INFLUENCES ON CHILDREN'S HUMAN CAPITAL IN RURAL MALAWI: THREE ESSAYS

Shirley Afua Appiah-Yeboah

A DISSERTATION

in

Demography

Presented to the Faculties of the University of Pennsylvania

in

Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

2013

Supervisor of Dissertation

_____

Hans-Peter Kohler, Professor of Demography

Graduate Group Chairperson, Demography

_____

Hans-Peter Kohler, Professor of Demography

Dissertation Committee

Janice Madden
Professor of Regional Science, Sociology, Urban Studies, and Real Estate

Jere Behrman
Professor of Economics

INFLUENCES ON CHILDREN'S HUMAN CAPITAL IN RURAL MALAWI: THREE ESSAYS

For Nyan and Kleshie

ACKNOWLEDGMENT

I thank my dissertation committee - Hans-Peter Kohler, Jere Behrman and Janice Madden. It has been an interesting journey where I've experienced many demographic events that have shaped my experience as a graduate student. Their collective patience and encouragement has brought me to this end. As my committee chair, I am very thankful to H-P for his time and sincere understanding. I thank Jere for his consistent optimism and support. And I am thankful to Janice for the countless times she has helped me to be clearer and more determined in my goals. I also appreciate the help of Tanya Yang and everyone past and present at the Population Studies Center who facilitated the dissertation process from a long distance.

This work is based on the Malawi Longitudinal Study of Family and Health and I thank the entire MLSFH project staff in Malawi who made my field experience memorable and far more meaningful to my work. I also thank my colleagues and friends Stephane, Philip, Monica, and Georges who at various points have shared their delights and insights on the dataset, fieldwork, my ideas or dissertation chapters.

I have the most supportive friends and family, many of whom have been there through the ups and the downs #teamafuaworldwide#: Pearl, Sylvie and Brian -"Villa Volel", Linda, Nana TD, Nana A, Sharene, Kwame, Charles, Joyce and Millicent. Pearl, thanks for always being able to listen, talk about anything and then eventually have a good belly laugh about it. Sylvie, thanks for always reminding me what is important,

while also inspiring all the future planning, jokes, funny accents, food and playlists that helped me through it all.

My greatest thanks go to my mother, who is an unconditional source of strength. She trusted my decisions when it wasn't easy to, and she taught me that there is no such thing as impossible. I am very grateful to my dad to whom I owe my appreciation for learning, always asking questions and setting your highest expectations. I thank them for giving me a strong sense of faith and for sharing the wisdom and stories of their journey that stay with me. I thank my husband Manyo for all his love and support. With your love, my goals were always reachable. Thank you for always believing this was good for us- it's been a journey and reaching the end with my best friend makes this more enjoyable. My children, Nyan and Kleshie are my greatest source of motivation because their laughs and smiles give me all the energy one could ever need… when there is little sleep allowed! Nyan and Kleshie, now we can celebrate!

ABSTRACT

INFLUENCES ON CHILDREN'S HUMAN CAPITAL IN RURAL MALAWI: THREE ESSAYS

S. Afua Appiah-Yeboah

Hans-Peter Kohler

The circumstances that characterize poor, rural communities in Malawi suggest that children's health-wealth gradient can vary from other settings. This dissertation begins with a description of the methods used to create a household wealth variable using assets data in the Malawi Longitudinal Study of Families and Health project. By using a fixed effects model to minimize omitted variable bias, I determine the influence of participating in a farm subsidy program on the levels of household wealth in 2004, 2006 and 2008. The results show that the program is positively associated with the wealth index score and this association is stronger when using lagged explanatory variables. This chapter demonstrates how asset data broadens the possibilities of wealth-poverty research that can be undertaken in poor settings. In the next chapter, I use the wealth index to identify a health-wealth gradient for children under 5 years, and I determine whether the gradient varies with age. I find that children in wealthier households have decreased risk of stunting but this is not significant until the oldest age groups (36-47 and 48-59 months). While there is no apparent health-wealth gradient across these ages, there is evidence of an emerging gradient as children get older. The final chapter explores the role of maternal social capital in children's schooling outcomes, using an

index measure of women's membership in community groups and instrument variable analysis to address endogeneity concerns. I find that maternal social capital has a significant, positive association with primary school enrollment for younger children and primary school completion for older children. In contrast, maternal social capital has significant, negative association with school enrollment for older children. Maternal social capital is discussed within the context of government policies to improve enrollment and retention. Poor, rural children in Malawi face unique circumstances that have long-lasting implications. The findings across these chapters underscore the need for research that contextualizes and seeks to understand these specific challenges. If this can be achieved, Malawian children have a better chance in becoming healthier, productive adults.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER 1 Introduction

Malawian children face a host of health and educational challenges that can affect their lives as adults. Addressing these challenges requires an understanding of the Malawian rural context since an overwhelming majority of Malawians (85%) live in rural communities and this has been relatively consistent over time (see Appendix 1). There is evidence that urban growth will not be as rapid as previously projected for countries such as Malawi because of the high cost of city living. As a result, people are often involved in circular-migration where elderly or young children remain in rural areas while working adults move between rural and urban households (Brockerhoff 1999; Potts 2009, 2012). Poverty levels are higher in rural areas. According to the 2010/11 Integrated Household Survey, the level of poverty in rural areas is 56.6% and 17.3% in urban areas. In addition, 28.1% of the rural population and 4.3% of the urban population is in an ultrapoverty category (World Bank 2012) . Rural schools usually receive fewer resources than urban schools (Chimombo 2009) (see Appendix 2). Together, these reasons help to explain why research on the factors that influence the health and educational outcomes of rural children is important, and meaningful to the future of Malawian society.

In this dissertation I specifically investigate the role of household wealth and maternal social capital, as investments in children's nutritional status and schooling outcomes. I aim to address these questions in the following chapters:

Chapter 2

Does social welfare program participation predict household wealth as measured by asset ownership data?

Chapter 3

Is there a health-wealth gradient in children's stunting, and does this gradient increase with children's age?

Chapter 4

Does maternal social capital influence children's schooling enrollment and primary school completion?

Malawi is a small sub-Saharan African country of 15.4 million people in 2011. It is one of the ten most densely populated countries in Africa, with a population density of 158 people per sq. km in 2010 (World Bank 2010). Malawi is a land locked country with a lake (Lake Malawi) that runs from the north to the south of the country. The country is located south of the equator, sharing borders with Tanzania, Mozambique and the Republic of Zambia. In 1964, Malawi, formerly called Nyasaland became independent

Figure 1.1 Map of Malawi

from British rule. Since independence, Malawi has undergone only three regime changes due to the 30 year presidency of the inaugural president Hastings Banda. The first multiparty elections were held in 1994, which resulted in the election of Bingu wa Mutharika, whose controversial presidency was highlighted by some positive economic reforms, but also marred by civil protests over the high costs of living and human right violations. In April 2012, the former-vice president, Joyce Banda (no relation to Hastings Banda) replaced Mutharika as president after he suffered a cardiac arrest.

Malawi's economic activity is based mainly on agriculture. More than one-third of GDP (composition) and 90% of export revenues are from the agricultural sector. Agriculture employs 80% of the labor force and 70% of this total are smallholder farmers who mainly produce food to sustain their family. The remaining 10% are involved in large-scale commercial farming. Subsistence farmers rely on rain-fed agricultural production, so these households may encounter weather-related fluctuations in their harvests that can easily push households into poverty (African Development Bank Group 2011).

For over 15 years, Malawi has implemented programs and policies that seek to improve smallholder farmers' agricultural production and in turn improve household food security. In 1994, the government repealed a 1972 Special Crops Act to allow smallholder farmers to grow export crops such as burley tobacco, sugar and cotton. Until 1994, the majority of smallholder farmers relied solely on maize cultivation. According to reports, this policy in addition to a scaled up Farm Input Subsidy Program (FISP) in 2005 (also commonly known as Starter Pack program, discussed in chapter 2), increased the share of smallholder agriculture from 1.5% of the GDP in 2004 to 14% of the GDP in 2008 (African Development Bank Group 2011). These figures suggest that rural households experienced improvements in their livelihoods during this time.

Chapter 2: Household Wealth and Social Welfare Measures in Rural Malawi Using Panel Assets Data and Fixed Effects Analysis

In Chapter 2 of this dissertation, I use longitudinal data from rural Malawi to explore the factors associated with household wealth changes in 2004, 2006 and 2008. I specifically explore whether participation in social welfare programs were associated with changes in household wealth using both random and fixed effects models. I expected that being married, attending school, being a member of a farmer group and participation in the Starter Pack program would be correlated with household wealth. Moreover, I expect a stronger relationship between safety net participation and household wealth using lagged variables. Before this analysis however, I discuss the methodology of constructing a wealth index variable using assets data, as an alternative wealth measure when monetary data is not available.

Using the preferred fixed effects model, I find a surprisingly positive and significant association between being unmarried and household wealth. I also find positive and strongly significant associations between household wealth index scores and participation in farmer groups and the Starter Pack program, respectively. This association is strengthened when using lagged explanatory variables.

Chapter 3: The Health-Wealth Gradient in Children's Nutritional Outcomes in Rural Malawi

Poverty is widespread in Malawi. According to the UNDP Human Development Index 2011, Malawi is one of the world's least developed countries- it ranks 171th among 187 countries. About 52% of the population lives in poverty, surviving on less than 32 cents a day, and about 20% live on even less than 20 cents a day. In 2011, children aged 0-14 constituted about 46% of the Malawian population (World Bank 2010). Children are vulnerable and highly exposed to poverty and its consequences. UNICEF estimates that 4 million out of 6.8 million total children in Malawi live in poverty (UNICEF n.d.). These numbers illustrate the challenges to parental or government's investments in children's human capital, which broadly refer to the "embodied knowledge and skills" (Becker, Murphy, and Tamura 1994) that enable children to provide economic or social value as adults. Human capital, in this analysis specifically refers to children's health and educational attainment. Until recently, there has been surprisingly little research evidence to support that poor children suffer disadvantages as working adults. Case and Paxson's (2006) review of the literature has shown that poor children are less healthy than non-poor children, and that adults in poor health have worse labor force outcomes such as lower wages and fewer hours worked. The availability of longitudinal evidence in Britain has shown that childhood health problems affect adult economic status through their employment and earnings. As a first step in understanding the role of wealth in rural children's human capital, I use 2006 and 2008 household data from Malawi to replicate a "health-wealth" analysis of children's

stunting in a poor, rural context. The majority of research evidence from high income countries shows a "health-wealth" gradient which indicates a positive correlation between children's health and household wealth. The research also shows that the health-wealth gradient becomes steeper with children's age which means that the influence of wealth on health is stronger as children become older (Case, Lubotsky, and Paxson 2001). There is limited evidence of whether similar relationships persist in low income countries. This analysis seeks to be among the first to determine this relationship in a low income country, using Malawi as an example.

Malnutrition is a common childhood health problem in Malawi. Almost half of all children under age 5 are stunted (FAO 2010). Within the "health-wealth" framework, I analyze the relationship between stunting among children under age 5, and household wealth in this setting.

I find that in general, children in better off households have lower risk of stunting even in a setting where poverty is widespread. Using the asset based wealth index, I am able to identify evidence of a "wealth health" gradient beginning in the oldest age groups. I discuss some of the limitations of the data, including concerns about unobserved heterogeneity and causality. However, by using "change in wealth" variables that incorporate the household wealth from previous waves, I improve the inferred causal mechanism in these regression models.

Chapter 4: Maternal Social Capital and Education Outcomes in Rural Malawi

Inadequate schooling also limits children's abilities to achieve economic success in adulthood. Since independence in 1964, Malawi implemented several policies to improve children's schooling attendance. During this time, the education system has expanded from a total enrollment of 359,841 in 1964 to 1.8 million in 1994. In 1994, the newly elected government enacted the Free Primary Education (FPE) policy which allowed all children to attend primary school without paying school fees. As a result, more than one million more children enrolled in the educational system within one year of the policy change (total of 2.8 million). The educational system however, was not equipped and ready to absorb the high influx of children and the quality of education deteriorated. Primary school enrollment rates have increased in the lower grades, which is attributed to the FPE policy of waived fees. However, the waived school fees has not improved primary school dropout or grade repetition after grade two (Chimombo 2009; Southern and Eastern Africa Consortium for Monitoring and Evaluation 2011).

The reasons for primary school dropouts despite the no-fee policy, is not well understood and in the research literature, the influence of non-economic factors has rarely been investigated. Therefore in chapter 4, I explore the role of maternal social capital in schooling enrollment and primary school completion. I review the research literature on social capital, and hypothesize that maternal social capital, as measured by participation in community groups has a positive association with children's current

enrollment and completion of grade 8. Moreover, I use instrument variables to account for the endogeneity of mothers' endowments.

In this analysis, I find that the influence of social capital differs by schooling level (primary vs secondary schooling). Primary school aged children whose mothers are involved in community groups, are significantly more likely to be enrolled in school. Older children with mothers, who are current members of these groups, are also significantly more likely to have completed their primary school education. In sharp contrast, secondary school aged children whose mothers are involved in community groups are significantly less likely to be enrolled in school. While maternal social capital has a positive influence on children's primary school enrollment and completion, it has a negative influence on secondary schooling enrollment. These findings are discussed within the context of the FPE policy, its objectives and challenges. It appears that maternal social capital influences schooling outcomes only if schooling costs are eliminated. This is a unique finding for the education literature and can have implications for future interventions and policies.

CHAPTER 2 Household Wealth and Social Welfare Measures in Rural Malawi Using Panel Assets Data and Fixed Effects Analysis

Introduction

Demographic research in developed countries typically uses income or expenditure data to measure household welfare. Such data however, are not widely available for most developing country datasets, thereby limiting the amount of empirical research on wealth and poverty in African countries. Over the last decade, the research that uses alternative ways of collecting and measuring wealth has grown, as it become more evident that research is needed to develop poverty reduction policies and programs.

Malawi is a developing country that struggles to create economic growth and reduce poverty. In 1994, the Malawi government created a Poverty Alleviation Program as an inaugural effort to reduce poverty through various social and economic policies. A Poverty Monitoring System (PMS) was also created to closely monitor the population and analyze the influence of poverty-oriented policies, programs and project. The first quantitative survey of living standards across Malawi[i] in 1997 was part of this monitoring system (Mukherjee and Benson 2003). Still poverty reduction remains a significant challenge to Malawi's economic progress today.

[i] 1997–98 Malawi Integrated Household Survey (IHS) carried out by the National Statistical Office (NSO) under the auspices of the PMS.

Background

The wealth and poverty research gap reflects the challenge of acquiring monetary data to measure socioeconomic status in an agricultural economy. Collection on incomes data is often unreliable and burdensome for the interviewer and the respondent. Moreover, incomes in less cash-based economies are also subject to short term fluctuations. Consumption expenditures are more stable over the long term because households may lend and borrow resources to compensate for temporary income losses. This data is often ideal for long wealth analysis however, they are rarely collected in detail because it is time consuming and costly. They are also vulnerable to considerable reporting and recall error (O'Donnell et al. 2008) .

Instead, researchers are increasingly using ownership of household assets to measure long-term socioeconomic status (Montgomery et al. 2000). These asset variables can be included in the analysis separately or aggregated in various ways to measure wealth (for comparable techniques see (Cortinovis, Vella, and Ndiku 1993; Ferguson et al. 2003; Gwatkin et al. 2000; Montgomery et al. 2000; Morris et al. 2000; Vyas and Kumaranayake 2006)). In the health inequity literature, the construction of a *household wealth index* using principle component analysis (PCA) of household assets is widely cited (Bollen, Glanville, and Stecklov 2002; Gorman and Pollitt 1997; Houweling and Kunst 2010; Houweling et al. 2007; Houweling, Kunst, and Mackenbach 2003; McKenzie 2005; Schellenberg et al. 2003). In a salient article, Filmer and Pritchett (2001) showed that the wealth index predicted educational enrollment just as well as

the expenditure data in Southeast Asian countries. Ferguson et al. (2003) found that the combination of the wealth index and socio-demographic characteristics predicted permanent income, which is often used interchangeably with long-term economic status(Behrman and Knowles 1999; Bollen et al. 2002). Schellenberg et al. (2003) found that the wealth index detected relative differences in household socioeconomic status and was robust to measuring certain child health inequalities, even among the very poor. These studies show the emergence of the wealth index using asset data as a "best practice" method for measuring wealth in the absence of consumption expenditure data (Filmer and Pritchett 2001; Montgomery et al. 2000).

The Malawi Longitudinal Survey on Families and Health (MLSFH) (formerly known as the Malawi Diffusion and Ideational Change Project (MDICP)) is an appropriate dataset for investigating alternative approaches to studying wealth in a poor, rural setting. Firstly, the panel design allows analysis of transitions into and out of poverty and the application of statistical techniques that control for unobserved heterogeneity. Secondly, the panel data includes questions about asset ownership which allows for a nonmonetary and arguably more reliable, measure of household wealth in a rural setting. Few datasets contain data on asset ownership for the same respondents over time.

Using the MLSFSH dataset, I construct a wealth index to measure 2004, 2006 and 2008 household wealth levels in rural Malawi. I first describe the data and methods, and then descriptively analyze household wealth over time and region. In a random and

fixed effects analysis, I investigate whether participation in social welfare ("safety net") programs predict household wealth levels. I expect to find a positive relationship between involvement in safety net programs and household wealth in a poor, rural setting. Moreover, I expect this relationship to be stronger when using lagged variables for safety net participation.

Context

Malawi is composed of three administrative regions - the Northern, Central and Southern regions. The MLSFH has been carried out in three rural districts since 1998, which represent each region respectively- Rumphi, Mchinji and Balaka. The regions share some commonalities, but they are composed of three distinct ethno-linguistic groups that practice different religions and social customs. The Tumbuka ethnic group lives in the Northern region and practices Christianity. Early establishment of Christian mission schools is associated with the region's higher educational levels compared to the other regions. Polygyny is common in this region, inheritance is patrilineal and post-marital residence is patrilocal. The Yao ethnic group largely resides in the most densely populated Southern region. The majority of them are Muslim and they follow a matrilineal system of inheritance. They also follow matrilocal residence customs where a man moves into his spouse's household after marriage. The Chewa ethnic group resides mainly in the Central region and they practice either matrilocal or patrilocal residence customs. Traditionally, they follow a matrilineal system of descent which has deteriorated because of the influence of other patrilineal groups. Divorce rates also

differ between ethnic groups. Marriage is almost universal, but within fifteen years divorces occur for over 50% of first marriages in the Southern region, and 30% and 40% in the Central and Northern regions, respectively (Reniers 2003, 2008)

Malawi has a largely agricultural economy with more than one-third of the Gross Domestic Product (GDP) and 90% of export revenues from the agricultural sector. The export trade is dominated by tobacco, tea, cotton, coffee, and sugar. About 85% of Malawians reside in rural areas. Most Malawians are smallholder farmers who practice subsistence farming on customary land that is allocated through traditional customs. The high population density in an overwhelmingly rural country means that households often have inadequate (and poor quality) land for producing enough food to last through the year (Harrigan 2008). The heavy reliance of maize as a subsistence crop, makes households vulnerable to fluctuating trade prices, rain variability and natural disasters. Almost all maize is grown without irrigation and during the single rainy season from October to April (Denning et al. 2009).

Although Malawi has one of the lowest per capita incomes in the world, it sustained strong economic growth from 2005 to 2010. For example, their GDP real growth rate increased from 1.6% in 2005 to 8.5% in 2006 and similar growth rates continued until 2010 when rates declined to 6.5%. Since 2010, the growth of Malawi's economy has slowed, coinciding with global economic downturns (CIA 2012).

Malawi's recent economic progress contrasts sharply with its history of economic dependency. Malawi has always relied heavily on foreign aid from multilateral donor organizations and nation states. In 2006, under the Heavily Indebted Poor Countries (HIPC) Initiative, Malawi became eligible to receive 2.4 US billion debt relief which allowed government to increase social spending (CIA 2012; IMF 2006). Concurrently, government increased its efforts to reduce poverty and improve household and national food security. These efforts included a return to the early 1990 subsidy programs. One example, the Farm Subsidy Input Program (FISP), popularly known as the Starter Pack program was designed to boost the production of maize to feed a family of six for an extra two and a half months by giving smallholder farmers a packet of maize seeds, fertilizer, legumes. The wide availability of maize lowered prices, which helped families who were compelled to buy food. The addition of legumes and fertilizer in the packet helped to diversify output and improve soil fertility. Nevertheless, the Starter Pack program was a contentious issue between donor agencies, NGOs and the Malawi government for a variety of reasons (For detailed history of Malawi food security programs see (Harrigan 2008)). In a response to previous droughts and the need for food aid, the government, in the face of donor adversity scaled-up the FISP in 2005 and continued to do so until the 2008/9 season. This provided an opportunity for the MLSFH project to ascertain the influence of social welfare programs on the panel respondents. In the 2008 wave, women were asked about household participation in

the Starter Pack and other social welfare ("safety net") programs that were part of a larger Malawi National Safety Net Strategy in 2005, 2006 and 2007.

Dataset

The MLSFH dataset examines the role of social networks in changing attitudes and behavior related to HIV/AIDS, family size and family planning in rural Malawi. The broader MLSFH project also consists of a collection of qualitative data and HIV and STI biomarker data. The first wave of survey data collection occurred in 1998 (MLSFH-1) with a sample of 1536 women and 1065 husbands. This sample was based on a cluster sampling strategy used on a total of 145 randomly selected villages in the three districts of Mchinji (Central), Rumphi (North) and Balaka (South). The second (2001, MLSFH-2) and third (2004, MLSFH-3) waves of data collection re-interviewed the first wave respondents and any new spouses from marriages that occurred between waves. The third wave (2004, MLSFH-3) included a new sample of 1,000 adolescents aged 15-24. (see http://malawi.pop.upenn.edu/malawi-documentation-sampling, for details). The fourth (2006, MLSFH-4) and fifth (2008, MLSFH-5) waves re-interviewed the same respondents and again, any new spouses from marriages that occurred between waves (Anglewicz and Kohler 2009).

Attrition

Attrition or respondent loss to follow up is an important concern in panel data analysis because of its potential effect on parameter estimates. If attrition occurs

randomly in the population and respondents who remain in the survey are no different from those respondents who are not re-interviewed, then attrition is not expected to bias parameter estimates. In contrast, attrition of respondents that are selective on important characteristics bias and distort our interpretations of estimates in a multivariate analysis (Alderman et al. 2000; Anglewicz et al. 2007; Bignami-Van Assche, Reniers, and Weinreb 2003).

Attrition, however is a normal feature of longitudinal surveys and expected in rural Malawi where labor migration is widespread, mortality is high and marital instability is relatively common (see Anglewicz (2007) for a review of attrition reasons in African surveys). Figure 2.1 diagrams the survey outcomes in 2004 when 1,526 women completed the MLFSH survey (these women are the basis of this analytic sample). Almost one-fifth (17%) of 2004 respondents did not complete a 2006 surveys, and almost a third (29%) of 2004 respondents did not complete surveys in both 2006 and 2008.

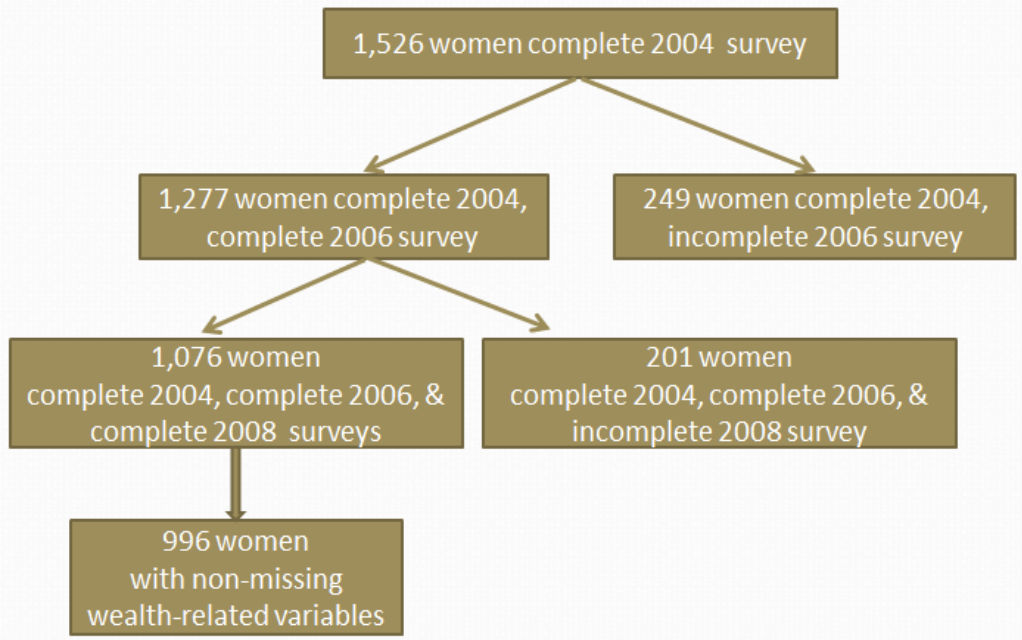


Figure 2.1 Survey outcomes for women sampled for 2004, 2006 and 2008 MLFSH

Researchers can estimate the attrition bias by using econometric models or comparing similar datasets with no attrition. This is not possible with this dataset however. At best, the possibility of attrition bias due to selection on observable factors is explored using t-test comparison of the characteristics of respondents and follow up non-respondents (see Alderman et al. (2000) for other approaches). An examination of attrition begins with the sample of 1,536 women interviewed in the first MLSFH survey round in 1998. Table 2.1 shows that 536 out of the initial total of 1,536 women did not complete a survey in 2004, 2006 or 2008, which yields a 40% attrition rate. The t-test results indicate that the follow-up non-respondents possess more assets- a significantly greater proportion of follow-up non-respondents own four out of the five asset items which were asked about in all survey waves. Follow-up non-respondents are also are

more likely to have lived elsewhere for more than six months and they are also more educated. This finding suggests that the respondents remaining in the sample have fewer economic resources than non-respondents, and that this may bias our inferences about household wealth in the general population.

The next examination of attrition focuses on women who completed surveys in 2004 but lost to follow-up and not included in this panel investigation. In 2004, an additional sample of 1,500 women and adolescents was included in the survey. Table 2.2 shows that 450 out of 1,526 women surveyed in 2004 did not complete surveys in either or both 2006 and 2008 waves which yields a 30% attrition rate. The t-test results indicate that follow-up non-respondents are significantly younger and more educated than the re-interviewed respondents. Follow-up non-respondents are less likely to be married, have fewer children and live in smaller households. They are also more likely to have lived elsewhere since age 15, for more than six months and have husbands who live outside of the village. The profile of follow-up non-respondents includes smaller households, better education and greater exposure to areas outside their village. These are variables that are selective in terms of social and physical mobility and could bias household wealth in our analysis. However, a mean comparison of respondent and non-respondent on asset ownership variables do not reveal any differences.

Response reliability

Anglewicz et al. (2007) found that a substantial proportion of 2004 and 2006 respondents report inconsistent background characteristics. For example, 13% of women reported school attendance differently in 2004 and 2006. In this analytic sample, about 11% of panel women report differences in school attendance in 2004 and 2006, and about 10% report differences in 2006 and 2008 which implies that using additional data waves slightly improves response reliability. As documented in the MLSFH literature, the rigorous verification of the respondent's identity, and the persistence of within wave inconsistencies suggests that response reliability is related to true differences in respondent reporting.

Table 2.1 T-test[a] for Difference Between Means for 1998 Respondents Re-interviewed and Not Re-interviewed in During Panel years (2004, 2006 and 2008)

	Re-interviewed		Not Re-interviewed		Difference		
Control Variables	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**t-test**	
Age	30.48	9.13	31.27	8.92	0.48	1.62	
Currently Married	0.87	0.33	0.86	0.35	-0.01	-0.74	
Number of living children	3.26	2.20	3.46	2.11	0.19	1.61	
Has lived elsewhere for > 6 mos	0.43	0.50	0.50	0.50	0.46	2.39	*
Schooling							
None	0.48	0.50	0.12	0.33	-0.36	-15.28	**
Attended primary schooling	0.49	0.50	0.77	0.42	0.27	10.79	**
Attended secondary schooling	0.02	0.15	0.11	0.32	0.09	7.66	**
Region							
North	0.00	0.00	0.90	0.30	0.90	94.52	**
Central	0.54	0.50	0.00	0.00	-0.54	-25.30	**
South	0.46	0.50	0.10	0.30	-0.36	-15.19	**
Religion							
None	0.01	0.08	0.00	0.00	-0.01	-1.95	*
Catholic	0.20	0.40	0.15	0.36	-0.05	-2.42	*
Muslim	0.29	0.45	0.08	0.27	-0.21	-9.72	**
Protestant	0.43	0.50	0.73	0.44	11.69	0.30	**
Evangelical Protestant	0.05	0.22	0.03	0.18	-0.02	-1.45	
Non-Christian Indigenous	0.02	0.13	0.00	0.04	-0.01	-2.55	**
Other religion	0.01	0.08	0.00	0.04	0.00	-1.16	
Wealth Related Variables							
Durable Asset ownership							
Bed	0.11	0.31	0.34	0.47	0.23	11.43	**
Lamp	0.19	0.39	0.48	0.50	0.29	12.28	**
Radio	0.51	0.50	0.66	0.47	0.15	5.71	**
Bike	0.55	0.50	0.43	0.50	0.51	-4.58	**
Any livestock ownership	0.75	0.43	0.88	0.32	0.14	6.36	**
Total number of respondents	996	64.84	539	35.16			

Notes: ** p<0.01. * p<0.05.

[a] Assumes equal variances

Table 2.2 T-test[a] for Difference Between Means for 2004 Respondents Re-interviewed and Not Re-interviewed in 2006 and/or 2008

	Re-interviewed		Not Re-interviewed		Difference		
Control Variables	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**t-test**	
Age	35.16	11.94	33.23	11.97	-1.92	-2.70	**
Currently Married	0.90	0.29	0.85	0.35	-0.05	-2.91	**
Number of living children	4.13	2.20	3.56	2.26	-0.57	-4.46	**
Has lived elsewhere for > 6 mos	0.08	0.27	0.12	0.32	0.04	2.53	**
Husband currently lives elsewhere	0.12	0.32	0.17	0.37	0.05	2.61	**
Schooling							
None	0.30	0.46	0.25	0.43	-0.05	-2.03	*
Attended primary schooling	0.65	0.48	0.66	0.47	0.02	0.61	
Attended secondary schooling	0.06	0.23	0.09	0.29	0.03	2.48	**
Region							
North	0.33	0.47	0.27	0.44	-0.06	-2.18	*
Central	0.31	0.46	0.39	0.49	0.08	2.93	**
South	0.36	0.48	0.34	0.47	-0.02	-0.79	
Religion							
None	0.00	0.05	0.01	0.10	0.01	2.05	*
Catholic	0.14	0.34	0.16	0.36	0.02	1.03	
Muslim	0.24	0.43	0.21	0.41	-0.03	-1.10	
African Indigenous Christian	0.16	0.36	0.15	0.36	0.00	-0.14	
Pentecostal	0.08	0.27	0.06	0.25	-0.01	-0.99	
Protestant	0.20	0.40	0.18	0.39	-0.02	-0.79	
Evangelical Protestant	0.01	0.09	0.02	0.13	0.01	1.81	
Non-christian Indigenous	0.01	0.07	0.00	0.05	0.00	-0.88	
Household size	5.67	2.19	5.41	2.25	-0.26	-2.11	*
Total number of respondents	1,076	70.51	450	29.49			

Notes: ** p<0.01. * p<0.05.
[a] Assumes equal variances

Table 2.2 (continued) T-test[a] for Difference Between Means for 2004 Respondents Re-interviewed and Not Re-interviewed in 2006 and/or 2008

	Re-interviewed		Not Re-interviewed		Difference		
	Mean	Std Dev	Mean	Std Dev	Mean	t-test	
Wealth Related Variables							
In last 12 mos…							
Received any transfers	0.44	0.50	0.43	0.50	-0.01	-0.51	
Given any transfers	0.60	0.49	0.60	0.49	0.00	0.04	
Durable Asset ownership							
Bed	0.26	0.44	0.26	0.44	0.00	0.17	
Sofa	0.09	0.28	0.10	0.30	0.01	0.92	
Table	0.36	0.48	0.36	0.48	0.00	-0.04	
Lamp	0.43	0.49	0.41	0.49	-0.02	-0.75	
Television	0.02	0.14	0.03	0.18	0.01	1.37	
Radio	0.70	0.46	0.65	0.48	-0.05	-1.83	
Phone	0.01	0.11	0.02	0.15	0.01	1.48	
Mosquito Net	0.62	0.48	0.64	0.48	0.02	0.73	
Bike	0.51	0.50	0.51	0.50	-0.01	-0.21	
Moto	0.01	0.11	0.02	0.15	0.02	1.77	
Oxcart	0.07	0.26	0.07	0.26	0.07	0.19	
Land ownership	0.77	0.42	0.78	0.42	0.01	0.39	
Any livestock ownership	0.79	0.41	0.79	0.41	0.01	0.23	
Main source of water							
Borehole	0.51	0.50	0.49	0.50	-0.02	-0.55	
Open well	0.22	0.42	0.28	0.45	0.06	2.30	*
River	0.08	0.26	0.06	0.24	-0.01	-0.90	
Total number of respondents	1,076	70.51	450	29.49			

Notes: ** p<0.01. * p<0.05.
[a]Assumes equal variances

Missing Values on Outcome Variable

Respondent's missing values on the asset ownership questions were replaced by their spouse's responses, if interviewed in the same wave. In each wave, about 2-3% of respondents had missing values on asset ownership questions. Missing values were usually attributed to the same respondents, so a total of 7% of women were excluded from the analytic sample (N=996). Removal of the respondents could bias our sample if women with missing values are likely to be poorer than their counterparts. However, a t-test group comparison of characteristics and ownership of assets (not shown) did not show any significant difference. In addition, the removal of respondents with missing observations is often used to treat missing values when creating the wealth index (Cortinovis, Vella, and Ndiku 1993; Fortson 2008; Schellenberg et al. 2003).

Methods

Multivariate Approach

The wealth index serves as a proxy for consumption, reflecting long run household wealth without accounting for shocks and short term changes to household's wealth (Filmer and Pritchett 2001). Various factors influence household wealth levels including household structure and individual's demographic characteristics. The availability of panel data means that the relationship between household wealth and various factors can be estimated using maximum information about households *n* at time *t.* This analysis considers both the random effect and fixed effect models to

estimate household wealth over time in order to address the possibility of unobserved heterogeneity. If there is no evidence of a correlation between independent variables and error terms then the random effects estimation is appropriate. If not, then fixed effects estimation is preferred because it removes the shared unobserved heterogeneity from the error term.

Explanatory variables

Respondent's marital status is expected to influence household wealth since unmarried status is an indicator of female headed household. The research literature suggests that female headed households in rural Malawi are poorer because of structural barriers (Chipande 1987). The female headed household disadvantage however is not well measured and definitive (Appleton 1996; Buvinić and Gupta 1997). Educational status has a positive relationship with income and this should persist using the wealth index measure. Household size is the preferred measure of household structure because of the missing values in the calculated dependency ratio. Household size was measured as a count of residents listed on the household roster. Respondent's membership in financial or farmer's development groups was also measured since membership access to resources and tools should improve their household wealth in a poor, rural setting. Since there is no data on membership fees, so they are ignored. The main parameters of interest-- participation in select safety net programs, refers to ten different programs (listed in Table 2.4, excluding scholarships). These variables are dichotomous. It is unlikely that each safety net program is equally available and

accessible across communities. The regressions control for region but regions are not small enough to capture the spatial heterogeneity of safety net programs. This is a limitation of the analysis.

Table 2.3 shows the social and demographic characteristics for respondents between waves. The proportion of unmarried respondents increases between waves. In 2008, almost 10% more respondents report working than they reported in 2006, and this includes a greater proportion of women involved in non-agricultural work. Household size increases between 2006 and 2008 and this is attributable to the increase in the number of children in the household. The next table (Table 2.4) reports the proportion of households who participated in each safety net programs. Almost 90% of households benefited from the Starter Pack program in at least one year.

Table 2.3 Summary Statistics for Socio-Demographic characteristics of MLFSH Panel Women 2004, 2006 & 2008

	2004	2006	2008
Mean age	34.9	37.1	39.6
(s.d)	*(11.5)*	*(11.3)*	*(11.5)*
Mean number of living children	4.1	4.3	4.6
(s.d)	(2.2)	(2.2)	(2.1)
Proportion of respondents:			
Married	90.2	89.86	86.04
Divorced/Widowed/Separated	9.5	10.04	13.86
Works in own agricultural fields	NA	70.78	65.06
Engaged in wage labor		19	32.93
Does not work		10.34	1.71
Partner stays within village	81.73	78	NA
Mean (s.d.):			
Household members under age 15yrs	2.19[a]	2.51	2.80
	(1.6)	*(1.7)*	*(1.6)*
Household size	5.67	5.39	5.46
	(2.2)	*(2.0)*	*(2.1)*
Standard dependency ratio	2.19[a]	1.82	1.49
	(1.8)	*(1.5)*	*(1.1)*
Total respondents			**996**

Notes: NA= not asked

[a]Based on only 495 observations because of missing HH roster age

Table 2.4 Proportion of 2008 Households Participating in Malawian Safety Net Programs, MLSFH, 2008

Program	% Ever	2005	2006	2007
Free food/maize distribution	29.4	15.3	15.6	10.4
Food/cash-for-work program - MASAF Public Works Program (PWP)	20.4	8.1	8.6	8.7
Inputs-for work program	3.3	0.9	1.3	1.3
Free Likuni Phala to children & mothers-Targeted Nutrition Program	11.0	4.1	4.8	6.8
Supplementary feeding for malnourished children-Nutritional rehab	5.7	1.5	2.6	3.8
Support from church	12.2	3.9	5.0	7.9
Farm Input Subsidy Program-Starter Pack seed, fertilizer voucher	89.0	40.0	60.3	82.1
Other free agricultural inputs distributions (not Starter Packs)	2.6	1.5	0.9	1.4
Scholarships for Secondary School	0.6	0.4	0.6	0.5
Scholarships for Tertiary School	0.2	0.1	0.1	0.1
Direct cash transfers (from Government, donor, NGO or church)	2.7	0.4	1.0	1.8
Other	1.2	0.2	0.2	0.8
Total Households				**996**

Dependent variable

The first step in this analysis was to create a wealth index based on ownership of household assets. Respondents were asked whether their household owned any of the following durable assets (sofa, table and chairs, lamp, television, radio, cell phone, mosquito net, bicycle, motorcycle, oxcart and beer drum), any land and any livestock. Table 2.5 compares the percent ownership for 2004 MLSFH respondents with the rural respondents in 2004 Malawi Demographic and Health Survey (MDHS). The table shows that MLSFH and rural DHS households have similar characteristics.

Table 2.5 Comparison of Mean Asset ownership in MLSFH and rural Malawi DHS Households, 2004

	Mean Ownership in 2004	
Asset item	**MLSFH households**	**Malawi DHS households (rural)**
Bed with mattress	0.26	0.15
Sofa set	0.09	0.06
Table and chairs	0.37	0.24
Parrafin lamp	0.43	0.36
TV	0.02	0.02
Radio	0.71	0.59
Cell phone	0.01	0.02
Mosquito nets	0.63	
Bicycle	0.51	0.42
Motorcycle	0.01	0.08
Oxcart	0.07	
Livestock	0.77	
Land	0.79	
None of the above	0.01	
Total households	996	11,402

[1] Demographic and Health Survey. This column of figures extracted from 2004 Malawi Demographic and Health Survey Report

Construction of wealth index score

The wealth index was constructed using Principle Component Analysis (PCA), a statistical procedure that reduces the number of variables in a data set into a smaller number of dimensions by providing weights for each of these variables. The PCA creates uncorrelated indices or components from an initial set of *n* correlated variables and each component is a linear weighted combination of the initial variables. The first component explains the largest amount of variation in the dataset. The subsequent component is uncorrelated with the first component and explains additional dimensions of the data, but a smaller proportion of the variation. Each additional component

follows accordingly (Vyas and Kumaranayake 2006). Several studies have demonstrated that only the first PCA component is required to construct the wealth index (Filmer and Pritchett 2001; Gwatkin et al. 2000; Houweling et al. 2003; McKenzie 2005). Demographic and Health Surveys (DHS) also construct the asset-based wealth index using the same techniques, so I replicate the same methodological approach.

This paper investigates changes in asset-based wealth scores over time. In order to draw accurate intertemporal comparisons, the PCA technique is based on pooled data from the three survey waves so that all asset variables were entered into the PCA model using the STATA software. The following dichotomous variables were used to construct the wealth index score[ii] because they were common to all survey rounds: a bed with mattress, sofa set, table and chairs, paraffin lamp, TV, radio, cell phone, mosquito nets, bicycle, motorcycle, oxcart, any livestock and any land. Upon entering these variables after the *factor, pcf* command, STATA produces an eigenvalue for each factor that accounts for some percentage of variation in the dataset. For those data, the eigenvalue for the first principal component is 7.7 which accounts for 20% of the explained variation. The *predict* command then yields scoring coefficients or weights for each variable which when summed up, generates a wealth index score for each household. These scoring coefficients are shown in Table 2.6. The similarity of values

[ii] Questions on access to utilities or infrastructure (solar panels, pit latrine, generator) and housing characteristics (type of roof and wall material, number of rooms) were asked in panel years but they are not included in this analysis for two reasons 1- the loss in sample size due to missing values and 2-poor results from a separate wealth index appraisal, as suggested in Vyas and Kumaranaya (2006).

across survey waves ensures that the wealth index score that is then calculated separately for each wave is comparable over time. If scoring coefficients were calculated from unpooled data, then it would be inappropriate to compare ownership of an asset in 2004 with ownership in 2006 because the market value of the asset changes over time.

Table 2.6 PCA Scoring coefficients

Asset item	**Scoring coefficients from pooled data**		
	2004	2006	2008
Bed with mattress	0.09	0.09	0.09
Sofa set	0.07	0.08	0.08
Table and chairs	0.08	0.08	0.09
Parrafin lamp	0.08	0.08	0.08
TV	0.03	0.04	0.05
Radio	0.06	0.05	0.06
Cell phone	0.00	0.03	0.07
Mosquito nets	0.05	0.04	0.05
Bicycle	0.05	0.05	0.04
Motorcycle	0.02	0.02	0.02
Oxcart	0.04	0.05	0.04
Livestock	0.05	0.04	0.05
Land	-0.04	-0.01	0.01

Since the variables are dichotomous, the scoring coefficient values can be interpreted as the change in wealth index score when the value moves from 0 to 1. For instance, the possession of a bed with mattress is associated with a 0.09 unit increase in the wealth index in any year (Table 2.6). Similarly, a household with land is associated with 0.04 unit decrease in their 2004 wealth index. The change in 2006 and 2008 scoring coefficients for land from 2004, suggests that interpretations about land warrants some

caution. In 2004, questions on land ownership were asked differently than the previous waves and perhaps this value reflects a data artifact.

Table 2.7 presents the overall mean ownership, standard deviation and mean ownership by quintile for the asset variables. The mean ownership for assets increases with wealth quintile category although the gradient between the poorest and richest households is mostly flat with land and livestock ownership. In 2004, 2006 and 2008 less than half of the richest households have a television, motorcycle and cell phone. There are some assets with little variation across households such as ownership of a television which is 0% among the poorest groups and about 14% among the richest groups across years. Then there are other assets with wider range of variation: 3.5% in the poorest households versus 92.8% in the richest households own a table and chairs over the years. In these poor, rural communities these variations are expected.

The PCA technique depends on the distribution of variables across households and "assets that are more unequally distributed between households are given more weight in PCA" (McKenzie 2003). In 2004 for example, bed with mattress ownership jumps from 1.3% in the poorest group to 96% in the richest group. Therefore, beds with a mattress, paraffin lamp and table and chair ownership are associated with the highest scoring coefficients (>0.08). Land ownership is consistently high across quintiles and cell phone ownership is consistently low across quintile which explains why these variables have the lowest scoring coefficients.

Based on the wealth index scores, households were categorized into wealth quintile groups- “poorest”, “poor”, “middle”, “rich” or “richest”. The consistent unit increase in the mean wealth index score from the poorest to richest quintile groups (Table 2.8) demonstrates that the asset-based measure reflects a uniform socioeconomic distribution in our setting.

Table 2.7 Summary Statistics for Asset ownership for MLFSH Panel Households

2004	Asset ownership		Mean Ownership by Quintile				
Asset item	**Mean**	**Std dev**	**Poorest**	**Poor**	**Middle**	**Rich**	**Richest**
Bed with mattress	0.263	0.441	0.013	0.088	0.146	0.484	0.961
Sofa set	0.088	0.284	0.000	0.012	0.013	0.091	0.598
Table and chairs	0.366	0.482	0.041	0.147	0.354	0.690	0.951
Parrafin lamp	0.432	0.496	0.092	0.259	0.399	0.778	0.961
TV	0.022	0.147	0.003	0.006	0.006	0.016	0.147
Radio	0.708	0.455	0.303	0.753	0.911	0.940	0.990
Cell phone	0.012	0.109	0.016	0.012	0.006	0.000	0.039
Mosquito nets	0.629	0.483	0.258	0.641	0.747	0.865	0.980
Bicycle	0.514	0.500	0.159	0.447	0.633	0.762	0.922
Motorcycle	0.011	0.105	0.000	0.006	0.006	0.004	0.078
Oxcart	0.070	0.256	0.019	0.024	0.025	0.087	0.333
Livestock	0.786	0.410	0.506	0.806	0.918	0.960	0.980
Land	0.765	0.424	0.752	0.800	0.835	0.726	0.735
2006	**Asset ownership**		**Mean Ownership by Quintile**				
Asset item	**Mean**	**Std dev**	**Poorest**	**Poor**	**Middle**	**Rich**	**Richest**
Bed with mattress	0.235	0.424	0.000	0.056	0.070	0.322	0.925
Sofa set	0.082	0.275	0.000	0.000	0.009	0.048	0.469
Table and chairs	0.345	0.476	0.029	0.087	0.192	0.639	0.918
Parrafin lamp	0.482	0.500	0.102	0.236	0.463	0.757	0.980
TV	0.027	0.162	0.000	0.019	0.009	0.013	0.129
Radio	0.720	0.449	0.270	0.665	0.874	0.922	0.986
Cell phone	0.033	0.179	0.008	0.019	0.014	0.030	0.122
Mosquito nets	0.782	0.413	0.455	0.733	0.883	0.939	0.986
Bicycle	0.552	0.498	0.107	0.472	0.645	0.761	0.918
Motorcycle	0.010	0.100	0.000	0.006	0.005	0.013	0.034
Oxcart	0.046	0.210	0.004	0.000	0.009	0.070	0.184
Livestock	0.822	0.382	0.541	0.789	0.897	0.970	0.986
Land	0.929	0.257	0.902	0.919	0.930	0.943	0.959
2008	**Asset ownership**		**Mean Ownership by Quintile**				
Asset item	**Mean**	**Std dev**	**Poorest**	**Poor**	**Middle**	**Rich**	**Richest**
Bed with mattress	0.288	0.453	0.004	0.065	0.300	0.472	0.864
Sofa set	0.095	0.294	0.004	0.000	0.007	0.075	0.429
Table and chairs	0.369	0.483	0.034	0.158	0.373	0.679	0.924
Parrafin lamp	0.532	0.499	0.095	0.374	0.747	0.887	0.939
TV	0.040	0.196	0.000	0.006	0.013	0.057	0.152
Radio	0.676	0.468	0.172	0.681	0.847	0.925	0.995
Cell phone	0.213	0.410	0.009	0.058	0.180	0.226	0.712
Mosquito nets	0.776	0.417	0.440	0.777	0.940	0.934	0.960
Bicycle	0.575	0.495	0.172	0.577	0.660	0.726	0.899
Motorcycle	0.008	0.089	0.000	0.000	0.000	0.009	0.035
Oxcart	0.047	0.212	0.000	0.016	0.020	0.047	0.172
Livestock	0.843	0.364	0.539	0.877	0.953	0.991	0.985
Land	0.925	0.264	0.841	0.926	0.960	0.972	0.970

Table 2.8 Comparison of Mean Wealth Index Score by Quintile for MLSFH Panel Households (N=996)

	Mean						
	Poorest	**Poor**	**Middle**	**Rich**	**Richest**	**All**	**Std. dev.**
2004	0.166	0.308	0.385	0.493	0.667	0.359	0.169
2006	0.186	0.308	0.385	0.494	0.661	0.390	0.163
2008	0.178	0.347	0.462	0.538	0.695	0.415	0.187

Descriptive Results

Persistence in household wealth status over time and region

The following table (Table 2.9) shows aggregate persistence in wealth classification over time. In 2006, about two third of all households across wealth categories remained in the same classification after two years. The most dramatic re-classifications occurred with the middle 40%. Between 2004 and 2008 only 37% of middle 40% households remained in that category. The poorest category of households retained their status more than the other categories. In 2008 over three quarters (77%) of the poorest households retained their 2004 status.

Table 2.9 Persistence of Household Wealth Classification of MLSFH Panel Households from 2004 to 2006 and 2008

	2006	**2008**
Wealth categories		
Poorest 40%	64.9	77.7
Middle 40%	61.2	37.1
Richest 20%	70.6	73.5

The table below (Table 2.10) describes the distribution of the richest 20% of households across regions. The largest proportion of the richest households is located in

the Northern region, while the Southern region has the smallest proportion of these households. This has persisted across the years.

Table 2.10 Distribution of richest 20% of MLFSH Panel Households across regions

Region	2004	2006	2008
Central	24.5	15.7	26.3
South	14.7	12.2	13.6
North	60.8	72.1	60.1
Total	100	100	100

Multivariate analysis results

The previous section describes the methods for constructing the wealth index score, and describes wealth levels across time and region. The remaining section of this investigates the correlates of household wealth in a poor, rural setting and using random effect and fixed effect regressions. The random effects model allows estimation of all observed explanatory variables which maximizes information from the data. The random effects model also addresses the serial correlation of panel data. This model assumes that the explanatory variables and the error terms are uncorrelated, so that there is no shared and systematic unobserved heterogeneity in the error term. All the explanatory variables that will influence the co-variables need to be identified. If this assumption is incorrect, this will cause omitted variable bias in the estimation.

As an alternative, time-invariant omitted variables can be addressed using fixed effects. This model allows for the systematic unobserved heterogeneity to be removed

from the error term. By demeaning the variables and giving each household its own intercept which absorbs any time-invariant characteristics, variation only occurs at the baseline level for each household. This within-household variation means that each household serves as its own comparison (Allison 1998; Helleringer and Kohler 2005). The equation for the fixed effect regression becomes:

$$Y_{it} = \alpha_i + \beta_1 X_{it} + u_{it} ,$$

where Y_{it} is the wealth index score of household i, at time t. The term, α_i is the unknown intercept for each household (i=1....n). X_{it} represents one explanatory variable, and β_1 is the coefficient for that explanatory variable. The u_{it} is the error term.

The fixed effects model eliminates the variation between households, which often excludes informative and time-invariant explanatory variables (Murray 2005). In consideration of this, this analysis include estimates for the random effect and fixed effect models, followed by a discussion of results and a Hausman test for the preferred model. In the Hausman test, the null hypothesis is the random effects model and the alternative hypothesis is the fixed effects model.

The first set of regression tables, Table 2.11 is based on households in all three districts. In the random effect model, households of married respondents have significantly lower wealth index scores (-0.0640) than unmarried respondents and the magnitude of the association is slightly reduced in fixed effects, which shows a similar effect if married respondents become unmarried. As expected, respondents and their

partners who attended primary school had significantly higher wealth index scores than those who did not attend school and the increase in wealth index scores is greater for those who attended secondary school. Household size is also strongly significant. With every additional person living in the household, the wealth index score increases by 0.00769 units in the random effect model and 0.00595 units in the fixed effect model. This positive relationship is supported by findings on household size and consumption expenditures in Malawi in the 1990s (Mukherjee and Benson 2003). The likelihood that wealthier families have more children in agricultural societies is well- documented in the rural fertility and household literature. Respondents who were members of farmer groups had wealth index scores that were on average, 0.0119 units greater than other respondents. However, this increase was not a significant one when using the fixed effects model. A similar association was found for households that were members of finance groups. These findings suggest selection mechanism which lagged variable analysis attempts to address. In the case of selection, households which are involved in social groups, have larger families and are more educated may have already been wealthier before having these characteristics.

The continuation of table 2.11 examines the association between households that participated in safety net programs and their wealth index scores. Most of the safety net programs do not have a significant association with the wealth index score but it is possible that small sizes affect these results. In contrast, the Starter Pack program was well patronized. This is reflected in Table 2.4, in which almost 90% of

respondents participated in this program for at least one out of three years. Participation in the Starter Pack program is strongly significantly associated with an increase in the wealth index scores. Participants have wealth index scores that are on average 0.03 units ($p<0.001$) higher than non-participants.

As shown in the continuation of table 2.11, both Mchinji (Central) and Balaka (South) had significantly lower wealth index scores, compared to the Rumphi (North). For these reasons, Tables 2.12-2.14 further examine demographic characteristics and safety net program involvement by region. In Mchinji (Table 2.12) households, being unmarried, having any education, and having larger households are significantly associated with increased wealth scores. In Mchinji, there is no advantage to belonging to a social group. However, participants in the Starter pack program have scores that are 0.03 unites higher than non-participants. In Balaka (Table 2.13), households with famer group members are advantaged by 0.02 units in the random effects regression. Households that participated in the Starter Pack program have wealth index scores that are 0.01 units higher, in a random effects model. In Balaka, participation in the food for cash program or MASF was strongly associated with household wealth in the fixed effects model. In the fixed effects model, the Starter Pack had no significant association. In contrast to the other two regions (Table 2.14) there is no significant difference between the wealth status of unmarried respondents and married respondents in Rumphi. Moreover, the gains from respondent's schooling are only significant if comparing respondents who did not attend school with those who attended secondary

school. Similar to the other regions, households that participated in the Starter Pack program had wealth index scores that were 0.03 units higher than non-participants.

The final table, Table 2.15 shows the association between select lagged measures and the wealth index score (all the controlled variables are lagged, just not shown). The variables are all lagged by one and two panel waves. In general, the results are consistent with contemporaneous measures. Lagged household size has similar coefficients, but the relationship with the wealth index is more strongly significant in a random effect model. The coefficients for respondents who were farmer group members or financial group members the previous year are also of similar magnitudes to contemporaneous measures and more strongly significant. Lagged Starter Pack Program participation variables had significantly stronger association with the wealth index score but the magnitude of the association was similar to the contemporaneous measure.

Hausman tests show that the fixed effects model is the preferred model and suggests that unobserved heterogeneity or correlated variables would otherwise bias regression estimates. The preference of the fixed effects model then precludes use of time-invariant characteristics such as parent's education and household size.

Table 2.11 Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, All districts

	Random Effects	Fixed Effects
Respondent age	0.00509***	
	(3.57)	
Respondent age squared	-0.0000500**	
	(-3.06)	
Married (ref=divorced/sep/widowed)	-0.0640***	-0.0408***
	(-6.65)	(-3.90)
Respondent schooling (ref=never attended school)		
Attended primary school	0.0458***	
	(5.82)	
Attended secondary school	0.134***	
	(7.86)	
Partner's Schooling (ref=never attended school)		
Attended primary school	0.0272***	
	(3.57)	
Attended secondary school	0.0655***	
	(5.51)	
Missing category	0.0410***	
	(3.88)	
Household size	0.00769***	0.00595***
	(5.95)	(4.03)
Social group membership		
Farmers group	0.0119*	0.00408
	(2.22)	(0.71)
Finance/development group	0.0223*	0.00876
	(2.18)	(0.80)
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.11 (continued) Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, All districts

	Random Effects	Fixed Effects
Safety net program participation		
Free food/maize distribution	0.00102	-0.000217
	(0.21)	(-0.04)
Food/cash-for-work program - MASAF Public Works Program	0.00210	0.00642
	(0.34)	(0.91)
Inputs for work program	0.0123	0.0120
	(0.71)	(0.62)
Free Likuni Phala to children & mothers-Targeted Nutrition Prgm	0.0113	0.00942
	(1.51)	(1.12)
Supplementary feeding for malnourished children	-0.0236*	-0.0197
	(-2.25)	(-1.66)
Support from church	0.00852	0.0166*
	(1.20)	(2.07)
Farm Input Subsidy Prgm (starter pack seed, fertilizer voucher)	0.0257***	0.0260***
	(10.85)	(10.74)
Other free agricultural inputs distributions (not Starter Packs)	0.0151	0.00927
	(1.05)	(0.57)
Direct cash transfers (from Government, donor, NGO or church)	0.0275	0.0169
	(1.63)	(0.89)
Other	0.00833	0.0171
	(0.27)	(0.50)
Region (ref=North)		
Central region	-0.0548***	
	(-5.11)	
South region	-0.0689***	
	(-6.13)	
Intercept	0.187	0.332
N	**2841**	**2841**
R^2	0.1146	0.1103
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.12 Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Mchinji

	Random Effects	Fixed Effects
Respondent age	0.00429	
	(1.58)	
Respondent age squared	-0.0000463	
	(-1.47)	
Married (ref=divorced/sep/widowed)	-0.102***	-0.0737**
	(-5.12)	(-3.29)
Respondent schooling (ref=never attended school)		
Attended primary school	0.0631***	
	(4.83)	
Attended secondary school	0.0160	
	(0.36)	
Partner's Schooling (ref=never attended school)		
Attended primary school	0.0449**	
	(3.06)	
Attended secondary school	0.0898***	
	(3.71)	
Missing category	0.0619**	
	(2.90)	
Household size	0.00964***	0.00687*
	(3.70)	(2.23)
Social group membership	0.00324	-0.0110
Farmers group	(0.33)	(-1.04)
Finance/development group	0.0324	0.0282
	(1.56)	(1.26)
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.12 (continued) Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Mchinji

	Random Effects	Fixed Effects
Safety net program participation		
Free food/maize distribution	0.00971	0.0151
	(1.10)	(1.50)
Food/cash-for-work program - MASAF Public Works Program	-0.00575	-0.0104
	(-0.42)	(-0.66)
Inputs for work program	0.00254	0.0144
	(0.08)	(0.41)
Free Likuni Phala to children & mothers-Targeted Nutrition Prgm	0.00841	-0.00178
	(0.83)	(-0.16)
Supplementary feeding for malnourished children	-0.0313	-0.0306
	(-1.85)	(-1.59)
Support from church	0.00633	0.0258
	(0.47)	(1.70)
Farm Input Subsidy Prgm (Starter Pack seed, fertilizer voucher)	0.0290***	0.0256***
	(6.83)	(6.00)
Other free agricultural inputs distributions (not Starter Packs)	-0.00219	-0.0151
	(-0.07)	(-0.44)
Direct cash transfers (from Government, donor, NGO or church)	-0.0432	0.0366
	(-0.53)	(0.43)
Other	0.0648	0.0854
	(1.15)	(1.35)
Intercept	0.121*	0.310***
N	**845**	**845**
R^2	0.159	0.1538
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.13 Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Balaka

	Random Effects	Fixed Effects
Respondent age	0.00562**	
	(2.68)	
Respondent age squared	-0.0000606*	
	(-2.53)	
Married (ref=divorced/sep/widowed)	-0.0804***	-0.0465***
	(-5.80)	(-3.35)
Respondent schooling (ref=never attended school)		
Attended primary school	0.0344***	
	(3.35)	
Attended secondary school	0.0571	
	(1.33)	
Partner's Schooling (ref=never attended school)		
Attended primary school	0.0244**	
	(2.62)	
Attended secondary school	0.0371	
	(1.52)	
Missing category	0.0327*	
	(2.15)	
Household size	0.00496*	0.00392
	(2.28)	(1.53)
Social group membership		
Farmers group	0.0194*	0.0162
	(1.98)	(1.54)
Finance/development group	0.0213	0.00871
	(1.07)	(0.41)
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 ***p<0.001	

Table 2.13 (continued) Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Balaka

	Random Effects	Fixed Effects
Safety net program participation		
Free food/maize distribution	-0.00573	-0.00994
	(-0.74)	(-1.11)
Food/cash-for-work program - MASAF Public Works Program	0.0161	0.0250**
	(1.90)	(2.59)
Inputs for work program	0.0635	0.0516
	(1.70)	(1.27)
Free Likuni Phala to children & mothers-Targeted Nutrition Prgm	0.00703	0.0131
	(0.38)	(0.63)
Supplementary feeding for malnourished children	-0.0395	-0.0548*
	(-1.84)	(-2.24)
Support from church	-0.00362	0.00881
	(-0.27)	(0.58)
Farm Input Subsidy Prgm (Starter Pack seed, fertilizer voucher)	0.0138**	0.00842
	(2.79)	(1.59)
Other free agricultural inputs distributions (not Starter Packs)	0.0358	0.0311
	(1.59)	(1.20)
Direct cash transfers (from Government, donor, NGO or church)	0.0323	0.0236
	(1.34)	(0.86)
Other	-0.0883	-0.0842
	(-1.83)	(-1.67)
Intercept	0.145**	0.297***
N	**1043**	**1043**
R^2	0.0616	0.0569
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.14 Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Rumphi

	Random Effects	Fixed Effects
Respondent age	0.00610*	
	(2.32)	
Respondent age squared	-0.0000512	
	(-1.71)	
Married (ref=divorced/sep/widowed)	0.0000998	0.00948
	(0.01)	(0.44)
Respondent schooling (ref=never attended school)		
Attended primary school	0.0534	
	(1.71)	
Attended secondary school	0.172***	
	(4.74)	
Partner's Schooling (ref=never attended school)		
Attended primary school	0.0198	
	(0.70)	
Attended secondary school	0.0619*	
	(2.06)	
Missing category	0.0380	
	(1.25)	
Household size	0.00828***	0.00730**
	(4.05)	(3.26)
Social group membership		
Farmers group	0.0131	0.00539
	(1.53)	(0.59)
Finance/development group	0.0182	0.00115
	(1.23)	(0.07)
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.14 (continued) Random Effect and Fixed Effect Model Linear Regression of Wealth Index Score on Demographic Characteristics and Social Welfare Participation, Rumphi

	Random Effects	Fixed Effects
Safety net program participation		
Free food/maize distribution	0.000203	-0.00476
	(0.02)	(-0.46)
Food/cash-for-work program - MASAF Public Works Program	-0.000149	0.0123
	(-0.01)	(0.83)
Inputs for work program	-0.0114	-0.0235
	(-0.43)	(-0.80)
Free Likuni Phala to children & mothers-Targeted Nutrition Prgm	0.0143	0.0158
	(0.85)	(0.86)
Supplementary feeding for malnourished children	-0.00367	0.00582
	(-0.20)	(0.28)
Support from church	0.0151	0.0149
	(1.38)	(1.22)
Farm Input Subsidy Prgm (Starter Pack seed, fertilizer voucher)	0.0283***	0.0329***
	(7.60)	(8.95)
Other free agricultural inputs distributions (not Starter Packs)	-0.00633	-0.00269
	(-0.27)	(-0.10)
Direct cash transfers (from Government, donor, NGO or church)	0.0237	0.00408
	(0.96)	(0.15)
Other	0.0997	0.105
	(1.57)	(1.55)
Intercept	0.133	0.387***
N	**953**	**953**
R^2	0.1933	0.1918
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Table 2.15 Random Effect and Fixed Effect Model Linear Regressions (1) of Wealth Index Score on Contemporaneous and Lagged Household Characteristics and Social Welfare Participation variables, All districts

	Random Effects	Fixed Effects
Household size	0.00452**	0.00243
	(2.66)	(1.00)
Household size (lagged)	0.00468**	0.00266
	(3.01)	(1.29)
Social group membership		
Farmers group	0.0180*	0.00448
	(2.55)	(0.51)
Farmers group (lagged)	0.0248***	0.00834
	(3.56)	(0.94)
Finance/development group	0.0319*	0.0169
	(2.41)	(0.96)
Finance/development group (lagged)	0.0431**	0.0252
	(3.19)	(1.39)
Safety net program participation		
Farm Input Subsidy Prgm (Starter Pack seed, fertilizer voucher)	0.0103*	0.00572
	(1.98)	(0.75)
Farm Input Subsidy Prgm (Starter Pack seed, fertilizer voucher) (lagged)	0.0151**	0.0172***
	(3.24)	(3.46)
Other free agricultural inputs distributions (not Starter Packs)	0.0523*	0.0871
	(2.32)	(1.92)
Other free agricultural inputs distributions (not Starter Packs) (lagged)	-0.0440	-0.0541
	(-1.65)	(-1.93)
N	**1783**	**1783**
R^2	0.07	0.072
t statistics in parentheses	+0.10 * p<0.05 ** p<0.01 *** p<0.001	

Discussion

In this analysis, I used asset data to construct a wealth index which measures household wealth in a rural, poor setting where monetary data is difficult to ascertain. I then examined the role of demographic characteristics and social welfare on household wealth. I expected that being married, attending school, being a member of a farmer group and participation in the Starter Pack program would be correlated with household wealth. In a random effects model, household size and parental education were strongly correlated with the wealth index score. Larger families were associated with higher wealth index scores and this is consistent with the literature on rural households in Africa. The relationship between schooling and wealth index scores for women who attended secondary school were twice that of women who only attended primary school. The strong correlation between the wealth index score and more schooling was consistent with the literature that indicates a high return to schooling through employment in rural Malawi (Castel, Phiri, and Stampini 2010).

The positive and strong association of being unmarried and household wealth was surprising. About one out of two women in Balaka are divorced so it is plausible women have learned to cope with divorce and protect their households from its financial consequences. Additional research could help to elucidate this relationship.

Lastly, I found positive and strongly significant associations between household wealth index scores and participation in farmer groups and the Starter Pack program,

respectively. Unlike farmer group membership or other demographic characteristics, there is some temporal ordering of safety net programs participation and household wealth. The household wealth index was measured for 2004, 2006 and 2008 and corresponding observations of safety net programs participation reflected years 2005, 2006 and 2007. The temporal order is not perfect a perfect approach, and it is only slightly improved upon by the addition of lagged variables since there is no baseline measure. However, this analysis does not rule out the possibility that that participation in the Starter Pack program improves household wealth as measured by asset data.

The collection of asset data minimizes the measurement error and costs associated with consumption expenditures, particularly in a rural setting (Montgomery et al. 1999; O'Donnell et al. 2008). Furthermore, there are ways to improve upon asset data collection and its measurement. It could be more meaningful to learn which possessions mark wealth in the local community before survey development. It may also be possible to further weight the assets by their age or condition to help draw better comparisons between assets over time. Nevertheless, finding more avenues in wealth and poverty research will go a long way in designing better policies and programs for rural populations.

CHAPTER 3 The Health-Wealth Gradient in Children's Nutritional Outcomes in Rural Malawi

Introduction

Investments in children's health and education are critical to developing economies, which rely on a healthy and well educated working population for economic growth. Various studies have established that poor health in childhood leads to lower educational attainment, worse labor earnings and poor health outcomes later in life (Ben-Shlomo and Smith 1991; Marmot and Smith 1991; Smith 1999; Strauss and Thomas 1998). As a result, there is increased research on the association between household wealth and children's health outcomes beginning with Case, Lubotsky and Paxson (2002) seminal work on parental income and child health in the United States. They found that income affected children's health outcomes in a "gradient" pattern where poorer children had worse health outcomes than wealthier children. Moreover, they found that the slope of the gradient increased by age groups so that that the association between wealth and health strengthened as children grew. This finding initiated a series of investigations to determine if the health-wealth gradient existed in other settings and to explore explanations for different findings. To date, Cameron and William's study (2009) is the only investigation of the health-wealth gradient in a developing country of Indonesia, although it is considered a middle income country. The analysis that I conduct here is a unique complement to this study because it is based in rural

communities in the highly impoverished country of Malawi. The analysis employs household asset ownership as a proxy measure of household wealth instead of the traditional monetary measures, which broadens the application of health-wealth research to similarly rural, poor settings with similar data limitations.

Background

In their literature review of early malnutrition effects on adult height, Elo and Preston (1992) concluded that 'nutritional status in childhood, as reflected in (adult) height, also elevates adult mortality in developing countries in part because it diminishes earnings. Many researchers have explored the relationship between childhood health, nutrition and adult health. Barker's (1997) research on 'fetal programming' points to the influence of in utero conditions on physiologic and metabolic process later in life. Earlier investigations directly link in utero conditions and obesity (Ravelli et al. 1999; Ravelli, Stein, and Susser 1976) and recent studies suggest that early under-nutrition programs the body to increase or preserve fat stores (Sawaya and Roberts 2003). Another theory on 'allostatic load' suggests that the accumulation of frequent, high level response to stress starting in childhood can result in a permanent functioning that leads to hypertension and diabetes later in life (Smith, 1999). It is well-established that early life conditions influence health and that adult health impacts socioeconomic status. It is less clear when these early life conditions, including specifically household wealth, begin its influence in childhood.

Case et al. (2002) found in her US sample that children's health is positively related to household income and that the relationship between household wealth and health became more pronounced as children got older. They did not find any evidence that family income affected child health through health care or that the gradient was explained by genetics or poor health at birth. Instead, the arrival and impact of chronic conditions largely explained this age steepening. They found that wealthier children recovered more quickly from the negative impact of poor health at birth and they reason that higher income parents are better able to manage chronic conditions than low income parents. Using panel data, J. Currie and Stabile (2003) further explore whether the gradient increase with age occurs as a result of health shocks, and whether poor Canadian children do not cope with health shocks because of information/ resource limitation, or if they receive more shocks due to their environment or lifestyle. The authors find a positive association and age-steepening gradient in Canada although to a lesser degree than Case et al's (2003) US study. They also considered the provision of universal health care in Canada, uphold the US finding that health insurance has no effect. They revealed that high income and low income children recover from health shocks almost equally but that steepening age gradient is due to low income children receiving more health shocks, especially a high number of chronic conditions. To continue this investigation, A. Currie et al (2007) explored if poor British children have more chronic health conditions and if higher income protects children from these

chronic conditions. A re-examination of this study revealed a similar but comparably smaller age gradient increase for British children (Case, Lee, and Paxson 2008; Case, Lubotsky, and Paxson 2002). Murasko (2008) investigates whether these income effects are contemporaneous or cumulative by using cohort data. Compared to the previous studies, he finds a relatively smaller effect of income on American children's health (Case et al. 2002; J. Currie 2009). Controls for baseline health help to flatten the income gradient for all ages but gradient still persists due to the cumulative effect from income. Khanam et al (2010) finds a similar age increasing gradient in Australia and the gradient flattens if controls for parental health and nutrition are added. They find that parental health, particularly mothers' health reduces the income coefficient to zero when included in the child health production function, which is similar to findings by Propper et al (2007) investigation of UK children using a rich set of controls including mothers' health before pregnancy. In the Propper et al (2007) analysis, income does not have any impact on child health when mother's anxiety and adversity during her own childhood is controlled.

Overall, there is some consensus amongst these most influential studies. Income has a positive relationship with children's health, without controlling for any other factors. Whether this positive relationship persists or increases with child age is less consistent. In some studies the child health-income gradient is robust to the inclusion of confounders and controls (Case, Lee, and Paxson 2008; Case et al. 2002; Condliffe and Link 2008; J. Currie and Lin 2007; J. Currie and Stabile 2002; Doyle, Harmon, and Walker

2007; Murasko 2008) and in others, the addition of parental health or other child characteristics significantly reduces the effect of income on health (Chen et al. 2006; Khanam, Nghiem, and Connelly 2009; Korenman, Miller, and Sjaastad 1995; Propper, Rigg, and Burgess 2007).

In contrast to previously cited studies in Western countries, children's health in developing countries is often measured using nutritional indicators or medical reports. Crespo and Poggio (2011, unpublished) reveal findings consistent with Case et al (2002) and others. They find that across ten South American and Caribbean countries, younger children in wealthier households have better measures of nutritional status than children in poorer households. When using a long term measure such as height-for-age, the "health-wealth" gradient becomes steeper with age, but this steepening does not occur when looking at weight-for-height. Cameron and Williams (2009) reveal a "health-wealth" gradient but did not find one that was more pronounced for older Indonesian children after accounting for various child characteristics, family structure, sources of health reporting, and type of health outcome variables. They find a stronger relationship between household resources and health, after accounting for mortality, but no gradient differences across age groups. Both paper's authors point to the well-established pattern that children in developing countries mostly suffer from acute illness such as diarrhea and fevers. Since these conditions are typically short term, even

fatal, the authors propose that they do not have an accumulative effect that would result in poorer health children get older.

Nutritional indicators are a well-established public health monitoring tool in poor settings and these indicators can provide insight into the health of individuals as well as the population with a considerable degree of objectivity, and no response bias. Using anthropometric data on children aged 0-59 months in rural Malawi, my objective is to replicate the findings reviewed, determine whether the health wealth gradient exists for children and whether this gradient steepens as children age. Given the preponderance of research evidence, my hypothesis is that the "health –wealth" gradient exists for Malawian children and this relationship should become steeper with age.

Dataset

In order to examine the role of children's welfare within the context of HIV/AIDS, family and health in rural Malawi, the fifth wave (2008, MLSFH-5) of the MLFSH collected anthropometric measures of children aged 0-59 months old. The data team first completed a family and household roster based on an interview with the respondent. The roster detailed the survivorship, age, gender, residence, mobility, health, marital status, educational status and occupation of the respondent, their parents, children and any current household residents. After an individual survey, team nurses asked for consent to measure the weight and height (standing or recumbent) of any resident children aged 0-59 months who were present. Exactly 2,368 women were

interviewed in that wave and their children are the focus of this analysis. Household wealth data were also utilized from 2006 completed surveys (MLSFH-4).

WHO Growth Standards

Anthropometric measurements were used to calculate the following z-scores: height-for-age z-score (HAZ), weight-for- age z-score (WAZ), weight- for- height z-score (WHZ) and body- mass- index for age (BMI) z-score for each eligible child. The calculation of z-scores was based on the sex- and age-adjusted growth curve referred to as the 2006 World Health Organization (WHO) Child Growth Standards which is a revision that now consists of children pooled from globally representative countries, rather than children solely from North America. According to WHO, this revision affects any previous nutritional estimates especially those in infancy (O'Donnell and World Bank. 2008; World Health Organization). Based on the z-scores, children could be classified according to the following binary nutritional indicators: mild, moderate and severe stunting (less than -1, -2 and -3 HAZ, respectively), mild, moderate and severe underweight (less than -1, -2 and -3 WAZ) or mild, moderate and severe wasting (less than -1, -2 and -3 WHZ).

Using the WHO Anthro 2005 software (version 2), outside of range ages and implausible values for children's weight- and height- for- age measurements were discarded. This resulted in a final analytic sample of 1,083 children. Almost half of the children (47%) in the sample share households with other children in the sample, so the

standard errors for all regression models were adjusted for clustering on the household level (respondent). On average, 1.5 children aged between 0 and 59 months, are clustered in one household.

Children's nutritional profile

Table 3.1 shows the classification[iii] of the 1,083 children into the following categories that are based on moderate or higher z-scores: stunting, undernourished, wasting, thinness, overweight and obese. A brief overview of each category follows:

Stunting (HAZ <-2). This is an important indicator of cumulative linear growth and it is an especially important indication of population health status. A low HAZ reflects chronic nutritional deficiencies and frequent illness, but is not a good measure of short term nutritional change. About half of all children (51%) in our sample are classified as having moderate stunted growth or worse, and almost 60% of boys aged 24-59 months are affected.

Undernourished (WAZ<-2). WAZ uses a composite measure of height- for- age and weight- for- age. Extreme cases of WAZ are commonly referred to as "underweight" and less severe cases as "undernourished". In this sample, about 13% of all children are classified as undernourished or worse, and this is affects both boys and girls proportionately.

[iii] Classifications explained in further detail (O'Donnell and World Bank. 2008)

Wasting (WHZ <-2). WHZ is a good indicator of changes in short term nutritional status and children with extreme scores as classified as "wasting". Wasting disproportionately affects younger children, aged 0-23 months.

*Thinness (*BMIZ<-2), *Overweight (*+1<BMIZ<+2) and *Obese (*BMIZ>+2). BMIZ indicates body fat levels and a child's optimal growth. For this sample of the children aged 0-59 months, BMI is complicated because the distributions of body fat changes rapidly as children grow. Especially low BMI is considered "thinness" and affects younger children more than older children. High BMI is classified as "overweight" and "obese". About half of all children are considered overweight in the sample and an additional 15-20% is considered obese by WHO classification standards.

Table 3.1 Prevalence of Children's Malnutrition based on WHO Classification Scheme, Children aged 0-59 months, MLSFH 2008

Age (months)	Gender	Stunting	Under-nourished	Wasting	Thinness	Over weight	Obese	n
0-11	**Boys**	33.0%	11.4%	6.8%	5.7%	27.3%	21.6%	88
	Girls	31.3%	7.3%	4.2%	6.3%	16.7%	22.9%	96
	Total	32.1%	9.2%	5.4%	6.0%	21.7%	22.3%	184
12-23	**Boys**	57.6%	12.0%	3.2%	1.6%	24.0%	16.8%	125
	Girls	55.0%	17.8%	8.5%	6.2%	30.2%	17.8%	129
	Total	56.3%	15.0%	5.9%	3.9%	27.2%	17.3%	254
24-35	**Boys**	67.2%	16.4%	4.3%	3.4%	31.0%	20.7%	116
	Girls	51.3%	8.5%	0.9%	0.9%	20.5%	19.7%	117
	Total	59.2%	12.4%	2.6%	2.1%	25.8%	20.2%	233
36-47	**Boys**	60.2%	17.6%	3.7%	2.8%	29.6%	18.5%	108
	Girls	53.6%	10.7%	0.9%	0.9%	23.2%	15.2%	112
	Total	56.8%	14.1%	2.3%	1.8%	26.4%	16.8%	220
48-59	**Boys**	48.9%	8.7%	0.0%	0.0%	20.7%	9.8%	92
	Girls	52.0%	17.0%	1.0%	1.0%	19.0%	7.0%	100
	Total	50.5%	13.0%	0.5%	0.5%	19.8%	8.3%	192

Children's socio-demographic characteristics

Table 3.2 summarizes the socio-demographic profile of the sample children. Half of the children are younger than 2.5 years old but there is a considerable range between ages. Despite the existence of high stunting rates and considerable rates of undernourishment, about 80% of all children are reported by the interview respondent to have good health or better. Children's health was reported by the respondent prior to the time when child measurements were taken or even requested. Most children live

in households where their mother/guardian (hereafter, referred to as mother) are married (85%) and work in their own agricultural fields as subsistent farmers (60%). Most rural Malawians have attended some school (75% of women and 80% of men), but most never complete primary school.

There is considerable variation in the general household characteristics. The average household size is 5.6 people, and the dependency ratio indicates that the total children and elderly outnumber working age-adults with a 1.6 ratio. The female weighted ratio is a calculation of the dependency ratio, weighted by the number of working aged females, so this ratio was greater at 2.8. The household wealth quintiles were based on the entire surveyed population of 2,368 respondents. More than two-fifths of the sample children live in the middle and rich quintile households. All of these summary statistics reflect households with multiple children in the analytic sample.

Table 3.2 Summary Statistics for All Children (aged 0-59 months) in the MLFSH 2008 Anthropometric Roster, Socio-Demographic Characteristics

	Mean	*Std. dev.*
Age in months	29.4	*16.5*
Gender		
Boys	48.9	
Reported Health Status (%)		
Excellent	30.3	
Very good	31.4	
Good	21.3	
Very poor	2.8	
Don't know	0.1	
Missing	14.1	
Household characteristics		
Respondent is married (%)	86.0	
Respondent works in own agric fields (%)	60.9	
Respondent engaged in wage labor (%)	33.5	
Partner works in own agric fields (%)	55.7	
Partner engaged in wage labor (%)	33.1	
Respondent attended any school (%)	74.9	
Partner attended any school (%)	80.6	
Respondent's number of living children	4.0	*2.1*
Household size (a)	5.6	*2.0*
Household members between 15-59 (b)	2.3	*1.0*
Household members under age 15yrs(d)	3.2	*1.5*
Standard dependency ratio (e)	1.6	*0.9*
Female weighted dependency ratio (f)	2.8	*1.4*
Household wealth Index Quintile (%) (g)		
Poorest	16.7	
Poor	18.8	
Middle	23.0	
Rich	22.5	
Richest	19.1	
North region (%)	30.8	
Central region (%)	35.1	
South region (%)	34.1	
Total number of children		**1083**

(a), (b), (d), (e), (f), and (g) <5% of observations missing based on household roster reports

Analysis Approach

An important challenge in the health-wealth research is identifying, disentangling and measuring all the possible ways household wealth and children's health are related. Prior to estimating the relationship between household wealth and children's nutritional outcomes, I will address my data limitations and concerns about the analysis, specifically the use of proxy measures, unobserved heterogeneity, and causality.

Household wealth

The main predictor variable is household wealth and this analysis uses the asset based wealth index score as a proxy measure of wealth. With few exceptions, the literature on health- wealth relies on current or permanent income as a measure of long term wealth. As described in Chapter 2, the wealth index serves as proxy for household's long term economic status. It is not intended to be a measure of current welfare. It is a measure that is used in the absence of more optimal alternatives (Filmer and Pritchett 2001) and serves as an important alternative for developing country datasets that do not collect relevant monetary data such as this one. Chapter 2 revealed that the wealth index score was positively correlated with levels of parental education, household size and participation in safety net programs which suggests that it should be a reliable measure of household wealth in this analysis.

Unobserved heterogeneity and causality

Unobserved heterogeneity is a concern because it causes omitted variable bias. In this cross-sectional analysis omitted variable bias is almost inevitable because there are several factors related to wealth such as seeking of medical care, which may also be related to nutritional status, but not observed in the data. This means the unobserved variable, medical care is correlated with the error term. Modeling of such relationship will result in biased estimates.

Causality is a problem if unobserved factors such as genetic or parental endowments jointly determine both household wealth and children's nutritional status. Another limitation of this analysis that unravels any causal interpretation is the cross-sectional treatment of the dataset. I attempt to minimize some of the cross-sectional limitations by including an analysis of nutritional outcomes using "change in wealth" over time variables. This is done for all children in households with 2006 data. Although the qualitative interpretation of the analysis is different, it offers a more causal interpretation in the analysis.

Covariates

The covariates in the analysis are other likely predictors of children's nutritional outcomes. They are limited to maternal and paternal education, and maternal self-reported health. Education is broadly measured as attending any school and not ever attending school and this is because the majority of children have mothers who have

only attended primary school (70%). This analysis also measures maternal education as the number of schooling years (father's education in years is mostly missing). On average, children's mothers have received about 4 years of schooling.

Nutritional outcome

About half of children aged 0-59 months in our sample are classified as moderately or severely stunted. This corresponds with stunting being identified as a major health problem for Malawian children (FAO 2010). Moderate stunting or worse is considered a z-score that is at least below 2 standard deviations from the growth standard mean. In our model, stunting is a dichotomous variable for whether children are moderately-severely stunted or they are not.

Descriptive Results

Nonparametric regression of Stunting on Household wealth

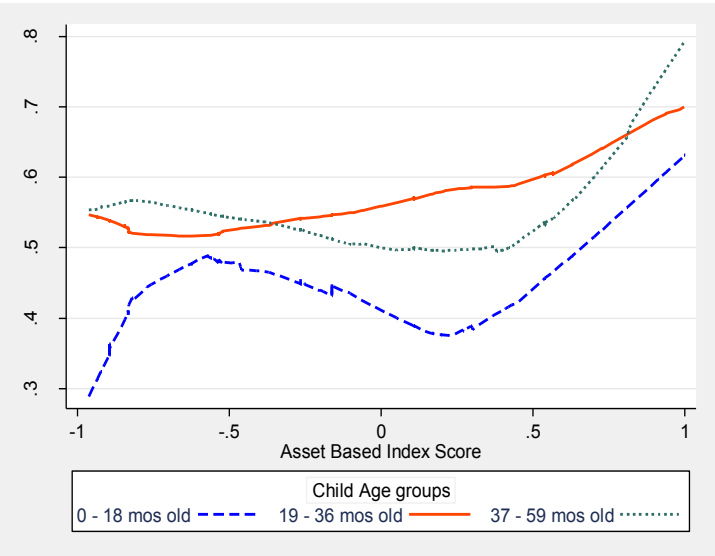
The analysis begins with the standard approach of using (Fan) nonparametric regressions to estimate the relationship between children's nutritional indicators and socioeconomic status at different ages (Fortson 2008). This regression does not assign a specific function, instead it uses the data to determine the shape of the function by giving local weights the most influence. The Fan regression is given as:

$$Y_{\mathrm{i}} = f(W_{\mathrm{i}}) + \varepsilon_{\mathrm{i}}$$

where Y_i is the nutritional indicator and W_i is the wealth measure, the wealth index score. This regression is estimated for the separate age groups 0-18, 19-36, and 37-59 months. The mean and standard deviation of the 2008 wealth index score is *x*= 0.04 and *s*=0.90. As such the nonparametric regression in Figure 3.1 is shown for wealth index scores within -1 and 1 units, since most of the wealth index scores fall into this range.

The estimated nonparametric relationship between stunted status and the 2008 wealth index score is illustrated mainly as "an exploratory graphic rather than model fitting with inferential apparatus", so the standard errors are not calculated (Cox 2006). Contrary to evidence of "health-wealth" gradient, the graph does not show that stunting risk declines with increases in household wealth. Rather, stunting risk does not vary with household wealth for the 19-36 age group. For the 37-59 age group, a similar pattern is shown for households with lower and middle wealth index scores.

Figure 3.1 Nonparametric Estimate of Wealth Index Score and Stunting for Children aged 0-59 months old



Multivariate analysis results

The multivariate analysis determines whether the lack of a "health-wealth" gradient across age groups persists with the inclusion of the individual and household characteristics. Table 3.3 shows the probit coefficients for the regression of stunting on the household wealth index. Child gender and age by month were controlled in all the regressions. The first column shows the coefficients of the wealth index score for all ages and the subsequent columns show the coefficients for the 12 month age groups. The predicted probability of stunting decreases with increases in the wealth index score, holding all covariates constant, for both pooled and age groups. However, the decrease is only significant for the oldest age group-48-59 months.

Table 3.3 Regression of Stunting Status on Household Wealth for Children aged 0-59 months, pooled and by age groups, MLSFH, 2008

		Age Groups				
	All Ages	***0-11***	***12-23***	***24-35***	***36-47***	***48-59***
A. HH wealth Index score	-0.076	-0.007	-0.091	-0.031	-0.040	-0.212+
	(0.048)	(0.111)	(0.099)	(0.096)	(0.106)	(0.114)
Number of observations	1057	179	246	231	211	190
B. HHH wealth quintiles (ref=poorest quintile)						
Poor	-0.140	0.497+	0.022	-0.234	-0.292	-0.665*
	(0.135)	(0.293)	(0.258)	(0.324)	(0.326)	(0.319)
Middle	-0.244+	-0.215	-0.248	-0.088	-0.387	-0.341
	(0.145)	(0.392)	(0.285)	(0.366)	(0.327)	(0.343)
Rich	-0.333*	-0.065	-0.028	-0.407	-0.230	-0.987**
	(0.138)	(0.324)	(0.263)	(0.337)	(0.318)	(0.308)
Richest	-0.154	0.156	-0.069	-0.067	-0.246	-0.638+
	(0.145)	(0.340)	(0.282)	(0.335)	(0.325)	(0.328)
Number of observations	1057	179	246	231	211	190

Standard errors in parentheses + p<0.10 * p<0.05 **p<0.01 ***p<0.001

All regressions controlled for child gender and dummy variables for age in months

Alternatively, the wealth index score was transformed into wealth quintiles and employed as the measure of household wealth. The coefficients shown for each group represents the difference in stunting risk between the specified quintile and the poorest quintile. The negative coefficient indicates that there is a decrease in stunting risk for the quintile categories, compared to the poorest quintile in the pooled model. With the exception of the 0-11 age group, the remaining age groups demonstrate that being in a higher than poorest quintile reduces the risk of stunting and that the relationships are even more pronounced in the oldest age group where the coefficients are significant for all but the middle wealth quintile.

Since the primary objective of this analysis is to determine the contribution of household wealth to children's health, it is important to measure other well-known components of household resources. Maternal education has been widely studied as an important determinant of children's well-being, and numerous studies have explored the specific pathways in which maternal education affects children's health. Table 3.4 shows the results for regression of maternal education on stunting. Maternal and paternal educational levels were first estimated separately from household wealth because education and wealth are often collinear, but the correlation coefficient was about .45 for each. When maternal education is measured as the number of years of schooling (Panel A), there was a decrease in the predicted probability of stunting with a year increase in mothers' schooling for all but the 12-23 age groups. Maternal

education was measured categorically (Panel B) and demonstrates an overall inverse relationship with stunting risk, although there are some inconsistencies with the two youngest age groups. It does not appear that stunting risk is sensitive to how maternal education is measured. Panel C shows the probit coefficients for paternal education. In comparison to the estimates for household wealth and mothers' education, the coefficients for paternal education are definitively consistent and often significant across age groups, unlike mothers' education and household wealth which are not consistent in the youngest age groups. While there is a strong influence of household wealth and parental education on children's stunting, there does not appear to be an increasing gradient by age. While some studies have found that the influence of household wealth is sensitive to the choice of age groups, my analysis on alternative age grouping (not shown) does not demonstrate any difference and perhaps this is because of the very young ages observed.

Table 3.4 Regression of Stunting Status on Parent's Educational Attainment for Children aged 0-59 months, pooled and by age groups, MLSFH, 2008

		Age Groups				
	All Ages	***0-11***	***12-23***	***24-35***	***36-47***	***48-59***
A. Mother's years of schooling						
Number of years	-0.008	-0.007	0.054*	-0.018	-0.017	-0.059+
	(0.013)	(0.033)	(0.027)	(0.027)	(0.030)	(0.031)
Number of observations	1048	178	244	228	211	187
B. Mother's any schooling (ref=no school)						
Attended school	-0.029	0.135	0.264	-0.115	-0.287	-0.162
	(0.093)	(0.245)	(0.184)	(0.201)	(0.206)	(0.229)
Number of observations	1083	184	254	233	220	192
C. Father's any schooling (ref=no school)						
Attended school	-0.249*	-0.000	-0.176	-0.413+	-0.437+	-0.224
	(0.104)	(0.255)	(0.214)	(0.244)	(0.230)	(0.227)
Number of observations	1083	184	254	233	220	192

Standard errors in parentheses + p<0.10 * p<0.05 **p<0.01 ***p<0.001

All regressions controlled for child gender and dummy variables for age in months

Table 3.5 demonstrates whether the relationship between household wealth, measured by the wealth index score and predicted probability of stunting is robust to the inclusion of mother or father's education to the regression model. In Panel A, the household wealth index score has a consistently inverse relationship with the risk of stunting, across age groups. When comparing the age groups in Panel A1 or A2, the inclusion of either the mother or father's education affects estimates of household wealth in the model. There is consistency between the models for the 48-59 age group which suggests that at that age, household wealth is robust to parent's educational status.

Table 3.5 Regression of Stunting Status on Household Wealth and Parental/Guardian Background Characteristics for Children aged 0-59 months, pooled and by age groups, MLSFH, 2008

		Age Groups				
	All Ages	***0-11***	***12-23***	***24-35***	***36-47***	***48-59***
A. HH wealth Index score						
Score	-0.076	-0.007	-0.091	-0.031	-0.040	-0.212+
	(0.048)	(0.111)	(0.099)	(0.096)	(0.106)	(0.114)
Number of observations	1057	179	246	231	211	190
A1. HH wealth Index score with Mother's Schooling attendance						
Score	-0.068	-0.019	-0.106	-0.023	0.042	-0.240+
	(0.051)	(0.114)	(0.105)	(0.106)	(0.111)	(0.126)
Number of observations	1039	177	241	227	209	185
A2. HH wealth Index score with Father's Schooling Attendance						
Score	-0.041	-0.012	-0.051	0.015	0.054	-0.214+
	(0.050)	(0.111)	(0.103)	(0.102)	(0.110)	(0.125)
Number of observations	1039	177	241	227	209	185

Standard errors in parentheses + p<0.10 * p<0.05 **p<0.01 ***p<0.001

All regressions controlled for child gender, dummy variables for age in months and mother's self-reported health and education variable specified in table

Table 3.5 (continued) Regression of Stunting Status on Household Wealth and Parental/ Guardian Background Characteristics for Children aged 0-59 months, pooled and by age groups MLSFH, 2008

	All Ages	Age Groups				
		0-11	*12-23*	*24-35*	*36-47*	*48-59*
B. HH wealth quintiles (ref=poorest quintile)						
Poor	-0.140	0.497+	0.022	-0.234	-0.292	-0.665*
	(0.135)	(0.293)	(0.258)	(0.324)	(0.326)	(0.319)
Middle	-0.244+	-0.215	-0.248	-0.088	-0.387	-0.341
	(0.145)	(0.392)	(0.285)	(0.366)	(0.327)	(0.343)
Rich	-0.333*	-0.065	-0.028	-0.407	-0.230	-0.987**
	(0.138)	(0.324)	(0.263)	(0.337)	(0.318)	(0.308)
Richest	-0.154	0.156	-0.069	-0.067	-0.246	-0.638+
	(0.145)	(0.340)	(0.282)	(0.335)	(0.325)	(0.328)
Number of observations	1057	179	246	231	211	190
B1. HH wealth quintiles (ref=poorest quintile) with Mother's Schooling attendance						
Poor	-0.121	0.465	0.148	-0.168	-0.245	-0.680*
	(0.136)	(0.299)	(0.264)	(0.331)	(0.333)	(0.331)
Middle	-0.222	-0.375	-0.194	-0.018	-0.278	-0.366
	(0.149)	(0.409)	(0.298)	(0.377)	(0.338)	(0.355)
Rich	-0.298*	-0.118	0.053	-0.305	-0.038	-1.009**
	(0.142)	(0.336)	(0.270)	(0.352)	(0.351)	(0.324)
Richest	-0.126	0.116	-0.073	0.003	-0.087	-0.631+
	(0.151)	(0.349)	(0.292)	(0.353)	(0.346)	(0.358)
Number of observations	1039	177	241	227	209	185
B2. HH wealth quintiles (ref=poorest quintile) with Father's Schooling Attendance						
Poor	-0.111	0.494	0.108	-0.193	-0.324	-0.659*
	(0.136)	(0.304)	(0.263)	(0.337)	(0.333)	(0.333)
Middle	-0.158	-0.316	-0.119	0.069	-0.280	-0.306
	(0.150)	(0.420)	(0.297)	(0.376)	(0.337)	(0.364)
Rich	-0.240+	-0.080	0.127	-0.268	-0.044	-0.945**
	(0.142)	(0.336)	(0.274)	(0.346)	(0.341)	(0.327)
Richest	-0.054	0.162	0.039	0.091	-0.092	-0.547
	(0.149)	(0.349)	(0.289)	(0.350)	(0.335)	(0.363)
Number of observations	1039	177	241	227	209	185

Standard errors in parentheses + p<0.10 * p<0.05 **p<0.01 ***p<0.001
All regressions controlled for child gender, dummy variables for age in months and mother's self-reported health and education variable specified in table

A similar pattern is evident in the continuation of Table 3.5, where the wealth measure is transformed into wealth quintile dummy variables. The household quintile measure is consistently robust to the father's and mother's education at the oldest age groups, and there does not appear to be any clear pattern between age groups.

Changes in Household Wealth

The next set of analysis tries to improve the specification of the model by taking advantage of the panel data. Tables 3.8 and 3.9 use the same model approach as the previous section but employs a household wealth measure that captures the "change in wealth" over time for the 868 children who have 2006 survey data. First, Tables 3.6 and 3.7 describes the distribution of children in households that have experienced a number of years categorized as poor and the distribution of children in households that have moved into and out of wealth quintiles between the 2004 and 2006 panel years. Table 3.6 shows that the majority of children in the sub-analysis sample live in households that have not been defined as poor or poorest in the two panel years. Table 3.7 is a transition matrix that shows only 4.4-11 % of households remain in the same quintile as the previous year (although this is a relative measure). In addition to these two household change variables, a third variable in Table 3.8 measures the difference in the wealth index score in 2004 and 2006.

Table 3.6 Children in Households Experiencing Different Panel Periods of Being in the Poor and Poorest Quintile, MLSFH 2004 and 2006

Number of Panel Years	%	Number of Children
0	43.7	379
1	27.7	240
2	28.7	249
N	**100**	**868**

Table 3.7 Percentage of Children in Households That Remain or Transition into Wealth Quintiles in 2006 and 2008

Wealth Quintile in 2006	Wealth Quintile in 2008					
	Poorest	Poor	Middle	Rich	Richest	Total
Poorest	8.4	6.1	3.0	1.5	0.5	19.5
Poor	4.4	9.8	5.8	5.0	1.2	26.0
Middle	1.6	5.8	4.4	5.3	1.0	18.1
Rich	1.0	2.0	3.2	7.7	6.2	20.2
Richest	0.0	0.5	0.8	3.9	11.1	16.2
Total	15.4	24.1	17.2	23.4	19.9	100.0
N						**868**

Panel A of Table 3.8 shows that children in households that spend one more year as poor increase their probability of stunting based on the pooled model. This pattern is consistent across most ages, but not significant. Panel B shows that an increase in wealth index scores (difference) results in a decreased probability of stunting. Panel C shows that children in households where their wealth quintile remains the same or increase have a decreased risk of stunting compared to households where there is a decline in the wealth quintile. This is consistent across all age groups. Table 3.9 illustrates whether the change in household wealth variable is robust to mother or

father's education. The relationships here are consistent with the pattern that greater wealth decreases the risk of stunting and that the influence of wealth is often significant only for the 48-59 age groups. There is no clear pattern of health gradient even when the model is improved by accounting for changes in household wealth over time.

Table 3.8 Regression of 2008 Stunting Status on Change in Household Wealth (2006-2008) for Children aged 0-59 months, pooled and by age groups

		Age Groups				
	All Ages	***0-11***	***12-23***	***24-35***	***36-47***	***48-59***
A. Number of Years Being Poor, 2006-2008						
Years	0.048	0.017	0.165	0.040	-0.074	0.093
	(0.057)	(0.144)	(0.117)	(0.114)	(0.123)	(0.134)
Number of observations	868	134	208	195	179	152
B. HH Wealth score difference, 2006-2008						
Score	-0.109	-0.303+	0.007	-0.034	-0.066	-0.322*
	(0.069)	(0.177)	(0.146)	(0.148)	(0.142)	(0.164)
Number of observations	868	134	208	195	179	152
C. HH Wealth Quintile Transition, 2006-2008 (ref=Wealth quintile decline)						
Wealth quintile remain same	-0.259*	-0.186	-0.428	0.099	-0.318	-0.479+
	(0.123)	(0.312)	(0.267)	(0.263)	(0.251)	(0.273)
Wealth quintile increase	-0.182	-0.493	-0.209	0.164	-0.275	-0.300
	(0.123)	(0.319)	(0.257)	(0.270)	(0.254)	(0.285)
Number of observations	868	134	208	195	179	152

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

Standard errors in parentheses

All regressions controlled for child gender and dummy variables for age in months

Table 3.9 Regression of 2008 Stunting Status on Changes in Household Wealth (2006-2008) and Parental Background Characteristics for Children 0-5 and age groups

	All Ages	Age Groups				
		0-11	*12-23*	*24-35*	*36-47*	*48-59*
A. Number of Years Being Poor, with Mother's School attendance						
Years	0.027	0.009	0.209+	0.009	-0.207	0.089
	(0.061)	(0.153)	(0.122)	(0.131)	(0.135)	(0.137)
Number of observations	864	134	205	194	179	152
A1. Number of Years Being Poor, with Father's School attendance						
Years	0.003	0.011	0.154	-0.037	-0.195	0.091
	(0.060)	(0.150)	(0.120)	(0.122)	(0.133)	(0.141)
Number of observations	864	134	205	194	179	152
B. HH Wealth score difference, with Mother's School attendance						
Score	-0.105	-0.299+	0.024	-0.052	-0.056	-0.312+
	(0.069)	(0.177)	(0.147)	(0.147)	(0.144)	(0.170)
Number of observations	864	134	205	194	179	152
B1. HH Wealth score difference, with Father's School attendance						
Score	-0.082	-0.272	0.055	-0.013	-0.053	-0.319+
	(0.070)	(0.175)	(0.151)	(0.148)	(0.145)	(0.170)
Number of observations	864	134	205	194	179	152
C. HH Wealth Quintile Transition, (ref=Wealth quintile decline) with Mother's School						
Wealth quintile remain same	-0.248*	-0.187	-0.436	0.032	-0.322	-0.416
	(0.123)	(0.315)	(0.270)	(0.267)	(0.254)	(0.276)
Wealth quintile increase	-0.174	-0.494	-0.177	0.101	-0.280	-0.283
	(0.124)	(0.321)	(0.259)	(0.272)	(0.261)	(0.287)
Number of observations	879	136	211	194	185	153
C1. HH Wealth Quintile Transition, (ref=Wealth quintile decline) with Father's School						
Wealth quintile remain same	-0.236+	-0.189	-0.409	0.036	-0.339	-0.416
	(0.124)	(0.316)	(0.274)	(0.267)	(0.258)	(0.275)
Wealth quintile increase	-0.137	-0.455	-0.135	0.143	-0.290	-0.274
	(0.125)	(0.321)	(0.265)	(0.272)	(0.262)	(0.291)
Number of observations	879	136	211	194	185	153

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

Standard errors in parentheses

All regressions controlled for child gender, dummy variables for age in months and mother's self-reported health and specified education variable

Analysis of variance

The multivariate analysis above assumes that the occurrence of stunting is independent from one child to another. However, this is not likely since on average households have 1.5 of children in the sample and children may share characteristics that lead to stunting. The mean and standard deviation of stunting is x= 0.51 and s=0.5. A one-way analysis of variance (ANOVA) was calculated to determine how much of the variation in children's stunting is between households and how much of the variation is within households. The intra-class correlation coefficient (*rho*) measures the level of association between stunting of children in the same household and is calculated as the ratio of the between household variance to the total household variance. Table 3.10 shows the intra-class correlation coefficient as 0.12. This is fairly low and suggests that the coefficients and standard errors in the standard probit regression models, which were adjusted for clustering, are accurate. More importantly, this suggests that stunting may not be highly influenced by shared family or environmental characteristics as co-resident children's stunting was correlated by only 12%.

Table 3.10 Results of One Way Analysis of Variance (ANOVA) on Children's Stunting Status, MLSFH, 2008

Source	SS	Df	MS	F	Prob>F
Between respidn	210.898	812	0.260	1.18	0.053
Within respidn	59.000	268	0.220		
Total	269.898	1080	0.250		

Intra-class correlation coefficient	S.E.	Confidence Interval	
0.11912	0.069	0	0.25365

Estimated SD of household effect	0.173
Estimated SD within household effect	0.469

Discussion

Children in better off households have lower risk of stunting even in a setting where poverty is widespread and stratification by socioeconomic status is not often clear to the observer. Yet the possession of assets helps to distinguish the wealth of households from each other well enough to see some evidence of a wealth health gradient beginning in the oldest age groups.

The early health-wealth literature points to an increasing effect of household wealth on health outcomes- that is a stronger health-wealth gradient, as children age which is not completely evident in our dataset. From this analysis, wealthier households are associated with decreased risk of stunting across age groups but there is no evidence of a gradient by age. This finding is consistent with more recent health-wealth literature (Cameron and Williams 2009; Khanam et al. 2009; Propper et al. 2007). The

"change in household wealth" variables improves the model by accounting for wealth changes between 2006 and 2008, and this helps to build a causal argument for this analysis. Increased wealth index scores and the transition into a better wealth quintile is associated with reduced probability of stunting. The emerging "health-wealth gradient" however remains similar to the 2008 wealth only models.

Most of the health wealth literature looks at children across a wider age range. The results here suggest that that household wealth does not significantly influence the health of children at the youngest ages. It is possible that other unobserved factors such as birth weight and breastfeeding are more important health determinants at those ages. As shown in this analysis, the stronger influence of wealth on health only begins to emerge with the oldest age group 48-59. This is also when the relationship between wealth and health is robust to the inclusion of parent's education.

A significant challenge with this analysis is the possibility of omitted variable bias in measuring all the factors that contribute to stunting for children under 59 months old. At these young ages, the health stock of mother and the child at birth are strong determinants of health. However, the consistent coefficients of father's education across age groups shows that there is more to learn in understanding father's role in children's nutritional status whether it is directly or indirectly through the provision of household resources. Future analysis on child health and nutrition in these districts of Malawi could improve on the model specified here, using additional data to help build a

case for policies that can improve household resources and hence, child nutritional outcomes.

CHAPTER 4 Maternal Social Capital and Schooling Outcomes in Rural Malawi

Introduction

As the Malawian government and institutions consider poverty reduction policies, there is a broader appreciation for educational policies that invest in children's human capital to develop a better skilled and educated future workforce. In a report on Malawian education and employment using the 2004/5 Integrated Household Survey, researchers found that secondary school education was associated with a 123% wage premium in regular wage employment, and 234% wage premium for tertiary education, compared to those who are illiterate. These pronounced gains reflect the relative scarcity of human capital among working age adults in Malawi (Castel et al. 2010). It is in consideration of these statistics that Malawian policymakers try to improve the educational status of children in the country.

There is a growing research literature on children's education in Africa and most of the literature examines the prohibitive cost of education for poor, rural families. In 1990, the Jomotien World Conference on Education for All declared that countries provide Universal Primary Education (UPE) or universal access to learning. In response to this declaration and as a promise to its electorate, in 1994 the newly elected Malawian government implemented the Free Primary Education (FPE) policy. Malawi was the first sub-Saharan African country to offer a free primary education to all

children. Under FPE policy, no child would be denied a primary school education because of school fees (Chimombo 2009). One would expect that Malawi would have witnessed gains in their education system. By some measures they did, but by most measures they did not.

There was a great influx of children into the education system in response to the fee waiver. Prior to the FPE policy, government and donor agencies implemented targeted fee-waiver schemes for non-repeating girls, and gradually reduced fees for children in grades 1 through 4, but none of these policies resulted in increased enrollment. The FPE program however, increased enrollment dramatically. At a 1994 baseline, Malawi had 1.8 million children enrolled in the school system. Within one year of the policy change, an additional 1 million children entered the schools. Under the strain of so many students and an ill prepared, inefficient school system, children endured poor teacher to child ratios, a shortage of qualified teachers and learning materials. The quality of the educational system declined and this was evident by test score comparisons with other schools from neighboring countries like Zambia and South Africa (Southern and Eastern Africa Consortium for Monitoring and Evaluation 2011).

The educational system was also faced with another conundrum-- although primary school rates increased, especially in the lower grades due to the FPE policy, children in the primary school still had high dropout levels (Chimombo 2009; Southern

and Eastern Africa Consortium for Monitoring and Evaluation 2011). Although the FPE policy successfully addressed primary school enrollment, it did not address retention.

The state of Malawi's education system warrants research on wider range of factors beyond direct schooling costs. In this chapter, I examine the association between maternal social capital and schooling enrollment and completion of primary school respectively. I follow Coleman (1998) and Lin's (1999) conceptual framework of social capital as "[capital] captured from the embedded resources in social networks" where there is an investment in social relations with an expected return. While the framework describes an expected return to social investments, in my analysis, returns can be expected or unexpected because none of the community organizations aim to improve children's schooling performance or outcomes. I hypothesize that maternal social capital is positively correlated with primary school completion. Using the same the framework, I also hypothesize a positive relationship between levels of maternal social capital and school enrollment. Higher levels of social capital can be associated with improved schooling outcomes through the following suggested ways. First, through broader or deeper ties to non-household networks, mothers may be more able to request or receive transfers during hardship that enable schooling. Secondly, mothers who are more involved in the community may influence their have children to be more social and this may be related to school performance. Next, mothers who have more social interactions may have better access to health information which improves their children's health and healthier children are more likely to have better schooling

outcomes. Lastly, mothers who are more social may have a preference for investments in better educated children. Evidence of these mechanisms is reviewed in the following background section.

Background

Social capital has received considerable attention across academic disciplines. Coleman's (1988) sociological research on children's education however, was the first to define social capital as an individual-level resource. He described social capital as the resources determined by social ties, which take on the forms of obligations and expectations, information channels and social norms (Astone et al. 1999; Furstenberg and Hughes 1995; Morrow 1999). Moreover, his work suggests that social capital is critical to children's human capital (Dika and Singh 2002) which underscores the motivation for this analysis.

There is limited research literature on the formal theory of social capital in Africa but some studies have related social capital to household welfare and income generation (Adato, Carter, and May 2006; Hassan and Birungi 2011; Maluccio and Haddad 2000; Narayan and Pritchett 1999), HIV status (Campbell, Williams, and Gilgen 2002) and field experimental measures of social capital components such as trust (Carter and Castillo 2011). None of the research that draws on the social capital theory in a rural African setting, explores the role of social capital on children's health or educational outcomes.

In general, the social capital literature shows that women's social interactions improves children's health in settings where maternal education is low (Adams, Madhavan, and Simon 2002; Furstenberg and Hughes 1995; Nobles and Frankenberg 2009) and children's health is important to schooling outcomes. There is correlational evidence that parental involvement in parent-teacher associations and civic organizations reduce the likelihood that children drop out of school, and involvement improves educational performance (Coleman 1988; Goddard 2003; Menahem 2011). The mechanisms for these relationships are less clear. Parental involvement in community groups may enrich their children's sociability and connections with other students and teachers which improves their schooling outcomes (Asadullah 2008). Parent's involvement may also increase or broaden their access to individuals who can provide support during hardship when a child would otherwise be taken out of school. Dika and Singh (2002) provide a very comprehensive review and cross-comparison of social capital in the education literature.

Measurement Bias in social capital and education literature

Few empirical investigations account for the endogenous nature of social capital and education (Durlauf 2002; Godoy et al. 2007). In a regression analysis, the endogenous variable is a variable that creates a bias in the estimation of the regression parameters because of its relationship to other variables. This bias can arise from 1) omitted variable bias which is bias from an unobserved variable that cannot be included

in the analysis, 2) simultaneous causality where the explanatory variable and outcome variable are jointly determined and 3) errors in variables in which the explanatory variable is measured with error. Without an appropriate methodological approach, the resulting measurement bias threatens the internal validity of the empirical findings (Angrist and Krueger 2001; Wooldridge 2003).

I refer to two papers that are most relevant to my analysis. These research studies are based on poor, rural communities in developed countries[iv] and more importantly, they address measurement bias in their analysis of social capital. Using community fixed effects analysis, Nobles and Frankenberg (2009) regress child height for age on mothers' community organization participation in rural Indonesia. They find that mothers' community participation is positively and significantly associated with children's height for only financially and educationally disadvantaged mothers. Despite the use of fixed effects, temporal ordering and interactions to reduce measurement bias, the authors admit that there still remains a possibility of omitted variable bias. The next study determines whether parental sociability and NGO membership, influences children's schooling attainment in rural Bangladesh. Using two stage least square (2SLS) regressions to address the endogeneous relationship between social capital and maternal social knowledge (an index variable measured by responses to community and political questions), Asadullah (2008) does not find any evidence that the two measures

[iv] Narayan and Pritchett (1999) analysis of social capital and household income in rural Tanzania is also relevant and they also address concerns about endogeneity. However, the focus on this analysis is social capital at the village, not individual level.

are related. Furthermore, the author finds that maternal social knowledge has a positive correlation with children's schooling attainment and it is robust to various controls.

Children's Education in Malawi

Two measures of schooling status and attainment are employed in this analysis. The first, current attendance provides an instantaneous measure of schooling status and by nature allows for schooling choice to be related to contemporaneous associations such as household or maternal characteristics at a given point in time. The second outcome, the completion of grade 8 for ages 15-20 is a cumulative measure and reflects children's educational history including dropping out of school. Each measure allows for a distinct interpretation of children's schooling outcomes.

Social capital in Malawi

Using the MLFSH 2006 and 2008 data, I examine whether maternal social capital is positively associated with children's schooling attendance and grade completion in rural Malawi. I measure maternal social capital by mothers' membership in community groups. A limitation of my analysis is that data is not available on frequency of community organization meetings, attendance or qualitative importance of the group to individual mothers. It is important to also note that none of the community groups are expected to have goals of promoting school attendance or improving school performance.

The literature on community based organizations in Malawi is limited to scarce evidence of secular changes in secret societies and communal work (Englund 1999; Phiri 1983). Early studies using MLFSH data and its sister dataset, Kenya Diffusion and Ideational Change Project (KDICP) have identified the salience of informal social networks such as friends and acquaintances to women's contraceptive use and perceptions of HIV//AIDS risk (Behrman, Kohler, and Watkins 2002; Helleringer and Kohler 2005; Kohler, Behrman, and Watkins 2007). Also research on religion and religious affiliations have been documented using MLSFH data (Trinitapoli and Regnerus 2006; Yeatman and Trinitapoli 2008).

Data

The analysis is based on the 2006 and 2008 Malawi Longitudinal Study of Families and Health (MLSFH), formerly the Malawi Diffusion and Ideational Change project (MDICP). The initial aim of this survey was to examine the role of social networks in changing attitudes and behavior regarding HIV/AIDS, family size and family planning in rural Malawi. These social networks were primarily informal and based on friendships and acquaintances. In order to begin to understand the role of formalized groups in rural areas, questions about community group and political group attendance were included in the 2006 individual women's survey. Since the outcome of interest is children's schooling, the analysis is restricted to women with school aged children who are reported as residents on the household roster during the 2008 survey. The mother/guardian must also have completed a survey in 2006 to be included in this

analysis. Eleven percent of children had values that were missing on the key predictor variable and were removed from the analysis. Only 1-2% of children had missing values on education. In total, 1,082 mothers or guardians and their 3,330 children aged 6-20 formed the final analytic sample.

Table 4.1 shows the percentage of mothers who are members of the four different community groups: Farmers, Health, AIDS and Finance/loan group. Almost 40% of women report membership in at least one community group. The table also illustrates how frequently mothers participate in social activities in the last month. Market visits and funerals are common features of Malawian rural social life. On average, women attend the market more than once a week and attend funerals about 3 times a month. Women demonstrate some civic responsibilities as almost a quarter of women attended at least one political meeting within the last year. Most Malawian women are responsible for the household farming, so it is not unusual that close to one-third of women belong to a farmers group.

Table 4.1: Description of Social Capital Proxy Measures, MLSFH 2006

Social activities and Community group Participation	Mean	*s.d.*
Mean number of times attended social activities in last month		
Drama	0.4	*1.2*
Beer	0.2	*1.2*
Dance	0.1	*0.8*
Market	5.0	*5.2*
Funerals	3.4	*2.3*
Mean number of political meetings in last year	0.5	*1.2*
Attended political meetings (%)	22.3	
Community group membership (%)		
Farmers group	29.2	
Health group	12.5	
AIDS group	8.1	
Finance/loan group	7.9	
Any group	39.0	
Total number of mothers/guardians		**1082**

Methods

Social capital index score

This analysis includes a regression of children's schooling outcomes on a maternal social index score. This index score is a continuous variable based on women's response to questions about whether they were members of the following community based groups: farmers group, health group, AIDS group, a finance/loan group and the frequency of attending political meeting in the last year. The variable on the political meetings frequency was dichotomized, given that less than a quarter of women report attending any political meeting (Table 4.1).

An index score was constructed using Principle Component Analysis (PCA), a statistical procedure that reduces the number of variables in a data set into a smaller number of dimensions by providing weights for each of these variables. The PCA creates uncorrelated indices or components from an initial set of *n* correlated variables and each component is a linear weighted combination of the initial variables and the first component explains the largest amount of variation in the dataset. The subsequent component is uncorrelated with the first component and explains additional dimensions of the data, but a smaller proportion of the variation (Vyas and Kumaranayake 2006). Putnam's widely cited work on social capital, uses a comparable technique, known as factor analysis, to create a social capital variable. It is a common methodological approach to combining several measures to create one index variable (Putnam 2001).

In considering the analytic model, it is possible that social capital runs in the direction of mothers' social activities to children's education. Children in school or children who perform well in school, may motivate mothers to become more socially active and there are studies that at least indicate that individual schooling increases an individual's likelihood of participating in community groups (see Godoy 2007 for a comprehensive review). For this reason, temporal ordering of the explanatory variables and schooling outcomes is used to avoid the reverse causality that can arise from measuring both variables at the same time. The social capital index score and other maternal and child characteristics are modeled as time lagged variables- all the

explanatory variables are based on the 2006 data wave and children's schooling outcomes are based on the 2008 wave.

The problem of endogeneity bias stemming from omitted variables can result if children's schooling outcomes and social capital are jointly determined by an unobserved variable and the explanatory variables are correlated with the error term. In order for a standard regression to provide consistent estimators, the error term, ϵ must be unrelated to the regressor, x, $E(\epsilon \mid x)=0$ and this cannot be easily assumed. The following equation (1) models the relationship between social capital and schooling outcomes.

$$Schooling\ outcome_i=\alpha_i+\beta social\ capital_i+\gamma X_i+\epsilon_i \quad (1)$$

Just as schooling is a parental choice, mothers also have a choice in joining a community group. It is possible that some women are naturally inclined to join community groups and that this trait is also associated with a preference for schooling their children. Since mother's natural traits are not observed, it is accounted for in the error term, ϵ and any estimate is biased. In order to address this problem, one approach is to employ an instrument variable (IV) estimator, Z. This estimator must meet certain conditions to be considered a valid instrument. First, Z must be reasonably identified as being correlated with the endogenous variable, x. It should relevant to the investigated outcome. Second, Z must be uncorrelated with the error term $E(u \mid z)=0$. It should be exogenous. A

valid instrument, in this analysis, must be correlated with social capital but not be correlated with children's attendance or completion.

In searching for a valid instrument, I explore the use of mothers' characteristics and social activity related variables including frequency of attending dramas, beer bars, dances, markets, funerals and political meetings (summary statistics in Table 4.1). Table 4.2 demonstrates that social capital index score has a small but significant association with maternal age. The index score also has a positive, significant association with number of children and the household wealth index score. Mothers with schooling have significantly more social capital than mothers without schooling.

In considering the use of social activities for instrumentation, one could argue that attendance at these activities- dramas, beer bars, dances and markets are related to socio-economic status, which then creates correlation in the error term in the model. However, the number of attended funeral visits and dramas in the past month is significantly associated with the social capital index score. It is reasonable that women who are active in community groups are more likely to have larger social networks that extend beyond their familial networks. As a result, they may be likely to attend more funerals. Both reasoning and the data support the first IV condition that frequency of funeral attendance and women's social capital index score must be correlated.

As in many rural part of Africa, funerals in Malawi often involve travel and monetary contributions. One could argue that the time and money spent on funerals

could also affect schooling outcomes because money is spent on funerals instead of schooling needs. However, time and financial burdens are usually limited to the deceased's family and there is no data available on whether these funerals attended were for household or non-household family members. One empirically based argument against the relationship between funeral attendance and children's schooling is evidence from a highly HIV/AIDS endemic area that primary school children in households that experience adult deaths do not drop out of school and households cope with deaths without delays to older children's schooling. Delays were found among primary school aged children who were maternal orphans. However once enrolled, these orphans had the same enrollment rates as non-orphans (Ainsworth, Beegle, and Koda 2005). Another longitudinal study in South Africa found differences in the impact of mother's or father's death on schooling. Only maternal orphans are less likely to be enrolled in school and have completed significantly fewer years of schooling, conditional on age, than children whose mothers are alive (Case and Ardington 2006). Over 80% of children in our analytic sample are biological children of the respondent. Based on these empirical findings, there is little support that schooling outcome will be correlated with frequency of funerals attendance, which satisfies the second IV condition for instrumentation.

Table 4.2 Correlates of Mothers' Social Capital Index Score, MLSFH, 2006

	OLS coefficients	*std error*
Maternal Age	0.008***	*(0.002)*
Mother' s education(ref= no schooling)		
Primary school	0.347***	*(0.039)*
Secondary school	0.539***	*(0.089)*
Number of children	0.028**	*(0.009)*
Wealth index score	0.192***	*(0.020)*
Number of times attending last month		
Beer Places	-0.000	*(0.015)*
Drama	0.133***	*(0.015)*
Dance	0.029	*(0.023)*
Funerals	0.032***	*(0.008)*
Wedding (in a year)	0.012	*(0.015)*
Market	-0.005	*(0.003)*
N		**3131**

Standard errors in parentheses
+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

Descriptive Results

Table 4.3 describes our analytic sample of children and women. Although the term "mother" is used to describe the survey respondents, about 20% of children in the analytic sample are not the biological children of the respondent as discussed previously. The table shows that there are more girls than boys in the sample despite Malawi having an at-birth sex ratio of 1.03 male/female. However, by age 15, the sex ratio becomes equal, and for adults aged 15-64, the sex ratio is in favor of females (0.97

male/female) (CIA 2012). The shift in the sex-ratio reflects excess male mortality. Globally, excess male mortality from age 15 is attributed to accidents but it may also result from HIV related deaths[v]. Since the sample includes older children between the ages of 15-20, the gender distribution should reflect mortality of the older boys

Less than half of the children aged 15-20 have completed grade 8 and among children between 6 and 14, only 86% of them are currently enrolled in school. The majority of mothers are married and almost a third of them have never attended school. Almost 70% of mothers are involved in subsistent farming. The household wealth index score is derived from ownership of different assets (this methodology and rationale is detailed in Chapter 2). In order to maintain intertemporal comparisons, the responses to asset ownership in 2006 and 2008 are pooled before creating an index score.

[v] Within the context of Malawi, it is possible that some deaths are HIV related. A study finds that female survival for HIV patients receiving antiretroviral treatment was higher than males. Being male and younger (15-24) was significantly associated with increased mortality (Chen et al. 2008)

Table 4.3: Socio-Demographic characteristics for Household Resident Children, MLFSH 2008

	Mean	*s.d.*
Child characteristics in 2008		
Age	12.5	*4.3*
Male gender (%)	48.8	
Respondent relation is Mother (%)	80.0	
Aged 15-20 (n=1,135)		
Completed 8th grade(%)	0.49	
Currently enrolled (%)	0.55	
Aged 6-14 (n=2,195)		
Currently enrolled (%)	0.86	
Total number of children	**3,330**	
Maternal/guardian and household characteristics in 2006		
Maternal age [(a)]	35.3	*12.6*
Number of children	4.2	*2.2*
Married (%)	90.3	
Divorced/Widowed/Separated (%)	9.4	
No schooling (%)	32.9	
Attended Primary schooling (%)	60.8	
Attended Secondary schooling (%)	6.4	
Works in own agricultural fields (%)	69.1	
Engaged in wage labor (%)	20.4	
Asset-based household wealth score (%)	0.4	*0.2*
Standard dependency ratio[(b)]	1.8	*1.6*
North region (%)	33.8	
Central region (%)	30.1	
South region (%)	36.4	
Total number of mothers/guardians		**1,082**

Multivariate analysis results

The following tables show results from the regression of children's schooling outcomes on social capital and other determinants. These regressions are carried out using two-stage least squares (2SLS) regression procedure in STATA. In this procedure, the first stage of the estimation, predicts the endogenous social capital index score using the instrumental variable, number of times attended funerals in last month, and other covariates X_i as shown in Equation (1).

$$Socialcapital_i=\alpha_i+\beta funeralfrequency_i+ \gamma X_i+\epsilon_i \quad \text{Eq. (1)}$$

The second stage of the estimation, Equation (2) uses the predicted value of social capital to predict the schooling outcomes. Since the schooling outcomes, completion of grade 8 and current enrollment are binary outcomes the relationship between social capital and schooling outcomes is appropriately modeled as a probit regression. Specific to the 2SLS STATA procedure, I use the *ivprobit* command because the endogenous variable, which is the social capital index score is a continuous variable. All of the regressions control for background characteristics such as children's age, sex, maternal age, number of children, maternal education and household wealth.

$$Schoolingoutcome_i=\alpha_i+\beta socialcapital_i+ \gamma X_i+\epsilon_i \quad \text{Eq.(2)}$$

First stage regressions

Tables 4.4 and 4.5 show the results of the first stage of the 2LS regression for children aged 6-14 and 15-20, respectively. The signs on the coefficient for number of funerals attended are as expected. The greater the number of funerals attended, the larger the maternal social capital index score for both younger and older children. The relationship is more significant for older children[vi].

Table 4.4 First Stage Regression of Social Capital index score on the Funeral attendance instrument, Children aged 6-14

	Coefficient		Std Err
#of times attended funeral	0.025	**	*0.009*
Child age	0.009		*0.008*
Child gender (ref=girl)	0.009		*0.041*
Mothers' age	0.006	**	*0.002*
Mother' s education(ref= no schooling)			
Primary school	0.315	***	*0.048*
Secondary school	0.497	***	*0.105*
Number of children	0.021	*	*0.011*
Wealth index score	0.197	***	*0.024*
F-test			25.89
N			2,052

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

[vi] Diagnostic tools that determine the strength of the instrument variable for the ivprobit command are not developed. It is possible if using linear probability model and the ivreg2 command but that is not available on the author's version of the STATA or accessible (http://www.stata.com/meeting/chicago11/materials/chi11_nichols.pdf).

Table 4.5 First Stage Regression of Social Capital index score on the Funeral Attendance instrument, Children aged 15-20

	Coefficient		Std Err
#of times attended funeral	0.069	***	*0.014*
Child age	-0.018		*0.018*
Child gender (ref=girl)	-0.098		*0.062*
Mothers' age	0.005		*0.003*
Mother' s education(ref= no schooling)			
Primary school	0.438	***	*0.071*
Secondary school	0.615	***	*0.168*
Number of children	0.027	+	*0.016*
Asset index score	0.181	***	*0.035*
F-test			18.98
N			1,062

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

The next set of tables compares the result of the standard probit models and probit models with instrumentation for the different schooling outcomes. Table 4.6 regressions predicts current school enrollment for children between 6 and 14. The results of the standard probit column adhere to the expected relationships between school enrollment and several characteristics. As children age, the predicted probability of enrollment increases and reflects that often children do not begin schooling until about age 8. Higher levels of maternal education and higher household wealth are associated with an increased probability of current enrollment. The social capital index score has a significant, positive association with current enrollment for this age group. When the instrumentation of funeral visits is employed, the maternal social capital loses its significance and reverses direction, while the significance, magnitude and direction of

the other variables are mostly unchanged. The standard error for the social capital coefficient is larger which suggests that this model is estimated with less efficiency.

The Wald test of exogeneity which is given in the *ivprobit* output, determines whether the error term in the structural equation Eq. (2), on schooling outcomes and the reduced form equation Eq. (1), for the endogenous social capital variable are correlated (or if the correlation parameter rho is equal to zero). In the 2SLS, the residuals from the first stage regressions are included in the second- stage regressions as regressors, and the Wald test is a test of significance of those residual's coefficients or a test of the null hypothesis that social capital is exogenous. The test of significance is associated with a p-value of 0.7131 which provides weak evidence against the null hypothesis of exogeneity and therefore, the null hypothesis is accepted. In this model, there is no need to use an instrument variable approach, and the simple probit model is more consistent.

Table 4.6 Probit Regression of Current Enrollment on Maternal Social Capital, without and with instrumentation, Children aged 6-14 , MLSFH, 2008

	Without Instrumentation	With Instrumentation
Maternal Social capital Index score	0.128*	-0.108
	(0.057)	(0.711)
Child age	0.108***	0.110***
	(0.017)	(0.019)
Child gender (ref=girl)	-0.010	-0.007
	(0.075)	(0.085)
Maternal age	-0.001	0.001
	(0.004)	(0.006)
Mother' s education(ref= no schooling)		
Primary school	0.585***	0.660**
	(0.096)	(0.250)
Secondary school	1.191***	1.308**
	(0.317)	(0.474)
Number of children	-0.029	-0.024
	(0.025)	(0.030)
Wealth index score	0.204**	0.250+
	(0.065)	(0.140)
N	2052	2052

Standard errors in parentheses

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

When the same model is specified for the current enrollment of the 15-20 age group, the maternal social capital (Table 4.7) demonstrates a negative and insignificant association with the outcome. Wealth and maternal education continues to have a positive association with enrollment. The IV regression results in a significantly negative association with enrollment. The Wald test of exogeneity tests the null hypothesis that

social capital is exogenous in the model. Since the test is associated with a p-value of 0.0101, there is strong evidence against the null hypothesis that social capital is exogenous and so the null hypothesis is rejected. Based on this, the instrument variable model to address the endogenous relationship between social capital and schooling outcomes is preferred.

The next Table 4.8 presents the regression results of grade 8 completion for the 15-20 age group. Unlike the previous tables, neither household wealth nor maternal education has any significant positive association on children's completion of grade 8 for this older age group. However, maternal social capital does have a significant positive association with grade 8 completion. In order to determine if endogeneity explains this significant association, the second column shows the results of the IV regression. In this column, the magnitude of the maternal social capital effect increases and its significance is strengthened by instrumental variable. The Wald test of exogeneity tests the null hypothesis that social capital is exogenous in this model. The test is associated with a p-value of 0.0184 which indicates strong evidence against the null hypothesis. Therefore, the instrument variable model which addresses the endogeneity of social capital is preferred over the standard probit model.

Table 4.7 Probit Regression of Current Enrollment on Maternal Social Capital, without and with instrumentation, Children aged 15-20 , MLSFH, 2008

	Without Instrumentation	With Instrumentation
Maternal Social capital Index score	-0.041	-0.716*
	(0.045)	(0.310)
Child age	-0.346***	-0.360***
	(0.026)	(0.034)
Child gender (ref=girl)	0.678***	0.620***
	(0.092)	(0.113)
Maternal age	0.012**	0.017***
	(0.005)	(0.005)
Mother' s education(ref= no schooling)		
Primary school	0.452***	0.754***
	(0.109)	(0.167)
Secondary school	0.828**	1.239**
	(0.279)	(0.400)
Number of children	-0.008	0.010
	(0.025)	(0.024)
Wealth index score	0.213***	0.336***
	(0.055)	(0.085)
N	1062	1062

Standard errors in parentheses
+ p<0.10 * p<0.05 **p<0.01 ***p<0.001

Table 4.8 Probit Regression of 8th grade completion on Maternal Social capital, without and with instrumentation, Children aged 15-20 , MLSFH, 2008

	Without Instrumentation	With Instrumentation
Maternal Social capital Index score	0.073+	0.711*
	(0.039)	(0.325)
Child age	0.374***	0.388***
	(0.027)	(0.029)
Child gender (ref=girl)	-0.384***	-0.328**
	(0.084)	(0.105)
Maternal age	0.001	-0.004
	(0.005)	(0.005)
Mother' s education(ref= no schooling)		
Primary school	0.061	-0.223
	(0.111)	(0.187)
Secondary school	0.646*	0.272
	(0.301)	(0.297)
Number of children	-0.020	-0.039
	(0.024)	(0.029)
Wealth index score	0.073	-0.041
	(0.054)	(0.074)
N	**1062**	**1062**

+ p<0.10 * p<0.05 **p<0.01 ***p<0.001
Standard errors in parentheses

Discussion

The goal of this chapter was to determine the value of maternal social capital to children's schooling outcomes. In order to model the relationship appropriately, 2SLS regressions were conducted and the Wald test was used to test the null hypothesis that

social capital is exogenous. The Wald tests demonstrated that there is evidence to accept the alternative hypothesis that social capital is endogenous to current enrollment and primary school completion of children aged 15-20. For these two outcomes, the IV probit model was preferred and estimates of social capital and schooling outcomes would have been biased if an instrumental variable approach was not used. I found that the influence of social capital differs by level of schooling. Primary school aged children whose mothers are involved in community groups, are significantly, more likely to be enrolled in school. This is regardless of mother's education or their household wealth. It is possible that mothers with better access to information through community groups understand the gains to education, or they are better supported through social interactions to send their children to school. Such mechanisms would underscore the importance of social capital.

For the 15-20 age group, the influence of maternal social capital on enrollment outcome was opposite. In the preferred IV model, secondary school aged children whose mothers are involved in community groups are significantly less likely to be enrolled in school. The observation that secondary children whose mothers are wealthier or more educated are significantly more likely to attend school suggests that there is a possible selection between mothers who belong to community groups and those who do not.

The analysis of primary school completion reveals the history of secondary school aged children. Children whose mothers are involved in community groups are significantly more likely to have completed primary school. There is no way to know if these mothers *were* involved in community groups at the time of their older child's primary school enrollment. However, it is very coherent with the finding that primary school aged children whose mothers are involved in community groups are more likely to be currently enrolled. Social capital seems to have an influence on children's primary school enrollment and completion. It does not seem to have an influence for secondary schooling. Before this analysis, it was obvious that the waiving of primary school fees through the FPE policy removes a significant obstacle towards school enrollment. However, from this analysis we learn that the influence of maternal social capital appear to be conditioned on schooling costs. Secondary schools in Malawi require tuition, and so social capital matters less to children's schooling at this level.

Nevertheless, the role of social capital for children at primary school level cannot be discounted. Malawi confronts a problem of dropout rates at the primary school level. For girls, the drop rates rise from 10% in grade 5 to 20% in grade 8 (Castel et al. 2010). Since maternal social capital has protective association with school dropouts, then the role of community groups in children's educational interventions is worthy of support.

The contrasting stories about social capital and children's schooling demonstrate the importance of treating social capital as endogenous to the outcomes. The use of an instrument variable attempts to simulate the conditions of randomization which can provide estimates of causal effects. In the absence of a policy or lottery process however, funeral attendance frequency satisfied the requirements of a valid instrument. Further research can identify other instruments to improve the model and further clarify the mechanisms that emerge from this analysis.

CHAPTER 5 Conclusion

In the first set of analyses, I found that participation in farmer groups and the Starter Pack program respectively was positively correlated with the household wealth index scores using panel data. Furthermore, using lagged measures strengthened the association between the agricultural subsidy and wealth scores. The analysis used fixed effects to account for unobserved heterogeneity, and although this analysis does not determine causality, it would be inappropriate to definitively eliminate a causal association.

In the analysis of health-wealth gradient in rural Malawi, I found evidence of an emerging health-wealth gradient in the older age groups (36-47 and 48-59 months) using either contemporaneous wealth variables or "change in wealth" variables. The varying association between stunting and household wealth in the earliest ages is consistent with studies that find strong associations between stunting and proximate exposures such as birth weight, gender and maternal age at delivery (Willey et al. 2009). Such data were not available for analysis. Future data collection should include anthropometric measures of older children as well as additional waves of anthropometric data for this cohort in order to enrich our understanding about the health-wealth gradient over time. This evidence that stunting risk declines with increases in household wealth in a poor setting, is a unique contribution to a very narrow literature. Furthermore, it underscores the importance of addressing the

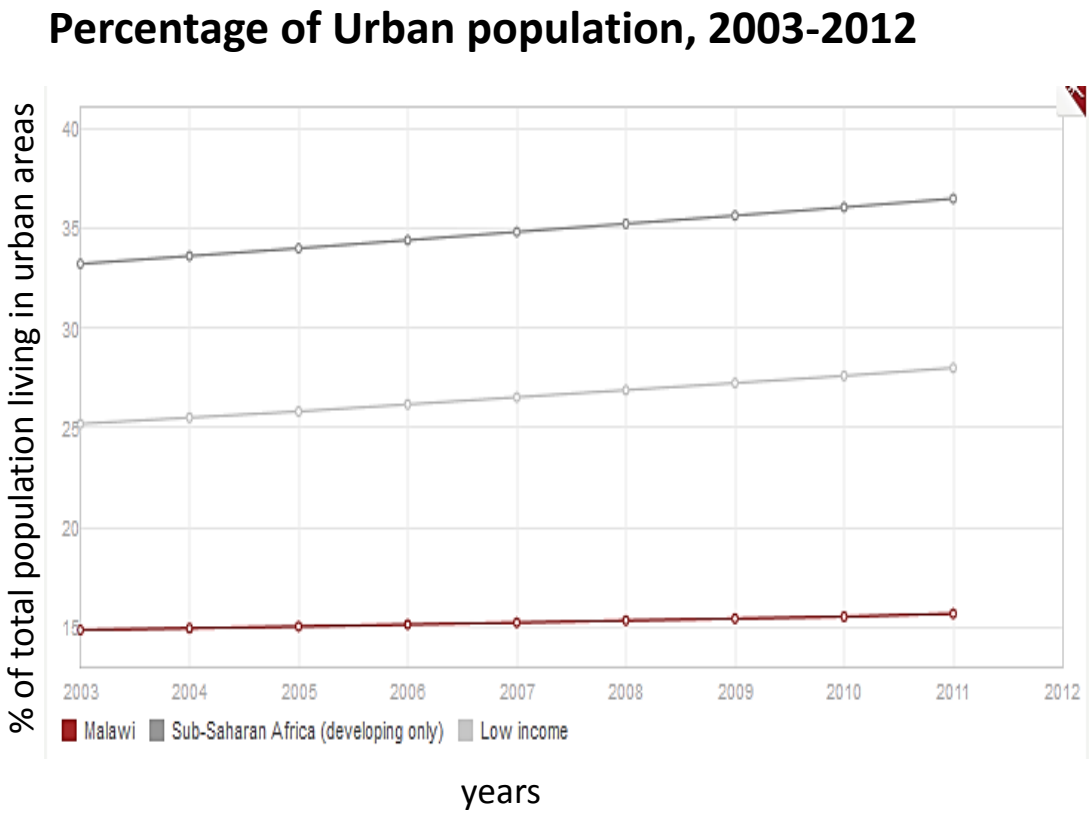
nutritional status of the poorest children so they can also achieve health and educational success.

In my analysis of maternal social capital, I found a relationship between maternal social capital and children's schooling outcomes that differ by school level (primary vs secondary school). In order to address concerns about endogeneity, 2SLS regression were used. Primary school aged children whose mothers are involved in community groups, are significantly, more likely to be enrolled in school. In the preferred IV model, secondary school aged children whose mothers are involved in community groups are significantly less likely to be enrolled in school. The subsequent regressions reveal that secondary school aged children whose mothers are currently involved in community groups, are significantly more likely to have completed their primary school education. Since the FPE policy offers free education only at the primary school level, I infer from the results that the costs of secondary school mask any influence of social capital on children's schooling outcomes. Nevertheless, the availability of the FPE and the high dropout rates especially among girls suggest that community groups could have a role in educational interventions.

In conclusion, the evidence from these analyses indicate that despite the absence of monetary data, there are alternative approaches to collecting and measuring wealth which can create greater opportunities for poverty research in Africa (Pradhan and Ravallion 2000). Each analysis in this dissertation employs the asset- based wealth

index variable as a measure of household wealth. The positive correlation between safety net program participation and household wealth over time is a reassuring indication that the asset based wealth index score is a reliable measure. Chapter 3 finds evidence an emerging "health-wealth" gradient in malnutrition. This has not been documented in a poor and rural setting and it is likely that the limited availability of monetary data explains why. However, a broader range of ways to measure wealth in rural communities is critical to understanding the future development of the poorer children. The finding in Chapter 4 on the role of maternal social capital also supports the importance of exploring other determinants of rural children's education. Similar research enhances our understanding of rural children's circumstances and better informs policies that can increase their chances at having healthier and more productive lives.

APPENDIX 1



Extracted from World Bank website: http://data.worldbank.org/indicator

APPENDIX 2

Table 1. Distribution of selected resources between rural and urban schools as indicated by teachers of literacy and reading.

	Percentage of pupils	
Indicator	Isolated/Rural	Town/City
Teacher housing poor and in need of major repairs	81.2	18.8
Schools with no water	30.6	24
Schools with female teachers	11.1	67.4
Schools with buildings that need major repairs	59	57
	Mean numbers	

Credit: Joseph Chimombo (2009): Changing patterns of access to basic education in Malawi: a story of a mixed bag?, Comparative Education, 45:2, 297-312

BIBLIOGRAPHY

Adams, A. M., S. Madhavan, and D. Simon. 2002. "Women's social networks and child survival in Mali." *Social Science & Medicine* 54(2):165–78.

Adato, Michelle, Michael R. Carter, and Julian May. 2006. "Exploring poverty traps and social exclusion in South Africa using qualitative and quantitative data." *Journal of Development Studies* 42(2):226–47.

African Development Bank Group. 2011. "African Development Bank Group- Malawi Interim Country Strategy Paper 2011-12." Retrieved March 7, 2013 (http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Malawi%20-%20ICSP%202011-12.pdf).

Ainsworth, Martha, Kathleen Beegle, and Godlike Koda. 2005. "The impact of adult mortality and parental deaths on primary schooling in North-Western Tanzania." *The Journal of Development Studies* 41(3):412–39.

Alderman, Harold, Jere R. Behrman, Hans-Peter Kohler, John Maluccio, and Susan C. Watkins. 2000. "Attrition in Longitudinal Household Survey Data: Some Tests for Three Developing-Country Samples." *World*.

Allison, P. D. 1998. *Multiple regression: A primer*. Sage Publications, Incorporated. Retrieved September 24, 2012 (http://books.google.com/books?hl=en&lr=&id=20tgP-Wr4QMC&oi=fnd&pg=PR13&dq=Paul+Allison+a+primer&ots=KaGoWjS7cG&sig=xzwlflbrZxnIDESOSokd6PHE_xs).

Anglewicz, P., J. Adams, F. Obare, S. Watkins, and HP Kohler. 2007. "The Malawi Diffusion and Ideational Change Project 2004–06: Data collection, data quality and analyses of attrition." *Unpublished working paper, Population Studies Center, University of Pennsylvania, Philadelphia, PA Available online at http://www.malawi.pop.upenn.edu*.

Anglewicz, Philip, and Hans-Peter Kohler. 2009. "Overestimating HIV infection: The construction and accuracy of subjective probabilities of HIV infection in rural Malawi." *Demographic research* 20(6):65–96.

Angrist, Joshua, and Alan B. Krueger. 2001. *Instrumental variables and the search for identification: From supply and demand to natural experiments*. National Bureau of Economic Research. Retrieved February 14, 2013 (http://www.nber.org/papers/w8456).

Anon. n.d. “WHO | The WHO Multicentre Growth Reference Study (MGRS).” *WHO*. Retrieved October 12, 2012 (http://www.who.int/childgrowth/mgrs/en/).

Appleton, Simon. 1996. “Women-headed households and household welfare: An empirical deconstruction for Uganda.” *World Development* 24(12):1811–27.

Asadullah, Mohammad Niaz. 2008. “Sense in sociability? Maternal education, social capital and child schooling in rural Bangladesh.” *European Journal of Development Research* 20(3):482–96.

Astone, Nan Marie, Constance A. Nathanson, Robert Schoen, and Young J. Kim. 1999. “Family Demography, Social Theory, and Investment in Social Capital.” *Population and Development Review* 25(1):1–31.

Becker, Gary S., Kevin M. Murphy, and Robert Tamura. 1994. “Human capital, fertility, and economic growth.” Pp. 323–50 in *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education (3rd Edition)*. The University of Chicago Press. Retrieved March 10, 2013 (http://www.nber.org/chapters/c11239.pdf).

Behrman, Jere, and JC Knowles. 1999. “Household income and child schooling in Vietnam.” *The World Bank Economic Review* 13(2):211–56.

Behrman, Jere R., Hans-Peter Kohler, and Susan Cotts Watkins. 2002. “Social networks and changes in contraceptive use over time: Evidence from a longitudinal study in rural Kenya.” *Demography* 39(4):713–38.

Ben-Shlomo, Y., and G. D. Smith. 1991. “Deprivation in infancy or in adult life: which is more important for mortality risk?” *The Lancet* 337(8740):530–34.

Bignami-Van Assche, S., G. Reniers, and A. A. Weinreb. 2003. “An assessment of the KDICP and MDICP data quality: Interviewer effects, question reliability and sample attrition.” *Demographic Research* 19. Retrieved September 23, 2012 (http://www.demographic-research.org/special/1/2/s1-2.pdf).

Bollen, K. A., J. L. Glanville, and G. Stecklov. 2002. “Economic status proxies in studies of fertility in developing countries: Does the measure matter?” *Population Studies* 56(1):81–96.

Brockerhoff, Martin. 1999. “Urban Growth in Developing Countries: A Review of Projections and Predictions.” *Population and Development Review* 25(4):757–78.

Buvinić, Mayra, and Geeta Rao Gupta. 1997. “Female-Headed Households and Female-Maintained Families: Are They Worth Targeting to Reduce Poverty in Developing Countries?” *Economic Development and Cultural Change* 45(2):259–80.

Cameron, L., and J. Williams. 2009. “Is the relationship between socioeconomic status and health stronger for older children in developing countries?” *Demography* 46(2):303–24.

Campbell, C., B. Williams, and D. Gilgen. 2002. “Is social capital a useful conceptual tool for exploring community level influences on HIV infection? An exploratory case study from South Africa.” *Aids Care* 14(1):41–54.

Carter, M. R., and M. Castillo. 2011. “Trustworthiness and Social Capital in South Africa: Analysis of Actual Living Standards Data and Artifactual Field Experiments.” *Economic Development and Cultural Change* 59(4):695–722.

Case, A., D. Lee, and C. Paxson. 2008. “The income gradient in children’s health: A comment on Currie, Shields and Wheatley Price.” *Journal of Health Economics* 27(3):801–7.

Case, Anne, and Cally Ardington. 2006. “The impact of parental death on school outcomes: Longitudinal evidence from South Africa.” *Demography* 43(3):401–20.

Case, Anne, Diana Lee, and Christina Paxson. 2008. “The Income Gradient in Children’s Health: A Comment on Currie, Shields and Wheatley Price.” *Journal of health economics* 27(3):801–7.

Case, Anne, Darren Lubotsky, and Christina Paxson. 2001. “Economic Status and Health in Childhood: The Origins of the Gradient.” *NBER*, June 1. Retrieved February 24, 2012 (http://proxy.library.upenn.edu:2191/papers/w8344).

Case, Anne, Darren Lubotsky, and Christina Paxson. 2002. “Economic Status and Health in Childhood: The Origins of the Gradient.” *The American Economic Review* 92(5):1308–34.

Castel, Vincent, Martha Phiri, and Marco Stampini. 2010. “Education and Employment in Malawi: Working Series, African Development Bank Group.” Retrieved March 10, 2013 (http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/WORKING%20110%20PDF%20d%2022.pdf).

Chen, E., A. D. Martin, K. A. Matthews, and others. 2006. “Socioeconomic status and health: Do gradients differ within childhood and adolescence?” *Social science & medicine* 62(9):2161–70.

Chen, Solomon Chih-Cheng et al. 2008. “Increased mortality of male adults with AIDS related to poor compliance to antiretroviral therapy in Malawi.” *Tropical medicine & international health* 13(4):513–19.

Chimombo, J. 2009. “Changing patterns of access to basic education in Malawi: a story of a mixed bag?” *Comparative Education* 45(2):297–312.

Chipande, G. H. R. 1987. “Innovation Adoption among Female-headed Households: The Case of Malawi.” *Development and Change* 18(2):315–27.

CIA. 2012. “Central Intelligence Agency (CIA) - The World Factbook Malawi.” Retrieved September 21, 2012 (https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html).

Coleman, James S. 1988. “Social capital in the creation of human capital.” *American journal of sociology* 95–120.

Condliffe, S., and C. R. Link. 2008. “The relationship between economic status and child health: Evidence from the United States.” *The American Economic Review* 98(4):1605–18.

Cortinovis, I., V. Vella, and J. Ndiku. 1993. “Construction of a socio-economic index to facilitate analysis of health data in developing countries.” *Social science & medicine(1982)* 36(8):1087–97.

Cox, Nick. 2006. “RE: st: -mlowess- available on SSC.” *The Stata listserver*. Retrieved February 5, 2013 (http://www.stata.com/statalist/archive/2006-10/msg00752.html).

Currie, J. 2009. “Healthy, wealthy, and wise: Socioeconomic status, poor health in childhood, and human capital development.” *Journal of Economic Literature* 47(1):87–122.

Currie, Janet, and Wanchuan Lin. 2007. “Chipping Away At Health: More On The Relationship Between Income And Child Health.” *Health Affairs* 26(2):331–44.

Currie, Janet, and Mark Stabile. 2002. “Socioeconomic Status and Health: Why is the Relationship Stronger for Older Children?” *National Bureau of Economic*

Research Working Paper Series No. 9098. Retrieved (http://www.nber.org/papers/w9098).

Denning, Glenn et al. 2009. "Input Subsidies to Improve Smallholder Maize Productivity in Malawi: Toward an African Green Revolution." *PLoS Biol* 7(1):e1000023.

Dika, Sandra L., and Kusum Singh. 2002. "Applications of Social Capital in Educational Literature: A Critical Synthesis." *Review of Educational Research* 72(1):31–60.

Doyle, O., C. Harmon, and I. Walker. 2007. "The impact of parental income and education on child health: Further evidence for England."

Durlauf, Steven N. 2002. "On The Empirics Of Social Capital*." *The economic journal* 112(483):F459–F479.

Englund, H. 1999. "The self in self-interest: land, labour and temporalities in Malawi's agrarian change." *AFRICA-LONDON-INTERNATIONAL AFRICAN INSTITUTE-* 69:139–59.

FAO. 2010. "Food and Agriculture Organization of the United Nations, Nutrition country profiles: Malawi summary." Retrieved March 11, 2013 (http://www.fao.org/ag/agn/nutrition/mwi_en.stm).

Ferguson, B. D., A. Tandon, E. Gakidou, and C. J. L. Murray. 2003. "Estimating permanent income using indicator variables." *Health systems performance assessment.Ginebra: World Health Organization* 747–60.

Filmer, D., and L. H. Pritchett. 2001. "Estimating wealth effects without expenditure data - Or tears: An application to educational enrollments in states of India." *Demography* 38(1):115–32.

Fortson, J. G. 2008. "The gradient in sub-Saharan Africa: socioeconomic status and HIV/AIDS." *Demography* 45(2):303–22.

Furstenberg, Frank F., and Mary Elizabeth Hughes. 1995. "Social Capital and Successful Development among At-Risk Youth." *Journal of Marriage and Family* 57(3):580–92.

Goddard, Roger D. 2003. "Relational Networks, Social Trust, and Norms: A Social Capital Perspective on Students' Chances of Academic Success." *Educational Evaluation and Policy Analysis* 25(1):59–74.

Godoy, Ricardo et al. 2007. "Schooling's contribution to social capital: study from a native Amazonian society in Bolivia." *Comparative Education* 43(1):137–63.

Gorman, K. S., and E. Pollitt. 1997. “The contribution of schooling to literacy in Guatemala.” *International review of education* 43(4):283–98.

Gwatkin, DR et al. 2000. “Socio-economic differences in health, nutrition and population: Malawi 1992, 2000.” *HNP/Poverty Thematic Group of the World Bank*.

Harrigan, J. 2008. “Food insecurity, poverty and the Malawian Starter Pack: Fresh start or false start?” *Food Policy* 33(3):237–49.

Hassan, Rashid, and Patrick Birungi. 2011. “Social capital and poverty in Uganda.” *Development Southern Africa* 28(1):19–37.

Helleringer, S., and H. P. Kohler. 2005. “Social networks, perceptions of risk, and changing attitudes towards HIV/AIDS: New evidence from a longitudinal study using fixed-effects analysis.” *Population Studies* 59(3):265–82.

Houweling, TA, and AE Kunst. 2010. “Socio-economic inequalities in childhood mortality in low- and middle-income countries: a review of the international evidence.” *British Medical Bulletin* 93(1):7–26.

Houweling, TA, AE Kunst, M. Huisman, and J. Mackenbach. 2007. “Using relative and absolute measures for monitoring health inequalities: experiences from cross-national analyses on maternal and child health.” *International Journal for Equity in Health* 6(1):15.

Houweling, TA, AE Kunst, and JP Mackenbach. 2003. “Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter?” *International Journal for Equity in Health* 2(8):(9October2003).

IMF. 2006. “Press Release: World Bank and IMF Support Malawi’s Completion Point under the Enhanced HIPC Initiative and Approve Debt Relief under the Multilateral Debt Relief Initiative.” Retrieved March 10, 2013 (http://www.imf.org/external/np/sec/pr/2006/pr06187.htm#P28_1118).

Khanam, R., H. S. Nghiem, and L. B. Connelly. 2009. “Child health and the income gradient: Evidence from Australia.” *Journal of health economics* 28(4):805–17.

Kohler, Hans-Peter, Jere R. Behrman, and Susan C. Watkins. 2007. “Social networks and HIV/AIDS risk perceptions.” *Demography* 44(1):1–33.

Korenman, S., J. E. Miller, and J. E. Sjaastad. 1995. “Long-term poverty and child development in the United States: Results from the NLSY.” *Children and Youth Services Review* 17(1):127–55.

Maluccio, John, and Lawrence Haddad. 2000. “Social Capital and Household Welfare in South Africa, 1993-98.” *Journal of Development Studies* 36(6):54.

Marmot, M. G., and G. D. Smith. 1991. “Health inequalities among British civil servants: The Whitehall II study.” *Lancet* 337(8754):1387.

McKenzie, D. J. 2005. “Measuring inequality with asset indicators.” *Journal of Population Economics* 18(2):229–60.

Menahem, Gila. 2011. “The Impact of Community Bonding and Bridging Social Capital on Educational Performance in Israel.” *Urban Education* 46(5):1100–1130.

Montgomery, M. R., M. Gragnolati, K. A. Burke, and E. Paredes. 2000. “Measuring living standards with proxy variables.” *Demography* 37(2):155–74.

Montgomery, M. R., M. Gragnolati, K. A. Burke, E. Paredes, and Policy R. Council. Population. 1999. *Measuring Living Standards with Proxy Variables*. Population Council.

Morris, S. S., C. Carletto, J. Hoddinott, and L. J. M. Christiaensen. 2000. “Validity of rapid estimates of household wealth and income for health surveys in rural Africa.” *Journal of Epidemiology & Community Health* 54(5):381–87.

Morrow, Virginia. 1999. “Conceptualising social capital in relation to the well-being of children and young people: a critical review.” *The sociological review* 47(4):744–65.

Mukherjee, S., and T. Benson. 2003. “The Determinants of Poverty in Malawi, 1998.” *World Development* 31(2):339–58.

Murasko, J. E. 2008. “An evaluation of the age-profile in the relationship between household income and the health of children in the United States.” *Journal of Health Economics* 27(6):1489–1502.

Murray, M. P. 2005. *Econometrics: A modern introduction*. Pearson/Addison-Wesley.

Narayan, D., and L. Pritchett. 1999. “Cents and sociability: Household income and social capital in rural Tanzania.” *Economic development and cultural change* 47(4):871–97.

Nobles, J., and E. Frankenberg. 2009. “Mothers’ community participation and child health.” *Journal of health and social behavior* 50(1):16–30.

O’Donnell, Owen, Eddy Van Doorsslaer, Adam Wagstaff, and Magnus Lindelow. 2008. *Analyzing health equity using household survey data: a guide to techniques and their implementation*. World Bank Publications. Retrieved March 9, 2013

Phiri, K. M. 1983. “Some Changes in the Matrilineal Family System among the Chewa of Malawi since the Nineteenth Century.” *The Journal of African History* 24(2):257–74.

Potts, Deborah. 2009. “The slowing of sub-Saharan Africa’s urbanization: evidence and implications for urban livelihoods.” *Environment and Urbanization* 21(1):253–59.

Potts, Deborah. 2012. “Whatever Happened to Africa’s Rapid Urbanisation?” Retrieved March 9, 2013 (http://dspace.cigilibrary.org/jspui/handle/123456789/32571).

Pradhan, Menno, and Martin Ravallion. 2000. “Measuring poverty using qualitative perceptions of consumption adequacy.” *Review of Economics and Statistics* 82(3):462–71.

Propper, Carol, John Rigg, and Simon Burgess. 2007. “Child health: evidence on the roles of family income and maternal mental health from a UK birth cohort.” *Health Economics* 16(11):1245–69.

Putnam, R. 2001. “Social capital: Measurement and consequences.” *Canadian Journal of Policy Research* 2(1):41–51.

Ravelli, A. C. J., J. H. P. van der Meulen, C. Osmond, D. J. P. Barker, and O. P. Bleker. 1999. “Obesity at the age of 50 y in men and women exposed to famine prenatally.” *The American journal of clinical nutrition* 70(5):811–16.

Ravelli, G. P., Z. A. Stein, and M. W. Susser. 1976. “Obesity in young men after famine exposure in utero and early infancy.” *New England Journal of Medicine* 295(7):349–53.

Reniers, G. 2003. “Divorce and Remarriage in Rural Malawi.” *Demographic Research* 1:175–206.

Reniers, G. 2008. “Marital Strategies for Regulating Exposure to HIV.” *Demography* 45(2):417–38.

Sawaya, A. L., and S. Roberts. 2003. “Stunting and future risk of obesity: principal physiological mechanisms.” *Cad Saude Publica* 19(Suppl 1):S21–8.

Schellenberg, JA et al. 2003. “Inequities among the very poor: health care for children in rural southern Tanzania.” *The Lancet* 361(9357):561–66.

Smith, J. P. 1999. “Healthy bodies and thick wallets: the dual relation between health and economic status.” *The Journal of Economic Perspectives* 13(2):145–66.

Southern and Eastern Africa Consortium for Monitoring and Evaluation. 2011. “Education in Malawi - Southern and Eastern Africa Consortium for Monitoring Educational Quality.” Retrieved March 8, 2013 (http://www.sacmeq.org/education-malawi.htm).

Strauss, J., and D. Thomas. 1998. “Health, nutrition, and economic development.” *Journal of economic literature* 36(2):766–817.

Trinitapoli, Jenny, and Mark D. Regnerus. 2006. “Religion and HIV Risk Behaviors among Married Men: Initial Results from a Study in Rural Sub-Saharan Africa.” *Journal for the Scientific Study of Religion* 45(4):pp. 505–528.

UNICEF. n.d. “UNICEF Malawi.” *UNICEF Malawi - The Situation of Women and Children*. Retrieved February 18, 2013 (http://www.unicef.org/malawi/children.html).

Vyas, S., and L. Kumaranayake. 2006. “Constructing socio-economic status indices: how to use principal components analysis.” *Health policy and planning* 21(6):459.

Willey, Barbara A., Noel Cameron, Shane A. Norris, John M. Pettifor, and Paula L. Griffiths. 2009. “Socio-economic predictors of stunting in preschool children: a population-based study from Johannesburg and Soweto.” *SAMJ: South African Medical Journal* 99(6):450–56.

Wooldridge, Jeffrey M. 2003. “Cluster-sample methods in applied econometrics.” *The American Economic Review* 93(2):133–38.

World Bank. 2010. “The World Bank DataBank.” *The World Bank Databank*. Retrieved March 7, 2013 (http://databank.worldbank.org/data/home.aspx).

World Bank. 2012. “Malawi, The World Bank.” *The World Bank*. Retrieved March 7, 2013 (http://data.worldbank.org/country/malawi#cp_wdi).

World Health Organization. n.d. “WHO | The WHO Multicentre Growth Reference Study (MGRS).” *WHO Multicenter Growth Reference Study*. Retrieved October 12, 2012 (http://www.who.int/childgrowth/mgrs/en/).

Yeatman, Sara E., and Jenny Trinitapoli. 2008. “Beyond denomination: The relationship between religion and family planning in rural Malawi.” *Demographic research* 19(55):1851.