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Are Assets a Valid Proxy for Income? An Analysis of Socioeconomic Status and Child Mortality in South Africa[1]

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Research indicates that there is a strong relationship between socioeconomic status and demographic outcomes. While in the developed world measures of socioeconomic status are widely available, this type of data is seldom available for developing countries. Consequently, there is a dearth of research on socioeconomic status and demographic outcomes in developing countries that move beyond the effect of education. One solution to this data dilemma proposed in demographic literature is to estimate an assets index using questions commonly found in surveys and census data. In this paper, we assess the validity of a commonly used assets index as a proxy for socioeconomic status. Using 1996 South African Census data, we analyze the similarities between income and the assets index, and examine the consistency between the two measures in predicting child mortality at the household and community level. We conclude that the assets index and household income extremely similar measures. Yet, both SES measures make a unique contribution in models of child mortality.

Are Assets a Valid Proxy for Income? An Analysis of Socioeconomic Status and Child Mortality in South Africa

There exists a strong relationship between an individual's socioeconomic status (SES), and their health and mortality (Adler et al. 1994; Duncan et al. 2002; Winkleby et al. 1992). Specifically, those with high SES generally have lower levels of morbidity and a longer life expectancy than their low SES counterparts. Although demographers measure SES in various ways (e.g., income, education, occupation, wealth), each measure is generally a robust predictor of both individual and group health outcomes in a population. Consequently, it is important to incorporate SES measures into demographic analyses that aim to understand mortality variation.

Demographic research on developed countries typically focuses on a variety of socioeconomic indices in analyzing health outcomes (Backlund, Sorlie and Johnson 1996; Duncan et al. 2002; Kitagawa and Hauser 1973; Krieger, Williams and Moss 1997; Menchik 1993; Ostrove et al. 2000; Preston and Taubman 1994). In contrast, research on developing countries generally focuses on one measure of SES, education (Bollen, Glanville and Stecklov 2001; Caldwell 1977, 1986; Cleland, Bicego and Fegan 1992; Cleland and van Ginneken 1988; D'Souza and Bhuiya 1982; Farah and Preston 1982; Hobcraft, McDonald and Rutstein 1984; Sandiford et al. 1995). The focus on education in this body of research is attributable to the lack of survey and census data containing accurate information on income (Montgomery et al. 2000). While education is a significant predictor of health outcomes, it's effect is both empirically and substantively different from other measures of socioeconomic status (Duncan et al 2002; Farah and Preston 1982; Krieger et al. 1997; Mirowsky, Ross and Reynolds 2000; Sandiford et al. 1995). As such, we must further incorporate other SES measures (such as income) into demographic analyses of developing countries to fully understand the role of SES in health outcomes (Bollen et al. 2001).

Recently, demographers began using a proxy to measure income in developing regions. This proxy, the assets index, is based on a variety of household assets/characteristics (Bollen et al. 2001; Filmer and Pritchett 1999, 2001; Montgomery et al. 2000). One constructs the assets index by using a series of questions on household assets/characteristics that are commonly found in both census and survey data (e.g., source of energy for heating, toilet facilities on premises). Research using the assets index indicates that there is a significant relationship between the index, household expenditures and demographic processes (Filmer and Pritchett 2001; Montgomery et al. 2000). It is unclear, however, if the index is a valid proxy for income and it's relationship with health outcomes. The aim of this paper is to assess the validity of the assets index as a proxy for income, and as a predictor of demographic outcomes at the individual and community level. Using 1996 South African Census data, we analyze the similarities between household income and the assets index, and examine the consistency between the two measures in predicting child mortality at the household and community level.

We begin the paper with a review of SES measures and their relationship with health outcomes in general, and child mortality in particular. After this review, we discuss the methodology used to generate assets index. Additionally, we discuss the indirect estimation procedures we use to analyze socioeconomic variation in child mortality. Using 1996 South African Census data, we then examine the relationship between the assets index, household income and child mortality. We conclude the paper with a discussion of the results and the implications of our findings for research using assets as a proxy for income.

Background

The SES concept is widespread in demographic, sociological and economic literature. The concept generally refers to an individual's or household's possession of a certain set of resources (Krieger et al. 1997; Bollen et al. 2001). These resources (e.g., education, income, occupation) formulate a measure of an individuals status in a society, and are determinants of ones social and physical well-being. As such, individuals/households that possess these resources are able to convert them into real differences in life chances. Individuals convert SES into better health outcomes by using the resources to decrease exposure and susceptibility to the environmental sources of disease (Mosley and Chen 1984).

The most popular measure of SES in research on developing countries is education, especially maternal education. Education, like other SES measures, is hypothesized to play a role in health outcomes by decreasing exposure and susceptibility to disease via changes in behavior (Bollen et al. 2001; Mosley and Chen 1984). In developing countries, mother's with higher education are more likely to utilize Western medicine and are less likely to follow traditional social taboos regarding disease (Desai and Alva 1998). Furthermore, maternal education is argued to lead to differences in a mother's interaction with family members and medical professionals (Caldwell 1977; Sandiford et al. 1995).[1] It is hypothesized that these mechanisms are largely responsible for the significant relationship between maternal education and child health outcomes.

Although research indicates that mothers education is a significant determinant of children's health outcomes, some argue that mother's education may just be a proxy for other dimensions of household SES (Casterline, Cooksey and Ismail 1989; Desai and Alva 1998). Research on this topic has produced mixed results. Using DHS data, Desai and Alva (1998) found that after controlling for access to piped water and toilet, and residential area, maternal education had an insignificant effect on infant mortality in all but a few countries. In contrast, Montgomery et al. (2000) found in their analysis of 3 countries that by controlling for access to piped water and toilet, and a variety of other household assets maternal education was a significant determinant in 2 of the 3 countries. Altogether, there exist research findings supporting both the argument that maternal education is a proxy for other variables (Casterline, et al. 1989; Desai and Alva 1998; Sastry 1996), and the argument that mother's education is a unique determinant of children's health and mortality (D'Souza and Bhuiya 1982; Farah and Preston 1982; Merrick 1985; Montgomery et al. 2000; Muhuri 1996; Sandiford et al. 1995).

While the results are mixed on the significance of mother's education, existing research on income and assets indices indicates they are both significant determinants of children's health and mortality in developing countries (Bawah 2002; Casterline et al. 1989; Montgomery et al 2000; Muhuri 1995, 1996). Income, here, refers to the flow of money into a household during a given period of time. As such, it is arguably a concrete measure of household purchasing power for a given time period. Unlike education, income is hypothesized to impact health outcomes via an increase in the purchasing power of a household. Specifically, it is argued that households with higher incomes are able to purchase health producing goods and services that lead to better health outcomes for household members (Gornick et al. 1996).[2]

One critique of the income measure is that it varies considerably over the life course of primary household members (Bollen et al. 2001; Mirowsky et al. 2000). In fact, income can vary considerably in a short period of time by both internal (e.g., health) and external factors (e.g., recession). For this reason, Friedman (1957) argued that income [*y*] consists of two dimensions:

1) transitory income [y_c], and 2) permanent income [y_p]. The transitory income is generally observed in surveys. It varies widely from year to year reflecting accidents and chance events, and it is not the basis of household consumption. In contrast, permanent income is not readily observed and reflects the nonhuman capital in the household, the earning potential of household members based on their attributes (e.g., education, training, ability), and the economic activity of each household member. Friedman (1957) argued that permanent income varies less considerably than transitory income, and that households use their permanent income to make decisions regarding consumption behavior throughout the life course.

In conjunction to having different relationships with household consumption, the concepts permanent and transitory income are hypothesized to each have a unique relationship with health outcomes (Bollen et al. 2001). For example, a significant drop in transitory income may lead to short term health issues (such as wasting) for a household. In contrast, changes in permanent income may lead to lower average nutrition levels and decreased use of preventive health services. While income, in general, is hypothesized to have a reciprocal relationship with health (Mirowsky et al. 2000; Preston and Taubman 1994), the effect of health on income is likely to be stronger with transitory income. In all, a household's transitory and permanent income may each play a critical role in determining members' short- and long-term health outcomes.

The assets index that is increasingly being used in demographic research on developing countries is argued to be an index of permanent income. As such, recent analyses have examined similarities between the assets index and data on household expenditures (Filmer and Pritchett 2001; Montgomery et al. 2000). Less is known, however, of the similarities between the assets index and household income. Household income is subject to vary more considerably than the assets index. Income, then, may not truly reflect the well-being of the household in a given time period. As a consequence, the assets index may have a stronger relationship with child health outcomes than household incomes. The goal of our analysis is to highlight the similarities between household income and the assets index to ascertain if the index is a good proxy for household income in analyses of child mortality.

Constructing the Assets Index

The assets index is based on a number of questions commonly found in surveys and censuses of developing countries. These questions generally pertain to housing characteristics (e.g., access to toilet) and ownership of particular items (e.g., radio, bicycle). While each question only represents one good/characteristic of responding households, the totality of the questions is representative of the households economic status. The task for social science is to find a way to combine the information in these questions so that the end product is an index of household well-being in the respective population.

Indeed, one can use a variety of ways to construct the assets index (Filmer and Pritchett 2001; Montgomery et al. 2000). Each technique aims to create an index that represents the long term economic status of a household. In this paper, we use principal components analysis to estimate the assets index (Filmer and Pritchett 1999, 2001). Principal components analysis allows us to construct a single SES index from a set of variables (e.g., questions). More specifically, the principal components procedure extracts from a set of variables a few orthogonal linear combinations to capture their common information. The first linear combination of the variables (the first principal component [c_1]) contains the most information on the variation in the underlying set of variables, while the second linear combination (the second principal component [c_2]) captures the second most information on the underlying variables (Dunteman 1989; Hamilton 1992) These first two linear combinations can be written as

$$c_1 = \gamma_{11}x_{1j} + \gamma_{12}x_{2j} + \ldots + \gamma_{1n}x_{nj} \tag{1}$$

$$c_2 = \gamma_{21}x_{1j} + \gamma_{22}x_{2j} + \ldots + \gamma_{2n}x_{nj} \tag{2}$$

where c_1 and c_2 refer to the first and second components, respectively. The x_{ij} terms refer to variable i for household j, and the $_{hi}$ terms refer to the factor loadings (linear coefficients) for component h and variable i. The principal components procedure extracts the factor loadings for n components (the number of initial variables). After extracting the factor loadings, principal components generates "scoring factors" - the weights applied to the variables normalized by their means and standard deviations - from the linear composite of the variables that constitute each principal component (Filmer and Pritchett 2001).

Our focus in this paper is on the first component in the principal components analysis which explains the most variation in the original set of assets variables. Like others, we assume that household SES explains the most variance among the household asset/characteristic variables (Bawah 2002; Doctor 2003; Filmer and Pritchett 1999, 2000). Consequently, the first principal component should be a valid index of long-run household SES.

Data

For our analysis, we use the 30% sample of the 1996 South African population census. This data was made available through the African Census Analysis Project at the University of Pennsylvania. The South African census data contain information on household income and the variables used to construct the assets index. Consequently, it allows us to identify similarities between the distribution of household income and assets, as well as examine the similarities in their relationship with child mortality at the household and community level.

Household Income

The 1996 South African census gathered information from households about the weekly/monthly/annual income derived from each member in the previous 12 months. Statistics South Africa (SSA) used this information to produce a *derived* variable for household income. The derived variable was estimated by adding together all the household members incomes, and any additional income and remittances.[3]

As in many surveys, the data on household income in the 1996 South African census are grouped. There are 14 groups ranging from no income[4] to greater than R360,000. Over the course of the analysis we present the grouped data on household income in a form similar to the assets index by using various methodologies. Specifically, we used all 14 groups in our graphical analysis of child mortality across SES groups. We recreated the same 14 groups in the assets index for this portion of the analysis by using the same percentile cutoffs points we observe in the grouped income distribution. In addition, we combined the income categories into "approximate quintile" groups for our negative binomial regression analysis of child mortality at the household level.[5] Lastly, we estimated the mean income of magisterial districts by using the midpoints of each group as an estimate of household income for all groups except the open-ended interval. For the open-ended interval, we used the median of a fitted a Pareto distribution to estimate household income (Parker and Fenwick 1983). While we used varied methods to make the income data comparable to the assets index, the household income variable proved to be a consistent SES proxy throughout our analysis.

The Assets Index

For the assets index, we use information on 9 types of household assets/characteristics. These include: 1) number of rooms [household has enough rooms[6]], 2) source of energy for cooking [electricity/gas, paraffin, wood/coal/animal dung or other], 3) source of energy for heating, [electricity/gas, paraffin, woo/coal/animal dung or other], 4) source of energy for lighting [electricity/gas, paraffin, candles], 5) toilet facilities [flush and chemical, pit latrine and bucket, no toilet], 6) telephone, 7) type of dwelling structure [modern, traditional/informal, other/caravan/tent], 8) ownership of dwelling unit, and 9) source of water [piped water inside, piped water on site, public tap, other source]. While some may object to the use of electricity items in the index because access to these type services is often a community level characteristic. We argue for the inclusion of these factors since all households in a community without these services are constrained (Bawah 2002; Montgomery et al. 2000). This constraint, however, does not limit the ability of rich households to use other sources of energy (batteries, generators, etc).

Using information on the forementioned 9 types of household assets/characteristics we created 22 binary variables. We used the principal components procedure to estimate the assets index from these 22 variables. Table 1 contains the scoring factors and summary statistics for the 22 variables used for the assets index. An examination of the scoring factors in Table 1 reveals that the scoring factors are all in the expected direction. Specifically, the variables that are indicative of household SES (e.g., telephone, using electricity/gas for lighting, having a flush toilet, etc) all operate to increase the assets index. Since all of the variables are binary, one can interpret a one unit increase in any variable as an increase in the assets index by SF_i /SD_i where subscript i refers to variable i. Therefore, a household that has enough rooms has an assets index that is 0.020 points higher than a household with less than enough rooms. Likewise, a household that owns a telephone has an assets index that is 0.143 points higher than one without a phone.

(Table 1 About Here)

To further examine the validity of the index, we aggregated the assets index into quintiles. Table 2 shows the percentage of households with a particular asset/characteristic by quintile. Households in quintile 1 are the least likely to use electricity or gas for household energy, have a flush toilet, own a telephone, have a modern dwelling structure and have piped water inside their dwelling. In contrast, those in quintile 5 are most likely to use electricity or gas for household energy, have a flush toilet, own a telephone, have a modern dwelling structure and have piped water inside their dwelling. Ownership of dwelling is the one unique variable in Table 2. Poor households are most likely to own their dwelling, while rich households are the least likely. This is attributable to urban/rural differences in home ownership. Rural households are more likely to own their dwellings, but these dwellings are generally inferior to those observed in urban areas. Altogether, these results suggest that the assets index is a valid measure of SES.

(Table 2 About Here)

Other Variables

In addition to data on household income and the necessary information for constructing the assets index, the 1996 South African census contains information on age, age at first birth, maternal education, children ever born, children alive, race, and occupation. Information on children ever born and children alive was acquired from all women aged 12 and over. In our analysis of the similarities in the SES indicator's relationships with child mortality, we use Brass-type methods to estimate the dependent variables (e.g., children ever born technique to estimate child mortality). The data on age, age at first birth, maternal education, race and occupation are generally used as control variables in our models of child mortality.

Methodology

We use a variety of methodologies in our analysis of the similarities between the assets index and income. We refrain from reviewing the basic OLS regression methodology used at various points in our analysis, and instead focus on: 1) The more advanced methods of estimating child mortality at the group level, and 2) The negative binomial regression method we use to analyze variation in child mortality across households.

Indirect Estimates of Child Mortality

To estimate child mortality we use an indirect estimation technique often used in developing countries. As in many other developing countries, there is not complete reporting of vital events in South Africa. To overcome this limitation we use Brass' (1975) popular method of indirectly estimating child mortality (Preston, Heuveline and Guillot 2001; United Nations 1983). The basic idea of the method is that the proportion of children dead among a group of women will depend on the exposure distribution among the children (which is related to the age pattern of fertility) and the mortality schedule operating in a population. Therefore, given an age pattern of fertility one can deduce the relationship between age of mothers and births (e.g., exposure distribution among children), and in turn the proportion of children surviving to a specific age - the l_x function of the life table (Preston, Heuveline and Guillot 2001; United Nations 1983).

Brass' method of estimating child mortality requires information on: 1) Children ever born classified by five-year age group of mother, 2) Children surviving (or dead) by five-year age group of mother, and 3) Number of women classified by five-year age groups.[7] The first step in estimating child mortality is to calculate the proportion of dead children for women in each five year age group [d(a)]. We then adjust this estimate by a multiplier, k(a), to account for the role of non-mortality factors (e.g., reproductive histories) and determine the appropriate life-table q(x) values. This is shown below

$$q(x) = d(a) \times k(a) \tag{3}$$

where *a* refers to age-group and takes on values from 1 to 7 (e.g., 1 = [15-19], 2 = [20-24]. . .). The corresponding x values for the 7 age groups are: 1, 2, 3, 5, 10, 15, and 20. Therefore, the 2nd age group (20-24) generates estimates of the probability of dying before age 2, q(2).

There exist several multipliers one may use to adjust for the effect of non-mortality factors (Brass 1975; Sullivan 1972; Trussell 1975). Recent developments in the demography of developing countries (e.g., the emergence of HIV/AIDS) has called the suitability of these multipliers into question. In particular, the existing class of multipliers are unable to capture the observed mortality patterns in many developing countries. As a consequence, we follow Brass (1985) and estimate our own multipliers using the equation

$$k(a) = \frac{q^s(x)}{\hat{d}(a)} \quad for\ all\ (a, x) \tag{4}$$

where $\hat{d}(a)$ refers to the estimated proportion dead children among women in age group *a* based on a fertility model[8] and a standard mortality pattern. The term $q^s(x)$ refers to the probability of dying prior to age *x* in a standard life table. We use the World Health Organization's (WHO 2002) standard age pattern of HIV mortality for sub-Saharan Africa [AfrE][9] as the standard mortality schedule since the estimation of this model life table used recent mortality data from South Africa. We use the multipliers acquired from Eq. 4 to estimate the respective probabilities of dying in Eq. 3. These probabilities form the basis of mortality comparisons across SES groups, and estimates for magisterial districts.

Negative Binomial Regression Model of Child Mortality

In addition to using Brass' indirect method, we also perform a negative binomial regression to examine the relationship between SES and child mortality. This type of regression is appropriate given that our event of interest is a count variable (e.g., children dead). The negative binomial regression is a model based on a Poisson probability distribution (Agresti 1990; Long 1997). Let us assume that *z* is a variable that can only be a positive integer, the Poisson model defines the probability that *z* is equal to *r* as

$$\Pr(z = r) = \frac{\lambda^{r} e^{-\lambda}}{r!} \tag{5}$$

where *r* is the observed count of the variable *z*, is the expected value of *z*, and *r!* refers to the factorial of *r* (Wackerly, Mendenhall and Scheaffer 1996). In a Poisson regression model, the parameter depends on a set of explanatory variables. One drawback of the Poisson regression model, however, is that the variance of the dependent variable is equal to it's mean (e.g., E(z) = Var(z)). In practice, the variance tends to be higher than the mean. In addition to this drawback, the Poisson model does not account for the effect of unobserved heterogeneity which leads to the problem of over-dispersion. When present, over-dispersion leads to biased standard errors and inefficient test statistics (Long 1997).

These problems can be corrected by using the negative binomial model with an error term to account for unobserved heterogeneity. This model is written as:

$$\ln \lambda_i = \ln(\phi)\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + \sigma\varepsilon_i \tag{6}$$

This model assumes that the dependent variable y_i (children dead) has a Poisson distribution with the expected value $_i$ conditional on $_i$. Furthermore, the model assumes that this random disturbance term has a log gamma distribution (Allison 1999; Long 1997). The advantage of including the $_i$ term is that it captures the unobserved variables that have not been included in the model. In addition to the inclusion of a disturbance term, the negative binomial model above also adjusts for exposure by including an offset term, ln( ), whose coefficient is constrained to1. We use children ever born, B_i, as our offset to account for duration of exposure and the non-mortality factors (e.g., reproductive histories) for women in age group *a*. The dependent variable for our negative binomial analysis is children dead. We use Maximum Likelihood Estimation to calculate the coefficients in Eq. 6 for two groups of women: 1) 20-24 year olds, and 2) 30-34 year olds. Using these groups in separate regressions allows us to examine the correlates of q(2) and q(5), respectively.[10] These relationships are based on those created by Brass (1975) which were discussed earlier. Using these negative binomial regressions and other methodological techniques, we now examine the similarities between the assets index, household income, and child mortality in South Africa.

Results

Our first analytical aim is to further examine the validity of the assets index as a measure of household SES. The results of a Spearman rank order correlation (not shown) indicate that the assets index is strongly related to household income (r = 0.58). To further examine the validity of the assets index, we regress the index on household income, education of household head, age, race, and residential area. The results of this regression appear in Table 3. An examination of the coefficients for each variable reveals that the assets index is a valid measure of SES. Specifically, the assets index is significantly and positively associated with income and education. Furthermore, it has a significant relationship with other social indicators of SES in South Africa - namely, race and urban residence. Altogether, the independent variables account for 65% of the variation in the assets index. Given these significant findings, we confidently turn our analysis of similarities between the two SES measures relationships with child mortality.

(Table 3 About Here)

Figures 1a and 1b depict the relationship between SES and proportionate child survival (e.g., child survival for SES grouping as a proportion of country child survival) for each SES measure. Figure 1a pertains to the probability of dying prior to age 2, while Figure 1b depicts the proportionate probability of dying prior to age 5 by SES group. The results indicate that both household income and the assets index have similar mortality patterns across the SES distribution. Specifically, as we move up the socioeconomic distribution the level of child mortality declines. In addition to this pattern, there also appears to be a nonlinear relationship between child mortality and SES. Specifically, the largest SES differences in child mortality appear to exist amongst the lowest SES groups for both measures. As you approach the higher SES groups the level of mortality appears to plateau. This finding is in line with previous research which suggests there may be a ceiling effect for SES contributions to health outcomes (Backlund et al. 1996; Kitagawa and Hauser 1973). Both SES measures appear to follow this same pattern of mortality. The one aberration from this pattern pertains to the highest household income groups. These groups all have higher levels of mortality than the income groups slightly below them. Other than this aberration, both measures depict a theoretically consistent relationship between child morality and SES.

(Figures 1a and 1b About Here)

We now turn to our multivariate analysis of the SES measures and child mortality. Table 4 contains the results of our negative binomial regression of child mortality on the SES measures for women aged 20-24. As indicated earlier, these models are representative of the relationship between SES, the control variables and q(2). Model 1 indicates that the assets index has a significant relationship with early child mortality. These significant results, however, do not strongly support the non-linear trend observed in Figures 1a and 1b. While the two highest quintiles are not significantly different from each other, the 2nd and 3rd quintiles are also not significantly different from each other either. Consequently, the odds of having an additional child dead does not decrease as the assets index increases (e.g., it is not non-linear). Likewise, the results for household income [Model 2] do not show support for the non-linear hypothesis. Furthermore, the relationship between household income and early child mortality is not as strong as observed for the assets index. Specifically, only the highest three quintile groups are related to a significant drop in q(2), and the magnitude of the odds ratios is also smaller for household income.

(Table 4 About Here)

Upon controlling for a variety of factors, the assets index coefficients drop in magnitude [Model 3]. They still remain, however, highly significant predictors of early child mortality. The results indicate that a child in the top quintile of the assets index has a 40% reduced probability of dying in comparison to a child in the first quintile. After controlling for the same set of factors, the size of the odds ratios also drops for household income. These results indicate that a child in the top income quintile only has a 15% reduced probability of dying in comparison to their first quintile counterpart. Model 5 combines both SES measures into the same model with a vector of control variables. The assets index continues to have a significant relationship with early child mortality in the full model. In contrast, the inclusion of assets index in the same model has reduced the effects of household income to marginal significance. Altogether, these multivariate results suggest that the assets index has a stronger relationship with early child mortality than income at the household level. Additionally, the results suggest that the assets index captures some of the variation in child mortality that is normally attributed to household income.

Table 5 contains the results from our multivariate analysis of SES and child mortality for women aged 30-34 [these results pertain to q(5)]. As in the previous analysis, the results for Model 1 indicate that the assets index has a highly significant relationship with child mortality. Specifically, as we move up the SES ladder the child mortality rates decline. In addition, there is no evidence that this relationship is non-linear in form. Household income [Model 2] also has a significant relationship with child mortality. In contrast to the results for early child mortality [q(2)], these results indicate that all four higher quintile groups have significantly different child mortality experiences than households in the first quintile.

(Table 5 About Here)

After controlling for other factors, the relationship between the assets index and child mortality remains significant [Model 3]. The odds ratios for each quintile reduced in magnitude by 10-20% upon the inclusion of the control factors. A child in the top quintile of the assets index, however, still experienced mortality levels that were 50% lower than children in the first quintile. As in the previous analysis, the household income odds ratios also declined drastically upon inclusion of the control variables. The results of Model 4 indicate that a child in the top income quintile only experienced 25% lower mortality levels than their counterpart in the first income quintile. As in our analysis of q(2), child mortality differences are much larger across the distribution of the assets index in comparison to household income. Model 5 includes both SES variables in the same model with the control factors. These results are nearly synonymous with those in Table 4. In particular, the odds ratios for the income quintiles dramatically decline upon including the assets index in the same model. The odds ratios for the assets index, on the other hand, maintain their magnitude and significance.

Altogether, the results from our negative binomial analyses indicate that the relationship between assets index and child mortality is not a product of the index' relationship with household income. Rather, the assets index appears to make a unique contribution to the analysis of child mortality. In addition, the results indicate that the assets index has a much stronger relationship with child mortality, and that it captures much of the relationship between income and child mortality for low income groups.

While the assets index provides unique, theoretically consistent results at the household level, it remains to be seen if the index is representative of well-being at the community level. A community level correlation between the assets index and household income indicates that they are strongly related ($r = 0.79$). As such, there may exist similarities in the relationship between the SES measures and child mortality at the community level. Table 6 contains the results from regressions of magisterial district child mortality on district SES. Model 1 (in both panels) indicates that the assets index has a significant negative relationship with district level child mortality. Likewise, mean household income has a significant negative relationship with district child mortality [Model 2]. Models 3 and 4 show that by controlling for mean maternal education, mean age at first birth and mean age of mothers we reduce the coefficient magnitudes for both SES measures. They both, however, still have a significant relationship with district child mortality. In Model 5 we examine both SES measures in the presence of our control variables. The results indicate that the relationship between the assets index and district child mortality is markedly reduced once we control for mean household income. This suggests that relationship between the assets index and community child mortality is partially explained by the income-child mortality relationship. While there is a reduction in the mean assets index coefficient between Models 3 and 5, the magnitude of the coefficient on mean income remains the same in Models 4 and 5.

(Table 6 About Here)

Our last analysis further examines the non-linear relationships between SES and child mortality identified earlier. Since the relationship between child mortality and SES is argued to be strongest at the lowest levels of SES (Backlund, Sorlie and Johnson 1996; Kitagawa and Hauser 1973), we regress magisterial district child mortality on district poverty rates . If the non-linear hypothesis is accurate, poverty rates should have a much stronger relationship with child mortality than those observed for mean household income and assets.

For the poverty analysis, we use two poverty rates. The first is the official income-based poverty rates produced by Stats South Africa, and the second is based on the assets index. In line with previous research, we estimate the poverty line as ½ the median value of the assets index

(Brady 2003; Osberg and Xu 2000; Rainwater and Smeeding 2003; Ruggles 1990). Households that are below this poverty line are identified as "poor." Using this line, we estimated the proportion in poverty (assets) in each magisterial district.

The results of our poverty analysis appear in Table 7. Models 1 and 2 indicate that both income and assets based poverty rates are strongly related to child mortality at the community level. Since both poverty variables have the same form (e.g., proportion in poverty), we can readily interpret differences in coefficient size as evidence of differences in the relationship between income and the assets index, and child mortality. Therefore, the income based poverty measure has a stronger relationship with community level child mortality. Upon inclusion of other district level variables, the magnitude of the income and assets based poverty rates in our regression model sharply decline. Although both are still significant variables in the model, their coefficients each declined by a third. In Models 3 and 4, however, the coefficient on the income based measure is still drastically larger than that on assets based poverty rates. We include both poverty measures in our final model. The results for assets based poverty are inconclusive as it is not significant at the 0.05 level in our model of early childhood mortality [lnq(2)]. In contrast, the income based poverty rate still has a significant relationship with district child mortality, and the coefficients are over twice the size of those for assets based poverty.

(Table 7 About Here)

Altogether, the results of our district level analysis suggest that the mean district income is a proxy for the assets index in models of child mortality. The relationship between community child mortality, and mean community assets and assets based poverty rates is substantially reduced in models including mean community income or income based poverty rates.

Additionally, the results do not suggest that there is a non-linear relationship between SES and child mortality as the poverty models did not explain more of the observed differences in district child mortality.

Discussion

The SES concept is a probably the most widely recognized in social science. This paper examined two SES measures and their relationship with child mortality at the household and community level in South Africa. As in previous research on SES and health in developing countries (Bawah 2002; Caldwell 1977, 1986; Cleland, Bicego and Fegan 1992; Cleland and van Ginneken 1988; D'Souza and Bhuiya 1982; Farah and Preston 1982; Hobcraft, McDonald and Rutstein 1984; Sandiford et al. 1995), our results indicate that SES is a significant correlate of health outcomes. In all of our analyses higher SES was related to lower levels of child mortality. Although not all the SES measures were significant in every model, at least one SES measure was significant in each model. This variation in the strength of the relationship between child mortality and our SES measures brings us back to our initial question: Are assets a proxy for income?

Overall, the results indicate that the answer to our question is mixed. The household analysis suggests that the assets index is a proxy for low levels of household income. While household income was a significant variable in most models that did not contain the assets index, the inclusion of the assets index reduced many income coefficients to insignificance or to a marginal magnitude. In contrast to the results from our household analysis, the community level analysis suggests that community income may be a proxy for the mean assets index. Whether we used mean income or income based poverty, our results on early child mortality, q(2), indicated that the assets index was reduced to marginal significance upon inclusion of the income based district measures. Furthermore, the results of our poverty analysis suggest that income based poverty rates have a much stronger relationship with district child mortality [q(2) ad q(5)] than assets based poverty rates.

In addition to the findings concerning our initial question, the results on maternal education were also mixed. Table 3 showed that maternal education has a significant relationship with the assets index. In our household level models, maternal education was always a highly significant correlate of child mortality. Consequently, maternal education is not a proxy for household income and assets/characteristics in models of South African child mortality at the household level. The community level analysis, however, does not support the maternal education argument. While higher mean levels of education among women are significant correlates of child mortality prior to the inclusion of assets or income based measures (not shown), the relationship became insignificant upon inclusion of these measures. These mixed results on maternal education suggest that maternal education may operate through different mechanisms at the household and community levels.

Altogether, the results suggest a strong relationship between child mortality and SES. These results, however, are limited in that the mortality estimates refer to recent historical events. Specifically, child mortality in these models occurred prior to the observation of the SES. As such, the results of our analyses represent the historical mortality experiences of individuals in specific SES groupings. This limitation, however, does not minimize the significance of our results and conclusions on SES. The assets index is a valid measure of SES, a significant correlate of child mortality, and can be considered a proxy for household income.

Notes

1. In their analysis of child mortality in Sudan, Farah and Preston (1982) showed that maternal education operated independently of a woman's status in the family. However, they used a crude measure that may have failed to truly capture educational variation in familial interaction.

2. Mirowsky, Ross and Reynolds (2000) argue that this widespread theory of income increasing a households purchasing power of health commodities is misleading. They do, however, indicate that the role of income is greater at the lower end of the distribution. As such, we expect a stronger relationship than observed in developed countries.

3. The initial individual incomes were coded in several intervals. These intervals were coded as R1,600 for the first interval, coded as the midpoints for the intervening intervals, and coded as R720,000 for those in the open-ended interval. If "individual income" was missing for a household member aged under 15, the income was set to 0. However, if income was missing for a member over age 15, then the derived household income was set to missing as there was insufficient information to produce a reliable estimate.

Incomes obtained from adding up individual incomes were converted into 14 categories. Stats SA warns that this variable should be used with caution and that uses should be aware of its limitations. Some of the issues to be considered include: 1) Household income does not provide a measure of total income and its accuracy in representing relative income is unknown, and 2) In a large proportion of the households one or more members did not specify their incomes. Cross-tabulations reveal that the non-reporting of individual income is evenly distributed by education and occupation of respondents. The non-reporting of individual income - which lead to missing household income - reduced our sample size by approximately 13%.

4. A large portion of the households reported no income (14%). This high reporting of no income may be associated with a number of factors. First, the discriminatory history of South Africa may have induced certain households to report no income. Likewise, higher reports of no incomes may be associated with household expectations that the government would use the data to provide compensation to poor households. Lastly, labor migration may have lead to the high level of reporting no income. If the household relies on incomes and remittances from migrant workers, then the migrant laborers who were not home at the time of the census would not contribute to the estimates of derived household income.

5. Given that the household income data is grouped, the quintile estimates for income are not exact. Specifically, the "approximate quintile" points are 22nd, 40th, 65th, 85th, and 100th percentile points. Although these points are not exact, they provide a sufficient estimates from which we may compare the regression coefficients on the assets index and income.

6. This is based on a continuous variable on number of rooms in household including kitchens. For this analysis, we set a cut-off point of 4 rooms as a standard. We characterize households with less than four rooms as "poor" in this dimension. We use a dummy variable that indicates whether a household has more than four rooms (e.g., 1 = 4 or more rooms).

7. Women outside the childbearing ages [15-49] are generally excluded from the estimation procedure. We excluded those outside of this range and those with unspecified or missing data on age.

8. The model fertility schedule is derived using the formula $f(y) = (y - s) \times (s + 33 - y)^2$ where y refers to age of woman in single years, and s refers to the age at which fertility begins. The function of s is to change the location of the fertility distribution relative to the age acale. In the 1996 South African census data the lowest age at birth is 12. Since we excluded women below age 15 from our analysis we modeled the fertility schedule by setting s=15. This is not a major problem as very few women gave birth prior to age 15. The numeric value 33 in the above equation is a constant that represents the average length of a woman's reproductive period. In addition to estimating $\hat{D}_i$ using the model fertility schedule, we also estimated $\hat{D}_i$ using the observed fertility schedule and obtained similar estimates.

9. The AfrE model life table is based on mortality data from Demographic Surveillance Sites in South Africa, Tanzania and Zimbabwe.

10. In previous research (Bawah 2002; Das Gupta 1997), the common practice was to include all women in the model and use children ever born as an offset term to account for the effect of fertility and duration of exposure. This practice is partially problematic. The logic behind earlier models was that by controlling for children ever born one accounts for the exposure to the risk of having a dead child. An examination of this logic using Brass' method as a model highlights the limitation of this common practice.

Brass (1975) argued that to estimate child mortality one must adjust the standard deaths over exposure [D(a)/B(a)] equation by using a multiplier [k(a)] that accounts for non-mortality factors. Additionally, Brass (1975) argued that these adjusted estimates of child mortality must be dis-aggregated into maternal age-groups to estimate various child survival probabilities (e.g., q(1), q(2),. . .,q(20)). While the methodology used in previous research is based on the Brass procedure, it does not accurately specify the model, and, subsequently, produces biased estimates of the relationships between child mortality and the independent variables. Specifically, by not incorporating a multiplier into the model the models fail to account for the role of non-mortality factors in child mortality. This oversight, however, is minor since most multipliers are close to unity. A more vital mistake concerns including all women in the same model. The inclusion of women of all ages in the same model forces the estimation procedure to equate the estimates of child survival for several age groups (e.g., q(1)=q(2)=. . .=q(20). Furthermore, by including all age groups one assumes that every variable has the same relationship with different mortality estimates (e.g., SES operates the same for q(1) and q(20)). While the first mistake has minimal consequences, the latter mistake may lead to biased coefficient estimates in the negative binomial regression model.

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Figure 1a: Proportionate Probability of Dying Before Age 2 [q(2)] by Assets and Income Groupings [proportional to country q(2)]

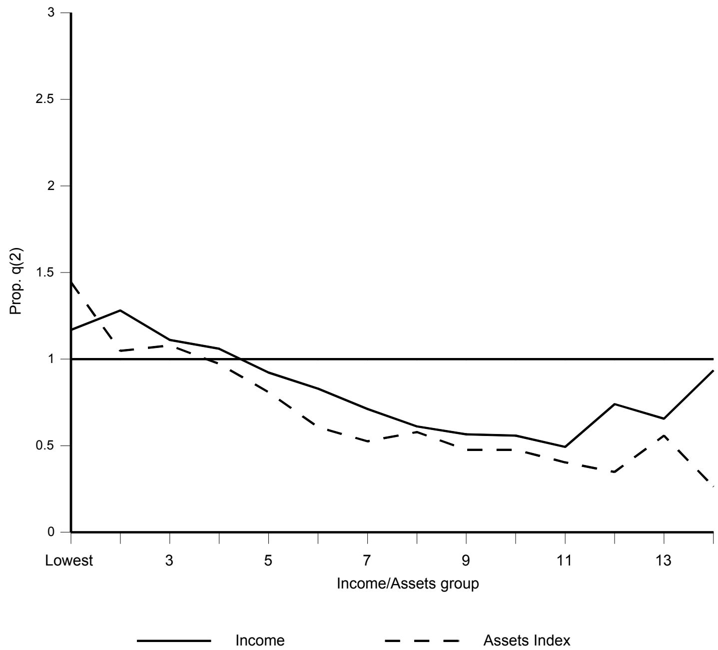

Figure 1b: Proportionate Probability of Dying Before Age 5 [q(5)] by Assets and Income Grouping [proportional to country q(5)]

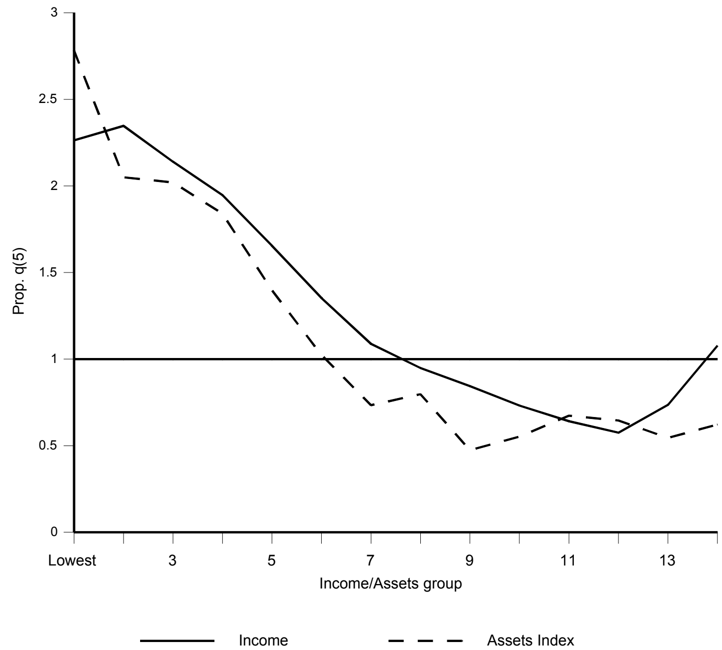

Table 1: Scoring Factors and Summary Statistics for Variables Used to Compute the Assets Index

Component	Scoring Factors[a] (SF)	Mean	Std Dev (SD)	SF/SD
Number of rooms				
Household has enough rooms[b]	0.010	0.538	0.499	0.020
Source of Energy for Cooking				
Electricity/gas for cooking	0.280	0.492	0.5	0.560
Paraffin for cooking	0.218	0.212	0.409	0.533
Wood/coal/animal dung and other for cooking	0.000	0.296	0.457	0.000
Source of Energy for Heating				
Electricity/gas for heating	0.256	0.458	0.498	0.514
Paraffin for heating	0.199	0.152	0.359	0.554
Wood/coal/animal dung and other for heating	0.000	0.390	0.488	0.000
Source of Energy for Lighting				
Electricity/gas for lighting	0.192	0.572	0.495	0.388
Paraffin for lighting	0.052	0.135	0.342	0.152
Candles and other for lighting	0.000	0.293	0.455	0.000
Toilet Facilities				
Flush and chemical toilet	0.254	0.488	0.500	0.508
Pit latrine and bucket toilet	0.099	0.380	0.485	0.204
No toilet	0.000	0.132	0.339	0.000
Telephone				
Household owns telephone/cell phone	0.064	0.277	0.448	0.143
Type of Dwelling Structure				
Modern dwelling structure	0.030	0.644	0.479	0.063
Traditional/informal dwelling structure	-0.109	0.354	0.478	-0.228
Other/caravan/tent	0.000	0.002	0.041	0.000
Ownership of dwelling unit				
Household owns dwelling unit	-0.033	0.789	0.408	-0.081
Source of water				
Piped water inside dwelling	0.240	0.428	0.495	0.485
Piped water on site	0.145	0.163	0.37	0.392
Public tap	0.128	0.199	0.400	0.320
Other source of water	0.000	0.210	0.407	0.000

Notes: N = 2 016 889 households.

a. A Scoring Factor is the weight assigned to each variable (normalized by its mean and SD) in the linear combination that constitutes the first principal component. The first component explains 37% of the observed variation in the variables.

b. This is based on a continuous variable on number of rooms in household including kitchens. For this analysis, we set a cut-off point of 4 rooms as a standard. We characterize households with less than four rooms as "poor" in this dimension. We use a dummy variable that indicates whether a household has more than four rooms (e.g., 1= four or more rooms).

Table 2. Proportionate Distribution of Assets in Households by Quintile

	Proportion with Asset				
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Number of rooms					
Household has enough rooms	0.392	0.385	0.391	0.620	0.903
Source of Energy for Cooking					
Electricity/gas for cooking	0.001	0.060	0.447	0.952	0.998
Paraffin for cooking	0.039	0.467	0.503	0.048	0.002
Wood/coal/animal dung and other for cooking	0.960	0.473	0.050	0.000	0.000
Source of Energy for Heating					
Electricity/gas for heating	0.000	0.015	0.350	0.937	0.989
Paraffin for heating	0.011	0.204	0.469	0.063	0.011
Wood/coal/animal dung and other for heating	0.989	0.781	0.181	0.000	0.000
Source of Energy for Lighting					
Electricity/gas for lighting	0.037	0.250	0.593	0.981	1.000
Paraffin for lighting	0.271	0.192	0.195	0.017	0.000
Candles and other for lighting	0.691	0.558	0.212	0.002	0.000
Toilet Facilities					
Flush and chemical toilet	0.001	0.088	0.371	0.978	1.000
Pit latrine and bucket toilet	0.534	0.750	0.594	0.022	0.000
No toilet	0.465	0.162	0.035	0.000	0.000
Telephone					
Household owns telephone/cell phone	0.002	0.012	0.078	0.294	1.000
Type of Dwelling Structure					
Modern dwelling structure	0.187	0.498	0.561	0.976	1.000
Traditional/informal dwelling structure	0.812	0.500	0.436	0.022	0.000
Other/caravan/tent	0.001	0.002	0.003	0.002	0.000
Ownership of dwelling unit					
Household owns dwelling unit	0.908	0.861	0.802	0.683	0.692
Source of water					
Piped water inside dwelling	0.009	0.088	0.221	0.820	1.000
Piped water on site	0.044	0.236	0.365	0.171	0.000
Public tap	0.194	0.482	0.313	0.009	0.000
Other source of water	0.753	0.194	0.101	0.000	0.000
Assets Index	-1.518	-0.6822	0.211	0.924	1.065

Table 3: Regression of Assets Index on SES and Demographic Variables

Variable	Coefficient
HH. Income Level	
Levels 1&2 (R.)	0.000
Level 3	0.113
Levels 4-5	0.246
Levels 6-7	0.428
Levels 8-14	0.446
HH Head Educ.	
No Educ. (ref)	0.000
Less than High School	0.288
High School and Above	0.481
Other Educ.	0.442
Age of HH Head	0.000
Race	
African (ref)	0.000
Coloured	0.382
Indian	0.582
White	0.469
Place of Residence	
Rural (ref)	0.000
Urban	0.970
Province	
Western Cape (ref)	0.000
Eastern Cape	-0.269
Northern Cape	-0.066
Free Sate	-0.068
KwaZulu-Natal	-0.181
North West	0.102
Gauteng	-0.011
Mpumalanga	-0.019
Limpopo	-0.055
R^2	0.6508

Notes: All coefficients are significant at the $p < 0.0001$ level.

Table 4: Negative Binomial Regression of Child Mortality[a] on SES Indicators for Women in 20-24 Age Group (Odds Ratios Shown)

	Model 1	Model 2	Model 3	Model 4	Model 5
Assets Index					
Quintile 1 (ref)	1.000		1.000		1.000
Quintile 2	0.762***		0.902***		0.907***
Quintile 3	0.693***		0.823***		0.830***
Quintile 4	0.478***		0.673***		0.686***
Quintile 5	0.366***		0.575***		0.591***
HH. Income Level					
Levels 1&2 (ref)		1.000		1.000	1.000
Level 3		0.967		0.969	0.975
Levels 4-5		0.872***		0.945*	0.960†
Levels 6-7		0.673***		0.865***	0.911**
Levels 8-14		0.552***		0.851***	0.927†
Age of HH. head			0.999***	0.999***	0.999***
Place of Residence					
Rural (ref.)			1.000	1.000	1.000
Urban			0.987	0.847***	0.988
Mother's Age at First Birth					
12-24			0.969	0.968	0.967
25-35 (ref)			1.000	1.000	1.000
36+			2.298***	2.424***	2.297***
Mother's Education					
No Schooling (ref)			1.000	1.000	1.000
Less than High School			0.683***	0.672***	0.684***
High School and Above			0.450***	0.426***	0.452***
Other Education			0.526**	0.496**	0.528**
Race of mother					
African (ref)			1.000	1.000	1.000
Colored			0.866**	0.807***	0.876**
Indian			0.563***	0.479***	0.573***
White			0.729***	0.639***	0.741***
Province					
Western Cape (ref)			1.000	1.000	1.000
Eastern Cape			1.509***	1.556***	1.495***
Northern Cape			1.294***	1.321***	1.285***
Free Sate			1.276***	1.306***	1.267***
KwaZulu-Natal			1.295***	1.326***	1.289***
North West			1.119†	1.109†	1.114†
Gauteng			0.991	0.976	0.991
Mpumalanga			1.081	1.089	1.076
Limpopo			0.804***	0.809***	0.797***
Occupation of HH. head					
Professional (ref)			1.000	1.000	1.000
Legis./Manager			1.069	1.074	1.058
Prof. Assoc.			1.018	1.018	1.006
Service & Other			1.108	1.140	1.076
Log-Likelihood	-41138	-40467	-39815	-39871	-39810

Notes: † p≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001

Each regression models also contains an offset term which controls for variation in children ever born.

a. Child mortality refers to the probability of a child dying given the children ever born, and the characteristics listed in the respective model.

Table 5: Negative Binomial Regression of Child Mortality[a] on SES Indicators for Women in 30-34 Age Group (Odds Ratios Shown)

	Model 1	Model 2	Model 3	Model 4	Model 5
Assets Index					
Quintile 1 (ref)	1.000		1.000		1.000
Quintile 2	0.762***		0.891***		0.895***
Quintile 3	0.654***		0.784***		0.793***
Quintile 4	0.376***		0.552***		0.569***
Quintile 5	0.243***		0.463***		0.487***
HH. Income Level					
Levels 1&2 (ref)		1.000		1.000	1.000
Level 3		0.953***		0.962**	0.978
Levels 4-5		0.811***		0.941***	0.973*
Levels 6-7		0.571***		0.831***	0.911***
Levels 8-14		0.351***		0.734***	0.862***
Age of HH. head			1.000***	1.000***	1.000***
Place of Residence					
Rural (ref.)			1.000	1.000	1.000
Urban			0.944***	0.775***	0.946***
Mother's Age at First Birth					
12-24			0.989	0.988	0.986
25-35 (ref)			1.000	1.000	1.000
36+			1.529***	1.531***	1.528***
Mother's Education					
No Schooling (ref)			1.000	1.000	1.000
Less than High School			0.782***	0.758***	0.785***
High School and Above			0.522***	0.483***	0.534***
Other Education			0.595***	0.551***	0.612***
Race of mother					
African (ref)			1.000	1.000	1.000
Colored			0.833***	0.739***	0.845***
Indian			0.528***	0.417***	0.537***
White			0.568***	0.477***	0.589***
Province					
Western Cape (ref)			1.000	1.000	1.000
Eastern Cape			1.394***	1.433***	1.381***
Northern Cape			1.349***	1.374***	1.332***
Free Sate			1.348***	1.365***	1.335***
KwaZulu-Natal			1.189***	1.204***	1.184***
North West			1.021	1.004	1.020
Gauteng			1.027	0.996	1.027
Mpumalanga			1.080*	1.087**	1.077*
Limpopo			0.703***	0.705***	0.724***
Occupation of HH. head					
Professional (ref)			1.000	1.000	1.000
Legis./Manager			1.012	1.000	1.003
Prof. Assoc.			1.056	1.035	1.040
Service & Other			1.165***	1.174***	1.118***
Log-Likelihood	-101726	-103162	-99709	-100102	-99684

Notes: † p≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001

Each regression models also contains an offset term which controls for variation in children ever born.

a. Child mortality refers to the probability of a child dying given the children ever born, and the characteristics listed in the respective model.

Table 6: Regression of District Child Mortality[a] on District SES and Mean Maternal Characteristics

Panel A: ln q(2) regression

	Model 1	Model 2	Model 3	Model 4	Model 5
Mean Assets Index	-0.222***		-0.181**		-0.131*
Mean Income (in thous.)		-0.014***		-0.010***	-0.009**
Mean years of maternal ed.			-0.008	-0.001	0.037
Mean age at first birth			0.028**	0.026**	0.031***
Mean age of mothers			-0.017***	-0.013**	-0.016***
R^2	0.152	0.170	0.195	0.198	0.213

Panel B: ln q(5) regression

	Model 1	Model 2	Model 3	Model 4	Model 5
Mean Assets Index	-0.303***		-0.223***		-0.163***
Mean Income (in thous.)		-0.019***		-0.010***	-0.010***
Mean years of maternal ed.			-0.041†	-0.034	0.012
Mean age at first birth			0.017*	0.013†	0.019**
Mean age of mothers			-0.014***	-0.009*	-0.012**
R^2	0.342	0.365	0.383	0.385	0.413

Notes: † p≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001

N=354 for ln q(5) models and 352 for ln q(2) models. Two districts had 0 values for q(2) and were dropped.

a. The regressions are actually on the logarithm of the probability of dying between ages 0 and 2, ages 0 and 5. We use the term child mortality for brevity.

Table 7: Regression of District Child Mortality[a] on Two Types of District Poverty and Mean Maternal Characteristics

Panel A: ln q(2) regression					
	Model 1	Model 2	Model 3	Model 4	Model 5
Assets Poverty	0.675***		0.484**		0.289†
Income Poverty		1.321***		1.012***	0.902***
Mean years of maternal ed.			-0.021	-0.027	0.007
Mean age at first birth			0.028**	0.025**	0.030***
Mean age of mothers			-0.018**	-0.017**	-0.018***
R^2	0.138		0.186	0.220	0.228

Panel B: ln q(5) regression					
	Model 1	Model 2	Model 3	Model 4	Model 5
Assets Poverty	0.940***		0.638***		0.410***
Income Poverty		1.734***		1.221***	1.065***
Mean years of maternal ed.			-0.051*	-0.065***	-0.017
Mean age at first birth			0.016*	0.013†	0.019*
Mean age of mothers			-0.014**	-0.013**	-0.015†
R^2	0.323	0.355	0.372	0.425	0.443

Notes: † $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

N=354 for ln q(5) models and 352 for ln q(2) models. Two districts had 0 values for q(2) and were dropped

a. The regressions are actually on the logarithm of the probability of dying between ages 0 and 2, ages 0 and 5. We use the term child mortality for brevity.