

Chapter 1

Problem

1.1 Background

1.1.1 Malnutrition and Poverty

Although the macro-economic prospects of Malawi are fairly good, with an average annual growth rate of around 9 percent in the mid-90s, its poor health record continues to inhibit development (HealthNet, 1999). Malawi, a south African country with one of the world's 10 lowest per capita income in 1996, was ranked 161 out of 174 countries by the 1998 Human Development Index (HDI)(UNDAF, 1998). Malawi's Gini coefficient is also among the highest in the world, at .62. Population pressures worsen the situation with a total population of 10.38 million, representing 227 persons per square mile (Population Reference Bureau, 2001).

Lowering child malnutrition is of primary concern in developing nations, and is of particular importance in Malawi. Malawi has one of the highest levels of malnutrition in sub-Saharan Africa. Forty percent of the population is unable to satisfy basic caloric needs and around 49 percent of children under five years of age are stunted, with half of them severely malnourished (UNDAF, 1998). Although vaccination coverage is good (LCSS, 1999), 22% of children die before reaching their fifth birthday, representing the eighth highest under-five mortality rate in the world (UNICEF, 1995).

In the short run, malnourished children are more likely to get sick and die. These outcomes have direct

welfare consequences for families and society. They also increase medical costs and lower school attendance rates. Work hours of family members who care for malnourished children are also likely to fall.

Reduced learning ability and educational achievement of malnourished children in turn have short- and long-run consequences. Listlessness and apathy due to undernourishment can decrease cognitive development. Malnourished children exhibit lack of interest, energy, and spirit as well as indifference, decreasing their intensity of interaction with immediate surroundings. Underdevelopment of cognitive skills reduces their potential to become productive members of society.

Future productivity losses accrue from malnutrition due to stunting, increased likelihood of psychological problems, and lower school achievement (Pinstrup-Anderson *et al.*, 1995). Diminished work capacity is also realized through reduced ability associated with lower levels of maximum oxygen consumption (Pinstrup-Anderson *et al.*, 1995). Finally, a significant loss to society can result from the death of mothers due to increased obstetric risk for women suffering from stunted growth (Pinstrup-Anderson *et al.*, 1995) and malnutrition of children born to undernourished mothers.

Among the causes for this high incidence of malnutrition are inadequate intake of food, a high prevalence of disease and inadequate maternal and child health care. In particular, low levels of protein and zinc contribute to both mother and child malnutrition. Many of these factors are closely associated with low incomes and poverty. In rural areas of Malawi, agricultural stagnation reduces the income of the farming population, lowers food

availability, and makes children more susceptible to disease and malnutrition.

1.1.2. Agriculture and Rural Poverty

Rural poverty in Malawi is closely related to agricultural stagnation. Although most also have off-farm sources of income, agriculture employs over 90% of the population, yet production grew at only 1.6 per cent per annum from 1980 to 1994, less than half the rate of population growth (UNDAF, 1998).

Problems related to agriculture in Malawi result from increasingly small land holdings, the lack of diversification in the agricultural economy and low productivity among *smallholder*¹ farmers. In 1968-69, 71% of rural households in Malawi had more than 2 hectares of land, but by 1987-88 this figure had been reduced to 13% (Gondwe and Githinji, 1998). Currently, over fifty per cent of households cultivate less than 1 hectare (GFA, 1993). Maize production dominates, and maize plantings represent 70% of the cultivated land (GOM, 1999). Out of a total of approximately 3.9 million hectares of arable land in 1998, maize comprised approximately 1.35 million hectares (FAO, 2001). This lack of agricultural diversification makes the economy susceptible to price and yield fluctuations and increases seasonality of income. Maize yields declined from an average of 1000 kg per hectare in the 1980s to 800 kg per hectare in the late 90s (GOM, 1999).

¹ *Smallholders* are individuals living on customary lands, generally of less than or equal to 2.0 hectares. The government owns customary lands and local chief or village headman grants consent allowing access to the land. In turn, *estates* are customary lands that have been released under leasehold or freehold agreements for periods from 22 to 99 years in length and are generally larger in size than customary lands (GFA, 1993).

1.1.3. Groundnut Production

The promotion of groundnut production is one possible means of improving productivity of poor farmers and of increasing rural food security. Groundnuts reduce the reliance of farmers on fertilizers, as they add nitrogen to the soil. With rising prices of inorganic fertilizers, groundnuts can represent an important nutrient substitute to increase soil productivity.

The majority of *smallholder* households run out of own-produced food supply 3-4 months before the beginning of the next harvest (Tobin and Knausenberger, 1998). Groundnuts are a cash crop that will generate income to purchase food in these periods when stored food has run out. Future prospects for groundnut production and marketing are good as Malawi has a comparative advantage in groundnut production (Nakhumwa *et al.*, 1997) and there is a strong regional demand for Malawian groundnuts (World Bank, 1997). Groundnuts are also easy to sell in local markets, which make it easier for farmers in remote areas to exchange them for cash.

Groundnuts can also increase household food security by supplying protein and zinc. In addition to monetary compensation, groundnuts can help improve household food security by providing an important source of protein to supplement Malawi's maize-based diet. Low ratios of phytic acid relative to zinc and low consumption of flesh foods have been reported as the main dietary factors contributing to sub optimal zinc status in Malawi (Ferguson *et al.*, 1993). Among the locally produced foods, groundnuts have been shown to be an essential element in Malawian diets as

they provide high levels of zinc, with low levels of phytic acid relative to zinc (Baker *et al.*, 1996).

1.1.4. Rising Fertilizer Prices

Declining soil fertility combined with rising fertilizer prices are major contributors to declining productivity, especially in the case of maize. From 1993 to 1995 the average annual depletion of nutrients in the soil in Malawi was among the highest in Africa at over 60-100 kilograms per hectare. At current rates of depletion, it is estimated that over 80 kilograms of NPK fertilizers per hectare are needed just to maintain current levels of soil nutrients (Henao and Baanante, 1999). Reduced access to credit in 1994 compounded by the removal of fertilizer subsidies during the 1992/93 growing season caused fertilizer uptake to decline from 74,000 metric tonnes in 1992/93 to fewer than 22,000 metric tonnes in 1994 (FAOSTAT, 2001). Fertilizer prices were high because of high freight costs from the closure of Mozambican rail routes, an 82 per cent devaluation in the kwacha from 1984 to 1988, rising world prices in fertilizer (Sahn *et al.*, 1990). A second devaluation of the Malawian kwacha of about 300 per cent in the 1994/95 growing season, helped to keep fertilizer prices at these previous high levels (Diagne and Zeller, 2001). Fertilizer use rebounded to 50,200 in 1998, but high prices continue to inhibit uptake (FAOSTAT, 2001).

1.1.5 Credit

Credit is important to improve *smallholder* well being as it facilitates adoption of technologies, helps the

purchase of inputs, and can be used to smooth consumption. Without credit, many *smallholders* are not able to finance purchase of technologies such as fertilizers or new seed varieties. With the seasonality of agricultural income in Malawi, *smallholders* face a cash constraint during pre-harvest months. Without access to credit they often resort to inefficient methods of coping, like producing less profitable crops that are lower-risk or store longer, like cassava. Food shortages are common before harvest. Consequently, many smallholders work off their farms in the period before harvest to gain wage income for food purchases. Off-farm work causes labor shortages during these periods when labor input is most critical, reducing yields in the upcoming harvest.

Smallholder credit was never abundant in Malawi, but in recent years, the situation has worsened. In 1994, the rural credit system collapsed due to political change and the drought of the 1993/94 cropping season. During this period, only fourteen per cent of loans were repaid to the *Smallholder* Agricultural Credit Administration. Political parties led farmers to believe that loans were a gift from the government. This misdirection coincided with confusion from the distribution of drought relief causing widespread default (Niles, 1996). By October 1995, the Malawi Rural Finance Corporation (MRFC), funded partly by the World Bank and partly by the International Foundation for Agricultural Development (IFAD), had collected only 56 percent of loans from the World Bank section, and the IFAD section was being restructured due to the crisis. Although nominal annual interest rates reached 54 percent in 1995 (Giarrizzo, 1997), inflation also peaked at this time (IMF, 2001) causing negative real rates of interest. These negative

real lending rates caused further losses for the financial sector. Even though annual inflation dropped off to 6.7 percent in 1996, the weakened condition of the formal sector contributed to more than a 30 percent increase in real annual interest rates in rural areas² (IMF, 2001). These high rates lowered demand for loans.

Two forms of agricultural credit exist: formal and informal. Formal credit is channeled through institutions such as commercial banks, NGOs, and marketing boards. Informal credit is often easier to obtain and is disbursed from friends, relatives, moneylenders and bosses among other sources. *Smallholders* generally are more restricted in their access to formal credit than informal sources of credit. A survey of rural households taken between October 1993 and February-March 1995, showed that 23% of the households had no access to credit, 55% had access to informal credit only, 4% had access to formal credit only, and 19% had access to both informal and formal credit (Diagne, Zeller and Mataya, 1996). With the demise of the formal credit system, it became even more difficult for *smallholder* farmers to access credit.

1.1.6 Gender Issues

Gender inequality exacerbates other elements of the poverty equation. Although women perform around 70 percent of work in small-scale agriculture, they only have marginal access to agricultural services and inputs (UNDAF, 1998). Women *smallholders* are 30 percent more likely than males to

² The real interest rate on 12-month time deposits in commercial institutions was 29.3 percent in 1996. Therefore, rural loans considered as higher risk than commercial loans and with higher transactions costs, must have higher rates of interest than this figure.

be in the lowest 20 percent of the income distribution, and 26 percent more likely to be in the lowest 40 percent (World Bank, 1995).

Women influence child nutrition through the use of health care knowledge in their role as caregiver, through childbirth, and in breastfeeding after birth. Greater knowledge allows women to take better care of themselves and their children by allowing them to choose nutritious foods and appropriate medicines and to promote good health care practices such as cleanliness. In turn, a mother's own nutritional status both directly and indirectly affects child nutritional levels. Stunting of mothers negatively affects the growth and survival chances of their children and their nutrient intake during and after childbirth influence the development of the fetus and quality of breast-feeding.

A lack of resources, such as credit, for women contributes to child malnutrition as well. In many cases, mothers are assumed to have greater concern for small children than fathers do (Pinstrup-Anderson *et al.*, 1995). In Malawi, it has been found that a higher proportion of food budgets are allocated to alcoholic beverages by male-headed households and a higher proportion of calories given to young children by the poorer *de facto* (male of household absent more than 50 per cent of the time) and *de-jure* (legal head of household is a woman) female-headed households (Kennedy and Peters, 1992). If women expenditure patterns increase child nutritional levels more so than that of males, greater resources available to women relative to that of men may be more beneficial to child nutritional status.

Gender inequality insures that women receive less in the allocation of resources. Therefore, one challenge to policy makers in decreasing child malnutrition is to determine how women's relative resources can be increased in the household.

Greater resources can be derived through increased access to credit relative to a spouse. Credit can increase cash crop production among female *smallholders* by giving them greater access to resources. Several studies have shown that increases in women's credit lead to improvement in the nutritional status of children (Haddad, Hoddinott, and Alderman, 1997). Pitt *et al.* (1999) determined that credit channeled through women had a large and significant effect on two of three measures of the healthiness of children. In contrast, credit entering the household through men had no statistically significant impact.

Cash crops have been proven to promote food security among female *smallholders* in Malawi by providing a source of income to reduce the risk of food shortages (Gladwin and Thomson, 1997). A study by Jones (1986) looked at technology adoption in Cameroon. She found that the promotion of rice cultivation among female farmers failed as it was considered a male crop and men controlled the income from its production even if women produced it. Therefore women preferred to produce alternative crops, which provided income under their control. If women in Malawi can control the income from crops such as groundnuts, and this added income benefits child nutritional status, then promotion of groundnut production may help decrease child malnutrition.

Discrimination by gender of child may cause differential treatment of boys and girls in the allocation

of nutritional resources. Hazarika (2000), in his study of Pakistan, showed that the motives behind intra-household gender discrimination may have origins in the relative returns parents receive from investments in the respective child. Although girls are as well nourished as boys, boys are favored in the provision of health care.

Overall, there are no large differences between measures of nutritional status among girls and boys in Malawi. Yet studies provide evidence that these measures are biased. Sahn and Stifel (2001) suggest that the relationship between standards of nutritional status for boys and girls may be biased in Africa, as girls consistently have greater nutritional scores (Svedberg, 1990), but receive less nutrients (Ferguson *et al.*, 1990). Three possibilities are given by Sahn and Stifel for this confounding relationship: there is a problem with the gender-specific standard for the African population, girls are genetically more robust than boys, or that parents invest more in young girls than boys. The last seems unlikely given that girls receive less education and nutrient intake.

The findings of Sahn and Stifel indicate that mothers have preferences for girls and fathers for boys in Africa. They take 25 DHS surveys from 14 African countries, separate child nutritional scores by the sex of the child and regress these nutritional scores against a number of variables, including the education of both mothers and fathers. Their results show that the positive marginal impact of higher father/mother education is greater for a child of the same sex than for that of the opposite sex. Gender bias can arise from a number of causes. It is possible that among the poorest families, demands for old-

age security could promote the investment in one child over another if one sex has greater economic prospects than the other. Depending on whether girls or boys are more likely to remain close to the parent as they age, a parent may be more likely to favor a particular sex over the other. Just being repressed throughout ones life or experiencing cultural norms promoting gender bias can lead an individual to promote one sex over another.

1.2. Problem Statement

Child malnutrition has proven to be a key problem in Malawi. Policy makers need to understand how alternative policies will affect nutritional status. Future agricultural growth will be necessary to solve this problem and increased resources for women can also help. Access to credit can help stimulate agricultural productivity, smooth consumption and increase women's income and relative resources. Evidence shows that the structure of the credit program, such as the gender of the individual having access to credit, can help determine its effectiveness in reducing malnutrition. Cash crops have been proven to increase income available to women. In particular, groundnut production may be effective in targeting and reducing child malnutrition by enriching women producers and providing protein and zinc to those deprived of such nutrients, while helping diversify the agricultural base of the economy.

1.3 Objectives

There are four primary objectives of this study:

- 1) To determine if access to credit is a significant determinant of child nutritional status.
- 2) To determine how impacts of access to credit vary for boys and girls.
- 3) To assess how relative access to credit of men and women in the household affects child nutritional status.
- 4) To determine if groundnut production and income diversification positively influence child nutritional status.

1.4 Methods

The data used in the analysis come from a year-long three-round survey conducted in 1995 by the International Food Policy Research Institute (IFPRI) in collaboration with the Department of Rural Development (DRD) of the Bunda College of Agriculture, University of Malawi (Zeller, Diagne and Mataya, 1997). The study was conducted with 404 households, containing 448 children under the age of five, in 45 villages in 5 districts of Malawi. The first round of the survey was in February-April 1995, the second round in July-August 1995, and the last round in November-December 1995. Four different local micro credit programs are studied. Approximately 50% of the survey households consist of current members of one, or more of these credit programs. Of the 50% who are not current members, 25% were past members and the remaining 25% were never members.

The theoretical model presented in this study consists of three tiers of influences on child nutrition: proximate, household and village level influence, income, both formal and informal access to credit by gender, measures of sanitation, clean water, infrastructure, diversification of income sources, prices & wages, female and male education and the relative access to credit of men and women are included in this framework. The empirical model follows a theoretical model of household utility maximization subject to time, income, and production constraints. A reduced form equation is derived that captures the relationships of interest: nutritional status of boys and girls as a function of exogenous variables.

Access to credit is used instead of credit uptake to measure the effects of credit. The primary difference between the two measures is that individuals choose freely to uptake credit while the program determines access to credit. Therefore uptake of credit is essentially a demand-side issue, while access to credit is a supply-side factor (Diagne, 1998).

The difference between the two methods becomes important from a policy perspective. Access to formal credit is often blurred with actual credit uptake in many studies giving results that limit policy usefulness (Diagne, 1998). Some households with credit availability from a particular program may not borrow because it is not optimal from them to do so.

Problems of endogeneity also arise when looking at the effect of access to credit on child nutritional status. The amount of access to credit for a given individual is partly determined by unobserved characteristics of that individual. These unobserved characteristics could affect

child nutritional levels independently of access to credit. For example, a careful and trustworthy man may receive more loans from his neighbors, bosses or a local NGO based on his good reputation. These qualities probably carry over to his care for his family as well. Therefore, his personal characteristics, which are not observed in the model, both give him access to credit and healthier children. This endogeneity can cause misleading results with respect to the influences of credit on child nutritional levels.

1.5 Organization of the Thesis

The following chapter provides more information concerning child nutrition, the macroeconomic environment, the rural credit system and the situation faced by Malawian *smallholders*. Chapter three describes the methodology, including the conceptual framework, theoretical model, and empirical model. Variables and techniques used to perform the analysis are also described. Finally, chapter four presents procedures and results, while chapter five discusses their implications, prescribes policy actions, and points to methodology limitations and opportunities for further research.

Chapter 2

An Overview of Factors Affecting Child Nutrition in *Smallholder* Families

Malawi has a varied topography and occupies the southern part of the East African Rift Valley. Its land locked position gives way to a long border on Lake Malawi. The country can be divided into three distinct geographical regions. The North region consists of the Great Rift Valley and the high tableland between Lake Malawi and Luangwa River 1,372 to 2,439 meters above sea level. The Central region contains the Shire highlands Plateau 610 to 1,607 meters above sea level. The South region is situated in the lowlands of Lower River Shire Basin. The Plateau region contains broad valleys among rolling hills and most of the agricultural production areas of the country (Nations of the Commonwealth, 2001). Rainfall in Malawi varies from 259.1 cm per annum on the slopes of the Mulange massif to 73.7 cm per annum at Mangochi (Nations of the Commonwealth, 2001). Frequency and amount of rainfall also vary extensively by area. Some areas in Malawi experience dependable extended periods of rainfall, while others have highly variable rainfall with periods of drought (Moyo *et al.*, 1993).

2.1 Background

Economic growth in Malawi after independence in 1964 through the late 1970s was strong, but narrowly focused. During the 1970s, Malawi's GDP grew at 6.3 percent, while population grew at 2.8 percent per annum. This growth was

fueled primarily by exports of tobacco, with tea, coffee, cotton, and groundnuts as minor contributors. The *estate* sector captured 88 percent of this growth while representing less than 10% of the population over the age of the 15 (Sahn *et al.*, 1990). In turn, the *smallholder* sector, which represented 72% of labor in Malawi, generated only 34.2% of Malawi's value added with income per worker less than half that of *estate* workers (Sahn *et al.*, 1990).

Government policies during these periods restricted *smallholder* crop production, promoted the redistribution of land from *smallholders* to *estates*, ensured low rural wage rates, and targeted access to credit to the *estate* sector. In the 1970s the government-owned Agricultural Development and Marketing Corporation (ADMARC) had accumulated cash surpluses through its exporting activities. These activities relied primarily on the implicit taxation of *smallholders* (Harrington, 1991). Between 1971 and 1979 ADMARC took approximately 181.9MK from the *smallholder* sector from profit margins between buying and selling *smallholder* output. Only 4.3 percent of these earnings were directed toward the development of *smallholder* agriculture (Kydd and Christiansen, 1982). This disregard for broad-based growth in the economy set the stage for a bursting of the bubble of gains during the 1970s.

2.2 Smallholder Population

Smallholders constitute about 80% of the population, representing 90% of the country's poor (World Bank, 1996). In general, *smallholders* in Malawi can meet their families' food needs through on-farm production only when farming more than 1.5 hectares. About 70% of *smallholders* cultivate

less than one hectare of land with the median area under cultivation of .6 hectares (World Bank, 1996). In 1982-83 reports showed that 27 percent of all Malawi *smallholders* cultivated .5 hectares or less. In 1992-93 this figure had risen to 48 percent (Tobin and Knausenberger, 1998).

2.3 Malnutrition in Malawi

Protein and energy deficiencies have been determined to be major causes of women and child malnutrition in Malawi. Protein-energy malnutrition is shown to cause wasting, increased child mortality, and decreased resistance to infection and disease among other consequences (Baker *et al.*, 1996). Primary symptoms of inadequate protein intake are low height-for-age, or stunting (Kean, Ntiru, and Giyose, 1999) and amenia (WHO, 1994). It is estimated that 51 per cent of all pregnant women and 42 percent of all women suffer from amenia (WHO, 1994), which has been determined to be the direct cause of about 8 per cent of maternal deaths in Africa (Ross and Thomas, 1996). In addition, studies conducted in five countries, including Malawi found that protein deficiency exponentially increased the risks of children dying in early childhood (Kean, Ntiru, and Giyose, 1999).

Women are particularly important in the production of child nutrition, and are more vulnerable to malnutrition due to the strain of childbirth. Nutritional status is a cumulative process beginning before birth (Merchant and Kurz, 1993). Not only are the nine months prior to delivery of a child important in determining their nutritional status, but so are the years leading up to the conception (Tinker *et al.*, 1994). It is a fact that "small mothers

give birth to small babies" (Chatterjee, 1989). Birth weights are also determined by the nutritional status of the mother. Low birth weight infants have a greater chance of dying in their early months of life, and low birth weight predicts the anthropometric status of the child up to two years of age (Kean, Ntiru, and Giyose, 1999). Stunted women are more likely to die during childbirth, and studies have shown that in cases of maternal death, two-thirds of infants die within a year of their mother (Abdulghani, 1994).

Lactation further strains maternal micronutrients reserves, which depletes stores of vital nutrients (Allen, 1994). Women need about an additional 500 to 650 kilocalories per day when breastfeeding (National Research Council, 1989), or the equivalent of one extra meal. In Malawi, seasonal fluctuations of food availability further burden lactating women. Among lactating women in Malawi, it was estimated that an average seasonal weight fluctuation of 2kg occurred between the period of lowest food availability and the post-harvest season (Ross and Habicht, 1995).

In Malawi, deficiency in zinc is particularly severe. One study estimated that 98 per cent of children and pregnant women in Malawi had inadequate zinc intakes, mainly because of the high phytate content of their diet (Gibson, 1996). Zinc deficiency impairs growth and increases susceptibility to infection, particularly diarrhea, acute respiratory infections, pneumonia (Kean, Ntiru, and Giyose, 1999; Caulfield, Zavaleta, and Shankar, 1996), and anorexia (Hambridge, 1989; Fraker, 1986). It has also been shown to cause stillbirths and low birth weights (Baker *et al.*, 1996).

Women's knowledge of health practices has significant effects on the nutritional status of their children. Studies have found that increasing the schooling of mothers significantly reduces the incidence of death of her children (Schultz, 1991; Browne and Barrett, 1991; Caldwell and Caldwell, 1993; Jejeebhoy, 1996). Many women lack information on nutrient requirements, the nutrient value of foods, or ways of preserving food quality during storage. For these reasons, increased income, or even a rise in caloric intake does not necessarily lead to increased nutrition (World Bank, 1994a). Customs and beliefs also contribute to women's inappropriate care for themselves, especially during pregnancy. Lack of knowledge about nutritional vulnerability and increased nutritional needs are considered to be primary causes for this inadequate care (Kean, Ntiru, and Giyose, 1999). Women with higher levels of education are said to use public health services or other resources more effectively and to be more careful about hygiene, recognize the need for rest, and to better feed their children, especially girls (Schultz, 1991; Caldwell and Caldwell, 1993). In Malawi, education, and particularly literacy, appears to significantly influence child nutritional status.

2.4 Previous Government Policies

The 1965 Land Act divided land tenure into two classes. *Estates* operate on freehold and leasehold land, and *smallholders* operate on customary land. This legislation allowed for the appropriation of customary land for *estates*. Exact figures on the total amount of land transformed into *estate* holdings are not available. In just

the leasehold estate sub-sector, figures show that from 1970 to 1989 these estates grew from 79,000ha to 760,000ha (GFA, 1993) out of the total of 3.9 million hectares of arable land (FAOSTAT, 2001). Almost all of this increase in estate land has been transferred from *smallholder* customary land (GFA, 1993).

With limited agricultural land, redistribution favoring the estate sector marginalizes the *smallholder* population. Overall estates hold 1.2 million hectares, or approximately 31% of all arable land in Malawi, with estate owners representing only .25 percent of the rural population (UNDAF, 1998). It is estimated that only one third of estate land is intensely cultivated (UNDAF, 1998). This transfer of land, along with population growth, diminished land available to the *smallholder* sector, decreasing their ability to make ends meet from farming. The shift in land ownership has benefited the wealthier members of society, as the majority of these estate owners are business people, senior civil servants, and politicians (Gondwe and Githinji, 1998).

During the 1980s, wages were kept low to benefit the estate sector. After independence, the Special Crops Act of 1972 prohibited *smallholders* from producing more lucrative crops such as burley tobacco and flue-cured tobacco (Sahn et al., 1990). This policy restricted *smallholders* from opportunities to earn higher returns on their labor, therefore depressing its value. In the early 1990s this restriction was gradually lifted, allowing smallholders to produce both burley and flue-cured tobacco and the Special Crops Acts was completely repealed in 1996 (Diagne and Zeller, 2001).

ADMARC retained a monopoly on rights to market *smallholder* crops during the 1980s, which allowed it to effectively squeeze profits out of the *smallholder* sector for investments in the *estate* sub-sector. This implicit taxation reduced the profitability of *smallholder* crops and created a substitution effect, which forced *smallholder* farmers to turn to wage labor on *estates* for income. This additional labor supply and the resulting decreased rural wages combined to benefit the *estate* sector.

In the 1970s, credit policies also tended to benefit the *estate* sub-sector. During this period, the government pressured commercial banks to extend loans to *estates* (Moyo *et al.*, 1993). Subsidized fertilizer, originally intended for *smallholders* was leaked to the *estate* sector, creating a system of implicit credit (Sahn *et al.*, 1990). A portion of the income that ADMARC collected through its implicit taxation of *smallholder* production was also provided to the *estate* sector in the form of loans.

This combination of policies expanded the income gap in Malawi and increased food insecurity among *smallholders*. Decreased *smallholder* wages reduced domestic consumption. In turn, less consumption in the rural economy reduced the demand for off-farm production and services that traditionally generate income for *smallholders* during seasons of food shortage.

Government investment was increased, but was not sustainable. Funds deemed to be "Development Funds" from abroad were invested in public projects of no economic return such as investments in military aircraft and palaces, or of long-term returns including investments in an international airport and colleges (Sahn, 1990). The funds from these investments were borrowed from abroad with

increasingly shorter maturities and higher interest rates (Sahn *et al.*, 1990).

2.5 Maize Policy

Beginning in the 1970s Malawi's agricultural policy was directed at increasing foreign reserves. This objective was promoted by avoiding imports through obtaining self-sufficiency in maize production and promoting the production and export of hybrid maize. A reduction in imports and increase in exports was hoped to increase reserves of foreign currency. These policies increased government expenditures and took resources away from alternative export revenue-generating crops. Government-induced price increases raised maize prices by 67 per cent in 1981/82, by 11 per cent in 1983/84, and by 44 per cent in 1988/1989 (Sahn *et al.*, 1990). Policy effects were undermined as a result of inflation, with real prices³ actually declining from MK.0894 per kilogram in 1982 to MK.0522 per kilogram in 1988 (Sahn *et al.*, 1990). Consequently, aside from a period from 1983-1987 maize was a net import crop (Sahn *et al.*, 1990 table 25) causing a loss in foreign reserves.

Hybrid maize was promoted as a primary export by subsidizing fertilizer, a required input for hybrid production. The aggregate fertilizer subsidy rate was 30.47 in the 1983/84 growing season, representing 5.06 per cent of the government deficit (Sahn *et al.*, 1990). This subsidization put additional strain on government finances and diverted resources away from alternative export

³ Prices use 1980 as the base year.

revenue-earning crops generally produced by *smallholders* such as groundnuts, cotton, and pulses. Additional export crops are needed in Malawi to diversify sources of foreign exchange earnings as shown by the fact that in 1989-1990 tobacco, tea, and sugar had grown to compose 86% of export revenue (Sahn *et al.*, 1990).

Low productivity gains among *smallholder* farmers, a high concentration of production in maize and drought create the need to diversify the income sources of poor farmers. The real value of *smallholder* production grew by a total of .5 percent between 1978-1988 (Tobin and Knausenberger, 1998). A large distribution of maize credit increased the hectareage grown of more productive hybrid varieties from 8 percent in 1985 to 25 per cent in 1992. Smallholders with less than 1 hectare produce traditional maize on approximately 82 per cent of their total landholding. Droughts worsen the effects of this lack of income diversification. Numerous areas in Malawi are prone to drought and the country has experienced droughts in the 1991/92 and 1993/94 growing seasons, with low rainfall occurring in 1994/95. The effects of drought are compounded when combined with such a large concentration of income from maize, which is less drought resistant than crops such as groundnuts. Alternative income generating mechanisms are needed to supplement this maize production to meet the calorie requirements of the poorest farmers.

2.6 Economic Decline

Malawi now finds itself in a situation of extreme poverty. The unraveling of the economy due to declining terms of trade and rising interest rates exposed the

underlying inefficiencies caused by the previously mentioned government policies. Reversing the negative effects of these policies on *smallholder* agricultural production is key to promoting broad-based growth.

The terms of trade in Malawi fell by 18.02% from the beginning to the end of the 1970s. By 1985, the terms of trade had fallen by another 6.1% since the end of the 1970s (Gondwe and Githinji, 1998). This negative trend combined with the increased fiscal deficit to increase Malawi's debt service from 7% of exports in 1970 to 22.8% in 1982 (Gondwe and Githinji, 1998). The influx of refugees from the civil war in Mozambique put an additional burden on the government due to the large amount of food imports needed. High transport costs, resulting from the war in Mozambique perpetuated this downward trend in the Malawi economy (Sahn *et al.*, 1990). Tobacco would come to represent 60% of total exports by the end of the 1980s. The export base was too concentrated, leaving the terms of trade vulnerable to international price fluctuations of a few commodities (Sahn *et al.*, 1990).

2.7 Restructuring

Since the late 1980s, Malawi implemented a program supported by the IMF, the World Bank, and donors to restructure its economy. Among the objectives of this plan is the development of free and competitive markets to stimulate agricultural production, off-farm rural activity, small scale and informal sectors, and labor-intensive manufacturing (GOM, 1996). Specific actions included repealing restrictions impeding production and marketing by

smallholders and lifting export restrictions on crops, including groundnuts.

To promote the development of *smallholder* income generating activities, the Malawi Rural Finance Company (MRFC), which was set up by the government in 1994, was prepared for privatization. MRFC plans to initiate a program to diversify its client base and activities, develop loan programs for rural business and women entrepreneurs, and support credit groups in adopting improved agricultural technologies and viable non-farm activities (GOM, 1996).

2.8 Groundnut Sector

Groundnuts are an important crop in Southern Africa and have considerable potential as a cash crop for Malawian *smallholders*. After beans, groundnuts are the most widely produced grain legume in Uganda and are the primary legume produced in large areas of Angola, Malawi, Mozambique, Tanzania, Zambia, and Zimbabwe. *Smallholders* are the primary producers of groundnuts, which are grown in most areas of Malawi. The main producing areas are in the Lilongwe and Kasungu ADDs, which account for over seventy per cent of the total groundnut production (Simtowe, 2000).

Groundnut production declined in Malawi until 1996, when production began to rise alongside a significant increase in yield (Table 1). The earlier production decrease is attributed to government pricing policy in the late 1980s, which made groundnut production less profitable than maize. Also, importer preference for smaller nuts, a drought in the 1991/92 growing season, a rosette disease

attack during the 1991 to 1993 seasons, and another drought in the 1993/94 growing season contributed to this decline in production. An upward jump in yield contributed to increases in production after 1996, which reached 690 kilograms per hectare in 1998. These yield increases have been attributed to market liberalization that raised groundnut prices relative to maize and therefore increased seed density during the period. This yield represented a 32 percent increase from the earlier peak in 1992/93 and was 97 percent above 1982/83 yields (Simtowe, 2000).

Table 1: Groundnut Area and Production in Malawi, 1982-98.

Growing Seasons	Production (t)	Area (ha)	Yield (kg ha)
1982/83	53991	146314	369
1983/84	54766	144935	378
1984/85	62240	135955	458
1985/86	88297	176293	501
1986/87	88073	209938	420
1987/88	76754	175819	437
1988/89	34752	139691	249
1989/90	18574	48185	359
1990/91	31051	69978	444
1991/92	12060	64386	187
1992/93	31936	61059	523
1993/94	30654	95309	321
1994/95	30664	89373	343
1995/96	31724	68722	462
1996/97	65718	100140	656
1997/98	101378	146845	690

Source: Economic Planning Unit of Agriculture, Malawi (Simtowe, 2000).

2.9 Credit System

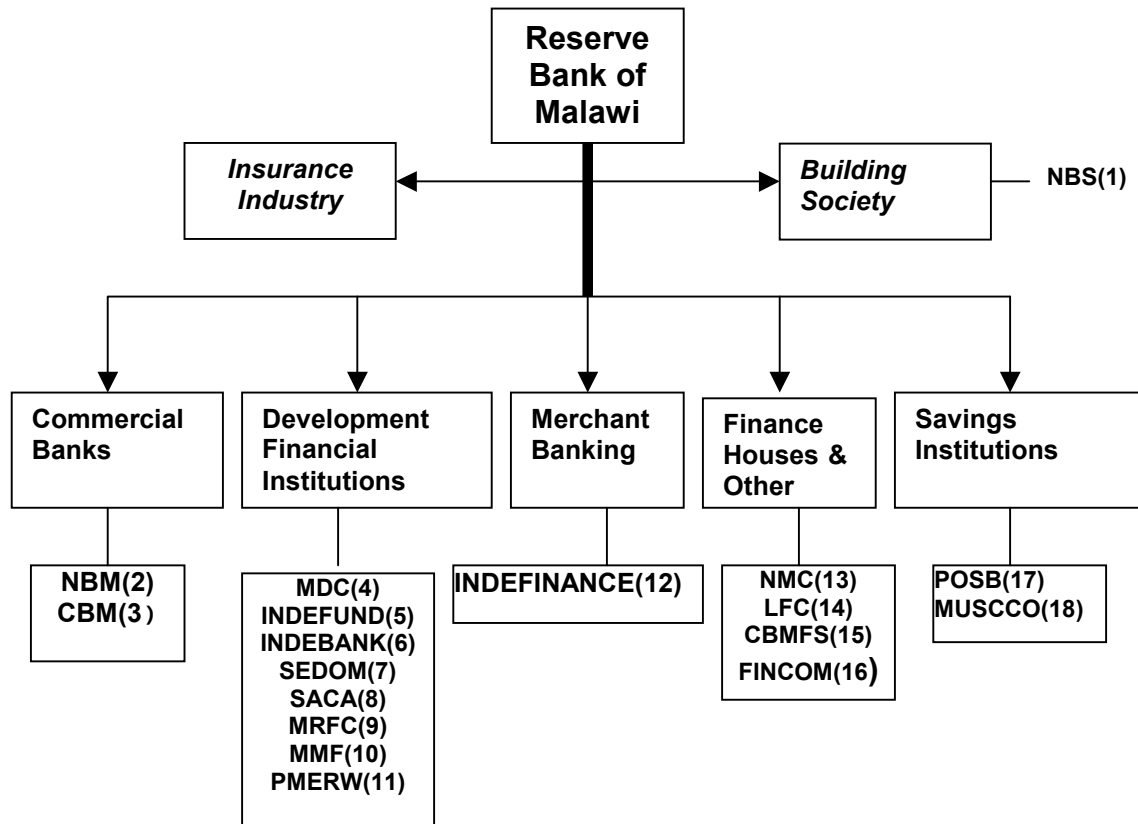
Credit can help increase farm productivity, increase income diversification and smooth consumption. A review of the credit system in Malawi shows that inefficiencies

inherent in the system probably contribute to the stagnation in the rural economy.

The formal credit sector in Malawi includes the Central Bank (the Reserve Bank of Malawi), two commercial banks (The National Bank of Malawi & the Commercial Bank of Malawi), seven development banks, and two savings institutions (the Post Office Savings Bank "POSB" & the Malawi Union of Savings and Credit Cooperatives "MUSCCO") (Figure 1).

Figure 1

Formal Financial System in Malawi



Notes:

- (1) New Building Society
- (2) National Bank of Malawi
- (3) Commercial Bank of Malawi
- (4) Malawi Development Corporation
- (5) Indefund Ltd.
- (6) Investment & Dev'p. Bank of Malawi Ltd.
- (7) Small Enterprise and Development Org. of Malawi
- (8) Smallholder Agriculture Credit Administration
- (9) Malawi Rural Finance Company Ltd.
- (10) Malawi Mudzi Fund
- (11) Promotion of Micro-Enterprises for Rural Women
- (12) Indebank Financial Services Ltd.
- (13) National Mercantile Credit Ltd.
- (14) Leasing & Finance Co. of Malawi Ltd.
- (15) CBM Financial Services Ltd.
- (16) Finance Corporation of Malawi
- (17) Post Office Savings Bank
- (18) Malawi Union Savings & Credit Co-operative Ltd.
- (19) New Building Society

Source: Southern Africa Department Agricultural & Environmental Division, World Bank

Real domestic resources in the formal financial system grew from MK 196 million in 1980 to MK 367.2 million in 1992 (Table 2).

Table 2: Domestic Resources in Formal Financial System
(figures in Million Kwacha and inflation adjusted)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Com. Banks	166.0	190.1	197.8	180.8	218.8	187.9	203.4	215.6	189.3	173.1	204.0	231.3	263.7
Leasing	1.4	1.4	1.4	1.4	1.4	0.9	0.0	3.0	6.3	9.5	12.4	18.6	25.2
POSB	20.6	22.0	25.1	30.4	43.1	32.1	31.2	35.3	40.6	36.3	35.4	34.4	33.5
NBS	8.0	10.1	11.5	11.4	13.3	14.6	14.4	15.6	17.5	18.1	20.0	32.3	44.8
TOTAL	196.0	223.6	235.8	224.0	276.7	235.4	249.0	269.6	253.7	236.9	271.7	316.7	367.2
Growth		23.6%	12.2%	5.7%	24.5%	-1.3%	10.7%	14.7%	7.1%	2.1%	4.6%	4.9%	4.6%
CPI*	100.0	110.4	120.1	136.2	151.2	173.8	199.5	252.9	332.2	384.4	395.9	407.10	418.40

* CPI index with base year 1980, (Sahn *et al.*, 1990) 1990 and 1991 CPI based on 11.5% and 11.2% inflation rates (World Bank, 1994a), and 1992 CPI was based on an inflation rate of 11.3% extrapolated from 1991 and 1992 figures.

Source: Reserve Bank of Malawi, Annual Reports.

Note: Data for LFC is for August each year, which understates the deposits in this category.
Information for POSB for 1985, 1988, and 1989 is based on Mission Estimates.

The informal financial sector includes moneylenders (Katapilas), traders, estate owners, friends and relatives, credit clubs and associations. This sector is estimated to provide over 66 per cent of the total value of loans given annually (World Bank, 1994b), although these figures are problematic due to the time of their collection and the difficulty in quantifying informal transactions.

The formal financial sector lacks outreach. Neither of two commercial banks significantly impacts the rural informal sector. The POSB has 158 post offices and 126 postal agencies and contains the largest amount of rural sector deposits among formal financial institutions. Due to its wide geographic coverage, competitive interest rates

and tax-exempt status of interest on savings the deposit base grew from MK 22.4 million to MK 35.4 million from 1980 to 1990 after adjusting for inflation. However, this institution has no lending mandate and therefore most of its savings are put into government securities and not directed as credit to *smallholders* through its extensive coverage of location.

Out of a total of MK 371 million (1991 kwacha) of credit provided annually to the rural sector, informal finance is estimated to provide MK 281.5 million with interest rates of 60 to 100 per cent annually⁴ (World Bank, 1994b). The formal sector provides MK 89.5 million with rates of only 6 to 25 per cent (World Bank, 1994b). This demand for credit despite higher rates of interest in the informal sector suggests that the growing capital base of the formal sector is not adequately structured to provide funds to meet rural credit demand. The informal sector could have more efficient mechanisms for delivering and monitoring credit that are needed in cases of formal market failure.

Markets fail when a disutility is received from engaging in a market transaction, resulting in the lack of use of this market (de Janvry et. Al). Market failure can result in "missing markets" for a good or service for particular households or individuals. In the case of credit, if the costs of formal credit, including transactions costs, time loss, etc. are greater than the prospective returns for a particular household, this household/individual would receive disutility from borrowing from formal markets and would attempt to only

⁴ Since family and friends tend to not charge interest, these figures do not appear to reflect the contribution of friends and family in the informal market.

transact borrowing from family and friends that charge little or no interest. A lack of adequate infrastructure or viable investment options, or inflexible payment schedules and high collateral requirements could lead to this "missing market" in formal credit for a particular household/individual.

Missing formal credit markets that force households/individuals to rely solely on informal credit sources for their credit needs, limits the ability of these households/individuals to improve productivity and smooth consumption because of limited informal funds.

The government may be missing a major opportunity to channel resources for improving child nutrition by its lack of interest in the informal credit market. Few informal credit lenders have the resources and legal authority to introduce financial instruments or to take advantage of central bank facilities. Consequently, the informal financial sector (IFS) is unable to expand its services to credit-constrained individuals because of limited funds. Linking the two sectors has been successfully implemented in countries such as Indonesia (Diagne, 2000), several Asian countries (Gate *et al.*, 1992) and Sri Lanka (Nimal, 1989). Under the Praja Naya Niyamaks scheme in Sri Lanka, the two state banks lend funds to individuals of proven creditworthiness at a rate around 18 per cent and expect these intermediaries to lend at an interest rate of less than 30 percent. These intermediaries do not have to provide proof or documentation of their lending activities. In addition to providing funds banks are using local information providers to reduce risks and default rates. Programs in Indonesia are successfully using local agents to assess the creditworthiness of borrowers.

Although these successes warrant interest, caution should be used when lending through intermediaries and using information providers because these individuals may have their own biases and political motives. Informal lenders are generally the wealthier members of society because these individuals have extra money to lend. Since men are more likely to be in the position of being able to lend in Malawi, cultural norms such as gender bias may restrict informal-sector funds from reaching the poorer members of society, generally women. In addition, giving additional funds to the wealthier members of rural areas could help strengthen political networks among this group and solidify their control over rural resources. Policy-makers must consider these factors when making appropriate policy decisions and determine the most appropriate restructuring given the current environment.

Seasonal needs for cash and inputs by rural farmers in Malawi leave little time for bureaucratic delays. Most *smallholder* farmers prefer informal sources of credit because of high cash and time costs associated with the process of acquiring formal loans, delays between the application approval and disbursement, and the uncertainty of loan approval. Although interest rates are high in the IFS⁵, approval and disbursement are immediate, transaction costs are low and terms are flexible. Restructuring the two credit systems would allow a larger number of *smallholders* to access cheaper credit in a timely manner. Since current lack of credit is a major contributor to rural food insecurity, this appropriate restructuring would increase

⁵ The exception being small loans among family and friends, which are not charged explicit interest, but imply reciprocity

food security among the poor and subsequently child nutrition.

2.9.1 Extending Rural Credit

Future expectations of benefits for borrowers and local knowledge and enforcement mechanisms are needed for rural lending. Diagne's study of the Malawi Rural Finance Corporation concluded that the traditional mechanisms in the formal sector for obtaining high repayment rates, such as peer selection and joint liability structures, are not feasible in the case of Malawi. The main reason for default was not *inability* to repay, but *unwillingness* to repay even within peer selection and joint liability structures. Since members of the credit groups are generally from more than one village and members of the group committee do not want to be seen as "spying" or "interfering in other members' private businesses" peer selection is ineffective. When peer pressure does appear in joint liability groups it is normally ineffective and has "social costs" to the individual applying the pressure. He concluded that in order to secure high rates of repayment, lenders must increase the value to borrowers of future access to credit. This is shown in the fact that on average MRFC borrowers are willing to pay 523 Malawi kwacha, representing 24 per cent of the average loan size per member, to maintain their access to credit. One effective manner to raise the future value of access to credit is to give larger and continuous access to credit to good borrowers.

High costs associated with effective screening and monitoring of borrowers can inhibit formal credit institutions from successfully entering rural markets.

Sharma and Zeller (2000) determine that among the tools used by informal lenders to ensure high repayment rates are reciprocity arrangements, knowledge of borrowers, frequent dealings with borrowers in non-loan circumstances, understanding of local production structures and flexibility. Family and friends loan within a social insurance scheme (reciprocity arrangements) where borrowers incur the costs of losing close and immediate funds and other support in times of need. The loss of this benefit is enough to deter borrowers from default. Moneylenders either have adequate information concerning borrowers or rely on community-wide understanding that permits the lender to seek punitive action in the event of default. Traders and landowners that interact frequently with borrowers in business-related activities effectively screen potential borrowers before lending and give the borrower the incentive of future benefits that would be lost if default occurs. All of these local lenders have adequate insight into the local production structure to make timely loans with feasible repayment schedules. Their long-term presence and social connections in the community gives borrowers the incentive of future services and benefits, which promotes repayment. Additionally, informal lenders remain more flexible to changing conditions and circumstances affecting the ability of borrower repayment than their formal sector counterparts.

These studies imply that formal financial institutions attempting to increase outreach in rural areas must adapt and remain flexible to local production structures such as timing of harvest, local climate and price variability and distribution systems. They also must provide long-term services with increasing benefits for good borrowers.

Greater use of extension agents and intermediate lenders can provide greater knowledge and flexibility to the formal sector. Blurring the boundaries of the formal and informal sectors in Malawi can effectively direct resources from the formal sector to fuel rural economic growth, diversify the economy, and consequently increase food security. Insight into the effects of credit on *smallholder* farmers, and therefore on the welfare of the poorer members of society, will allow policy makers to direct rural credit to projects with high social returns or to design appropriate mechanisms to increase the efficiency of the targeting of rural credit.

2.9.2 Smallholder Benefits from Credit

Credit demand is dependent on the net present value of the future returns from borrowing. If these returns are greater than the costs incurred from borrowing (i.e. interest charges, transactions and transportation costs, etc.) then there will be a positive demand for credit. Therefore, more viable investment options and reduced borrowing costs will increase credit demand for a given household or individual.

As discussed earlier "missing markets" for formal credit occur when there is a negative demand for a given household/individual indicating that there is either a lack of viable investment options, high borrowing costs or both. Therefore making credit affordable is necessary to allow households/individuals to gain benefits associated with access to credit.

Credit is seen by many as an effective instrument to increase income, smooth consumption and avoid inefficient

precautionary savings. Credit increases income generation by allowing for the purchase of inputs and technologies. Credit also reduces the risks of temporary shortages of basic needs, therefore smoothing consumption. If a farmer can borrow to feed her family for a month or two before the harvest season, then she can produce crops with higher returns. With access to credit, the family knows it can borrow in the case of food shortages and can therefore gain the higher returns associated with higher yielding food crops instead of lower yielding varieties which store for longer periods of time. The credit institutions under study only lend for income generating activities. This may help smooth consumption if these are off-farm enterprises creating income during the off-season, but benefits accruing from precautionary savings are being lost.

2.9.3 Access to Credit

The total amount that an institution or individual is willing to lend to a potential borrower is that potential borrower's access to credit from that institution or individual. Therefore, access to credit represents the supply of credit for a given potential borrower. The potential borrower may not demand this credit due to high borrowing costs or a lack of profitable investment opportunities. Access to credit is constrained for both men and women in Malawi, but especially for women. Diagne *et al.* (1996) found that 23 percent of households surveyed had no access to credit, 55 per cent had access to informal credit only, 4 per cent had access to formal credit only, and 19 per cent had access to both formal and informal credit. Women had less access to both formal and informal credit in both the formal and informal markets.

2.10 Summary and Forward

Chapter two described how past government policies in Malawi have worsened food insecurity among *smallholders*. Reversing these effects on *smallholder* agricultural production is a key to promoting broad-based growth. Evidence showed the severity of child malnutrition and the need to find ways to increase nutritional status. Women in particular were shown to directly affect levels of child nutrition, and the health and education of mothers to positively impact child nutritional status. Groundnuts can help raise child nutritional levels by supplying nutrients and calories, and providing a source of cash income to women. The groundnut sector in Malawi has recovered from earlier price distortions to realize strong yield gains in recent years. Major nutritional problems include energy and protein deficiencies. Groundnuts are primarily produced by *smallholder* farmers and therefore can diversify the rural economic base and enhance rural food security. Groundnuts provide essential nutrients for the soil and are a local source of energy and protein for mothers and children. Credit is needed to promote production of cash crops such as groundnuts. The current credit system in Malawi lacks integration. With limited rural outreach, the formal financial sector has limited power to influence broad-based rural economic growth and promote greater food security among the poor.

Chapter three will build the framework for the study. The conceptual framework and theoretical model will be presented. From these foundations, a reduced form equation is generated representing child nutrition as a function of

exogenous variables. This function is used to determine the effects of access to credit, income diversification, groundnut production and other factors on child nutritional status.

Chapter 3

Conceptual Framework

3.1 Introduction

The purpose of this chapter is to present the conceptual framework and theoretical model for this study. The review of previous studies, government policies, and empirical evidence in Chapter two indicates that child malnutrition is severe in Malawi and is probably influenced by credit opportunities, the health and nutrition of women, and household income diversity.

3.2 Conceptual Framework

The conceptual framework used here includes three levels of influences on child nutritional status: the village, household, and proximate levels (Figure 2). Other studies of nutritional status have used levels defined in terms of biochemical and behavioral levels; divisions across economic, social, and cultural considerations (Ferguson *et al.*, 1990); and basic, underlying, and immediate determinant levels (Engle, Menon, and Haddad, 1999).

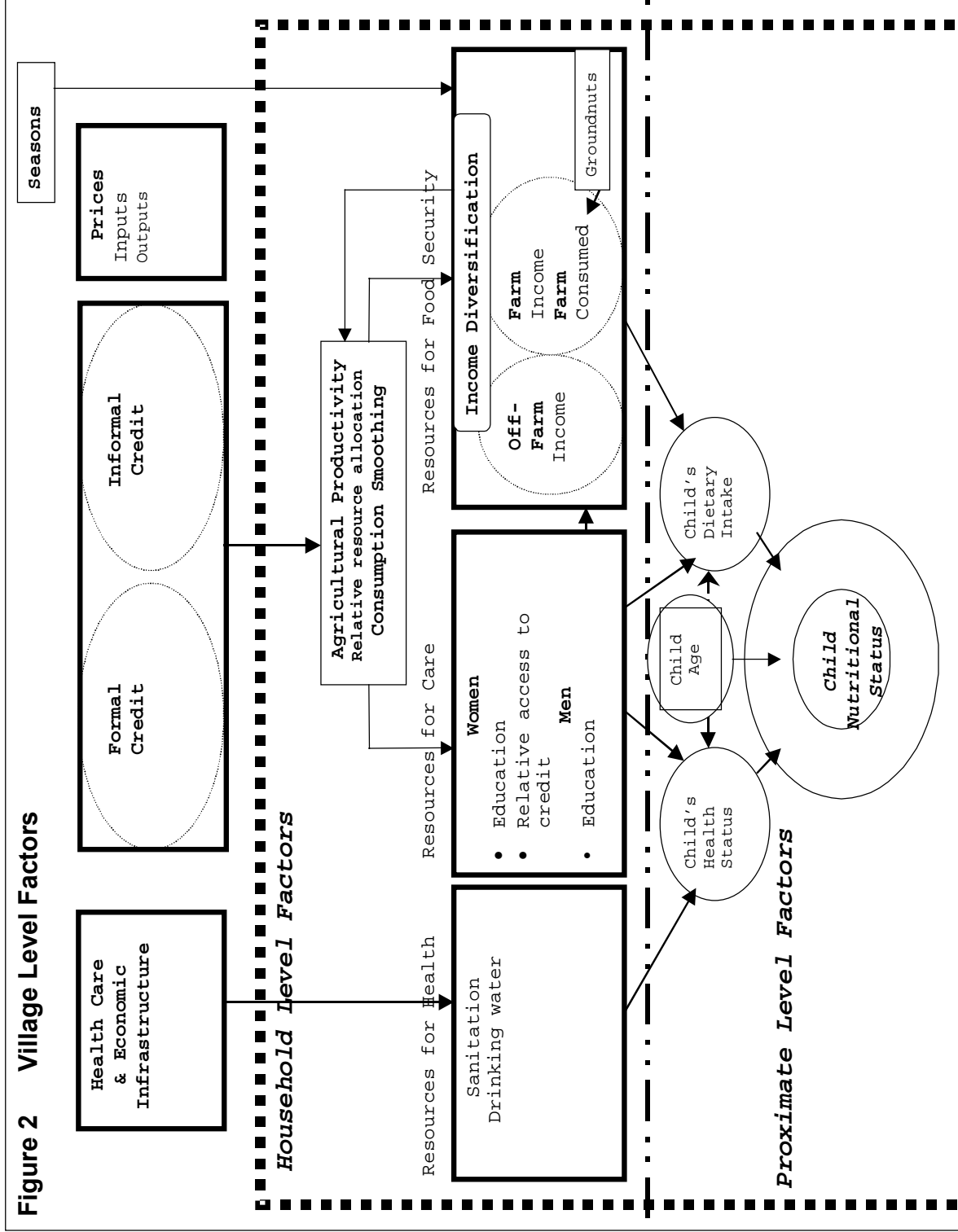
Ferguson, Millard, and Khaila create a framework to analyze the factors influencing child nutrition in Malawi with proximate, intermediate, and inclusive tiers of influence. They define the proximate level as "the immediate biochemical causes of malnutrition;" the intermediate as "those behavioral patterns that increase

exposure to the proximate causes;" and the inclusive level is defined as "the broad social, economic, and cultural processes and structures in which the proximate and intermediate causes of nutritional status are embedded." Engle, Menon, and Haddad apply these three levels yet clarify the micro-level determinants by defining household food security, care for mothers and children, and health environment and services as the three categories of influences on the immediate level. This study draws upon the latter framework, focusing on village and lower-level determinants of malnutrition.

The proximate level consists of factors influencing child nutritional status at the level of the individual being. These factors include child health status and dietary intake (energy, protein, fat, and micronutrients), and interdependencies between them. Dependency results from the fact that children with insufficient dietary intake are more susceptible to disease and diseases depress appetite, impede the absorption of nutrients, and compete for the energy of a given child (Haddad *et al.*, 1997).

Household-level influences consist of three broader categories that affect child health status and child dietary intake. These categories are resources for health, resources for care, and resources for food security. Each of these categories suggests a number of variables that influence child nutrition through health status and dietary intake.

Figure 2 Village Level Factors



Resources for health include sanitation and access to drinking water. Lack of these resources is associated with greater incidence of disease and higher levels of malnutrition.

Resources for care include women's relative access to credit and female and male education. A woman's access to credit relative to that of her spouse can have a significant effect on child nutrition. Studies from Sub-Saharan Africa (Doss, 1997; Hoddinott and Haddad, 1995) indicate that when the share of resources controlled by women increases, the food budget share of the household increases as well.

Resources for food security consist of off-farm and farm income, among other factors. Income diversification is a key element to food security among *smallholders* in Malawi due to the seasonality of food production and lack of year-round food supplies for most rural families. Diversification includes different combinations of farm and off-farm enterprises, and allocation of land to the production of crops with varied risks and production cycles.

Village-level effects consist of three sets of factors that represent the environment in which the household lives. Health care and economic infrastructure variables compose one set of effects. Access to credit is the second village-level effect. It starts at the village level, but influences child nutritional status within the household. Credit comes in two forms: informal and formal. Men and women have access to each source, and effects on nutritional status may depend on the gender of the potential recipient. Lastly, prices and seasonality

directly affect income, productivity and consumption smoothing.

3.3 Theoretical Model

To motivate the study, consider a simple, static household model. The household contains a husband, wife, and other adults, with a son and a daughter. The model consists of five components: 1) a utility function; 2) a nutrition production function; 3) an agricultural production function; 4) time constraints; and 5) a budget constraint.

Decisions are determined through bargaining between the adults in the household. Accordingly, household utility is a function of all the adults' individual utility functions posited to be:

$$(1) U_a = U_a(Q_{ca}, F_{ca}, T_{1a}, N_b, N_g) \quad a=\text{adult}$$

Where a represents adults. Q_{ca} is the quantity of purchased goods consumed by individual a , F_{ca} is the quantity of produced goods consumed and T_{1a} is the amount of leisure time of the individual. Each adult, a , gains utility from the nutritional status of the boy and girl, N_b and N_g respectively.

The utility function of the household is a weighted combination of the males' and females' functions. We formulate the aggregate household utility function as:

$$(2) U(Q_{ca}, T_{1a}, F_{ca}, N_b, N_g) = U_f + U_m, \quad f=\text{females}, m=\text{males}$$

The nutrition production function for each child is specified as the general function:

$$(3) N_s = N_s(Q_{cs}, F_{cs}, V, H, CR_a, T_{na}) \quad s=\text{child}, a=\text{adult}$$

Q_{cs} is the quantity of purchased consumption goods for the individual child: food, clothes, medicine, etc. F_{cs} is the amount of goods produced in the household that are consumed by child s . V and H are vectors containing village-level and household-level factors affecting child nutrition. The price of maize and wages affect income levels and time allocation. The variable, CR_a , represents access to credit by individual a . Access to credit can smooth consumption, which may raise short-term nutrition levels during periods of food shortage. T_{na} is the time of child caretaker a in the production of child nutrition.

Relative access to credit of men and women in the household affect the quantities of the factors in the child nutrition production function depending on the preferences of the women and men. The household produces crops, F_n , with X production inputs.

The aggregate farm production function is:

$$(4) F_n = F(X, T_{wpa}, CR_a, S) \quad a=\text{adult}$$

where T_{wpa} is the time spent working on production activities by individual a . Access to credit increases production by allowing for the purchase of technology, inputs, and the production of crops with greater risks that

yield greater returns. Seasons, S , directly affect production as agricultural production is primarily received at one point in the year, coinciding with the March harvest.

Household production is either sold in the market, represented by F_m , or consumed, F_c (5).

$$(5) \quad F_n = F_m + F_c$$

Total profit from household production is:

$$(6) \quad \pi = P_m * F_m - P_i * X_i - I$$

where P_m and P_i are the prices of output and inputs respectively. I is the amount of interest and transactions costs for loans paid out in the period, which is determined by CR_a .

The household faces time and budget constraints. The aggregate time of adults, \bar{T} , must be allocated between child nutrition production, T_n , household production work hours, T_{wp} , wage work hours, T_{ww} , and leisure, T_1 , in (7).

$$(7) \quad \bar{T} = T_n + T_{wp} + T_{ww} + T_1$$

In addition, the household will purchase Q_c goods in the market at price P_c and consume F_c produced goods producing the following budget constraint:

$$(8) \quad \pi + W * T_{ww} = P_c * Q_c$$

where W is the wage rate.

3.4 Specification of the Empirical Model

Maximizing utility (2) subject to (3) and constraints (7) & (8) results in the following reduced form empirical model:

$$9) \quad N_{rj} = (V, H, CR, P, S)$$

N_{rj} represents the r th short-term measure of child nutrition, and the j th gender (boy and girl) of the child. We now discuss each of these elements in some detail. For a full treatment of variable construction, please see Appendix A.

3.4.1 Nutritional Measures

Nutritional status of children up to six years of age is measured using z-score values⁶. These values are anthropometric measurements of weight and height compared to the World Health Organization standard population. Three such values are used in this study; height-for-age, weight-for-age, and weight-for-height. Height-for-age is a long-term indicator created by taking the height of the child of a given age, subtracting the population reference height for that age, and then dividing this new quantity by the

⁶ Z-scores are calculated by taking the deviation of an individual child's measurements from the mean of the WHO reference population, divided by the standard deviation of that reference mean.

reference population's standard deviation. This creates a z-score. Weight-for-age is a long-term and short-term indicator created by taking the weight of a child of a given age, subtracting the weight of the reference population for that particular age, and then dividing this quantity by the reference population's standard deviation. Weight-for-height is a short-term nutritional measure created by taking the child's weight and height, subtracting the reference population's weight for that particular height, and then dividing this quantity by the reference population's standard deviation.

3.4.2 Independent Factors

The variable vector V in (9) includes village-level factors such as the number of modern health clinics in the village or within 30 minutes of the household and if there is a tarred road to the nearest trading center. H includes household-level factors like the number of members in the household, education of men and women, income, income diversity, water sanitation and groundnut production. CR is a vector containing formal and informal access to credit by males and females and P is a price vector including price of maize and wages. Finally, S is a vector of seasonal dummy variables.

3.4.3 Relative Access to Credit of Men and Women

It is assumed that females initially have limited access to resources relative to men. This rationality is consistent with the large proportion of assets (83 percent)

in this study that are controlled by the household head, in which 72 per cent of the household heads are males (Diagne and Zeller, 2001). Consequently, a "Relative access to credit" dummy variable is included which is 1 when per capita monthly formal and informal access to credit of females is greater than or equal to that of males and 0 otherwise.

3.5 Data

The data for this study are drawn from a survey conducted by the International Food and Policy Research Institute (IFPRI) in collaboration with the Bunda College of Malawi. The survey was carried out in three rounds starting on February 21, 1995 and ending with the third round from November 13 to December 22, 1995. About 400 households were surveyed in five districts of Malawi: Dowa, Mangochi, Nkhonkhotakota, Lilongwe, and Rumphi. A drought in the 1991/92 growing season, one in the 1993/94 growing season and a below-average maize crop in the 1994/95 season affected the households right before and during the survey (Diagne and Zeller, 2001).

3.5.1 Credit Programs

This study concentrates on four rural formal credit institutions: Malawi Rural Finance Corporation (MRFC), Mudzi Fund (MMF), Malawi Union of Savings and Credit

Cooperatives (MUSCCO), and Promotion of New Enterprises for Rural Women (PMERW)⁷.

MRFC targets smallholder farmers that are put into joint liability groups of 5 to 10 members. Most of its loans are in-kind seasonal agricultural loans. MMF extends loans for off-farm enterprises for poor rural households (mostly females, representing 95 % of loans). Members are put into joint liability groups of 5 members. During a period in 1995, access to credit was suspended for all members when MMF was being incorporated into MRFC. MUSCCO is a federation of savings and credit cooperatives. Its members are mostly poor farmers and loans are for seasonal agricultural inputs.

PMERW provides business training and technical advice and credit to women joined in group-owned enterprises. This institution is split into two sections, PMERW1 and PMERW2. PMERW1 gives two-year loans of MK 1,000 to clubs consisting of up to ten to fifteen poor women. Only one half of the club can have outstanding loans at one time. Enterprises promoted usually sell produce or brew beer. PMERW2 loans to credit groups of five to ten women skilled in business activities. Members either "graduated" from PMERW1 or have business capital in the 300-1,000 MK range and are in the program area.

Credit program structure can be grouped according to the sex of the member. Female access to formal credit is primarily for promoting off-farm enterprises, while most male access to formal credit is directed at providing seasonal crop inputs. None of the access to credit from

⁷ Diagne and Zeller (2001) give detailed descriptions on the history, purpose, structure, and clients of these institutions.

the above institutions is provided directly for purposes of consumption smoothing or precautionary savings.

3.5.2 Choice-Based Sampling

Half the survey sample was households presently receiving credit from PMERW (90 participants), MRFC (60 participants), MUSSCO (30 participants), and the Malawi Mudzi Fund (30 participants). The other half consisted of households not presently receiving credit from any formal organization with half of these having never received credit from these institutions and the other half having defaulted and lost eligibility.

The 90 PMERW participants came from Mangochi, Nkhotakota, and Rumphi, with 30 coming from each district. The 60 MRFC participants came from Nkhotakota (15), Rumphi (15), and the Lilongwe Agricultural Development Division (30) with the participants in Nkhotakota and Rumphi coming from the same villages as the PMERW participants. The 30 MUSSCO members were selected from the Nafisi Savings and Credits Cooperative (SACCO) in Dowa.

The other half of the survey samples non-participants from the same villages by choosing the same number of participants and non-participants in each village. Half the sample was drawn randomly from a list of all participating households in the village; one fourth was drawn randomly from a list of past participants, and the last fourth from a list of all households who had never participated in any formal credit program. This form of sampling, where by stratifying along program membership and then randomly selecting samples within these strata is choice-based sampling. It should be noted that correction for this

sampling was not performed in this study and the results may be biased as a result.

3.5.3 Simultaneity Issues

Two other biases should be noted in this survey structure. First, since participants and non-participants were chosen from the same village, village level effects of the credit program may affect both groups. For example, the presence of a formal institution may benefit non-participants as it can allow for more informal sources of credit. This effect can result as formal credit increases the income of some households in the village allowing them to lend more informally and as individuals formerly borrowing in the informal market substitute for formal loans.

The second form of bias is caused by the fact that both PMERW1 and Mudzi Fund programs are set up to target the poor. PMERW1 is set up to target the poorest women, with women being able to "graduate" to PMERW2 (Diagne *et al.*, 1996). The Mudzi Fund was established in June 1990 and modeled after the Bangladesh Grameen Bank to provide financial services to the core poor in rural areas of Malawi (World Bank, 1994b). In the sample for this study, participants of Mudzi and PMERW1 have significantly lower per capita income levels than non-participating households (-520 and -300 MK respectively) (Diagne *et al.*, 1996). As a result of Mudzi and PMERW1's selection of poorer individuals, we can expect their long-term child nutritional measure (Height-for Age z-scores) to be lower than non-participants. Therefore, it will be important to not directly compare the child nutrition status of

participants and non-participants, but to look at the relative increases and decreases in child malnutrition from chronic and acute measures to discern the effects of credit on child nutrition. Controlling for program selection criteria can eliminate this bias.

3.5.4 Program Membership Vs Access to Credit

A distinction must also be made between program membership and access to credit. Just having membership in a credit program may benefit an individual due to its structure, training, contacts, etc. By aggregating access to credit by the gender of recipients this study does not attempt to distinguish between benefits to child nutritional status accruing from access to credit, or just membership in a program. With some families having membership in more than one program, aggregating the access to credit blurs the boundaries between individuals and particular programs. However, the structure of the programs is distinct for the majority of females on one hand and males on the other in the study group. Consequently, the conclusion of the study must allude to the fact that it may also be the structure of the program influencing child nutritional status.

3.6 Long-Term Models

Height-for-Age is a long-term indicator of child nutrition and therefore individual period observations were averaged across rounds for each child in the survey. Although, a young rapidly growing child may achieve a greater (or lesser) height because of the recent past, the

cumulative effects of past seasons are what ultimately determine long-term nutritional status. All independent variables are aggregated by household and then averaged across rounds for non-dummy variables. For factors represented by dummy variables, if the factor is present in any round it is considered that the household has this factor. The season dummy variables are not included in the Height-for-age regressions. The following regression equation is used:

$$10) N_{rj} = (MV, AH, ACR, AP) \quad r = \text{height-for-age} \quad j = \text{boy, girl}$$

MV is the maximum infrastructure measures across the rounds including the number of modern health clinics and the existence of a tarred road to the nearest trading center.

AH is the average of selected household factors, or the maximum for any dummy variables. Relative access to credit, groundnut production and the highest education level of males and females are maximum variables for each household, whereas household size, income diversification and income are all averaged across rounds. ACR is the average access to formal and informal credit for men and women. AP is the average price of maize and wages for the three rounds.

All factors were chosen and compiled from different sections within the original data set on the basis of matching households and members across the 3 surveys taken over the one-year collection period.

3.7 Summary of Chapter

This chapter drew on past studies to develop a conceptual framework for looking at child nutritional status, which contains proximate, household-level and village-level tiers of influencing factors. The specific factors were briefly discussed and a simple theoretical model constructed using a utility function, nutrition production function, agricultural production function, time constraints and a full income constraint. The empirical model followed with details on the six regression equations used in this study; weight-for-height, weight-for-age, and height-for-age equations for both boys and girls.

Chapter 4

Results

This chapter presents and discusses the descriptive statistics for variables used in the regression model. The parameter estimates from the model are then presented. Chapter five then provides conclusions, policy implications, methodological limitations, and future research possibilities.

4.1 Descriptive Statistics

This section presents summary statistics, describing the overall characteristics of the survey households. Child nutritional measures are presented first followed by village-level factors, access to credit, and then household-level characteristics. For a detailed description on the construction of the variables, refer to appendix 1. Table 3 gives the descriptive statistics.

Table 3 : Summary Statistics of Survey Households

<i>Variable</i>	<i>Variable definition</i>	<i>Mean</i>	<i>Median</i>	<i>Std. Dev.</i>	<i>Units</i>
WFHEIZF	Girl weight-for-height	0.307	0.290	1.322	Z-Score Std. Devs.
WFHEIZM	Boy weight-for-height	0.216	0.150	1.261	Z-Score Std. Devs.
WFAGEZF	Girl weight-for-age	-0.712	-0.800	1.180	Z-Score Std. Devs.
WFAGEZM	Boy weight-for-age	-0.935	-1.080	1.203	Z-Score Std. Devs.
HFAGEZF	Girl height-for-age	-1.954	-1.943	1.436	Z-Score Std. Devs.
HFAGEZM	Boy height-for-age	-1.976	-2.125	1.548	Z-Score Std. Devs.
NMODCLIN	Num. modern health clinics	0.452	0.000	1.204	Clinics
TRODTCEN	Tarred road to trading center	0.413	0.000	0.493	1 if tarred road, 0 otherwise
HHSEX	Sex of Household Head	0.252	0.000	0.434	1 if female, 0 if male
RCREDIT	Relative access to credit	0.318	0.000	0.466	1 if female access to credit>=men access to credit, 0 otherwise
WATER	Clean water available	0.418	0.000	0.494	1 if clean water, 0 otherwise
LATRINE	Latrine owned & used	0.829	1.000	0.376	1 if latrine, 0 otherwise
ffloan	Formal female cred. Access	23.811	0.000	79.413	MK
fmloan	Formal male credit access	41.863	0.000	173.645	MK
ifloan	Informal fem. cred. Access	9.782	0.000	33.727	MK
imloan	Informal male cred. access	14.104	0.000	31.111	MK
oindex	Income diversification	1.736	1.104	0.916	Extent of diversification
tincome	Total per capita monthly income	94.962	50.782	164.613	MK
HEFEM	Highest education of female	1.114	1.000	0.729	Level of education= 0 if no education, 1 if read/write chechwa, 2 if have primary school certificate
HEMAL	Highest education of male	1.181	1.000	0.718	Level of education= 0 if no education, 1 if read/write chechwa, 2 if have primary school certificate
gnut	Groundnut production	0.081	0.000	0.273	1 if produce groundnuts, 0 otherwise
cage12	Child age<12 months	0.035	0.000	0.183	1 if child <12 months, 0 otherwise
cage24	Child age 12-23 months	0.122	0.000	0.328	1 if child 12-23 months, 0 otherwise
cage36	Child age 24-35 months	0.264	0.000	0.441	1 if child 24-35 months, 0 otherwise
cage48	Child age 36-47 months	0.323	0.000	0.468	1 if child 36-47 months, 0 otherwise
cage60	Child age 48-59 months	0.187	0.000	0.390	1 if child 48-59 months, 0 otherwise
MOTHERHT	Mother Height	155.884	155.884	6.932	cm.
MOTHERWT	Mother Weight	55.633	55.000	7.008	kgs.
season2	Season 2	0.335	0.000	0.472	1 if season 2, 0 otherwise
season3	Season 3	0.302	0.000	0.460	1 if season 3, 0 otherwise
hhszise	Size of Household	6.656	7.000	2.569	Persons

4.1.1 Child Nutritional Status

A child is considered stunted if it is two standard deviations below the NCHS/WHO standard population's height-for-age, wasted if two standard deviations below the standard's weight-for-height and underweight if two standard deviations below the standard's weight-for-age. On average, children in Malawi are stunted. A total of 213, representing 50.1 per cent of the 425 children studied are stunted, 2 per cent, or 9 children are wasted, and 10.4 per cent (44 children) are underweight. The 1992 Demographic and Health Survey for Malawi (1992) shows that stunting, wasting and underweight children represent 49 per cent, 5

per cent, and 27 per cent of the population respectively. The difference between these percentages and those in this study is attributable to sampling differences. Malnutrition is severe in Malawi and some form of relief from this problem should be a primary concern of policymakers.

Girls in the study group are better nourished than boys. These nutritional differences are significant in four of the six nutritional measures. On average, girls' weight-for-height, weight-for-age, and height-for-age z-scores are .091, .223 and .022 standard deviations higher than those of boys are.

Girl and boy nutritional levels vary depending on the gender of the household head (Table 4). In fact, girls are nutritionally better off in female-headed households and boys are better off in male-headed households. Same-sex parental preference is a significant finding.

Table 4: Nutritional Status of Girls/Boys by Sex of Household Head

	<i>Female-Headed</i>		<i>Male-Headed</i>		<i>Difference Parameter</i> 0 if male head, 1 if female head	<i>t-statistic</i>
	<i>Mean</i>	<i>Std.Dev.</i>	<i>Mean</i>	<i>Std.Dev.</i>		
Weight-for-height girls	0.451	1.423	0.245	1.274	0.206	1.508
Weight-for-height boys	-0.023	1.177	0.277	1.277	-0.300	-2.175
Weight-for-age girls	-0.446	1.201	-0.827	1.154	0.381	3.157
Weight-for-age boys	-1.174	1.115	-0.873	1.221	-0.301	-2.289
Height-for-age girls	-1.684	1.434	-2.071	1.423	0.387	2.621
Height-for-age boys	-2.092	1.343	-1.941	1.597	-0.151	-0.890

The average height-for-age of boys and girls decreases each year until five years old, when it begins to increase (Table 5). This is attributed to the culmination of nutritional and health stress causing an increasing deterioration in growth relative to the norm (Sahn and Stifel, 2001).

Table 5: Nutritional Status of Children by Age-Group and Gender

Child Age	WFHEIZ								
	All			Boys			Girls		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
<=12 months	0.286	0.250	1.330	0.200	0.250	1.334	0.402	0.665	1.365
13-24 months	0.156	0.145	1.294	0.292	0.150	1.212	0.005	-0.080	1.375
25-36 months	0.242	0.170	1.159	0.258	0.140	1.115	0.225	0.270	1.209
37-48 months	0.278	0.200	1.326	0.182	0.190	1.311	0.393	0.375	1.339
49-60 months	0.349	0.290	1.416	0.235	0.190	1.414	0.486	0.490	1.414
61-72 months	0.158	0.070	1.246	0.032	-0.045	1.182	0.281	0.140	1.312

Child Age	WFAGEZ								
	All			Boys			Girls		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
<=12 months	-0.813	-0.910	1.342	-0.455	-0.450	1.267	-1.299	-1.590	1.329
13-24 months	-0.768	-0.900	1.514	-0.728	-0.820	1.589	-0.813	-0.900	1.440
25-36 months	-0.787	-0.830	1.229	-0.878	-0.920	1.245	-0.691	-0.810	1.209
37-48 months	-0.885	-1.000	1.160	-1.040	-1.220	1.173	-0.700	-0.795	1.121
49-60 months	-0.871	-0.960	1.066	-1.052	-1.130	1.007	-0.652	-0.715	1.101
61-72 months	-0.758	-0.740	0.844	-0.949	-0.990	0.690	-0.572	-0.630	0.945

Child Age	HFAGEZ								
	All			Boys			Girls		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
<=12 months	-1.664	-2.260	2.831	-1.011	-2.270	2.626	-1.998	-2.850	2.467
13-24 months	-1.761	-1.970	2.039	-1.927	-2.320	1.492	-1.953	-1.980	1.623
25-36 months	-1.926	-2.060	1.755	-1.987	-2.040	1.601	-1.913	-1.940	1.299
37-48 months	-2.066	-2.130	1.806	-2.045	-2.240	1.492	-2.037	-1.900	1.301
49-60 months	-2.149	-2.190	1.683	-2.120	-2.040	1.403	-2.024	-2.320	1.457
61-72 months	-1.668	-1.960	1.585	-1.803	-1.900	1.172	-1.568	-1.840	1.563

Even when separated into age categories, both weight-for-height and weight-for-age differ among girls and boys. Girl average weight-for-height decreases after the first year of age and then steadily increases until the fifth year, when it takes a downturn. This dip after the first year is consistent with the weaning period between 13 to 18 months of age, when vulnerability to diarrheal disease is high. Although the average boy weight-for-age does not follow this pattern, the median values do. This indicates

that a few boys not only did not see deterioration in their health status, but also fared well during weaning.

The difference in the weight-for-age age structure between boys and girls is large. The average boy weight-for-age z-score decreases until 61-72 month, when it increases. In contrast, the average girl weight for age score increases with age. This difference in patterns of weight-for-age by age among boys and girls is large, with boy average weight-for-age z-scores decreasing from -.45 for under 12 month boys to -1.052 for 61 to 72 month-olds. In contrast, girl average weight-for-age z-scores increase from -1.30 for under 12 month girls to -.57 for 61 and 72 month-olds. One explanation might be that as the children get older, boys spend more time with their fathers, and girls spend more time with their mothers. The boys may be involved in more physical activities than girls, like walking to far away fields, while girls remain around the house doing odd tasks for the mother. These children are less than 61-72 months old, but may still be involved in light activities to prepare them better for future work responsibilities. It is also possible that since boys will be involved in more strenuous future work they are breast-fed a little longer, accounting for the less severe drop in their weight-for-height scores than girls in the 12-23 month age group. These are hypotheses, but no evidence supporting these theories has been found.

4.1.2 Infrastructure

Infrastructure is underdeveloped in the areas surveyed. Only 41 per cent of the households have a tarred road to the nearest trading center. The mean number of

modern health clinics within 30 minutes to the households is .45 indicating that the majority of households lack nearby access to modern health facilities. In fact, only 15 per cent of the households have a modern health clinic within thirty minutes traveling time.

4.1.3 Access to Credit Measure

Access to credit appears to be limited. Average total per capita access is MK 89, about 5.6 per cent of per capita annual household income.

Women have less formal and informal access to credit than men do. Median levels of access to all sources of credit are 0 for both men and women. Since fifty per cent of the sample is not a current member of credit programs, and because membership in a program does not guarantee access to credit, it is apparent why median access to formal credit is 0.

Median informal credit limits of 0 require further discussion. The questionnaire asks, "What is the maximum amount you could borrow from any person if you really wanted to?" Furthermore, for access to credit to be an accurate measure the assumption is used that the amount of access to credit that an individual "expects" does not vary much from actual access to credit available to that person.

There are six reasons that come to mind where this question would not elicit the information desired and/or this assumption does not hold. First, the individual may not know that the access to credit is available. A woman who has a sickly child that may die could receive resources from even very distant friends and relative or others in

the community that she would not have included when answering the above question.

Second, culturally it may not be appropriate to "expect" someone to help you out in time of need, so an individual may rule out the possibility of obtaining credit from a source even though as a last resort, they know the credit would be there.

Third, work could be provided to an individual for a period of time, such as looking after children or household work that may not be needed by the employer, but is given to help out the worker in time of need. This way the pride of the worker is not sacrificed by having to take charity, even if they intended to pay it back when possible.

Fourth, a friend can delay payment for a job performed by a wealthier relative. When answering the above question, the individual may state that they have access to 100MK from this wealthier relative, but this figure is underestimated because, they owe that individual 200MK but are not paying it at that time because they are experiencing hard times.

Fifth, there may be confusion between what is a gift and what is an informal loan. Food, help in harvesting, looking after children, inviting someone over for dinner, giving medicine or spices to a neighbor, etc. can be considered gifts or "being neighborly" but are used to smooth consumption just like credit.

Finally, the accuracy of knowledge of an individual about their sources of access to credit must be questioned severely. Interrelationships among individuals in a community including links outside of the community are complex. Going to a relative for a small loan and finding out that, they just gave a loan to another relative and are

waiting on income from a "certain" source and can't help out until they receive that income could be common. To conclude, measuring informal access to credit is extremely difficult and is asked as a subjective opinion and therefore is not likely to be an accurate representation of the resources available to an individual. It is impossible to eliminate all measurement error in this variable, but more in depth questioning may improve upon its accuracy (this will be discussed in detail later).

Female-headed households are poorer, but actually females have more access to both formal and informal sources of credit when in female-headed households than in male-headed households (Table 6). This reflects the program structure of female formal loan programs, which direct credit to the poorest females.

Table 6: Income/Female Access to Credit by Gender of Household Head

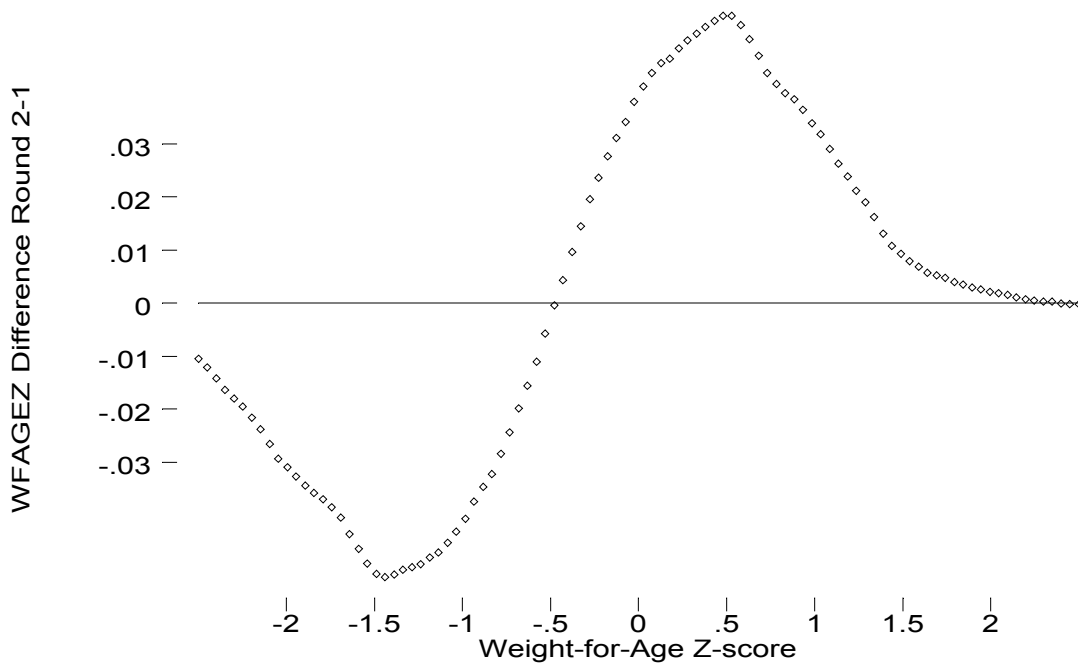
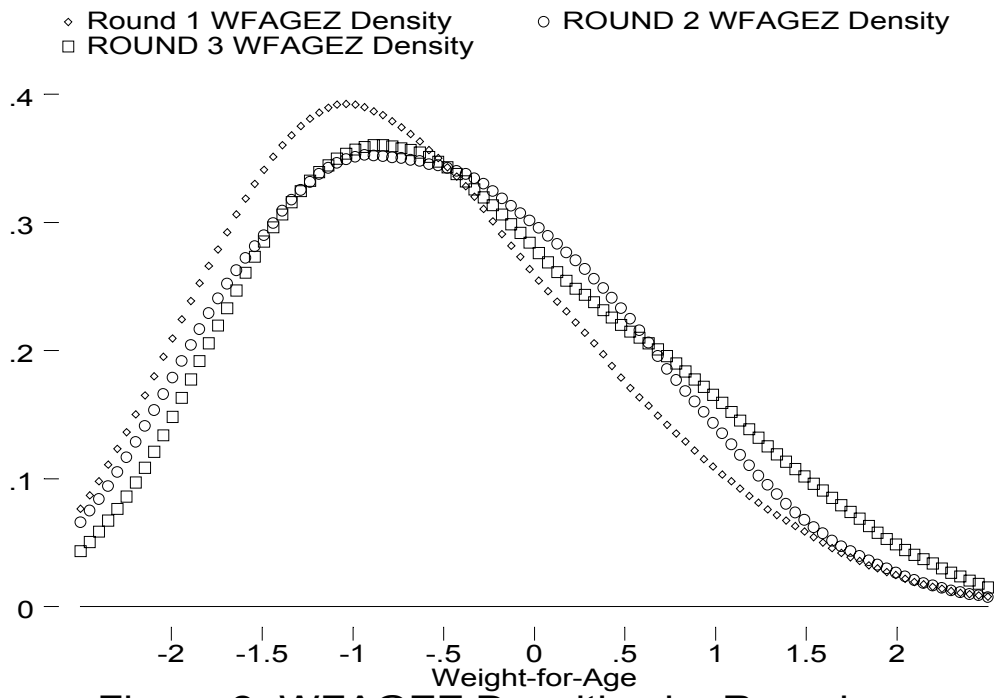
Variable	Mean	Median	St. Dev.
Female-Headed Households			
<i>Household Per Capita Income</i>	59.685	33.02	372.413
<i>formal female access</i>	41.750	0.000	119.246
<i>Informal female access</i>	17.402	0.000	56.668
Male-Headed Households			
<i>Household Per Capita Income</i>	106.992	57.125	1754.216
<i>formal female access</i>	17.797	0.000	59.317
<i>Informal female access</i>	7.216	0.000	20.431

4.2 Non-Parametric View of Situation

The seasonal nature of crop income and food availability, discussed earlier, is a primary contributor to child malnutrition in Malawi and is particularly

important to this study because households were experiencing drought over the period studied. The first round was conducted in February 1995 during the pre-harvest period of food insecurity. Round two coincided with the immediate post-harvest period, from May to June, where food insecurity should be the lowest. Data for round three was collected in October. A graphical analysis reveals an increase in both weight-for-age and weight-for-height from round one to round two (figures 3 and 6).⁸

⁸ The density functions used are univariate (one dimensional) kernels (Stata, 2001) with a .5 bandwidth.



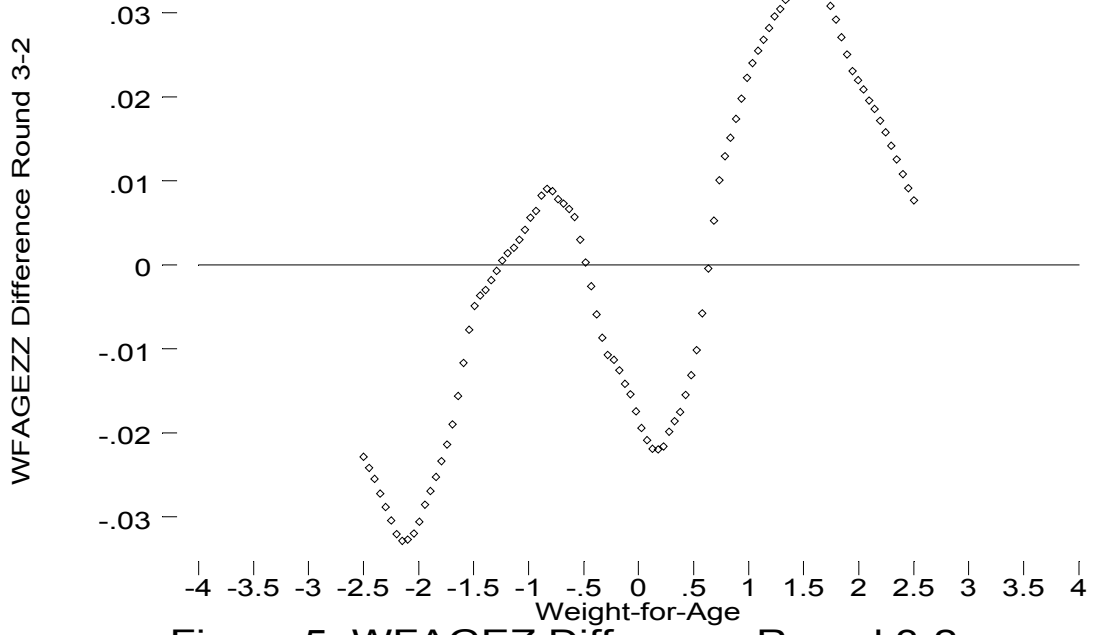


Figure 5: WFAGEZ Difference Round 3-2

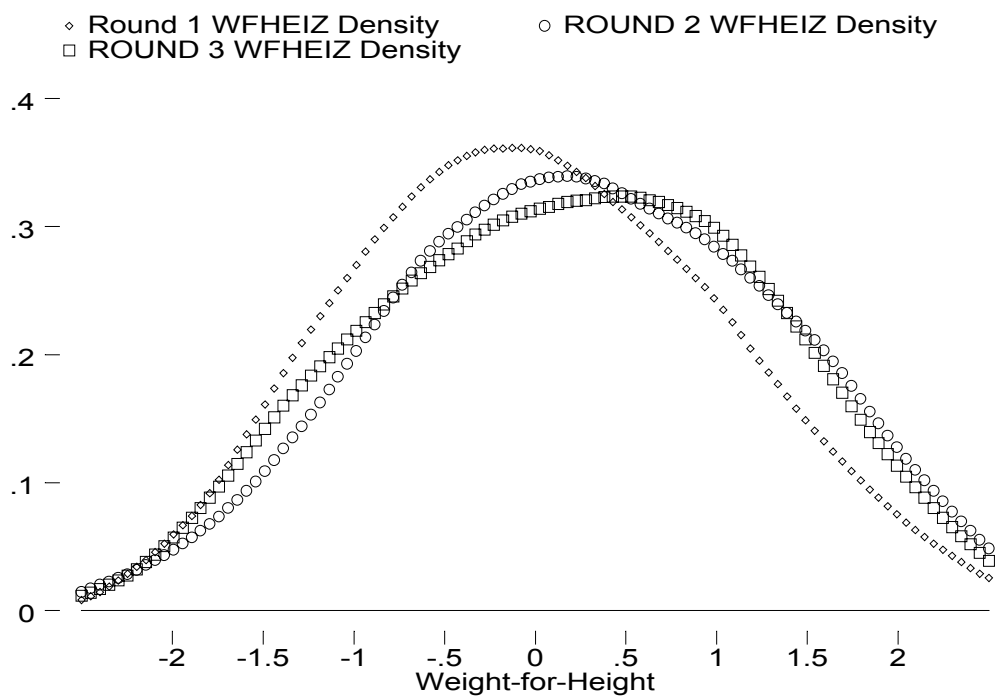


Figure 6: WFHEIZ Densities by Round

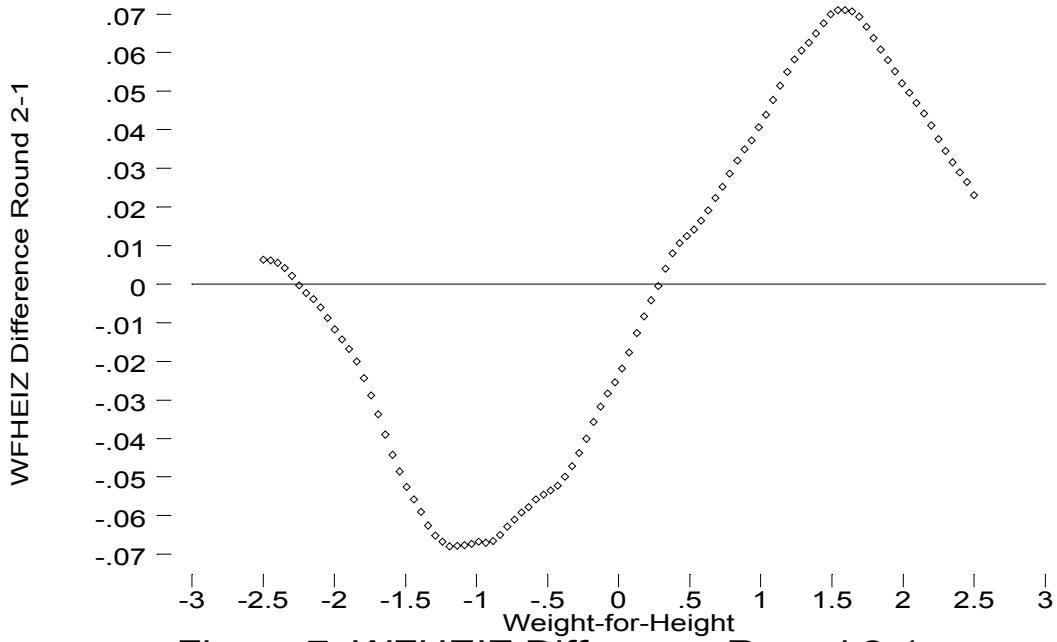


Figure 7: WFHEIZ Difference Round 2-1

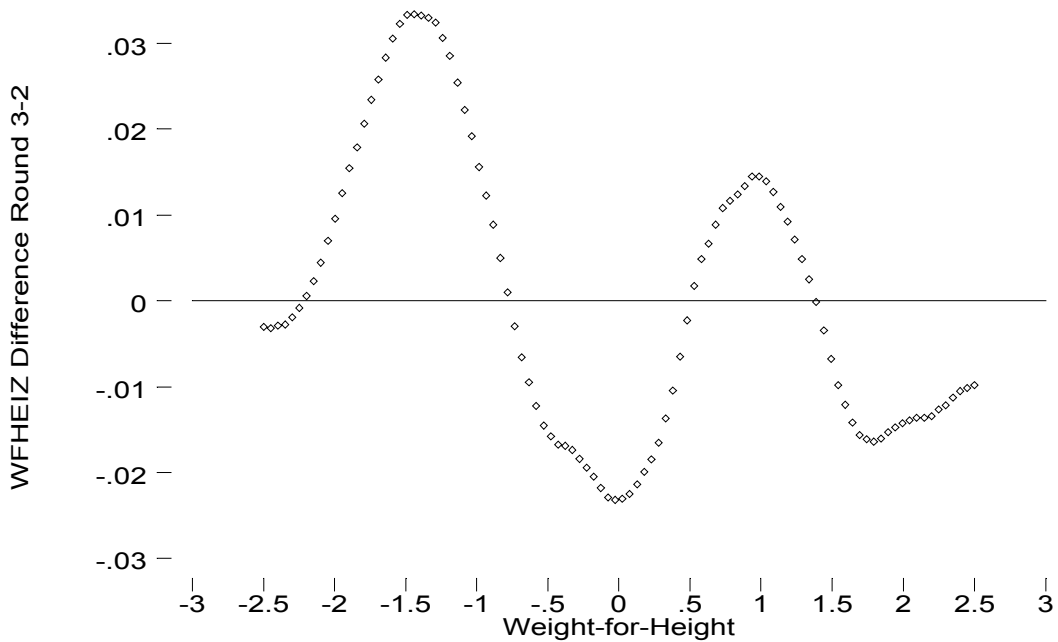


Figure 8: WFHEIZ Difference Round 3-2

The difference graphs in figures four and five represent the difference in round one and round two in the height of the weight-for-age density function measured at each weight-for-age z-score value. Specifically, the difference is created by subtracting the height of the round-two density function from that of round one at each weight-for-height value. Figure four shows that the round-two density function is less dense than that of round one at lower weight-for-height z-scores, but higher at higher scores. This relationship shows that the distribution shifted rightward between the survey periods.

From round two to round three the relationship is not as distinct, showing that the major jump is from round one to round two. In fact, the weight-for-height density actually shifts left at the center of the density from round two to round three. Since this measure of child nutrition measures the most immediate form of malnutrition, wasting, it is reasonable that it would pick up the effects of post harvest over compensation (eating more than usual) from the earlier lack of food, which is reversed in round three. It could also mean that households are tightening their belts in the third round to prepare for the upcoming food shortage period, especially when they had received less in March due to drought.

4.3 Model Estimation

Six models were estimated in total. Two models use the height-for-age dependent variable for both boys and girls and the averages of the independent variables across rounds. Since height-for-age measures long-term child nutritional status, these two models are considered long-

term models. The other four models are estimated using weight-for-height and weight-for-age nutritional measures for both boys and girls. These measures are used to identify short-term child nutritional status, and therefore the models are referred to as short-term models.⁹ The results of the regressions without separating boys and girls are presented first (Table 7).

Table7: Combined Parameter Estimates

<i>Variable</i>	Weight-for-Height		Weight-for-Age		Height-for-Age	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	-1.275	-2.824	-1.652	-3.974	-1.169	-2.298
season2	0.313	3.035	0.191	2.008	XXXXXXXXXX	XXXXXXXXXX
season3	0.288	2.588	0.252	2.461	XXXXXXXXXX	XXXXXXXXXX
NMODCLIN	0.099	2.443	0.145	3.894	0.118	2.582
TRODTCEN	0.160	1.695	0.342	3.923	0.413	3.840
WATER	0.165	1.800	0.186	2.202	0.067	0.639
LATRINE	-0.136	-1.176	0.059	0.560	0.244	1.864
ffaccess	0.001	1.743	0.001	1.006	0.000	-0.437
fmaccess	0.000	0.718	0.000	0.775	0.000	0.542
ifaccess	0.002	1.771	0.002	1.560	0.001	0.629
imaccess	0.000	-0.331	-0.001	-0.451	0.001	0.353
hhsize	0.027	1.576	-0.046	-2.924	-0.110	-5.674
HHSEX	0.031	0.283	0.218	2.193	0.317	2.590
oindex	0.006	0.121	0.010	0.214	-0.018	-0.329
tincome	-0.020	-0.539	0.024	0.701	0.063	1.514
gnut	0.206	1.294	0.101	0.686	-0.101	-0.573
RCREDIT	-0.214	-2.044	-0.255	-2.644	-0.199	-1.677
cage12	0.275	0.988	-0.127	-0.495	-0.077	-0.242
cage24	0.026	0.128	-0.083	-0.444	-0.429	-1.863
cage36	0.146	0.800	-0.016	-0.095	-0.360	-1.737
cage48	0.153	0.863	-0.098	-0.598	-0.369	-1.833
cage60	0.263	1.408	-0.085	-0.493	-0.456	-2.149
MOTHERWT	0.017	2.711	0.008	1.322	-0.011	-1.542
<i>R-Squared</i>		0.045		0.059		0.078
# Obs.		448		448		448

⁹ Details, data cleaning and model refinement are discussed in Appendix 2. Sixteen outlying observations were identified and dropped from the final regression.

Seasons 2 and 3 as well as infrastructural, water and sanitation variables are positive in all models. In the weight-for-height model season 2, season 3 and the number of modern health clinics within thirty minutes of the household are all significant at the five per cent level, while a tarred road to the nearest trading center and access to clean water are significant at the ten per cent level. In the weight-for-age model seasons 2 and 3, the number of modern health clinics within 30 minutes of the household, a tarred road to the nearest trading center and clean water are all positive and significant at the five per cent level. In the height-for-age model the number of modern health clinics within 30 minutes of the household and a tarred road to the nearest trading center are both significant at the five per cent level with the ownership and use of a latrine being significant at the ten per cent level.

Female access to both formal and informal is significant at the ten per cent level and positive in the weight-for-height model. In contrast, the relative access to credit of women with respect to men is negative and significant at the five per cent level in the weight-for-height model and the weight-for-age model, and at the ten per cent level in the height-for-age model.

Other significant variables include the household size, which is negative and significant at the five per cent level in the weight-for-age and the height-for-age models. The household sex dummy variable is positive and significant at the five per cent level in the weight-for-age models indicating that children are better off in female-headed households. A child's age appears to only be important in determining a child's height-for-age. In the

height-for-age model all age categories are negative indicating that child long-term nutritional measures are higher for children in the 61-72 month old group than for younger children. Since older children are less vulnerable to disease these results are reasonable.

By splitting the models along the lines of boys and girls we can determine if these results are different depending on the sex of the child.

4.4 Parameter Estimates

This section presents regression results for the models split between boys and girls. Parameter estimates for the short-term models (weight-for-height and weight-for-age) are presented in Table 8 and parameters for the long-term models (height-for-age) in Table 9. A comparison of the results in tables 8 and 9 with those of the aggregate models will follow the presentation of both sets of parameters. Overall the results were not very satisfying, as it was difficult to explain variations in nutritional status.

Table 8: Short-Term Model Parameter Estimates

Variable	Weight-for-Height				Weight-for-Age			
	Girl		Boy		Girl		Boy	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	-1.296	-1.954	-0.769	-1.220	-1.549	-2.651	-1.122	-1.950
NMODCLIN	0.139	2.179	0.098	1.817	0.192	3.416	0.128	2.615
TRODTCEN	0.166	1.157	0.087	0.649	0.305	2.412	0.145	1.183
Season 2	0.390	2.564	0.264	1.855	0.178	1.325	0.183	1.419
Season 3	0.262	1.600	0.277	1.793	0.286	1.979	0.180	1.275
ffaccess	0.001	1.982	-0.001	-0.718	0.001	1.887	-0.002	-1.624
fmaccess	0.000	0.551	0.000	0.515	0.000	0.436	0.000	0.610
ifaccess	0.002	1.081	0.001	0.380	0.002	1.342	-0.002	-0.432
imaccess	0.000	0.123	-0.001	-0.450	0.002	1.026	-0.001	-0.686
RCREDIT	-0.043	-0.293	-0.383	-2.424	-0.080	-0.610	-0.396	-2.733
HHSEX	0.116	0.765	-0.118	-0.749	0.368	2.761	-0.101	-0.700
hhsize	0.060	2.394	0.004	0.172	-0.005	-0.228	-0.083	-3.750
oindex	-0.090	-1.200	0.097	1.382	0.036	0.550	-0.006	-0.094
tincome	-0.033	-0.571	-0.004	-0.085	-0.046	-0.908	0.038	0.808
gnut	0.306	1.253	0.179	0.842	0.095	0.442	0.117	0.602
cage12	0.198	0.469	0.157	0.419	-0.811	-2.183	0.350	1.024
cage24	-0.335	-1.125	0.279	0.978	-0.338	-1.283	0.257	0.990
cage36	-0.075	-0.283	0.170	0.659	-0.124	-0.529	0.041	0.173
cage48	0.067	0.256	0.113	0.452	-0.136	-0.593	-0.077	-0.340
cage60	0.210	0.776	0.240	0.918	-0.102	-0.428	-0.038	-0.158
MOTHERWT	0.020	2.169	0.010	1.160	0.004	0.562	0.008	1.010
R-Squared		0.108		0.053		0.095		0.118
# of Obs.		442		501		442		503

4.4.1 Short-Term Model Parameter Estimates

4.4.1a Village-Level Variables

Infrastructure: Infrastructure has a positive effect on both measures of short-term child nutritional status. The variable representing the number of modern health clinics nearby is significant at the ten per cent level for both boy and girl weight-for-age and weight-for-height regressions indicating that access to health infrastructure helps lower child malnutrition. In the weight-for-age and the girl weight-for-height equations it is significant at the .05 per cent level. One additional modern health clinic increases the average short-term child nutritional measure

by .10 to .19 standard deviations. The tarred road to the trading center variable is significant at the five per cent level in the girl weight-for-age equation and at the ten per cent level in the girl weight-for-height equation. Its influence is a little greater than that of the number of modern health clinics, affecting girl weight-for-height by .30 standard deviations and girl weight-for-age by .31 standard deviations if there is a tarred road.

Seasons: The post-harvest season variables are also positive in all four short-term nutrition models. These results coincide with the observed shift in densities of nutritional measures from round one to round three in the non-parametric analysis.

4.4.1b Household-Level Variables

Access to Credit: Female formal access to credit has a positive influence on both girl weight-for-height and weight-for-age and is significant at the ten percent level. Both girl weight-for-height and weight-for-age increase by .00003 standard deviations when formal female access to credit is increased by one percent¹⁰. Formal female access to credit parameter estimates are negative but insignificant for both boy weight-for-height and weight-for-age, but is insignificant. There is not any significant effect of access to other forms of credit by males or females on short-term child nutritional status.

Relative access to credit and sex of household head:
Women having more access to credit relative to men

¹⁰ This relationship of the change in the z-score for a percentage change in access to formal female credit is calculated by taking the coefficient on the formal female access to credit variable and then dividing it by the mean of formal female access to credit in the respective equation.

negatively affects both boy and girl nutritional measures. These results are significant at the five per cent level for both the boy weight-for-age and weight-for-height models, but not statistically different in the case of girls. The extent of influence of this variable is also high; if women have more relative access to credit with respect to men boy weight-for-age is decreased by .4 standard deviations and weight-for height by .38 standard deviations. In addition, a female head of household positively affects all short-term girl nutritional models and negatively affects that of boys. This relationship is significant at the five per cent level in the girl weight-for-age equation, where girl weight-for-age is increased by .37 standard deviations if the household head is a female.

Other Variables: Income and income diversification do not significantly affect short-term child nutritional status. The insignificance of income is consistent with past studies showing that calorie intake does not necessarily follow from increased income (Grossman, 1998a; Grossman, 1998b; Grossman, 1991). Many factors dilute the direct effects of income on the nutritional status of children such as tastes, intra-household resource allocation, culture, etc. As credit can help smooth consumption in times of food shortage, it may have a significant influence on child nutritional status even when income does not. The presence and use of a latrine in the household positively affects boy weight-for-age and is significant at the ten per cent level. The weight of the mother parameter is positive in all models and is significant at the five per cent level in the girl weight-for-height model. Household size has a positive influence on two of the four short-term nutritional models and is

significant in two models. It has a positive effect on girl weight-for-height: each additional household member increases girl weight-for-height by .06 standard deviations. Conversely, household size negatively affects boy weight-for-age and each additional member decreases nutritional status by .08 standard deviations. This finding is significant at the five per cent level.

Finally, the effects of the household having access to clean water is positive in three of the four models and is positive and significant at the five per cent level in the boy weight-for-height equation. The only significant effect of any child age category on short-term child nutritional status is children of less than or equal to 12 months. If a girl is less than twelve months old her weight-for-age .81 standard deviations below that of a girl between the ages of 61 and 72 months old. As noted in appendix 2 wages and both male and female education are not significant in any equation.

Table 9: Long-term Model Parameter Estimates

Variable	Height-for-Age			
	Girl		Boy	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	-3.605	-1.123	-2.120	-0.715
NMODCLIN	0.175	1.549	0.014	0.136
TRODTCEN	0.854	3.187	0.026	0.106
ffaccess	-0.001	-0.392	-0.004	-1.136
fmaccess	0.000	0.475	0.000	0.231
ifaccess	0.003	0.827	0.003	0.359
imaccess	0.002	0.251	0.001	0.220
RCREDIT	-0.190	-0.719	-0.089	-0.295
HHSEX	0.296	1.116	0.226	0.835
hhsiz	-0.076	-1.762	-0.186	-4.373
oindex	0.162	0.836	-0.359	-1.999
tincome	-0.019	-0.181	0.173	1.660
gnut	-0.339	-1.008	-0.224	-0.720
cage12	-1.535	-1.563	0.231	0.382
cage24	-0.887	-1.697	-0.141	-0.267
cage36	-0.761	-1.664	-0.019	-0.042
cage48	-0.963	-2.095	0.121	0.266
cage60	-0.827	-1.730	-0.275	-0.572
MOTHERHT	0.011	0.593	0.010	0.553
R-Squared		0.110		0.133
# of Obs.		208		245

4.4.2 Long-Term Model Parameter Estimates

4.4.2a Girl Height-for-Age

The Tarred road to the health clinic, household size, and three child age category variables are the only significant factors in the girl height-for-age model. These factors are significant at the ten per cent level, except the dummy variable for child age between 37-48 months, which is significant at the five per cent level. A tarred road to the trading center has a strong positive affect on girl height-for-age; .85 standard deviations if the village

has a tarred road. An additional household member decreases girl height-for-age by .08 standard deviations and if the child is between 13-24, 25-36, and 37-48 months old their height-for-age is .89, .76, and .96 standard deviations below that of a child in the 61-72 month age category respectively.

4.4.2b Boy Height-for-Age

Only income diversification, income, and household size have significant effects on boy height-for-age. The income diversification index has a negative effect on nutritional status meaning that more income diversification increases child nutritional status. This finding is significant at the five percent level, with a .2097 per cent increase in boy height-for-age for a one percent change in the income diversification index. Income positively affects boy height-for-age, with a one per cent increase in household per capita monthly income causing a .173 increase in the standard deviation of boy height-for-age. As in the boy short-term nutritional model, household size negatively affects long-term boy nutritional status and this finding is significant at the one per cent level. Each additional household member decreases in the nutritional measure by .19 standard deviations.

4.4.2 Contrast of Aggregate Models

Three categories of differences in results emerge from the transition from the aggregate models (table 7) to the models separated by gender of the child (tables 8 and 9); variables that lose significance during the transition,

variables that gain significance and variables that when disaggregated are significant for either girls or boys, but not for both.

The effects of access to clean water and the presence and use of a latrine are both insignificant when separating the models by the gender of the child. Therefore, policy decisions to build more latrines or covered water wells based on the aggregate model may be ineffective because child gender has not been considered. These latrine and clean water projects may need to be accompanied by more effective promotion of sanitary practices to compound their benefits. In addition, informal female access to credit is no longer significant in the weight-for-height model.

The effect of formal female access to credit is significant at the ten percent level in the girl weight-for-age model when it is separated by the gender of the child, and in the boy height-for-age model both income and income diversification become significant at the ten percent level in the disaggregated models. Formal female access to credit could be more beneficial to girl nutritional status than is shown in the aggregate model and variables related to income (income and income diversification) could be more influential for boys in the latter models.

A tarred road to the nearest trading center, formal female access to credit, the sex of the household head, the mother's weight and the child age category are all significant in the girl and not in the boy models. One manner to explain the differences in the influence of a tarred road to the nearest trading center is that girls accompany their mothers to the trading center more frequently than boys from ages 60 to 72 months old. This

trip would be more physically exhausting when there is less infrastructural development. Along the same line of reasoning, the sex of the household head may affect the tasks and responsibilities of girls more than those of boys. The mother's weight and formal female access to credit may reflect the physical activity required for females in the household, and therefore that of young girls accompanying these females whom may be involved in small tasks that prepare them for their future responsibilities. It is certainly questionable that boys and girls of less than 72 months of age could have tasks or duties, much less have different tasks and duties. This study provides no clear insight into the causes for the gender differences above, but does signal the need to consider these differences when making policy decisions.

The significance of girl age categories, in light of the insignificance of those of boys, could be providing valuable information to policy makers. If specific differences in tasks or care for boys and girls are determined, policies to reduce overall child malnutrition levels in Malawi can use this information to more effectively target the most vulnerable children.

Relative access to credit, income diversification, and income are each significant in the boy models and not significant in the girl models. With absolute credit being controlled for, the share of access to credit may be affecting responsibilities and/or care within the household in a manner that affects boys and not girls.

These differences in aggregated versus disaggregated models imply that girls may be more "protected" from changes in income and income diversification than boys. In any case, through the contrasts in the two types of models

evidence is provided that policymakers and researchers considering child malnutrition in Malawi should be concerned with intra-household relationships and how these relationships are affected by outside factors.

4.5 Chapter Summary

From the summary statistics of the households in the study it is apparent that levels of malnutrition are astoundingly high in Malawi. Also, child nutritional status varies according to seasons. Infrastructure is underdeveloped for many of the villages in the survey and this may be causing higher levels of child malnutrition. The regression results confirm that higher levels of infrastructure positively and significantly affect child nutritional status.

Females have more access to credit when they head a household, than when residing in a male-headed household. This finding becomes interesting when considering that girls tend to be better off in female-headed households than in male-headed households while boys are better off in male-headed households. It would appear that female access to credit might positively affect girl nutritional status and not that of boys. The regression results seem to support this relationship, as formal female access to credit positively and significantly affect short-term girl nutritional status and negatively, although insignificantly affects that of boys. The results of the women's relative access to credit variable also support the evidence in the summary statistics that boys may be worse off with women in control of resources. If females have higher average access

to credit than men do, both boys and girls are worse off and this finding is significant in the case of boys. This finding is of great interest and concern and therefore requires further discussion and scrutiny.

Furthermore, differences in the aggregated models and the models disaggregated by gender imply that there are relationships within the households that are worthy of consideration for both policy makers and researchers concerned with malnutrition in Malawi.

Chapter 5

Conclusions and Policy Recommendations

This study has looked into the effects of credit, income diversification and other factors on child nutrition in Malawi. Specifically, this study has attempted to determine if access to credit is a significant determinant of child nutritional status and how the impacts of access to credit vary by gender of children in the family. In addition the study has assessed how women's relative access to credit affects nutritional status and if groundnuts and income diversification positively influence child nutritional status.

Children in Malawi are extremely malnourished with half of the children in the study group stunted. The effects of access to credit are not conclusive; income diversification and groundnut production do not appear to have a significant effect on child nutritional status. The results support the possibility of parental same-sex preference in the production of child nutritional status.

5.1 Conclusions from Results

5.1.1 Access to Credit Does not Appear to Have a Major Influence on Child Nutritional Status

Female formal access to credit shows signs of having a positive influence on girl nutritional status but the level of significance is low and the variable was often insignificant in different versions of the model. Access to

credit by male adults in the household has no significant impact on child nutritional levels.

The lack of significance of male formal access to credit may be due to the structure of the credit programs. Formal male credit is frequently tied to in-kind crop production packages while that of females to off-farm enterprise promotion. Because of this structure, in times of drought like that suffered during the 1993/94 growing season, male access to credit would not be effective because crop production packages may fail without sufficient rainfall. Fungibility among these loans could, however, blur the distinction between male and female access to credit.

Informal access to credit has no significant effect on child nutritional status. Informal access to credit may not be used for consumption smoothing if the household has formal loans. We used access to credit to isolate the effects of supplying credit, which is more useful for policymakers, but the measure is conceptually and empirically weak.

The measurement of informal access to credit may not be accurate. Individuals may not know the extent of access to credit available to them and the questions asked to solicit the amount of access to credit are not specific. The limitations of its measurement will be discussed in detail later.

Informal credit supply may also be affected by droughts in the 1991/92 and 1993/94 growing seasons and below-normal rains and subsequent low crop yields in 1994/95. Lower income due to drought and low crop yields not only increases demand for informal loans to smooth consumption, but also reduces the supply of informal credit

through the deteriorating financial reserves of lenders. This "credit crunch" increases the interest rates on informal credit and may reduce perceived access. Differences identified between the impacts of access to credit for men and women on boys and girls provide some evidence of parental same-sex child preference.

5.1.2 Women's Relative Access to Credit and the Sex of the Household Head Show Parental Same-Sex Bias

Women's relative access to credit has a negative effect on all child nutritional measures, but is only significant for boy's weight-for-height and weight-for-age. This significance does indicate the possibility of empowered women taking resources away from boys, but does not indicate that these resources are given to girls.

There are three possible explanations for gender bias. The first explanation is that in matrilineal households, women are more inclined to give resources to their daughters, as girls are more likely to be close to their mothers in old age. This argument seems implausible because in Malawi men tend to send a portion of their money to their sisters' families (Lindskog and Lundqvist, 1989). This transfer of funds would allow the sister to free up other resources to care for the mother.

A second explanation is that women use their resources to balance discrepancies in resource allocation favoring boys. Sahn and Stifel (2001) bring up the possibility of inappropriate anthropometric standards being applied to Africa. If girls in Africa are naturally more robust than boys, the use of children from the United States as standards of comparison could bias results. The results may

show that women's relative access to credit and control over resources help to correct for this unbalanced distribution of nutritional resources among boys and girls. Although plausible, this hypothesis has yet to be decisively proven after years of acknowledgment and debate and no positive effects of women's relative access to credit on girl nutritional status is found.

A more practical explanation is that we are seeing the effects of intra-household resource shifts as household members bargain and try to maximize future investment returns. It could be that formal female access to credit is used for off-farm enterprises that are important in smoothing seasonal income fluctuations. If women are operating these enterprises, the education and health of girls may be considered more important to the future well being of the entire family than before. Therefore, a shift of resources to capitalize on these future benefits would seem rational.

5.1.3 Income Diversification is not Effective During Droughts

The income diversification index had a significant influence on just one child nutritional measure, boy height-for-age. Evidence that income diversification positively affects long-term child nutritional status is promising, but the low significance invalidates a strong conclusion. In the short-run, droughts lower rural purchasing power, reducing demand for off-farm goods and services.

5.2 Contributions of Study

Access to credit by gender: This study shows the complexity of determining which factors influence child nutritional status and how this influence is realized. The gender of the individual with access to credit may matter, but this relationship is unclear.

Infrastructure: This study concludes that infrastructure is a key component to the creation of better-nourished rural children. Infrastructure affects the frequency of market interactions, transaction costs and accessibility to information and health services.

5.3 Policy Implications

Access to Credit & Intra-Household Dynamics: Policymakers should not restrict themselves to considering overall household welfare effects, but must also consider the effect of access to credit by different individuals and the impacts on intra-household distribution of resources. Giving more access to credit to women than men may redistribute some resources from boys to girls. More balanced programs that give access to credit to both men and women may have a more equal distribution of benefits. Although the answers to these questions remain unanswered, it is clear that these questions should be addressed when researching to provide information for policymakers.

Invest in Infrastructure: The most direct policy implication for those attempting to increase child nutritional levels in Malawi is to improve roads and build health and economic institutions in more remote areas. This should be a starting point not only for decreasing child

malnutrition directly, but to stimulate the rural economy for providing future positive impacts on the welfare of rural households.

5.4 Limitations of Study

The limitations included in this study include: the lack of accounting for choice-based sampling (sampling across specified strata), the poor measurement of access to informal credit, too short a study period to capture long-term effects, fungibility and endogeneity of access to credit, not accounting for indirect effects of access to credit, and not considering the previous health of the child. Each one of these limitations is important and therefore is discussed in turn in the following section.

Choice-Based Sampling: To collect a sample with an adequate representation of members and past members of the credit institutions under study, a sampling technique was used to draw random households within selected subgroups; participants, past participants, and non-participants. To correct for this sampling procedure each subgroup must be weighted appropriately according to the overall population. The correction of this sampling procedure was not performed and therefore the results may not conform to the population whole. However, the study looks at access to credit and therefore, a sub-sample of the population with access to credit it what is relevant.

Measuring informal access to credit: As discussed earlier, access to informal credit is difficult to measure accurately. More work needs to be done to adequately measure informal access to credit and the conceptual weaknesses must be addressed.

Length of survey period: Since the effects of access to credit may not surface until returns on investments undertaken as a result of this access to credit are received, a longer study period is needed to follow the effects of this access on even short-term nutritional status.

Fungibility and endogeneity: It can be hard to identify if a female's access to credit is actually her access to credit or her husband's. This measurement error has been recognized in the measurement and effects of loan uptake (Rahman, 1999) and should be considered with access to credit as well.

Endogeneity can arise from either an individual or program. Certain qualities of an individual that positively affect the nutritional status of her children (such as the drive to excel in life) may also propel these individuals to search out opportunities such as access to credit. This form of endogeneity shows the conceptual problems with attempting to isolate the supply-side of credit. If these qualities that affect both child nutritional status and access to credit are not accounted for in the model then the results may be biased. The same relationship holds in the provision of access to credit. The criteria that the program uses to target individuals, such as location, income, or even relation to the organizer of the credit group can also directly influence child nutritional levels. This study controls for income, but the other factors may distort the results of the study.

Previous child nutritional status: Previous child nutritional status matters. The same children were not followed over the three survey rounds, making it difficult to lag for a particular child. This is not to say that it

is not possible to account for the earlier nutritional status of each child if available, but it is beyond the scope of this present study to do so.

Missing Market Literature: The theories of missing markets may be an alternative manner to study the effects of credit on factors such as child nutrition. This study uses access to credit, but may benefit from an attempt to incorporate the missing market literature into the analysis.

5.5 Future Research

Three primary areas need to be researched to acquire additional knowledge of the benefits of access to credit. First, since many of the benefits of access to credit are long-term, an attempt to collect data over a 5-10 year span would allow researchers to determine the extent of these impacts on child nutritional status. It would be interesting to examine the effects of different forms of access to credit through droughts and good crop years.

Secondly, anthropological studies are needed to determine the social links and influences between the credit program household and individual outcomes. A participatory approach to understanding the thinking process of the individuals will better allow economic researchers to extract and compose the most appropriate variables for representing the actual process being studied. For example, asking individuals to describe the process in which they determine that they should borrow and how they think through different credit options and chose the best option for their needs.

Thirdly, and related to the second area, is to determine appropriate questions to increase the accuracy of the access to credit measure, especially for informal credit. This information can help economists elicit more precise responses about informal access to credit and maybe even redefine the theoretical construct of the variable itself.

It could be that informal access to credit should be split into "everyday" and "last resort" forms. If questions could elicit accurate measures of these two forms of credit access then access to informal credit of "last resort" could be controlled for. Then the effects of "everyday" access to informal credit, which may have more relevance for policy-makers concerned with the benefits of connecting fragmented credit markets, could be obtained.

5.6 Final Conclusions

A great amount of time and resources are being spent on rural credit programs to benefit the poor. Gaining knowledge about the impacts of these expenditures is of considerable importance. This study shows no real support for continued investment in credit if nutritional status is the main objective. Credit and child nutrition are complex factors. This study has shown that to simplify these complex interrelationships, a deeper look into social relationships and the effects of access to credit and possibly credit program structure on these relationships is needed. Development is long term and the impacts of access to credit may not show up until later generations. It is the task of researchers to look long term. They must fill gaps in knowledge of these benefits to enable policymakers

to more effectively use the resources at their disposal. The findings of this study should help policymakers in Malawi focus on the important direct influences on child nutritional status; infrastructure. Investment in infrastructure should be seen as the base of any development program. Roads, institutions and marketplaces increase market transactions, decrease transactions costs, and allow individuals and families to more readily access healthcare and other services.

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Appendix 1

Variable Construction

A1.1 Measures of Access to Credit

This paper uses access to credit, as opposed to participation in formal credit programs to measure the amount of credit the household has¹¹. A household has access to credit if it is able to borrow, even if it chooses not to borrow. The maximum amount an individual is able to borrow is a measure of access to credit. By summing individual access to credit across credit programs and across males and females, the measures of access to credit of males and females are determined.

The questionnaire on credit and savings was administered to all adult household members (over 17 years old). In each round, respondents were asked the maximum amount they could borrow during the recall period from informal and formal sources. If the respondent borrowed or tried to borrow, the question was asked for each loan transaction (both for granted and rejected loans). If the respondent did not ask for any loan, the question was asked separately for formal and informal sources of credit, with no reference to particular formal or informal lenders. Respondents who received loans were also asked the same general question (that is, with no reference to particular formal or informal lenders) in a way that elicited the credit limit they would face if they wanted more loans. Consequently, for formal and informal credit, the maximum

¹¹ For a discussion of the benefits of using this measurement technique see Diagne, 1998 and Diagne & Zeller, 2001.

limits for each adult household member were obtained in each round, even if the member was not involved in any loan transaction (Diagne, 1998).

A1.2 Measures of Relative Access to Credit

Access to credit not only impacts child nutrition through the absolute amount received, but who has more relative access to credit also matters. In this study, a dummy variable is constructed for each household that takes the value of one if the per capita access to both informal and formal credit of women is greater than or equal to that of men.

A1.3 Measurement of Income

The compilation of the income variable was a process of five stages: the calculation of profits from various sources, the calculation of expenditures from the sources, the deflation of profits and expenditures and any credit costs during period, the subtraction expenditures from profit to arrive at income, and then the summation of household income and adjustment for household size to arrive at per capita income. The details of the questions asked to extract these values and the recall periods are given in table A1.b. A description of the process follows.

The quantity of each crop sold was first divided by the total value received from the sales to arrive at unit value of production. This unit value was then multiplied by the total production quantity to arrive at profit. If the household did not sell the crop, the area averaged was used. Profit for each crop was adjusted for inflation by

dividing by the calculated GDP Deflator and then multiplying by 100, using October 1993 as the base month (table A1.c). Monthly inflation was taken as the average yearly inflation. The month used to deflate each crop was the month in the middle of the recall period unless the specific time on income reception could be determined (For example, most rainfed crops are harvested in March). Next crop expenditures and irrigated expenditures are added for each crop and deflated in the same manner¹². Similarly, credit expenses and interest costs were added and then deflated. Finally crop expenditures and credit costs were subtracted from crop profits to get income, with income summed by household to arrive at household income. This procedure was performed in each round with household income for each round held separate.

The above procedure was followed for all of the remaining sources of income, with one exception: Gifts and remittances gave the exact month and year of the transaction and therefore, no approximate month for deflating was needed, each was deflated at the exact month of the transaction. It should be noted that gifts and remittances are an intricate part of family and reciprocity arrangements in Malawi and therefore are essentially a source of income and/or expense for the period in which they occur. For example, a man may send money to his sister's family in a neighboring village.

Once all sources of income were deflated and aggregated by household for each round, all sources of income were aggregated by household, still keeping rounds

¹² Interest costs were determined by subtracting the amount of repayment by the amount of the loan. For example, if a loan of 100MK was taken out in Round 1, 50MK was paid back in round 1, 60MK in round 2 and 20MK in round 3, interest charges are calculated as: Round 1=0MK, Round 2=10MK, Round 3=20MK

separate. With the recall periods falling reasonably close to annual income periods, total household income was then divided by twelve to arrive at monthly income. Since Round two and three both heavily rely on crop income from the March harvest (94/95 rainy season), this income was included in both rounds. These final values were divided by the number of individuals in each household, giving per capita monthly income for each round.

A1.4 Income Diversification Measure

Income diversification is measured by using the Ogive

Index:
$$\sum_{n=1}^N \frac{(x_n - 1/N)^2}{1/N},$$

where N is the number of sources of income generation that the total income has been divided and X_n is the share of this income for the nth sector. The Ogive index is a goodness-of-fit measure, which by nature are highly sensitive to standard used to calculate the deviations and the number and division of the sources of income used. The standard used in the Ogive index is based upon an equal allotment of income coming from each of the N sources. Therefore, the "ideal" proportion of total income from each sector is $1/N$, which produces a value for the Ogive index of 0. Deviation from this "ideal" proportion leads to a positive Ogive index, which increases as the true allotment moves further away from this ideal (Siegel, Johnson and Alwang, 1993). The maximum value for the index is one less than the number of income sources used to calculate. In this case four income sources are used, giving the index a maximum value of three.

This study divides income into four categories; business, maize, tobacco, and groundnuts. Income is calculated as the total value of production minus and expenses incurred. All income variables are adjusted for inflation¹³. Business income is included, as it does not necessarily follow the season harvest of crops. Therefore income from this source acts as a hedge against crop income seasonality. The crops chosen were determined to be the most widely produced crops of smallholders in Malawi for which data was available in the years preceding the recall period of the study, which was between 1993 and 1995 (local maize and groundnuts) and the major smallholder cash crop (tobacco) (Table A1.a).

Table A1.a: Malawi: Smallholder Land Cultivation, by Crop 1986/87

	1986/87
	Hectarage
Local maize	1104583
Groundnuts	209938
Pulses	140476
Cassava	63174
Tobacco	39872
Cotton	34504
Sorghum	30626
Sweet Potato	25698
Rice	18803
Millet	18163
Others	10288

Source: Malawi Ministry of Agriculture

¹³ See section on income variable construction for details on the compilation of income. The same procedure is used for the income in the Ogive index, but the sources of income are kept separate.

A1.5 Other Variables

Dummy variables are included in the household vector for clean water and a latrine, which take the value of 1 if the household has the asset and 0 if not. A dummy variable representing 1 if the household plants groundnuts and 0 if not is included in the household level vector to discern if and how the production of groundnuts influences child nutrition. In addition, if there was no trading center in the village, yet there was a tarred road to the nearest trading center a variable is created that takes the value of one. If there is no trading center in the village and there is no tarred road to the nearest trading center, the variable takes the value of 0. Household size and number of modern health clinics within thirty minutes of the household were extracted straight from the survey as the values given to the interviewer, with mother's weight and height measured by the interviewer.

Table: A1.b Generation of Income Variable

Income/Expenditures	Question	Round 1/Recall Period	Round 2 Recall Period
Major Rainfed Crops	What was total Production (Kg)?... Quantity sold (Kg)?... Value received (MK)?	93/94 Rainy Season	94/95 Rainy Season
Major Irrigated Crops	What was total Production (Kg)?... Quantity sold (Kg)?... Value received (MK)?	May-October 1994	XXXXXXXXXXXXXXXXXXXXXX
Minor Crops	What was total Production (Kg)?... Quantity sold (Kg)?... Value received (MK)?	Since October 1994	Since Last Visit
Crop Expenditures	Please recall all expenditures for recall period... Seed planting... Chemical fertilizer... Pesticides... Transport/processing... labor costs.	93/94 Rainy season	94/95 Rainy Season
Irrigated Crop Expenditures	Please recall all expenditures for recall period... Seed planting... Chemical fertilizer... Pesticides... Transport/processing... labor costs.	May-October 1994	XXXXXXXXXXXXXXXXXXXXXX
Livestock Flows	How many heads of each animal do you own now? ... did you own at beginning of recall period? How many heads of each animal did you sale during recall period? What values was received (MK)? How many of each animal was purchased?... What value (MK)?	Since October 1993	Since Last Visit
Other Livestock	Did you produce or sell and eggs. Freshly born or very young animals (for cattle and goats, less than 6 months: for poultry, less than 2 months), milk, and/or sell dung, and/or rent out a cow, hen, or goats? If yes, Total production since October 1994 List	Since October 1994	Since Last Visit
Expenditure for Livestock	What is the type of animal? List: Young animals bought, fodder bought, medicaments, hired labor, other expenses (all in MK).	Since October 1994	Since Last Visit
Lease-out of Land	Describe plots of land you own-if leased at fixed payment or put in share tenancy during recall period ask.. What was value received? if share tenant ask.. What were expenses?	Since October 1993	Since October 1994
Lease-in Land	Did your family rent any land during recall period? How much did you pay (MK)?	Since October 1993	Since October 1994
Gifts/remittances: Exact Year/Month Provided	What/When was received? Cash/In-Kind-Value	Last 8 weeks	Last 8 weeks
gifts/remittances Less than 15MK	What/When was received? Cash/In-Kind-Value	Since October 1994	Since Last Visit
Gifts/remittances 15-100 MK	What/When was received? Cash/In-Kind-Value	Since October 1993	Since Last Visit
Gifts > 100MK	What/When was received? Cash/In-Kind-Value	Since October 1993	Since Last Visit
Remittances w/in Malawi >100 MK	What/When was received? Cash/In-Kind-Value	Since October 1993	Since Last Visit
Remittances Outside Malawi >100 MK	What/When was received? Cash/In-Kind-Value	Since October 1993	Since Last Visit

Table: A1.b Continued

Wage	for wage&contract labor-what was total amount received for period (In-kind included) Have you received income off farm from.. (list of possibilities)? What was value of sales for recall period? ...total Quantity produced?... Quantity given away?(Recall period was chosen by individual for some time after Oct. 94, but for this study is kept at What were the cost of the raw materials used in the products sold, consumed, or given away during recall period?...transport costs? Did you hire labor? How much is labor costs for products sold, consumed, and given as gifts during recall period?	Since October 1994	Since Last Round
Non-farm Self-Employeed		Since October 1994	Since Last Round
Expenditures for off-farm Self Employment		Since October 1994	Since Last Round
Credit Costs: <i>Informal:</i>			
Loans less than 15 MK	How much was loan? .. do you have to repay? How much repaid to date? In Order To Obtain Loan did you give borrower a gift? Did You have any other expenses for Obtaining loan? (Work for free, etc.) How much was loan? .. do you have to repay? How much repaid to date? In Order To Obtain Loan did you give borrower a gift? Did You have any other expenses for Obtaining loan? (Work for free, etc.)	Since Last 8 Weeks	Since Last Round
Loans 15MK - 100MK	How much was loan? .. do you have to repay? How much repaid to date? In Order To Obtain Loan did you give borrower a gift? Did You have any other expenses for Obtaining loan? (Work for free, etc.)	Since Last 3 Months	Since Last Round
Loans > 100MK <i>Formal:</i>	How much was loan? .. do you have to repay? How much repaid to date? In Order To Obtain Loan did you give borrower a gift? Did You have any other expenses for Obtaining loan? (Work for free, etc.)	Since Last 15 Months	Since Last Round
All Loans		Since Last 3 Years	Since Last Round

Table: A1.c GDP Deflator

Month/Year	Oct.93	Nov.	Dec.	Jan. 94	Feb. 94	Mar. 94	Apr-94	May-94	Jun-94	Jul-94	Aug-94	Sep-94	Oct-94
Monthly Inflation		1.525	1.525	1.525	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
GDP Deflator	100	101.525	103.05	104.575	110.075	115.575	121.075	126.575	132.075	137.575	143.075	148.575	154.075
Month/Year	Nov-94	Dec-94	Jan-95	Feb-95	Mar-95	Apr-95	May-95	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95
Monthly Inflation	5.5	5.5	5.5	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
GDP Deflator	159.575	165.075	170.575	176.825	183.075	189.325	195.575	201.825	208.075	214.325	220.575	226.825	233.075

Appendix 2

Model Estimation

All models are estimated using Ordinary Least Squares (OLS). To validate the separation of the regressions by gender, an f-test is performed. The unrestricted model used is a regression equation with the weight-for-age z-score as the dependent variable and all the initial independent variables on the right-hand side along with variables constructed by multiplying each independent variable by a sex dummy variable; one if the child is a girl, zero otherwise. The p-value of .00041478 indicates the hypothesis that no difference exists between the two models is rejected.

To check for outlier observations, tests were performed and possible outliers were individually checked for irregularities. Following the work of Belsley, Kuh, and Welsch (1980), DFBETA's were calculated for the income and access to credit variables in each of the seven regression equations to discern outliers in the multivariate distribution. The DFBETA technique looks at the change in the estimated regression coefficients that would occur if the *i*th row were deleted. The formula used is:

$$DFBETAS_i = \frac{\sqrt{n} * e_i}{(n-1)s(i)}, \text{ where } n \text{ is the number of}$$

observations, *e* is the residual vector, and *s* is the estimated standard error; *i* denotes the *i*th observation. An outlier is an observation, which individually has a larger impact on the calculated variables than do most other observations. DFBETA's greater than or equal to $2/\sqrt{n}$ (*n* representing the number of observations), are considered to

be possible outliers. Income and access to credit variables were plotted against the dependent variable for each regression equation and observations that are visibly outliers were noted. If these visible outliers matched those signified by using DFBETA, they were dropped from the regression equation. Sixteen observations were considered outliers and consequently dropped from the model.

Data cleaning was assisted by the use of the (ANTHRO) and the surveyors rechecked extreme variables and their values were either corrected, in the case of data entry errors, or dropped from the model. ANTHRO is based on the 1978 NCHS/CDC/WHO growth reference. It calculates anthropometric z-scores and flags observations that are possible errors and should be checked. Flags are presented for extreme outliers without any determined cause indicating that either the child is an extreme case or more than one of the components of the anthropometric score (age, weight, and height) is incorrect. Flags are also given which indicate that one of these three components may be incorrect. The components that should be check and the criteria for flagging them are:

Age if HFAGEZ>3.09 and WFAGEZ>3.09 or HFAGEZ<-3.09 and WFAGEZ<-3.09

Weight if WFHEIZ>3.09 and WFAGEZ>3.09 or WFHEIZ<-3.09 and WFAGEZ<-3.09

Height if HFAGEZ>3.09 and WFHEIZ<-3.09 or HFAGEZ<-3.09 and WFHEIZ>3.09

115 observations were eventually dropped from the model by the data collectors due to extreme dependent variable outliers, leaving 949 observations in the three rounds for the final regression. These observations were either split by the gender of the child (for the short-term

models), or averaged across rounds and then split by the gender of the child (for the long-term models).

The price of maize, wage rate, and female and male education were insignificant in each regression and were consequently dropped from the models.

