	**Model III** Risk Ratios	**Model I** Risk Ratios	**Model II** Risk Ratios	**Model III** Risk Ratios
LSI									
Low (RC)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.24***	1.14***	1.12***	1.07***	1.08***	1.08***	1.14***	1.02***	1.02***
High	1.37***	1.21***	1.17***	1.37***	1.26***	1.22***	1.29***	1.25***	1.24***
Household size									
1-5 (RC)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6-10	0.79***	0.76***	0.76***	0.57***	0.62***	0.64***	0.41***	0.55***	0.54***
11+	0.89***	0.76***	0.77***	0.88***	0.78***	0.81***	0.56***	0.55***	0.54***
Age of Mother									
15-19		1.30***	1.31***		1.34***	1.34***		1.49***	1.50***
20-24 (RC)		1.00	100		1.00	-----		1.00	-----
25-29		0.66***	0.66***		0.66***	0.66***		0.49***	0.49***
30-34		0.36***	0.36***		0.39***	0.38***		0.19***	0.19***
Marital Status									
Never married (RC)		1.00	1.00		1.00	1.00		1.00	1.00
Married		0.65***	0.66***		0.80***	0.80***		0.54***	0.56***
Living together		0.79***	0.79***		-----	-----		-----	-----
Separate/Div		0.68***	0.68***		0.73***	0.72***		0.76***	0.78***
Widowed		0.42***	0.43***		0.90***	0.90***		0.58***	0.59***
Education									
No Education (RC)		1.00	1.00		1.00	1.00		1.00	1.00
Primary		1.49***	1.47***		1.23***	1.23***		1.07***	1.07***
Secondary		2.00***	1.95***		1.72***	1.68***		1.60***	1.59***
Mother's work Status									
Currently works (RC)		1.00	1.00		1.00	1.00		1.00	1.00
Not working		0.95***	0.95***		0.92***	0.94***		0.94***	0.92***
Household head's occupation									
Prof./Managerial (RC)		1.00	1.00		1.00	1.00		1.00	1.00
Sales		0.88***	0.87***		0.96	0.94*		0.98	0.98
Clerical		0.91***	0.89***		1.00	0.98		1.01	1.00
Service		0.85***	0.84***		0.86***	0.88***		0.99	0.98
Agric		0.76***	0.80***		0.96	0.96		0.91***	0.95*
Production		0.86***	0.84***		0.97	0.94		0.97	0.97

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Table 4 Cont'd

Place of Residence			
Rural	0.87***	0.88***	0.96***
Urban (RC)	1.00	1.00	1.00
Province of Residence			
Central			1.00
Copper Belt			0.91***
Eastern			0.93*
Luapula			0.79***
Lusaka			1.00
Northern			0.83***
N. Western			1.05
Southern			1.04**
Western			1.05

LR test of alpha=0 For all models, the chi2 =0.000.

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