Graduate School of Development Studies

Food Price Inflation and Child Health:

An Investigation into the Short-Run Effects of the 2002 Food Crisis on the Health Status of Children in Malawi

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“Every child who dies of hunger in today’s world has been murdered.”

Jean Ziegler (2006), UN Special Rapporteur on
the Right to Food from 2000-2008

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List of Acronyms

BMI	Body Mass Index
CFA	Communauté financiere d'Afrique
CLSS	Côte d'Ivoire Living Standards Survey
DID	Difference-in-difference
DFID	Department for International Development
DHS	Demographic and Health Survey
EMOP	Emergency Operation
ETIP	Extended Targeted Input Programmes
EU	European Union
FAO	Food and Agricultural Organisation
FEWSNET	Famine Early Warning Systems Network
GDD	Generalized-difference-in-difference
GDP	Gross Domestic Product
JEFAP	Joint Emergency Food Aid Programme
HAZ	Height-for-age z-score
HDI	Human Development Index
HDR	Human Development Report
HH	Household
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
IFLS	Indonesian Family Live Survey
IFP	Input Factor Programme
IMF	International Monetary Fund
Kw	Kwacha
NFRA	National Food Reserve Agency
NGO	Non-governmental Organisation
NSO	National Statistical Office of Malawi
OLS	Ordinary Least Squares
PIH	Permanent Income Hypothesis
PMS	Poverty Monitoring System
PPP	Purchasing Power Parity
SD	Standard Deviation
SE	Standard Error
SGR	Strategic Grain Reserve
UNDP	United Nations Development Programme
UNICEF	United Nations Children Fund
USAID	United States Agency for International Development

USD	United States Dollar
VAC	Vulnerability Assessment Committee
WAZ	Weight-for-age z-score
WFP	World Food Programme
WHO	World Health Organisation
WHZ	Weight-for-height z-score

Abstract

In 2002 Malawi faced a major food crisis by country standards. Based on theory and empirics, this shock is expected to have a temporary, as well as, lasting effect on the health status of children. Focusing on the short-term, the paper tries to quantify the impact of the event with respect to changes in child mortality, stunting, wasting, and the degree of underweight. With data from the Malawian Demographic and Health Surveys of the years 2000 and 2004, I exploit district variation in the severity of the crisis to measure the short-run consequences. I find that the shock did not lead to a significant increase in the probability of child mortality in the affected areas. Furthermore, the results indicate that the crisis did not have an effect on acute undernutrition. Children from regions experiencing severe food shortages exhibit 0.14 SD higher weight-for-age and 0.15 SD higher height-for-age z-scores. The affirmative outcome on the indicators for the degree of underweight and chronic malnutrition could, for example, be attributed to successful interventions. Not finding a significant short-run impact, however, does not automatically imply that a period of limited food availability does not have long-run consequences.

Relevance to Development Studies

Children have specific nutritional needs to ensure optimal development. Failure to meet these requirements, even over a short period of time, can have enduring consequences including stunting, reduced cognition and increased susceptibility to infectious diseases. All of them, in turn, have negative effects on productivity, which in the end denies the individual to break the intergenerational cycle of poverty. Hence, identifying the impact of food shocks on child health aids to design appropriate preventive and recuperative interventions and policy measures with the ultimate objective of improving the standard of living in countries facing these challenges.

Keywords

Child Mortality, Malnutrition, Food Crisis, Malawi

Chapter 1 Introduction

Since September 2006 global food prices are on the rise. Particularly, cereal prices have increased dramatically. The FAO cereal price index, for example, rose by 123 percent from 2006 to mid 2008 (FAO 2008a). Several development agencies, practitioners and research institutions have warned about the detrimental effect of these developments on the worlds poorest. The World Bank (2008a) estimated that the current price hike threatens to force about 100 million people back under the absolute poverty line of 1USD/day. Thus, cancelling out some of the progress made in terms of poverty reduction over the past decades.

Food price inflation recently manifested itself as a global question of affordability. But, formerly, it was often only seen as a locally contained phenomenon resulting from a major production shortfall. The latter was also the case in Malawi. The country experienced a period of high food price inflation as a symptom of a major food crisis in 2002. Within a few months, the price of maize, which is the staple food in Malawi, quadrupled. Given that Malawian households spend on average two thirds of their income on food (PMS 2000), significant price increases of aliments gnaw at the entity's budget and have detrimental implications for households, which can no longer afford sufficient foodstuffs to meet their nutritional requirements. But, to pin down the effects is not so easy, because rising food prices are not bad per se. They rather have a very heterogeneous impact on households depending on their income levels, insurance mechanisms, consumption patterns and market positions, i.e. if the household is a net buyer or net seller of food. Normally, net producers will benefit from higher food prices because their income effects outweigh the price effects, while households that are net consumers will suffer real income losses. Since the Malawian crisis was not only characterised by rapidly rising prices but also a production shortfall, the net producers benefit might be lower then expected because of the volume shock. Hence, they may not remain net sellers to the same extent. Relating to the food crisis in Malawi, the net sellers should overall still have benefited as the price shock of a 400 percent increase outweighs the 32 percent production loss.

In the developing country context, it is generally proposed that the urban population is more exposed to rising food prices for two reasons: First, they are more likely to consume tradable commodities as basic food (e.g. rice and wheat) while the rural population consumes more traditional staple. Second, the urban population is less likely to produce own food or food for sale (FAO 2008b). In consideration of the fact that about 85 percent of the households in Malawi are engaged in agriculture, which are to 81 percent located in rural compared to 15 percent in urban areas (NSO 2005), one could fleet-footed conclude that Malawi is predominately a country of net sellers. However, the crux of the matter is that, the agricultural sector is dominated by smallholder farming with households cultivating comparatively small plots of land. Therefore, a large part of the agricultural households food production is below subsistence level, i.e. not sufficient to sustain a living and generate income by selling the produce on the market. With only 11.8 percent of the households in Malawi being net staple food sellers the FAO (2008b) has estimated that a 10 percent increase in the price of maize would lead to a welfare loss of 2 percent for the poorest quintile and a loss of 1.4 percent for the country as a whole. Another recent study by Ivanic and Martin (2008) comes to a similar conclusion. They found that both urban and rural households in Malawi are net buyers of maize. An increase in its price by 10 percent would raise poverty by 0.5 in rural areas and 0.3 percent in urban areas or 0.5 percent nationwide (Ivanic and Martin 2008). The results of the two studies point to a scenario, where already a moderate price increase has significant macro-economic consequences and probably detrimental effects for many households in Malawi. Studies on household vulnerability (Dercon 2004, Dercon et al. 2005, Makoka 2008, Republic of Malawi 2006) showed that rising food prices and drought are the two most severe shocks identified by the respondents. Ex-post households that respond to the price increase or the reduction in yields lower consumption, increase their labour efforts, spend cash savings or sell assets. Borrowing is not really an option in the Malawian context as financial markets are not sufficiently developed (Republic of Malawi 2006).[1] Reducing consumption, particularly the number of meals per day is often the last resort for households. Under severe and prolonged conditions the calorie intake will drop below a minimum level, leading to hunger, hunger related diseases and ultimately to starvation[2] if the situation does not improve. In many studies (see e.g. Devereux 2002b), the groups identified to be most affected by these fierce conditions are the elderly and the children. Even if death can be prevented, failure to meet the nutritional needs over a certain period of time, especially during very early childhood, may have permanent consequences on the health status of children including stunting, reduced cognition, and increased susceptibility to infectious diseases (von Grebmer et al. 2008). Roughly, closing the loop, adverse health conditions, similar to and also magnifying insufficient educational attainments[3], usually have a negative impact on productivity levels of a country and thus, reduce the potential for long-term income growth on the micro-, as well as, on the macro-level. For example, in Zimbabwe Alderman et al. (2004) found that the effects of early childhood malnutrition result in a loss of at minimum 14 percent of lifetime earnings. Related work by Hoddinott at al. (2008) showed that nutritional needs have to be satisfied at specific times in the live cycle and Guatemalan boys that received high-energy and high-protein supplements during the first two years, earned 46 percent higher wages as adults compared to boys which have not received any supplements (Hoddinott et al. 2008).

Bearing the long-term consequences in mind, this paper will rather focus on the short-run outcomes building on a number of studies (see e.g. Pongou et

[1] See Skoufias (2003) for a detailed discussion on coping mechanisms and their implications.

[2] See e.g. Martorell and Ho (1984) on the coherences.

[3] See e.g. Glewwe et al. (2002) on the impact of malnutrition on education.

al. 2006) from developing countries that suggest, that declines in the household economic status due to national economic downturns, or natural catastrophes such as rainfall shocks, drought or flood may adversely affect children's mortality risk and nutritional status. More precisely, the paper does pick up on those previous findings but examines the probability of child mortality and changes in the anthropometric measures weight-for-age, height-for-age and weight-for-height caused by an episode of severe food shortages in the Malawian context. Since not all districts in the country were affected by the 2002 food crisis to the same extend, I am exploiting the spatial variation in the severity of the event with the application of econometric impact evaluation methods in order to quantify the effect of food shortages on child health.

The paper adds and expands on existing literature in several ways. First, after a number of qualitative studies reconciling the emergence and the effects, this is the first quantitative analysis on the impact of the 2002 food crisis. Using district variation, I am able to more precisely pin down the effects of severe food shortages on children and its implications for Malawi, something which to my knowledge no other paper has attempted, so far. Second, it adds on to the existing literature concerned with the impact of food shocks on health outcomes. Finally, it links into the current debate on the global food price inflation and its impact on the poor showing potential short-term health consequences on the exemplary case of Malawi.

For Malawi, which is a country frequently prone to food shortages, the 2002 food crisis did not lead to a significant increase in the probability of child mortality. Also, the econometric results did not depict an impact on acute undernutrition. The double-difference estimates show that the event had a positive effect on stunting and the degree of underweight. Despite the fact that no short-run impact of the crisis could be identified, the results do not automatically mean that the shock did not have lasting consequences, even on the health status of children.

The remainder of the paper is structured as follows. Section 2 lays the ground for the analysis including a literature review, conceptual framework, and background information on the 2002 food crisis and the health status of children in Malawi. Section 3 describes the empirical strategy and data used for analysis. A discussion of the main results follows in section 4. Section 5 concludes.

Chapter 2 Background

2.1 The Link between Food Shortages and Child Health

2.1.1 Related Literature

There is a large literature examining the impact of economic shocks on future welfare in general. The impact of food shortages on child health is much less studied. Research from developing countries found a predominantly negative impact of food scarcity on health outcomes. Recent work on nutrition deficits and health includes that by Akresh and Verwimp (2006), who used the local nature of crop failure and civil war to identify the effects of these exogenous shocks on child health. They applied a province-birth cohort fixed effects model to a 1992 panel data set from Rwanda, where the coefficient of the interaction term of the shock region and being born after the crisis measures the impact of exogenous shocks on children's health status. While the exogenous shocks have no impact on the health status of boys, they find that the height-for-age z-score of girls born in the region after experiencing a crisis is 0.72 standard deviations (SD) lower. Evidence in the same direction is also found in Zimbabwe. Hoddinott (2006) investigated the impact of shocks on rural households in Zimbabwe using longitudinal data between 1994 and 1999. He found evidence that the 1994-95 drought was associated with children older than two not affected by the drought. Whereas, children younger than two lost 15-20 per cent of their growth velocity. Moreover, children residing in poor households – including the ones that did not sell assets – are likely to have suffered a permanent loss in stature, schooling, and earnings. In another study, Hoddinott and Kinsey (2001) analysed the impact of drought caused by rainfall shocks on child growth with a panel data set and found that Zimbabwean children aged between one and two years lost 1.5-2 cm of growth in the aftermath of the event. This faltering does have a permanent effect where children on average do not catch up. However, for children of older age, they do not find a slowdown in growth. Furthermore, as expected, there is evidence that children from poorer households suffer disproportionately more. Looking at the long-term consequences of early childhood malnutrition in Zimbabwe, Alderman et al. (2004) used a maternal fixed effects instrumental variables estimator and concluded that children lost 3.4 centimetres of height, 0.85 grades of schooling and half a year of school attendance by adolescence. Research on the impact of an agricultural production loss on child health by Yamano et al. (2005) identified that for Ethiopia, crop damage has a detrimental effect on growth for children aged between six and 24 months. They found a loss of growth of about 0.9 cm over a six months period, compared to areas where crop loss was 50 percentage points lower. Their paper further indicates that food aid can compensate for this negative effect. The problem is, however, that inflexible targeting, endemic poverty and low maternal education keep stunting at high levels. Ruel et al. (2008) contest the catch-up argument. On the basis of work in Haiti, they concluded that the nutritional deficit of young children could not be made up later as stunting, wasting and underweight were 4-6 percentage points lower in communities that participated in preventative child health and nutrition programs compared to those in recuperative ones. In a more recent work Cogneau and Jedwab (2008) investigated the impact of the 1990 cocoa price shock on child outcomes in Côte d'Ivoire and found that children in cocoa producing households experiencing an income shock in 1990 due to a drastic cut in cocoa producing prices by 50 percent from 400 to 200 CFA francs were relatively smaller compared to other agricultural households measured by height-for-age z-scores. Testing the perfect insurance hypothesis for the case of Côte d'Ivoire, Jensen (2000) examined if children living in regions exposed to adverse weather shocks faced lower investments in education and well-being. In order to asses the impact on health, he looked at differences in the nutritional status measured by the child's weight-for-height z-score and the use of medical services. Based on household data from the Côte d'Ivoire Living Standards Survey (CLSS) collected between 1985 and 1988, the author concluded that investments in children are significantly affected by adverse agricultural conditions, leading inter alia to a 50 percent increase in malnutrition. From his research, Jensen (2000) can, however, not manifest, if the periodic investment shortfalls have permanent effects.

Studies outside the Sub-Saharan context also confirm the negative impact of food shortages on child health. For example, Rukumnuaykit (2003) investigated the effects of the Asian financial crisis and drought in Indonesia on infant mortality and birth weight. Using data from the Indonesian Family Live Survey (IFLS) the mortality status and birth rates of different cohorts were analysed. Due to detailed information on the birth and time of death, mortality rates at different specific ages of children could be examined. The results from applying hazard models indicated that overall the economic shock increased infant mortality risks in rural and urban areas by 3.2 percentage points. The drought, which struck predominately villages nearly at the same time as the financial crisis, increased rural infant mortality risks by 4.4 percentage points. Comparing the cumulative distributions of birth weights suggested that the financial crisis had adverse effects on birth weight in urban areas. But, these results are not robust under multivariate analysis which shows no effect. This lack of sufficient evidence is due to a selection problem in the reported birth weights (Rukumnuaykit 2003).

Despite the striking evidence of a negative relationship between food shocks and child health, a few studies found no impact. De Waal et al. (2006) looked at child survival during the 2002/2003 drought in Ethiopia, which was potentially the worst in the modern history of the country so far with more than 13.2 million affected. The data from the Ethiopian Child Survival Survey of 2004 indicated that child mortality was higher in affected areas. In a more detailed analysis using multivariate regression, however, the authors reached the conclusion that the difference in the repercussions are rather attributable to the chronic conditions in the areas than to the immediate impact of the 2002/2003 drought (de Waal et al. 2006). The study by Strauss et al. (2002) investigating the impact of the economic crisis in Indonesia in 1997, which also led to increasing food prices, on child health outcomes indicated that three years after the crisis, children from the IFLS were not substantially worse off concerning their health or income poverty than they were before the crisis. Contrary to expectations, some seem to have been even better off but these results can not be universalised.

2.1.2 Conceptual Framework

The theoretical background of many of the papers presented in the previous section is that under liquidity constraints, caused by a lack of insurance and coping mechanisms, the possibilities to smooth consumption are limited which in the end leads to a reduction in health investments. So, even though the paper is mainly an empirical analysis the mechanisms at work can best be viewed within the simply live-cycle consumption smoothing paradigm (Kazianga and Udry 2006).

The 2002 food crisis in Malawi, which is subject to investigation in this paper was limited to a specific time period, i.e. the most drastic impact was felt over a three to four months period in early 2002. Due to the limited time span the event constitutes a short-term exogenous shock. This does not mean that there are no long-term consequences resulting from the crisis, rather it is assumed that once the event has passed households will settle back into a situation of normality.[4] Bearing this preliminary considerations in mind the theoretical starting point for the present scenario is the permanent income hypothesis (PIH) which predicts that, temporary variation in income can be addressed through consumption smoothing. To formally present the mechanisms the basic PIH model by Deaton (1992) has been chosen.[5] The mathematical formalization presented below was adopted from Kazianga and Udry (2006). In the PIH, households are assumed to be risk averse with a planning horizon set at T. In each period the household earns a risky income y_t and has access to a risk-free asset A_t.. The time discount rate is represented by β and interest rate by r. Given that the household i maximises an inter-temporal expected utility, with an instantaneous utility u defined over the

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[4] Further note that founded on the evidence that the majority of the population is engaged in agriculture and are net buyers of food, conceptually the food crisis represents an aggregate shock as many households in the same area might be affected. Hence, risk-pooling on community level as analysed for example by Townsend (1995) might not be a possible response to the crisis.

[5] For a more sophisticated model also considering coping through selling livestock see Fafchamps et al. (1998).

consumption of c_i, which is a single aggregated good, the households utility function at period T can be presented as follows:

$$Max_{c_{ir}} u(c_{i\tau}) + \beta_{t-\tau} E_{t=r} \left[\sum_{t=\tau+1}^{T} u(c_{it}) \right] \qquad [1]$$

which is subject to a budget constraint:

$$A_{it+1} = (1+r)A_{it} + y_{it} - c_{it} \qquad [2]$$

Deaton (1992) has argued that when T is large enough and A_{iT+1} is equal to zero, the problem resolves into a case where the marginal utility of current consumption is equal to the discounted expected marginal utility of future consumption, which is formally presented by:

$$u'(c_{it}) = \beta(1+r)E_t u'(c_{i\,t+1}) \qquad [3]$$

Assuming that preferences fulfil certain characteristics, i.e. that they are quadratic, time invariant and separable, and that β is constant and equal to r, a function is obtained where, current consumption equals expected future consumption, i.e.:

$$c_{it} = E_t(c_{i\,t+1}) \qquad [4]$$

This results in the PIH which implies that only shocks on permanent income would lead to changes in overall consumption while transitory changes are smoothed away (Deaton 1992). Even though the strict form of the PIH is usually rejected there is often evidence of significant intertemporal consumption smoothing, for example, through the use of assets as buffers (see e.g. Deaton 1991 and Paxson 1992). Apart from using assets or livestock as buffers for income shocks caused, inter alia, by significant price increases in the staple food, households can apply a number of other coping mechanisms already mentioned in the introduction. One of the measures described which is commonly used by households particularly when facing a period of high food price inflation is the reduction in the number of meals per day. Moving closer to the core of the problem, nutrition does not only have an inherent value of satisfying hunger but can also be seen as an important health input. Thus, the nutritional intake can improve the health status, which in the long run can have a positive impact on earnings, or the other way round, a lack of food can have severe negative impacts on the health situation. To outline the impact of prices on health investments the model from Pitt and Rosenzweig (1986) is used. The model is static, i.e. does only take a one period perspective, which might not be in line with the rather dynamic nature of the food crisis investigated. Nevertheless it is valuable to further describe the mechanism at work for two reasons: First, it can be seen as an extension the PIH model described above as now a closer look will be taken at c, which so far presented consumption as a single aggregated good that is now broken down into different elements. Second, it illustrates the interaction of foodstuffs and other consumption elements on health using the price elasticity of food which, compared to other items, might be relatively low.

Assuming the simplest set-up up of a farming household with one household member, the level of utility of the farmer is determined by the level of health, H, the consumption of the produced food commodity, X^c, the purchased food commodity, Y, and leisure, l. Hence, the utility function is:

$$U=U(H, X^c, Y, l) \qquad [5]$$

The degree of health is assumed to be influenced by the levels of food consumed and produced, X and Y, and a health input, Z, which yields no direct utility, the farmer's work time l_f, and by environmental factors and the individuals health endowments both summarized by μ, because they are beyond the control of the household. Hence, the health production function, depicting changes in food consumption, work time, health services and the environment on health is:

$$H=h(X^c, Y, Z, l_f) + \mu \qquad h_1, h_2, h_3 >0, h_4<0 \qquad [6]$$

The farmer's output production function is a function of labour input and also health described as

$$X=f(L, H) \qquad [7]$$

with L being the farm labour input consisting of own labour L_f and hired labour L_h. The effective labour units L_f are a function of time worked l_f and health, H:

$$L_f=m(l_f, H) \qquad m_1, m_2 >0 \qquad [8]$$

since an increase in health may also increase the number of healthy days available for leisure l or work l_f, thus

$$l_f+l=q(H) \text{ with } q'>0. \qquad [9]$$

Bringing all the equations together, the income constraint of the household is:

$$p_x X^c + p_y Y + p_z Z = \pi + \omega L_f = \pi + \omega m(q(H) - l, H) = I \qquad [10]$$

with p_x, p_y and p_z being the market prices of X, Y and Z, ω being the market wage rate, I being income and profits being $\pi = p_x X - \omega L$.

The reduced form consumption demand equations for foods, health inputs and leisure conditional on the farm profits derived from the model incorporating health production are:

$$X^c, Y, Z, l = D^i(P_x, P_y, P_z, \omega, \Pi, \mu) \qquad i=X^c, Y, Z, l. \qquad [11]$$

The reduced form health demand equation is:

$$H = D^H(P_x, P_y, P_z, \omega, \Pi, \mu) \qquad [12]$$

Consequently, the effect of a change in the price of the food good *X* on the household's health can be depicted as:

$$\frac{dH}{dP_x} = h_{x_c}\frac{dX^c}{dP_x} + h_y\frac{dY}{dP_x} + h_z\frac{dZ}{dP_x} + h_{l_f}\frac{dl}{dP_x} \qquad [13]$$

Assuming that all inputs in the health production function, including the food good *X*, have positive marginal products and contribute to improving health, from [13] it can be seen that the effect of an increase in the price of *X* is not clear. It could increase as well as decrease health. This is due to the interaction of the price of food with the consumption of the purchased food *Y* and leisure[6] for which the directions of the effects can not be predicted. Even though, dX^c/dP_x is likely to be negative, consumption of the *Y* good and the *Z*-input might increase (assuming that *Y* and health are gross substitutes for *X* in consumption) and health may improve. Hence, the net effect of a food price change on health depends on the magnitudes and signs of the own- and cross-price effects in consumption and on the relative magnitudes of the marginal productivities of the inputs in the health production function (Pitt and Rosenzweig 1986).

Bringing this model into the Malawian context and assuming that *X* represents maize, dX^c/dP_x is likely to be negative, due to rationing. However, considering that in Malawi even during the time of the crisis, no real shifts in consumption have occurred, *Y* may not be a gross substitute for *X*, therefore, also dY/dP_x will have a negative sign. Since the average household in Malawi spends more than 60 percent on food items and only about one percent on health (PMS 2000), it is unlikely that an increase in the price of maize will actually lead to in increase in health inputs. Therefore, dZ/dP_x might also have a negative impact on health. With respect to the consumption of leisure the effect is not so clear. A price increase in the major food item might encourage the farmer to work more, for example, through offering *ganyu*[7] labour. For diversification it is unlikely that the farmer works increases her work efforts in agriculture since nothing will be offered, therefore, the supply of maize reduces and we see the volume shock again coming into play. The effect does, however, also depend on the availability of additional labour opportunities, which during the crisis was very limited. It could be assumed that the overall effect on health is also negative. Therefore, a sharp increase in maize prices as a symptom of the food crisis is expected to lead to deterioration in health as income effects are likely to dominate over substantive effects.

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[6] Cross-price effects are non-zero (Pitt and Rosenzweig 1986).

[7] *Ganyu* is a form of a short-term labour relationship in the agricultural sector (mostly on the tobacco estates), predominantly in rural areas.

2.2 The 2002 Food Crisis – Production, Prices, Politics

Malawi is one of the most densely populated countries in Sub-Saharan Africa with a population currently estimated at 12.9 million and an average population growth of 2 percent per annum (World Bank 2008b). According to the 1998 Malawi Population and Housing Census, about 87 percent of the population live in rural areas (NSO 2006). Malawi is ranked 164th out of 177 countries in the HDI and hence, part of the countries with low human development (UNDP 2007). In 2005, the country earned a per capita GDP (in PPP) of 667 USD (UNDP 2007), which makes it the country with the lowest average income among the 177 rated in the latest HDR. Thus, the country has a relatively small economy with agriculture being the main economic activity (World Bank 2008b). The sector contributes 35 percent of the GDP, accounts for 80 percent of the export earnings and provides the livelihood basis for 85 percent of the population (World Bank 2008b). Nearly three quarters of the agricultural production are provided by smallholder farmers mainly engaged in rain-fed maize production but due to unequal land distribution 40 percent of the peasants cultivate less than 0.5 hectares (World Bank 2008b).

Southern Africa is a region frequently experiencing food shortages due to unfavourable weather conditions. Over the period from 1970 till 2006, Malawi experienced about 40 weather-related disasters, 16 of which occurred after 1990 (Roshni 2007). The most serious ones in the countries history were the Nyasaland[8] famine in 1949, the drought of 1991/1992 and the two major food crises in 2002 and 2005. Despite the gracious conditions with a bumper harvest in 1999/2000, a comparatively mild weather shock, and a less severe production loss than in 1991/1992 the impact of the 2002 food crisis is said to be the worst so far.[9] This raises a number of questions with respect to the triggers of the crisis. The most comprehensive analysis of the 2002 food crisis, also underlying later studies, was given by Devereux (2002b), Stevens et al. (2002), and Kydd et al. (2002), all three of which are the basis for the following paragraphs describing the major causes and consequences (see figure 3 for a summary of the main events). Analogue to Sen's entitlement approach the immediate triggers can be found in failures in production, transfers, trade and labour opportunities (Devereux 2002b):

a) Production shortfall

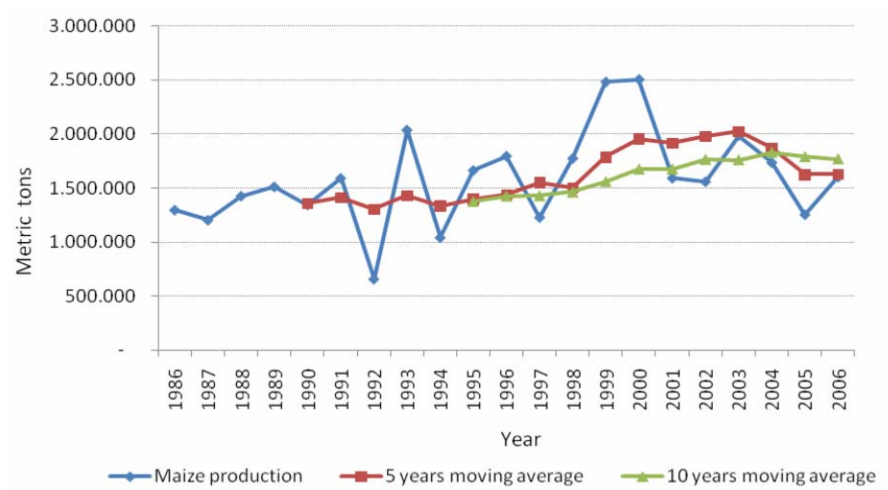
High rainfalls in February 2001 caused flooding in 13 out of the 27 Malawian districts (FEWSNET 2001a), which led to a fall in the national maize

[8] Former name of Malawi.

[9] The 2005 crisis might actually have been more severe. According to estimates 4.7 million people were affected and in immediate need of food aid (compared to 3.2 million in 2002 (Malawi National VAC 2002)). But, there is not enough information available to assess the situation, then (Roshni 2007).

production by 32 percent to 1.7 million metric tons in the 2000/2001 season (FEWSNET 2001b). Looking at the production figures over a longer time period (figure 1), it can be seen that the 2000/2001 harvest fell even below the five- and ten-year moving averages. In absolute figures, the production loss was less severe than the ones in 1992 and 2005. Compared to pre- and succeeding years, the production shortfall in 2001 should not have resulted in a major food crisis. However, taking into account the average population growth of 2 percent per year, a steady augmentation in output is needed in order to maintain subsistence levels. But, as can be seen from the trends in figure 1 only slight production increases could be realized over time. Hence, the 2000/2001 shortfall might have hit a population that was already living on the edge. A closer look at the price developments (figure 2)[10], might underline the before mentioned point. Even when adjusted for inflation, the average maize market price peaked in 2002. Seeing prices as a measure of scarcity, this would indicate a major food shortage.

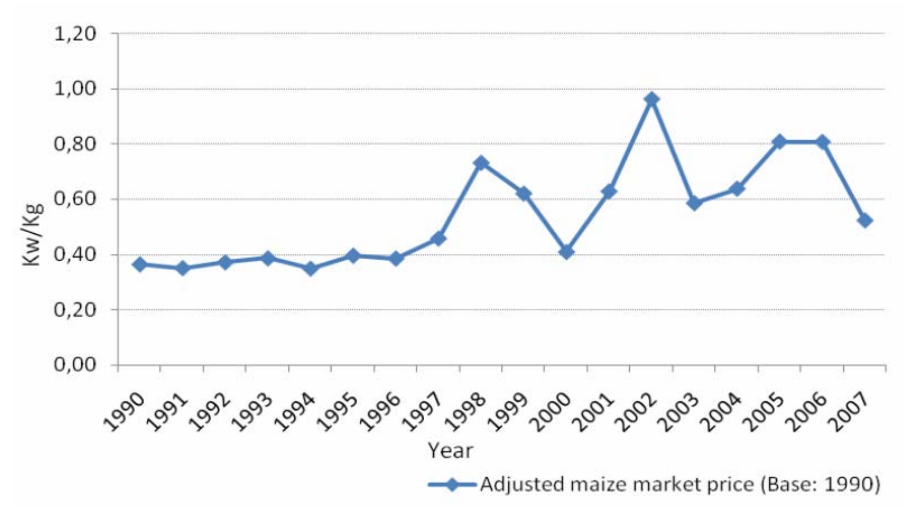
Figure 1
Maize Production in Malawi (1986-2006)



Source: Data from FAO Statistics Division (2008)

[10] Note: Prices displayed in figure 2 are consumer prices. Producer prices are much lower due to information asymmetries, lack of storage facilities etc. Maize market prices in Malawi follow a cyclical patter with a drop in prices after harvesting in June/July and a significant increase at the beginning of the year in January/February, the high point of the hunger season.

Figure 2
Real National Average Maize Market Price 1990 – 2007



Source: Data from FEWSNET (personal communication) and NSO (2008)

Due to 60,000 metric tons of maize held in stock by the National Food Reserve Agency (NFRA) and an estimated high roots- and tuber production, the approximate maize shortfall of 272,975 metric tons was considered severe but, the total food availability assessed to be more than adequate. However, the complacency of the food situation was based on a lack of or wrong information, particularly the roots and tuber production was overestimated. The data problem can be illustrated by the scenario that even though the first reports on a looming food crisis were made as early as August 2001 (Devereux 2002b), in January 2002, FEWSNET (2002a) still predicted an overall food surplus in the country for 2001/2002 up until the 27th of February 2002, when the president finally declared a state of disaster.

b) Transfers

Apart from the production shortfall further difficulties at the time posed the weak governance system in relation to the management of resources and delivery of services, which contributed to raise the tensions of the already difficult government-, NGO- and donor relations (Kydd et. al 2002), with donors suspending major aid programmes in November 2001. As a consequence, donors were hesitant responding to the aggravating situation. Even though the first reports of food shortages were made in autumn 2001, the donors did not offer unconditional food aid till mid-2002. The reasons given for this slow response were the difficult relations with the government of Malawi, and the unawareness of the severity of the issue due to limited information also, considered as inaccurate (Devereux 2002b). Furthermore, the Malawian crisis was never officially titled a "famine", as on the 27th of February 2002 the president declared "only" a state of disaster. One major problem according to Howe and Devereux (2004) are the ambiguities when using the term "famine". Nevertheless, it has signalling function creating a fast emergency and donor response.

c) Trade

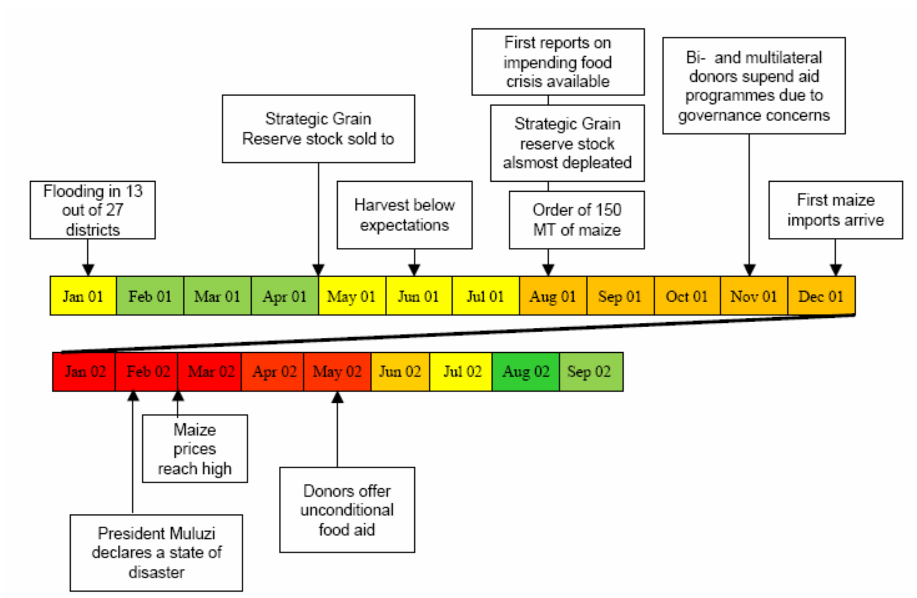
Related to the before mentioned factor, another issue impacting on the food crisis was the mismanagement of the Strategic Grain Reserve (SGR) run by the National Food Reserve Agency (NFRA) and the subsequent complications. At the high point in August 2000, the SGR held about 175,000 metric tons of maize in stock. About a year later by August 2001 the reserves were ran down to nearly zero. Based on advice from the IMF and World Bank, which considered the size of the SGR as excessive at the time, the NFRA sold significant parts of its maize stock to Kenya and Mozambique, to not distort the local markets. With the returns, a credit, taken up in 1999, when the NFRA was established, was repaid. Critical voices about the disposal have been raised, but the IMF objects to any accusations of being partly responsible for the food crisis, saying their advice has been based on objective studies (IMF 2002). To make things worse, a significant amount of maize, 60,000 metric tons, which were not officially exported, disappeared from the SGR raising questions on the quality of management and governance. Anecdotal evidence suggests that high-rank politicians have been involved, selling off the stocks to local traders at high returns (Devereux 2002b) This left the SGR with nearly zero reserves at the onset of the crisis in August 2001. In consequence, the Cabinet Committee on the Economy directed the NFRA to import maize which, after borrowing 33 mio. USD from a South African Bank, ordered 150,000 metric tons of maize from South Africa. Due to import delays, price increases and adverse exchange rate movements, finally only 134,000 tons could be purchased. The ordered maize was expected to be delivered at a rate of 50,000 metric tons per month and thus, should have arrived by December 2001 at the latest. But, since imports were deferred by logistical constraints and due to competition with the neighbouring food deficit countries, Zimbabwe and Zambia, only 94,000 tons arrived in Malawi by April 2002. Experts argued that if the food imports would have arrived at the planned rate, the food crisis could have been prevented.

d) Labour opportunities and vulnerability

In the time before the food crisis the Malawian economy was in recession. The commercial agricultural sector suffered from low commodity prices and unsuccessful diversification efforts. Employment opportunities declined with both formal as well as informal wages falling in real terms due to high rates of inflation and devaluation of the Malawian currency, the Kwacha (Kw). Because of the economic downturn at the time not much *ganyu* work was offered either. Moreover, anecdotal evidence suggests that, at the climax of the crisis people that managed to find occasional work, requested to be paid in maize directly instead of cash, which is a further indicator of the high insecurity on maize prices and -availability (Bryceson 2006). Hence, despite a bumper harvest in 1999/2000 the fall in maize production in 2000/2001 hit an increasingly vulnerable rural economy where people had very little to fall back on.

Commonly used coping strategies of the households experiencing food shortages ranged from rationing of meals to depletion of assets. Many households were forced to sell livestock. However, a large part of the poor households, that are affected most by food insecurity actually own only very little livestock. To complicate matters further, due to increased supply, prices for cattle, goats and chickens plummeted by more than half between July 2001 and February 2002. For example, while prices for goats and chicken ranged between 700-1,000 respectively 90-200 Kw per animal in July they dropped to 250-500 and 30-100 Kw in February (FEWSNET 2001, 2002b). Thus, income earned through selling livestock did often not enable the households to overcome the budget shortfall. Looking at figure 2 above again, after 1997 prices show enormous annual volatility between crisis and non-crisis years. In the case of Malawi, this price volatility is seen as very disruptive to economic activities and living standards of the poor as they do not have access to saving instruments to protect their consumption or non-income living standards like child schooling (Republic of Malawi 2006). So, the major problem at the time might not have been the production shock but different related vulnerability factors, i.e. the neglect of the smallholder agricultural sector, declining soil fertility, restricted access to inputs during the 1990s, the high market power of traders being able to keep producer prices low and push consumer prices up, deepening poverty eradicating asset buffers, erosion of social capital and informal social support systems, and HIV/AIDS and its social and demographic consequences. This view is also supported by Devereux (2002a) and Rubey (2003).

Figure 3
Timeline of the Crisis



With regards to the consequences of the food crisis, there are no official estimates on how many people died due to the shock. But, as a lower estimate, figures of 300-500 are widely accepted. Estimates of civil society groups based on death lists assume between 1,000 and 3,000 which are seen as the most accurate. NGOs have given the highest figures of 10,000 to 15,000 deaths based on hospital records but, most observers see them as highly overestimated. Even assuming the lowest estimates, the 2002 crisis would already be more severe that the Nyasaland famine of 1949 which only resulted in an estimated 200 deaths.

Similar to the mortality rates there are also no profound estimates on malnutrition rates during the crisis. A nutrition survey commissioned by Save the Children UK in December 2001 and February 2002 found an alarming deterioration in global malnutrition rates in the Salima district from 9.3 to 19.0 percent in just two months (Devereux 2002a). Due to the combined effect of prevention and treatment, malnutrition decreased from March 2002 onwards and in June 2002 rates were down from 19 to 9.7 percent (Taifour 2002). A further reduction was recorded by September 2002 when malnutrition went down to 3.8 percent (Taifour 2002). This, however, can be simply a post-harvest symptom.

2.3 Trends in Child Health in Malawi

Malawi is one of the success stories when looking at improvements in child mortality. In recent years the government of Malawi has increased public health spending[11], including higher salaries and training for health workers to address the chronic shortage of doctors and nurses in the country[12], or the distribution of bed nets to reduce malaria infections (Save the Children 2007). Overall theses measures seem to have had a positive impact on under five mortality rates, which dropped from 341 (per 1,000 live birth) in 1970 (UNDP 2007) to 221 in 1990 (UNICEF 2007) and finally to 125 in 2005 (UNDP 2007) or by 45 percent over the last 15 years. Considering that the country has experienced a number of weather related disasters and two major periods of food shortages, the decline between 1990 and 2005 seems remarkable but at the same time gives rise to a number of questions, e.g. if these periods of economic hardship did not have any impact on child health, opposite to common expectations? The decline has largely been attributed to the high rate of interventions with immunisation-, vitamin-A-supplementation- and "safe water access"-programmes. Despite this progress, Malawi is still listed on position 32 amongst the countries with high child mortality (UNICEF 2007).

[11] In 2004, it was equivalent to 9.6% of GDP or $58 per capita in PPP (UNDP 2007).
[12] According to the HDR 2007/2008 there are on average 2 physicians per 100,000 (UNDP 2007).

When looking at the mortality figures by income distribution, it becomes clear that behind the positive progress made overall, there still remains enough to be done. While child mortality of the richest quintile is at 149, on average 231 out of 1,000 children in the poorest quintile die before reaching the age of five (UNDP 2007).

With respect to malnutrition, the country generally seems to have progressed with the latest global hunger index rating in 2008 showing a drop from 32.2 points in 1990 to 21.8 points in 2008 (von Grember et al. 2008). Henceforth, the country moved from the extremely alarming countries to the group of alarming countries (von Grember et al. 2008), still indicating that malnutrition and its effects remain a problem in Malawi, with about 35 percent of the total population undernourished (UNDP 2007) and causing child death in more than 50 percent of the cases (see Peletier 1994, Peletier et al. 1995). The Poverty and Vulnerability Assessment from 2006 showed that there is not much dietary diversity in Malawi where 93% of the total cereal consumption is accounted by maize. The Central Region, despite being the area with the highest calorie availability has also the highest incidence of chronic child malnutrition (Republic of Malawi 2006). It should be noted that there are different types of malnutrition. The most common being protein-energy malnutrition, which is commonly reported during famines (Kloos and Lindtjorn 1994). The health consequences of protein-energy malnutrition include stunted growth, body wasting, retarded mental development and high mortality in younger children. Anthropometric measures are typically deficient in determining the nutritional needs of the affected population (Kloos and Lindtjorn 1994) but, nevertheless, they are commonly used measures for malnutrition. The ones that will be applied for further analysis in this paper are z-scores on height-for-age (HAZ)[13], weight-for-height (WHZ)[14] and weight-for-age (WAZ)[15]. Looking at these indicators for Malawi, they show that hardly any significant progress has been made over the past twelve years from 1992 to 2004 (table 1).

[13] Height-for-age is used as a measure for stunting indicating chronic undernutrition. Typically a standard deviation of below -3 indicates cases of severe stunting (same applies for wasting etc.).

[14] Weight-for-height is used as a measure for wasting indicating acute undernutrition.

[15] Weight-for-age is a combined measure giving information about the degree of underweight.

Table 1
Anthropometric Indicators for Child Health in Malawi

		Height-for-age ("stunting")		Weight-for-height ("wasting")		Weight-for-age	
		Percentage below -3 SD ("severe")	**Percentage below -2 SD ("moderate")**	**Percentage below -3 SD ("severe")**	**Percentage below -2 SD ("moderate")**	**Percentage below -3 SD ("severe")**	**Percentage below -2 SD ("moderate")**
1992	Male	24.5	50.9	2.0	6.0	8.5	28.3
	Female	21.4	46.5	0.9	4.9	6.7	26.1
	Total	**22.9**	**48.7**	**1.4**	**5.4**	**7.6**	**27.2**
2000	Male	25.3	50.5	1.2	5.1	6.0	25.7
	Female	23.0	47.6	1.3	6.0	5.7	25.1
	Total	**24.4**	**49.0**	**1.2**	**5.5**	**5.9**	**25.4**
2004	Male	23.8	50.0	1.9	5.5	4.5	22.4
	Female	20.7	45.6	1.4	4.8	4.5	21.6
	Total	**22.2**	**47.8**	**1.6**	**5.2**	**4.5**	**22.0**

Source: Elaborated, based on NSO and ORC Macro (1993, 2001, 2005)

Moreover, the figures in table 1 seem to suggest that boys are slightly more suffering from malnutrition compared to girls. Studies by Guha-Khasnobis and Hazarika (2007), Hardenbergh (1997) and Kabubo-Mariara et al. (2006) in different contexts confirm this proposition. Others find a female bias (see Klasen 1996). But, a large part of the research work does not find a gender bias – particularly not in Sub-Saharan Africa (see e.g. DeRose et al. 2000, Gunderson et al. 2007). Therefore, it appears that no uniform conclusion on the gender bias can be reached and that it is rather context specific.

Chapter 3 Empirical Strategy and Data

3.1 Empirical Model and Variables

In order to identify the causal relation between child health and food shortage, I will exploit the variation in the severity of the food crisis across districts applying difference-in-difference estimation (DID), a method commonly used for impact analysis working with randomised experiments and when panel data is available. In the present case, the data set used is not a panel but consists of repeated cross sections. In this case DID can also be applied. However, there are a few limitations with respect to the flexibility of the model and the interpretation of the results – a point to which I will come back to later. In general, DID estimation allows to estimate the causal impact, ignoring any structural considerations, when endogeneity is an issue. It is a means to use a policy change or an exogenous shock to create quasi-experimental conditions for estimating the structural parameters themselves. The main advantages of DID estimation are that it considers geographic and time variation and thus, can better account for unobserved spatial effects, i.e. controlling for the pre-existing differences between the treatment and control group, as well as, changes in "access" over time.

For the present analysis the most basic set-up of double-difference estimation will be used with observations of two groups over two time periods. The group affected by the intervention or shock being the treatment group and the other being the control group. The two time periods under review lie before respectively after the food crisis. In the present paper, I will use data from 2000 and 2004. The information from 2000 will serve as the baseline. The elementary assumption is that while the treatment group has been exposed to a treatment in 2004, i.e. in this case was suffering from food shortages in 2002, the control group has not been exposed to it in either period before or after.

If the sample units observed in each time period were the same, i.e. if panel data was used for estimation, the average effect in the control group is subtracted from the average effect in the treatment group. This removes biases in the second period comparison between the treatment- and control group, resulting because of permanent differences between the two groups and trend developments in comparison over time. As already mentioned, in the present case, the data set at hand is not a panel but consists of repeated cross sections. The basic principle remains the same but econometric estimation is slightly different as panel properties can not be fully exploited. More precisely, panel data allows to trace the individual behaviour over time while repeated cross-sectional observations only allows to make statements on average.

Furthermore, fixed or random-effects models can only be generated using panel data.

In line with the explanations above the most basic estimation equation of the paper is:

$$y_{int} = \beta_0 + \delta_1 dT_{in} + \delta_2 d2_{in} + \delta_3 d2_{in} \cdot dT_{in} + u_{int} \quad [14]$$

where *y* is either the discrete observation if a child died or not which is assumed to represent the latent variable of the probability of mortality or the different z-scores, which serve as an indicator for the prevalence of malnutrition. The subscript *i* indicates the observation unit or the individual, *n* the region and *t* the time period. With *T* representing the treatment group, the dummy *dT* captures possible differences between treatment- and control group prior to the food shock, the dummy *d2* absorbs aggregate factors that would cause changes in the outcome variable over time even in the absence of a shock or intervention. The variable of interest is the treatment or interaction effect, i.e. the coefficient, δ_3 which can also be represented as:

$$\delta_3 = (\bar{y}_{T,2} - \bar{y}_{T,1}) - (\bar{y}_{C,2} - \bar{y}_{C,1}) \quad [15]$$

and captures the difference in means within the treatment and control group before and after the crisis. Hence, the difference provides an estimate of the impact of the food shortages on the respective outcome variable.

Considering that the basic estimation equation only includes dummy variables directly related to the shock, the results might be suffering from a omitted variable bias, in the up- or downward direction. Therefore, additional variables will be included in the estimation equation to account for differences between the treatment and control group:

$$y_{int} = \beta_0 + \beta_1' C_{int} + \beta_2' H_{int} + \beta_3' M_{int} + \delta_1 dT_{in} + \delta_2 d2_{in} + \delta_3 d2_{in} \cdot dT_{in} + u_{int} \quad [16]$$

where *C* is a vector of child characteristics, including gender, birth size, if the child was a twin and the months breast fed. The vector *H* contains household specific information, i.e. rural or urban location, if the household is engaged in agriculture, the head of the household is a female, the number of household members and the number of children under five. The economic status of a household is represented by a dummy variable, based on an index which has been constructed using principal component analysis (according to Filmer and Pritchett 2001), which allows to measure the household wealth from the possession of household consumer durables such as a radio, a television or a car. The basic premise is that richer households are more likely to own a particular set of assets (e.g. a television and a car), while some durables are more likely to be owned by households with a relatively low economic status (e.g. radio). Principal component analysis allows to create wealth index scores by means of which the economic status of the household can be derived. Considering that wealth indexes have been criticised for a number of reasons[16], the economic status of a household can also be represented through the ownership of an asset directly. Again, using principal component analysis and excluding the ownership of a car as it is less than one percent in the sample , electricity has been identified as most suitable in the present case. Therefore, a variation of equation 3 has been estimated including a dummy for electricity. The years of education and the marital status are characteristics of the mother included in the vector *M*. Respective to each outcome variable under consideration, the age of the mother at birth is included in *M* in the mortality estimation. The reason for this is to account for the u-shaped relationship between maternal age at birth and child mortality as found e.g. by Miller et al. (1992), Mwabu (2008), and Sastry (1997). Young and old mothers have shown to exhibit higher risk of mortality due to unmature reproductive systems respectively declining maternal resources. The anthropometric measures of the mother are included in *M* for the estimations regarding the different z-scores. The underlying assumption is that there might be a relation between the z-scores of the child and the mother, when the child has been breastfeed, i.e. due to an extended period of breastfeeding during the crisis or the direct withdrawal of macro- and micro nutrients from the mother. Hence even in times of food shortages the child might have benefited with respect to her anthropometric endowments on the cost of the health status of the mother, which was etiolated.

The variable for child mortality is represented as a binary variable, i.e. a variable that can only take two different outcomes: One if the child dies and zero otherwise. When dealing with binary dependent variables, a linear regression model using OLS is not be appropriate as the estimators of $E(Y_i|X_i)$ are typically not bound by *0* and *1*, the error-term has a non-normal distribution and the variances of the disturbances are heteroskedastic (Gujarati, 2003). Hence, in order to obtain consistent estimates, in the case of binary dependent variables it is more appropriate to use logit or probit models. Logit and probit models assume a non-linear distribution of the data and the estimators of $E(Y_i|X_i)$ lie between *0* and *1*. Both models are typically estimated using the maximum likelihood technique. The disadvantage of this technique compared to OLS is that an additional assumption about the distribution of the error term is required. For the present study, I assume that the error term u is normally distributed, i.e. $u \sim N(0,1)$ and therefore, apply a probit model for the estimation of the child mortality outcome.

The z-scores of the children have been calculated based on WHO standards. A z-score for height-for-age subtracts from the child's height, the

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[16] Asset indexes can be biased particularly when comparing rural and urban areas, because they might not correctly reflect income differentials in varying locations due to differences in prices, the supply of assets and durable goods, and the variation in preferences between regions (Grimm et al. 2008).

median height in the reference population, for a child of the same sex and age in months, and divides it by the standard deviation of the height in the reference population, also for a child of the same sex and age in months. A weight-for-age or weight-for-height z-score is defined in an analogue manner, except that the standardization is done using the reference population median and standard deviation of weight for children of a given sex, age and height. Since the z-score of the anthropometric measures are continuous variables with a distribution close to normal the standard OLS technique is used for estimation.

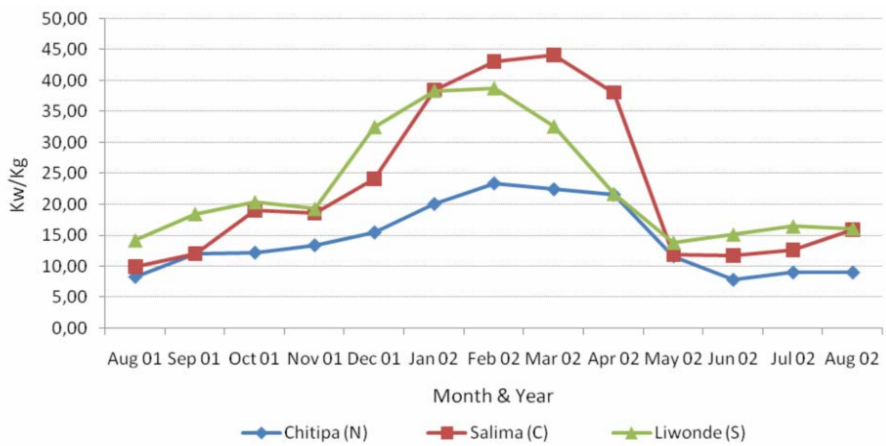
Due to the measurement and reporting, the estimates on child mortality and anthropometry are likely to be biased. More specifically, the mortality statistic are expected to be downward biased as the incidence of child mortality is usually underreported. The anthoropmetric z-scores, i.e. in particular the weight-for-age and weight-for-height z-scores, on the other hand, are anticipated to be upward biased. This is due to the fact, that the data used for calculation does not include information on the existence of oedema at the time of the measurement, which means that by default in the calculation it was assumed that the children had no oedema. Hence, the statistics of the z-scores on WAZ and WHZ are potentially overestimated as oedemas cause a weight increase.

3.2 Identification

Identification is the process to separate the treatment- and control group and is a central and often a hotly debated issue when using difference-in-difference estimation (see e.g. Angrist and Kruger, 1999). Therefore, a considerable literature on appropriately choosing control groups emerged, e.g. by and Abadie et al. (2007), Bertrand et al. (2002), Kubik and Moran (2003).

To identify the treatment- and control group in a food crisis, the best indicator to use would be an outcome indicator, such as calorie intake or degree of malnourishment. But, no information on either of these two outcomes could be obtained. Therefore, they can not be used for analysis. Another useful identifier could be the maize production levels. But, as outlined in section 2 of this paper, looking at the production levels over the years, the 2002 food crisis might not have been one in terms of overall output. Therefore, production levels don't seem to be a useful indicator in this context. Papers investigating similarly into the effects of drought on child health often used rainfall data (e.g. Akresh and Verwimp 2006). For this paper, I refrained from using precipitation data as the basis for identification for two reasons: First, the data that could be obtained was incomplete and second, not all areas that were flooded early 2001 experienced in consequence food shortages, as a number of other factors contributed to the food crisis than the mere production loss. Since none of the common outcome indicators could be used the present paper resorts to use a treatment indicator as identifier - the maize market prices. This is considered a suitable indicator for the food shortage regions for several reasons. First, seeing prices as a measure of scarcity, they are a good indicator for the lack of food if no major price distortions in the market exist. Second, there is significant variation in price levels across the districts which do largely tie in with a number of qualitative reports on food shortages (see figure 4).

Figure 4
Monthly Maize Market Prices from Selected Markets across the Country



Source: Data from FEWSNET (personal communication)

As can be exemplary seen from figure 4, at the market in the Northern Region, Chitipa, maize sold at much lower prices during the crisis than in the other two locations. The prices from Chitipa represent the food situation there at the time of the crisis. Namely, the majority of the northern districts have not reported any severe food shortages. The main reason for this was the cross-boarder-trade with Tanzania, from which maize could be imported without major obstacles.

To identify the food shortage areas, the monthly maize market prices from the selected markets throughout the country were averaged for the year. The threshold average price was set at 20 Kw/Kg for 2002, as it was reported to be the highest price to which the NFRA would buy maize. On the basis of this limit, districts with an average maize market price above 20Kw/Kg were sorted to the affected or treatment group, while the others were categorized into the control group. Through this mechanism, the following regions have been identified to be affected: Nkhotakota, Ntchisi, Dowa, Mchinji, Salima, and Dedza in the Central Region and Mangochi, Machinga, Zomba, Phalombe, Mulanje, Thyolo, Balaka and Mwanza in the Southern Region. The other districts predominantly in the Northern Region are classified as not-affected (see Appendix A1 and A2 for maps).

For the sensitivity analysis of the results, different other identification methods have been used. For example, selection based on the fact if districts are mainly maize or tuber- and roots-producing and -consuming, assuming that the predominately tuber- and roots-growing areas would be less affected by food shortages due to a good harvest in the 2001/2002 season. Another information used for identifying affected and non-affected areas was the emergency assessment carried out by the FAO and WFP in May 2002 immediately after the high point of the crisis was reached.

3.3 Data

In order to analyse the causal impact of food crisis on child mortality and -health in Malawi, I used pooled cross-sectional data from the Demographic and Health Surveys (DHS) conducted in Malawi in 2000 and 2004, representative at national, regional and rural-urban level. Sample selection was based on a stratified probabilistic two-stage cluster design selecting clusters and households within these clusters (NSO and ORC Macro 2005). The household response rate was 99 percent in 2000 and 98 percent in 2004 (NSO and ORC Macro 2001, 2005). The main respondents for the DHS are woman aged between 15 and 49. In each household, data were collected on household possessions and the demographic and socio-economic characteristics of its members including maternal education, child sex and age. Additional information included measured data on child anthropometry for children younger than 5 years and maternal health seeking behaviour. For the purpose of this paper, I did not use the full DHS data available but, work predominantly with a sub-sample containing the information on children less than five years of age. The combined dataset includes in total 22,840 observations, 11,926 from 2000 which serve as baseline and 10,914 from 2004. The response rate for the underlying data on the anthropometric indicators was 77.5 percent in 2000 and 74.8 percent in 2004. The questions with respect to child mortality were answered in all cases.

Comparing the affected and non-affected areas over the years, on the basis of the descriptive statistics presented in appendix A3 allows to get a first impression on the naïve estimate and the non-parametric difference-in-difference estimation. It can be seen that the percentage of children that died before the age of 5 dropped from 13.8 percent to 10.3 percent in the affected areas. Fewer children died over the years in the non-affected areas with on average 8.7 percent in 2004 or 1.6 percent less than in the affected areas. The anthropometric measures WAZ, HAZ and WHZ show diverging trends. While the WAZ has improved over time in both groups, with the non-affected areas showing a lower degree of undernutrition overall, the height-for-age z-scores fell for the affected regions but increased on average in the non-affected regions. Acute malnutrition, i.e. WHZ, improved at large. The mean for the non-affected areas, however, is lower than in the treatment group. The sample is gender balanced. Breastfeeding increased over the years. children in non-affected areas were on average fed 0.39 months longer in 2000 and 0.83 months longer in 2004. The size of the children at birth seems to have increased over time, with children in the non-affected areas being larger. In general, all these indicators hint at an improved health situation of children in

Malawi. In terms of household characteristics, in 2004 more households are located in rural areas and engaged in agriculture compared to 2000, with 50.4 percent respectively 58.4 percent of the households in the affected regions working as farmers. Directly comparing treatment and control groups, the affected regions appear to be poorer in comparison, with a larger number of households falling into the 40th percentile low income group. The average number of household members has reduced slightly over time with fewer members in the affected areas. A positive trend is the increase in the average years of mother's education with the mothers in the non-affected going to school longer. Together with the before mentioned points on the economic status of the households, the mother's education can be seen as an additional indicator for higher poverty levels in affected areas. The mothers' anthropometric measures deteriorated over time, but only to a small extent. The affected areas report on average a lower nutritional status then the control group. Overall, the BMI, used as an indicator for underweight shows that the average population still lies within the normal range between 18.5 and 25 points.

Chapter 4 Results

4.1 Effect of the Food Crisis on Child Mortality

As a preview to the econometric work, table 2 shows the bivariate correlation between child mortality and selected household-, child- and mother characteristics. The numbers show that, with the exception of the dummy on very large births size and medium household wealth, all other variables have a statistically significant impact on the incidence of child death. Furthermore, the variables behave according to expectations obtained from various previous studies on the determinants of child mortality (e.g. Bolstad and Manda 2001, Das Gupta 1990, Hill and Upchurch 1995, Manda, 1999, Mutunga 2007, Omariba et al. 2007). For example, mothers of surviving children have on average about 0.43 years more education than those that experienced child death.[17] As often reported in other contexts, particularly in the health literature, on average more male children died. The children that died were on average breastfed 10.4 months less. This, however, could be explained because they died already earlier, as the majority of child death occurred before reaching one year of age.[18] From the 2,615 child death reported in the sample 2,084 or 79.7 percent did not survive infancy. As anticipated, the children that died were on average of smaller birth size, i.e. with 76.5 percent the majority of the children that died were very small at birth. In line with the expectations, child death is more common in rural areas or poor agricultural households. Typically, one would assume that an increase in family size would raise mortality risks since, resources must be spread over more family members which might not directly contribute to production. Despite this proposition in the present case, it seems that the number of household members has a positive effect on child survival, as the children that survived came from households with on average 5.6 compared to 4.7 members in households that experienced child death. This does not confirm "hoarding effects" commonly presented in the literature,

[17] This is in line with findings from Benefo and Schultz (1996) investigating child mortality and fertility in Cote d'Ivoire and Ghana, which come to the conclusion, that fertility responds directly to child mortality and increases in female education are likely to contribute to declines in child mortality and hence fertility. Moreover, there is a lively discussion in the literature if it is education per se or behavioural responses due to education i.e. higher health care utilization.

[18] Normalizing the breast feeding variable, i.e. creating an index by setting the actual time breast feed into relation to the age (up to a maximum of two years) does not lead to a change in the overall results presented in this study.

where parents decide to hoard children as insurance mechanism in anticipation of additional child death in the future.[19]

Table 2
Bivariate Correlation of Child Death and Selected Child-, Household and Mother Characteristics

Variable	Child died = 0	Child died = 1	p-value*
Dummy child is a twin	0.291	0.104	0.000
Dummy child is male	0.498	0.538	0.000
Breast fed (months)	16.710	6.318	0.000
Dummy very small size at birth	0.034	0.765	0.000
Dummy small size at birth	0.115	0.151	0.000
Dummy average size at birth	0.540	0.489	0.000
Dummy large size at birth	0.206	0.162	0.000
Dummy very large size at birth	0.090	0.090	0.977
Dummy rural	0.854	0.897	0.000
Dummy agricultural HH	0.535	0.556	0.051
Dummy poor HH (40th percentile)	0.405	0.440	0.000
Dummy medium HH (40th percentile)	0.414	0.417	0.797
Dummy rich HH (20th percentile)	0.181	0.143	0.000
Dummy electricity	0.050	0.033	0.001
Dummy female headed household	0.195	0.209	0.077
No. of household members	5.670	4.740	0.000
No. of children under 5	1.785	0.977	0.000
Mothers education (years)	3.895	3.461	0.000
Marital status	0.845	0.828	0.030
Age at birth	25.865	25.090	0.000
Number of observations (n) varying but mostly	*20,225*	*2,615*	

*Note: The p-value reported gives an indication about the potential equality of the means (null hypothesis)

The results of the estimated probit specifications as outlined in section 3.1 are presented in table 3. The specification only including the dummy variables directly related to the incidence, shows no significant effect of food shortages on child mortality, which means that the food crisis has not led to an abnormal increase in mortality figures in the affected regions. To limit missing variable bias and control for difference in the treatment- and control-group, the estimation equation has been extended as already mentioned in section 3.1. Specifications (I) and (II), outlined in table 3 control for child-, household- and mother characteristics, representing the economic status of the household by dummies generated on the basis of the wealth index calculated respectively the ownership of electricity. In both specifications, the majority of the control

[19] A qualitative assessment of the insurance effect on fertility in Senegal and Zimbabwe by LeGrand et al. (2003) found that even so deliberate efforts exists in both countries, however, with a lesser degree in urban Senegal, the main aim is to ensure a minimum number of children, usually about two to three instead of achieving a specific family size.

variables are statistically significant, even at a one percent level of significance. These include, for example child characteristics, i.e. gender, multiple birth and breastfeeding, as well as, the location of the household and the education obtained by the mother. Using electricity or the wealth index to represent the economic status of the household does at large not particularly change the coefficients of the variables. Therefore, the following interpretation focuses on the results obtained from specification (I) shown in table 3. As expected, twin birth is positively related to the incidence of child mortality, hence, increasing the probability of child death in the early years of live. The coefficient shows that male children are more exposed to the incidence of death before reaching the age of five. Moreover, the results indicate that breastfeeding increases the chance of child survival. Living in rural areas is positively related with the incidence of child mortality, hence, raising the risk of child death. Further expected results are obtained for the education attainment and marital status of the mothers. Both coefficients indicate an inverse relationship with child death increasing the chances of child survival. In the present case an additional year of education reduces the probability of child mortality by 0.3 percentage points. Based on the average of 3.779 years, this means that an additional year of education raises the chances of the child dying before the age of 5 by 0.11 percent. This finding is in line with results from various studies, e.g. by Katahoire et al. (2004) in south-eastern Uganda, who found that maternal schooling, while not protecting the children from malnutrition and morbidity, had a positive impact on child survival, i.e. the risk of mortality was higher among children of mothers without any formal education. Interesting points for discussion are the coefficients of the dummy for female headed household and the number of children under five in the household. Looking at the signs of the coefficients of both variables they indicate a negative relationship with the incidence of child mortality that means that living in a female headed household reduces the probability of child mortality. This is still a controversial point. On the one hand, it is often the case that female headed households are poorer. On the other hand, there is an extensive literature confirming that women put more emphasis on food, health and education expenditure than men, thus, benefiting the children. A further complication is the concept of a female headed household. Female headed households can be a rather heterogenous group, in the sense, that they are not necessarily poorer or exposed to more vulnerability because the male had died for example, but instead moved away and supports the family through remittances, which in turn makes the household less assailable for shocks. For instance Kennedy and Haddad (1994) investigated if pre-schoolers from female headed households were less malnourished using weight-for-age z-scores comparing Ghana and Kenya and found a positive effect in Kenya while the results for Ghana were lower and more income is required to improve the nutritional status. The coefficient of the number of children under five in the household as presented in specification (I) in table 3 indicates that, the more children are living in the household, the smaller the probability of child death. More specifically, one additional child reduces the probability of child mortality by 7.4 percentage points. This might not appear to be of practical significance but, based on the average of 1.690 children under five in a household, an additional child would mean a reduction in the probability of child death by 12.7 percent which would be quite impressive and also means that higher fertility could reduce the risk of child mortality. This stands in contrast to the majority of the literature in this field which find predominantly a unidirectional relationship between fertility and child mortality. The causality and the direction of the relationship is, however, still a point of discussion (see Cleland 2001). Most interestingly for the hypothesis of the paper, the coefficient on the interacted time and treatment indicator is not statistically significant. That implies that the food crisis had no impact on the probability of child mortality. So, on the basis of the estimation results obtained, the hypothesis, which assumed an increase in mortality due to the shock has to be rejected. Using only infant mortality data the same results are obtained.

Table 3
Probability of the Incidence of Child Death – Marginal Effects (Probit)

	Dummies		(I)			(II)		
Variable	Marginal Effects	SE	Marginal Effects	SE	X	Marginal Effects	SE	X
Dummy child is a twin			0.196	0.018***	0.038	0.203	0.019***	0.038
Dummy child is male			0.007	0.002***	0.501	0.007	0.002***	0.501
Breast fed (months)			-0.007	0.000***	15.592	-0.008	0.000***	15.607
Dummy small size at birth			-0.012	0.004***	0.120	-0.012	0.004***	0.119
Dummy average size at birth			-0.019	0.005***	0.534	-0.019	0.005***	0.533
Dummy large size at birth			-0.018	0.004***	0.202	-0.018	0.004***	0.202
Dummy very large size at birth			-0.012	0.005**	0.091	-0.012	0.005***	0.091
Dummy rural			0.012	0.004***	0.862	0.013	0.003***	0.863
Dummy agr. HH			-0.000	0.003	0.537	-0.001	0.003	0.537
Dummy medium HH (40th percentile)			0.001	0.003	0.417			
Dummy rich HH (20th percentile)			-0.000	0.004	0.174			
Dummy electricity						-0.005	0.006	0.046
Dummy female headed HH			-0.007	0.003**	0.189	-0.002	0.003	0.183
No. of household members			0.003	0.001***	5.546	0.006	0.001***	5.499
No. of children under 5			-0.075	0.003***	1.690	-0.080	0.003***	1.705
Mothers education (years)			-0.003	0.000***	3.779	-0.003	0.000***	3.753
Dummy married			-0.011	0.005**	0.862	-0.005	0.004	0.861
Age at birth			-0.001	0.000**	25.912	-0.001	0.000***	25.950
Dummy 2004	-0.037	0.007***	-0.017	0.004***	0.464	-0.015	0.004***	0.468
Dummy treatment group	0.016	0.006***	0.000	0.003	0.576	-0.000	0.003	0.578
Time and treatment indicator interacted	0.003	0.009	0.002	0.005	0.278	0.003	0.005	0.280
n	*22,840*		*21,799*			*21,313*		
Log pseudo likelihood	*-8,085.59*		*-4,907.001*			*-4,679.205*		
Pseudo R^2	*0.005*		*0.370*			*0.384*		

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

4.2 Effect of the Food Crisis on Child Anthropometry

Analogue to the analysis of the impact of the food crisis on child mortality described above in section 4.1, the repercussions of the shock on children's anthropometry are investigated taking a similar approach. First, looking at the regression results obtained from regressing only the DID-dummies on the respective z-scores. Second, augmenting the estimation by including a number of relevant variables to reduce potential biases in the result. Table 4 shows the results of the specification with the DID-dummies only, for the different z-scores, i.e. weight-for-age, height-for-age and weight-for-height. Focusing on the coefficient of the interacted time and treatment indicator, the variable is statistically significant for the weight-for-age and height-for-age regressions but not for weight-for-height. This would in conclusion mean that the food crisis led to difference in the degree of undernutrition, represented by WAZ, and chronic malnutrition measured by HAZ. The food crisis however, did not lead to a difference in the outcome with respect to acute undernutrition. The positive sign on the coefficient of the interaction term further suggests that, the affected areas have actually benefited from the crisis leading to improvements of the nutritional status represented by the degree of underweight and chronic malnutrition.

Table 4
Estimation of the Anthropometric Measures – Dummies only

	WAZ		HAZ		WHZ	
Variable	Coef.	SE	Coef.	SE	Coef.	SE
Dummy 2004	0.045	0.029	-0.058	0.042	0.089	0.035***
Treatment group	-0.153	0.026***	-0.241	0.037***	0.020	0.031
Time and treatment indicator interacted	0.088	0.039**	0.099	0.055*	0.006	0.046
Constant	-0.923	0.019***	-1.797	0.027***	0.239	0.022***
N	*18,690*		*17,725*		*17,768*	
R^2	*0.003*		*0.003*		*0.001*	

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

In a next step, the estimation equation was extended to tackle missing variable bias (table 5). Compared to the two augmented regression specifications presented in the previous section on child mortality, here the respective z-scores of the mother are included as an additional variable, based on the suggestion that the children, when breastfed, might actually not have suffered from the food crisis on the cost of the mothers nutritional status. As already seen from the child mortality results, the two different specifications using either the dummies generated from the wealth index or electricity as variables to represent the economic status of the household, does not change the coefficients much. Again, the interpretation, therefore, focuses on the results of specification (I) in table 5 but is analogous also valid for the alternative one.

When looking at the regression results, two points strike. First and foremost, the conclusions drawn from the dummy-only regression remain also valid when child-, household- and mother characteristics are included in the estimation equation. So, as can be seen from table 5, even in the augmented estimation the interaction term is positive and statistically significant (at a 99 percent level of confidence) in the weight-for-age and height-for-age estimations, while the weight-for-height results still indicate no impact of the food crisis. Hence, it seems to suggest that the affected areas have benefited in consequence of the crisis with respect to the more chronic nutrition indicators. More precisely, children form the affected regions exhibit 0.14 SD higher weight-for-age and 0.15 SD higher height-for-age z-scores. On acute malnutrition the affected and non-affected areas appear to have not experienced any significant differences. Secondly, while for WAZ and HAZ most of the variables included are statistically significant, the majority of the household and mother characteristics included are insignificant to determine acute undernutrition. The weight-for-height z-score seems to a large part driven by the child's own endowment regarding the size at birth or being a twin birth, being breastfed, as well as, the mothers anthropometric status with (except for the twin status) all of these factors having a positive relationship to acute malnutrition. Any improvements would better the short-term nutritional status of the child. This does in turn not confirm the proposition that children would benefit from breastfeeding at the expense of the mothers nutritional status as the coefficients on both variables are not going in opposite but one and the same direction.

Table 5
Estimation of the Anthropometric Measures – incl. Child-, Household- and Mother Characteristics

	(II)						(II)					
	WAZ		HAZ		WHZ		WAZ		HAZ		WHZ	
Variable	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Dummy child is a twin	-0.808	0.063***	-0.833	0.074***	-0.249	0.072***	-0.816	0.063***	-0.831	0.074***	-0.245	0.072***
Dummy child is male	-0.112	0.019***	-0.228	0.026***	0.036	0.023	-0.110	0.019***	-0.226	0.026***	0.036	0.023
Breast fed (months)	-0.027	0.001***	-0.061	0.002***	0.011	0.001***	-0.027	0.001***	-0.061	0.002***	0.011	0.001***
Dummy small size at birth	-0.006	0.057	-0.112	0.074	0.046	0.068	0.004	0.058	-0.104	0.075	0.052	0.068
Dummy average size at birth	0.310	0.051***	0.148	0.066**	0.179	0.059***	0.320	0.052***	0.158	0.067**	0.184	0.060***
Dummy large size at birth	0.476	0.053***	0.271	0.069***	0.275	0.063***	0.478	0.054***	0.281	0.071***	0.274	0.064***
Dummy very large size at birth	0.639	0.058***	0.281	0.076***	0.514	0.068***	0.645	0.059***	0.289	0.077***	0.513	0.069***
Dummy rural	-0.128	0.031***	-0.153	0.044***	-0.040	0.039	-0.170	0.030***	-0.227	0.043***	-0.036	0.038
Dummy agr. HH	-0.042	0.021**	-0.093	0.028***	0.022	0.026	-0.060	0.021***	-0.125	0.029***	0.026	0.026
Dummy medium HH (40th per.)	0.093	0.021***	0.085	0.029***	0.013	0.027						
Dummy rich HH (20th per.)	0.203	0.032***	0.355	0.044***	-0.037	0.040						
Dummy electricity							0.148	0.046***	0.289	0.067***	-0.023	0.057
Dummy female headed HH	-0.048	0.027*	-0.010	0.038	-0.078	0.033**	-0.073	0.028***	-0.038	0.039	-0.078	0.034**
No. of household members	0.012	0.005***	0.024	0.006***	0.012	0.006**	0.013	0.005**	0.027	0.007***	0.011	0.006**
No. of children under 5	-0.012	0.014	-0.061	0.019***	0.010	0.017	-0.012	0.015	-0.069	0.021***	0.016	0.018
Mothers education (years)	0.021	0.003***	0.019	0.004***	-0.001	0.004	0.024	0.003***	0.023	0.004***	-0.000	0.004
Dummy married	0.025	0.031	0.139	0.043***	-0.005	0.038	0.024	0.032	0.139	0.044***	-0.002	0.039
Mothers respective z-score	0.064	0.003***	0.230	0.013***	0.246	0.014***	0.065	0.003***	0.230	0.014***	0.246	0.014***
Dummy 2004	0.031	0.029	-0.024	0.040	0.059	0.036	0.031	0.029	-0.047	0.041	0.072	0.036**
Dummy treatment group	-0.101	0.026***	-0.155	0.035***	0.027	0.031	-0.107	0.026***	-0.173	0.036***	0.036	0.032
Time and treatment indicator interacted	0.144	0.038***	0.147	0.052***	0.043	0.047	0.133	0.038***	0.159	0.053***	0.024	0.047
Constant	-2.242	0.106***	-0.693	0.107***	-0.037	0.094	-2.162	0.107***	-0.543	0.107***	-0.054	0.093
N	*17,719*		*16,820*		*16,828*		*17,369*		*16,482*		*16,495*	
R^2	*0.115*		*0.138*		*0.033*		*0.113*		*0.134*		*0.033*	

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

4.3 Caveats

So far the paper has largely refrained from the discussion of any critical methodological and data issues. But the results obtained might be flawed with respect to a number of issues regarding the econometric technique, identification, and data used. Therefore, the following section will highlight and discuss a number of crucial points and assumptions.

Beginning with the econometric methodology, difference-in-difference estimation is based on a number of restrictive assumptions. First, it assumes that the changes in the outcome variable in the absence of a shock would have been exactly the same in both, the affected and non-affected districts (Bertrand et al. 2004) or in other words, that the treatment- and control group follow constant and parallel counterfactual trends. To account for the potential diverging trend a number of control variables have been added to the estimation equation. These might, however, not be sufficient to fully remove the biases. Second, DID assumes that the intervention, or in this case the crisis, does not causes any spillover effects. In the scenario presented, I can not preclude that the control group was not affected from rising food prices, in their case, however, the situation was not as severe as in the acute food shortage areas. A more crucial issue related to the assumption of non-spillover effects is that the food crisis emerged as a result of a number of interwoven factors causing confounding trends (see explanations in section 2.2). Examples are the preceding economic shock and subsequent recovery, structural problems of the agricultural sector and potential effects of the HIV/AIDS pandemic. The effect investigated in the paper is, therefore, likely not only to be attributed to the food crisis itself but also the number of other events at the time. Thus, I am looking at the net-effect. The direct effect of the food crisis will henceforth be underestimated. Further criticism raised with DID estimation is the Ashenfelter dip, which describes a scenario where the "selection for treatment is influenced by individual-transitory shocks on past outcomes" (Abadie 2005: 1); an autocorrelation problem as identified by Bertrand et al. (2004) leading to inconsistent standard errors, which in turn means that significant effects are found in more cases than is actually true; and measurement error or selection bias. Considering that selection was not based on pre-existing characteristics the Ashenfelter dip is not a concern in the present case and so is the problem of autocorrelation, which is limited as I am only using two time periods, spanning over 4 years, for analysis and not a longer time series.

Apart from these rather technical concerns there is an argument with respect to the applicability of difference-in-difference estimation also related to the first assumption mentioned above. In section 3.3, I briefly mentioned that the treatment group appears to be on average poorer than the control group. This could lead to biased results if one sees the poverty related to the incidence of agricultural shocks and disease prevalence, i.e. the shocks actually not being exogenous but endogenous, because regions prone to natural disasters and disease "attract" mainly the poor, while the non-poor sort to more hospitable environments. Since vulnerabilities to food shocks are not random and neither are coping strategies, in the sense that wealthier households would probably be better prepared, through production-, saving-, and insurance decisions, poorer households in areas with frequent food insecurities are likely to be less able to smooth away income shocks. In either case the treated and non-treated would respond differently to the crisis. Hence, the impact of the crisis is likely to be higher in the affected areas than in the control areas, as the control population is more capable to deal with covariate shocks. In other words, the endogeneity of the "programme placement" may lead to substantial underestimates of their effect on child mortality and -health (Yamano et al. 2005). Considering that major agricultural and health programmes like the Input Factor Programmes (IFP) have been rolled out nationwide with similar coverage and targeting through the districts, the effect of contrary vulnerability responses might be mitigated or at least attenuated. The exception, however, is the impact of smaller scale NGO projects which could also not be accounted for in the analysis. In order to identify the impact of the endogeneity bias, the estimations on child mortality and anthropometry have been carried out for the poor and non-poor separately, which is further described in the sensitivity analysis (section 4.4).

To tackle the shortcoming of basic difference-in-difference estimation, Meyer (1995) has argued for the application of more sophisticated research designs, i.e. through the use of multiple treatment and control groups or pre- and post-intervention observations. Belasen and Polacheck (2007, 2008: 49) propose a generalized-difference-in-difference (GDD) estimator which incorporates "*many* experimental as well as *many* control groups" and also allows to generalize outcomes. This offers a major advantages to standard DID estimation, which is often criticized for its limited validity as it only applies to the specific exogenous shock assessed. Due to the limited data availability, these more sophisticated designs could unfortunately not be employed in the present case.

Apart from the econometric technique used, further confounding factors for the analysis can be found with respect to the identification strategy chosen. The identification by means of prices used for this paper is challengeable on various accounts. One issue is the cyclical pattern of maize market prices mentioned in section 2.2, which can, however, be easily refuted arguing that all districts experience a similar pattern throughout the cause of a year with a delay of a months at most as the harvesting season typically starts a bit earlier in the southern part of the country compared to the North. Using average prices these fluctuations are accounted for. A further and more severe critique point of the identification strategy applied is that it assumes a strict separation of markets, i.e. with no price integration and regulation and a very locally confined famine or food shortage situation. This point can not fully be refused. It is correct that there is a certain degree of price regulation in the market. At the time of the crisis any efforts by governments to prevent the rapid price increases, however, failed. The assumption of the food crisis being a locally contained phenomenon links back into the assumption of no spillover effects already discussed above. Another complication is that identification can be obstructed by internal migration effects, which could be identified comparing the changes in household composition in the affected and non-affected areas. The data source used in this paper, the Malawian DHS, only reports information on women and children under five and the total number of household members. On the basis of this data it is not possible to identify internal migration, i.e. to conclude on migration solely on the basis of a reduced household size might be misleading. However, work by other researchers, e.g. Makoka (2008) shows that migration is not a common ex-post strategy to cope with drought or increased crop prices in Malawi.

A last caveat is concerning the data. Despite what seem to be a quite large sample size, the DHS has its weaknesses particularly when estimating child mortality figures. Wang (2003) found the sample size of the DHS generally not sufficient for conducting within-country or regional level analysis and proposed to combine the DHS with census data. Jayachandran (2008) states the same critique, i.e. that the data from the DHS is too small to examine months-to-months or geographic variation. The combination with census data is not possible here as the last census in Malawi was in 1998, hence, prior to the baseline survey.

4.4 Sensitivity Analysis and Robustness Check

To address some of the confounding factors mentioned above, to confirm the results, and to give more credibility to the identification strategy, sensitivity analysis and robustness checks were performed. The inspection was carried out along five lines:

First, estimating the results using alternative identification strategies, e.g. by classifying the regions into tuber and non-tuber growing areas with the underlying argument, that the areas producing and consuming tuber as a staple food would not be affected by a food crisis resulting from shortages in maize. Other identification strategies used to check for the robustness of the results were a separation of the treatment and control group based on food security and vulnerability assessments carried out by the Malawi National Vulnerability Assessment Committee in September 2002 respectively the FAO and WFP in May 2002. While the former two identification strategies are found to have a number of drawbacks and also not returning conclusive results, as the segregation into tuber- and non-tuber growing areas is not clear enough, respectively the assessment was carried out too late with already another harvest after the major crisis, the FAO and WFP assessment is the most convincing. The major advantage is that, the FAO and WFP assessment was carried out very close to the high point of the food crisis. The FAO and WFP (2002) have classified 7 districts as facing a high severity of the food crisis: Nkhotakota, Salima, Lilongwe, and Ntcheu in the Central region and Mangochi, Blantyre and Zomba in the Southern region. For the estimation these districts make up the treatment group, while the rest of the country is the control group. The results obtained confirm the main conclusions drawn in section 4.1 and 4.2 showing no impact of the shock on the probability of child mortality, as well as no significant disadvantage of the affected areas with respect to malnutrition.

Second, to address Meyer's (1995) suggestion for more sophisticated research designs by including another pre-treatment cross-section from the DHS from 1992 does not change the overall results. Using the 1992 data might actually not aid to account for overall trend effects as the country suffered from a major drought in 1991/1992. Hence, including the 1992 data could actually introduce a bias instead of removing it.

Third, the data was re-estimated with respect to the differential impact on various groupings. More specifically, estimating the impact by poor and non-poor, rural and urban, male and female, the household occupation, i.e. households engaged in agricultural activity and non-farming households, the education level of the mother, and combinations of the before mentioned i.e. poor male and poor female. The majority of the differential analysis confirms the results from section 4.1 and 4.2, where no deviance in the impact on child mortality and acute malnutrition is found, while the treatment group seems to be positively affected by the food crisis in terms of the degree of underweight and chronic undernutrition. But a few interesting observations have been made when analysing the differential impact. While the results indicate that male children from poor households have benefited with respect to their weight-for-height z-score (0.31 SD higher), female children from poor households in the affected areas seem to have lost out compared to their counterparts from the non-affected region. More precisely the coefficient on the interaction term shows that girls in the food shortage areas exhibit on average 0.23 SD lower weight-for-height z-scores. Separating the sample with respect to the educational attainment of the mother revealed no differential impact of the food crisis on the child anthropometry when mothers had no formal education. But, a positive impact is found with respect to chronic undernutrition and the degree of underweight. Precisely, children of mothers with primary education in the treatment areas have on average 0.18 SD higher weight-for-age z-scores and also 0.21 SD higher height-for-age z-scores. The acute malnutrition of children from mothers having secondary education have been found to be not negatively affected by the food crisis in the affected areas. Rather, their weight-for-height z-score is on average 0.49 SD higher. These results confirm the conclusions of other studies investigating into the relationship between mothers education and child health concluding a positive impact of the former on the latter. An example would be the research by Katahoire et al. (2004).

Fourth, district dummies have been included in the estimation to account for district fixed effects. They, however, have not been found to be significant and again confirmed the conclusions drawn in sections 4.1 and 4.2.

A fifths and final variation in the estimation strategy was made by replacing the treatment dummy *dT* with the market price information combined with district fixed effects. Through this, more variation in the treatment variable is created. The results obtained have, however, not significantly changed with respect to mortality, the degree of underweight and chronic malnutrition. For acute malnutrition, measured with the weight-for-height z-score, the interacted time and treatment variable was found to be significant at a 90 percent level of confidence. The positive sign on the coefficient indicates that the children in the affected areas were actually benefiting from the crisis having on average a 0.02 SD higher weight-for-height z-score.

4.5 Discussion of Results

The results obtained from the analysis as presented in section 4.1 and 4.2 showed that the food crisis has not led to a significant increase in the probability of child mortality or acute undernutrition. But, the shock led to a difference in the degree of underweight and chronic malnutrition, with the positive signs on the coefficients of the respective interaction terms actually suggesting that the affected areas have benefited from the crisis having on average 0.14 SD higher weight-for-age and 0.15 SD higher height-for-age z-scores. These results have to a large extent withstood the sensitivity analysis and robustness checks.

Turning first to the mortality estimates, one of the objectives of the paper was to obtain more comfort on the actual mortality effect of the food crisis, as the numbers reported in different studies vary significantly. Finding no divergent impact in the estimation, does suggest that the fatal impact of the food crisis was limited and that it did not lead to a large increase in number of child deaths (at least to be statistically detected). Based on the fatal incidences caused, the food crisis might, therefore, actually not have been so severe. This conclusion would actually tie in with the results from Howe and Devereux (2004) that classified the Malawian food crisis of 2002 as a minor famine compared to the events in Sudan in 1998 and Ethiopia in 2000 which caused proportionately more deaths by starvation and hunger related diseases.

Apart from mortality which is the last consequence, there are other factors that could give details on the severity and the impact of the 2002 food crisis. One of those would be malnutrition which has also been studied in this paper. But, the results obtained on the anthropometric measures are rather unexpected. Nevertheless, there are some points to be raised trying to explain these outcomes. While the weight-for-height z-score, used to estimate acute undernutrition, might actually be the best indicator to measure the short-term impact of food shortages, the results obtained in the present case might be of limited significance. This is because the values have not been obtained immediately before and after the crisis but with a delay of two years, where a number of factors and events intervened. Hence, the results obtained can not be fully and only attributed to the food shock in 2002. To some extent this explanation also applies to the results obtained on the degree of underweight and chronic malnutrition but the impact might be smaller as these measures are by definition less volatile over a short period of time. One potential explanation for the affirmative outcome could be that the interventions and policy measures taken at the time were actually successful to tackle the negative impact of the crisis. This argumentation does in the present case, however, have a few complications as the effects can not be attributed to a single project or operation but a number of them working together at the same time.[20] Therefore, to pin down the effectiveness of one specific intervention is not possible. I will briefly only focus on the two major programmes initiated in response to the crisis – the Joint Emergency Food Aid Programme (JEFAP) and the Extended Targeted Input Programme (ETIP). Beginning with the JEFAP, based on the Emergency Operation (EMOP) of the WFP a consortium of NGOs implemented and distributed food aid in the districts (see appendix A2 for a map). The EMOP started in June 2002 with the initial objective to distribute 56,500 metric tons of food commodities to 2.1 million targeted beneficiaries in 18 districts by September 2002 (FEWSNET 2002c). The main target groups were children under 5, pregnant and lactating women and the elderly. Because of ongoing reports of households facing food shortages even after the 2002 harvest, food aid, funded mainly by USAID and the EU was extended beyond its initial period and in some areas provided up till early 2004. To increase the maize production after the crisis, the government with

[20] See Taifour (2002) for examples of successful feeding programmes in the Salima and Mchinji districts.

financial support from the World Bank, DFID, and Norway, extended the subsidised input programme to reach 3 instead of formerly one million households (FEWSNET 2002d). Also, the ETIP was sustained at this level for several periods after the crisis. Considering that both these large-scale programmes were targeted and extended over a longer time-frame than the immediate crisis, positive effects on the affected areas are feasible. Another potential explanation for the results could be a sort of "adaptation effect". As already mentioned in section 2.2 Malawi was frequently hit by adverse weather shocks which in consequence resulted in production losses for the smallholder farmers. Only in the period from 1990 to 2006, the people faced 16 of these shocks. Furthermore, food rationing is common for most of the agricultural households in rural areas during hunger season in the pre-harvest period starting around January. Therefore, their bodies might be more able to adapt to periods of food shortage without showing any immediate negative effects. The latter being a more unconventional proposal but both these propositions do require further research and might be looked at in a follow-up version of this paper.

Chapter 5 Conclusion

The present paper attempted to provide an analysis of the impact of the 2002 food crisis on child mortality and -malnutrition represented by the anthropometric measures weight-for-age, height-for-age and weight-for-height. The data used for the investigation was drawn from the Malawian Demographic and Health Surveys from the years 2000 and 2004. The difference-in-difference technique, exploiting the district variation in the severity of the crisis was used to obtain statistical estimates on the effect of the food crisis. The identification of the affected and non-affected areas was based on local market prices for maize. The interacted time and treatment variable, representing the impact of the shock on the respective outcome variables shows that the food crisis did not lead to a significant increase in the probability of child mortality or acute malnutrition. The analysis further found that children from areas experiencing the severe food shocks in 2002 have on average 0.14 SD higher weight-for-age and 0.15 SD higher height-for-age z-scores. The results obtained, as surprising as they are, might not be so far off considering that the crisis might actually not have been as severe as originally expected. Furthermore, the interventions carried out in response to the crisis were actually extended over a significantly longer timeframe past the aftermath which might have lead to positive results. Even though the results contradict the majority of the work carried out in this area, there are a few studies that have found no or even a positive impact. Examples shown in the literature review are the works of de Waal et al. (2006) in Ethiopia and Strauss et al. (2002) in Indonesia. Therefore, the present paper contributes to further discussions in the field.

On a note of caution, it would be short-sighted to draw water-proof conclusions on the severity of the food crisis or even on the impact of this event on child health, as only two aspects have been investigated in this paper. The influence of food shortages on the cognitive developments of the children and an number of further temporary and lasting consequences have not been studied. But this opens the door for further lines of research. Interesting undertakings would be to extend the period under review even combined with the analysis of the effects of the later food shock in 2005 in order to identify longer term consequences. Furthermore, an extension of the geographic area, comparing different countries frequently experiencing food shocks using generalized-double-difference estimation could help to universalise the conclusions.

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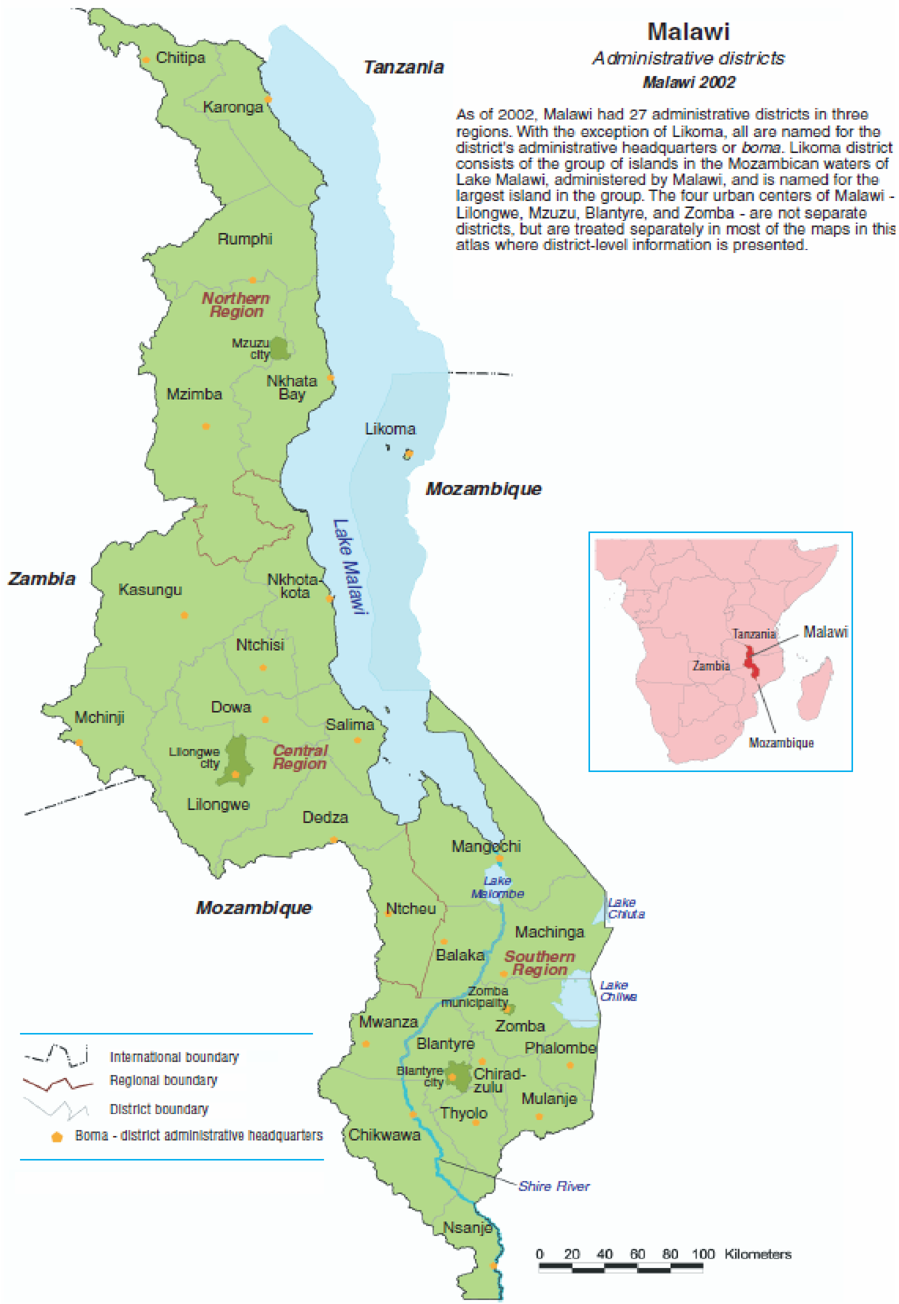
Appendix

Map A1
Map of Malawi in 2002



Source: Benson (2002: 6)

Figure A2
Graphic Representation of Districts Affected and Intervened

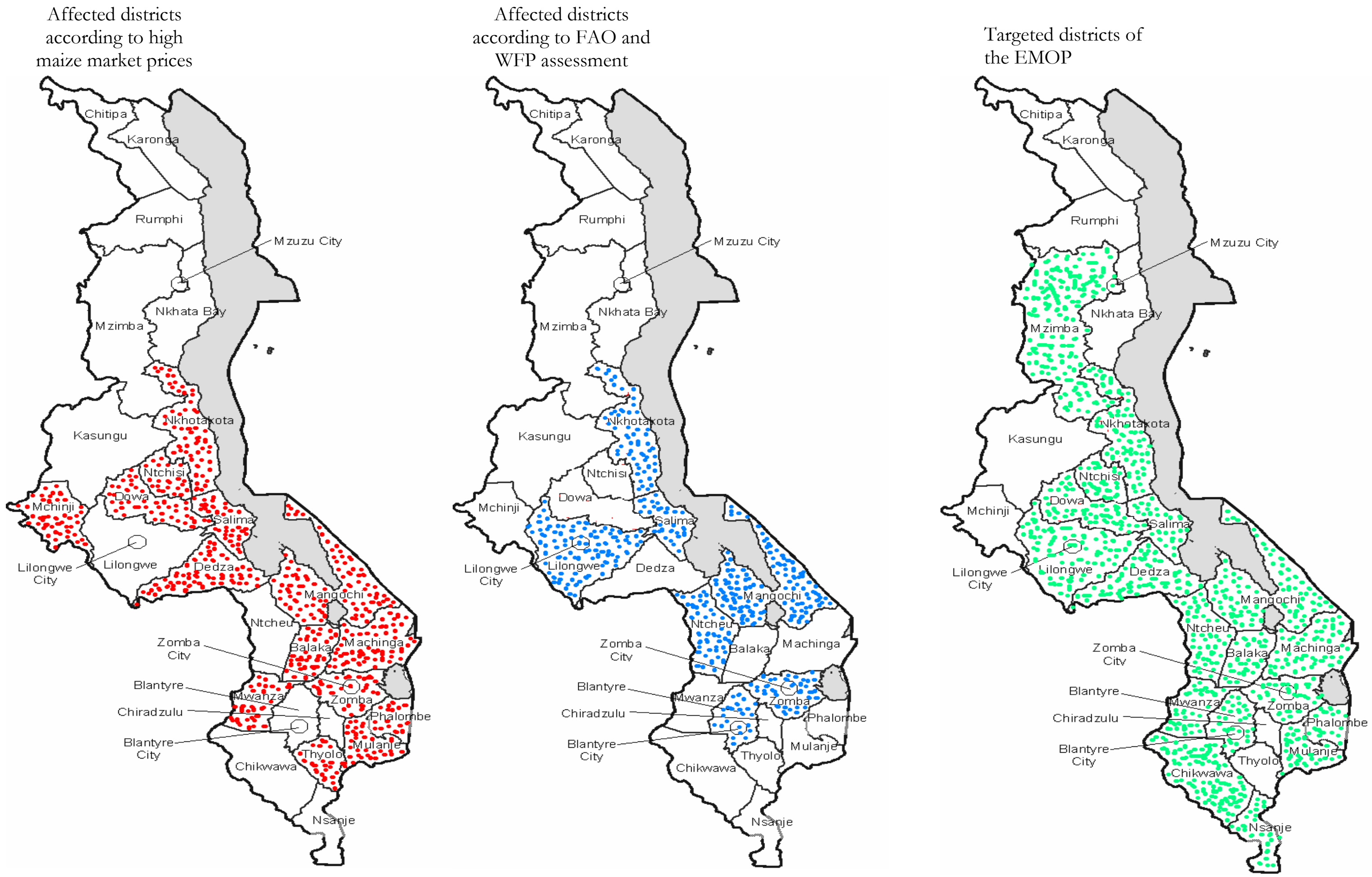


Table A3
Descriptive Statistics

	2000						2004					
		Affected			Non-affected			Affected			Non-affected	
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Dummy child died	6,622	0.138	0.345	5,304	0.121	0.326	6,547	0.104	0.305	4,367	0.087	0.281
Height-for-age SD	5,176	-2.037	1.777	4,231	-1.800	1.792	4,875	-1.997	1.772	3,443	-1.855	1.840
Weight-for-age SD	5,377	-1.076	1.330	4,413	-0.923	1.276	5,276	-0.943	1.302	3,624	-0.878	1.307
Weight-for-height SD	5,171	0.255	1.500	4,251	0.239	1.464	4,913	0.354	1.555	3,433	0.328	1.561
Dummy child is a twin	6,622	0.039	0.193	5,304	0.045	0.207	6,547	0.031	0.175	4,367	0.037	0.188
Dummy child is male	6,622	0.500	0.500	5,304	0.498	0.500	6,547	0.510	0.500	4,367	0.500	0.500
Breast fed (months)	6,622	15.106	9.111	5,304	15.487	8.966	6,547	15.455	9.225	4,367	16.285	9.321
Dummy very small size at birth	6,622	0.041	0.199	5,304	0.041	0.197	6,547	0.035	0.183	4,367	0.041	0.198
Dummy small size at birth	6,622	0.126	0.332	5,304	0.113	0.317	6,547	0.122	0.328	4,367	0.109	0.311
Dummy average size at birth	6,622	0.543	0.498	5,304	0.627	0.484	6,547	0.502	0.500	4,367	0.455	0.498
Dummy large size at birth	6,622	0.168	0.374	5,304	0.160	0.367	6,547	0.224	0.417	4,367	0.266	0.441
Dummy very large size at birth	6,622	0.114	0.318	5,304	0.051	0.221	6,547	0.083	0.275	4,367	0.112	0.315
Dummy rural	6,622	0.876	0.330	5,304	0.762	0.426	6,547	0.951	0.216	4,367	0.813	0.390
Dummy agricultural household	6,497	0.504	0.500	5,181	0.471	0.499	6,052	0.584	0.493	4,071	0.587	0.492
Dummy poor HH (40th percentile)	6,622	0.416	0.493	5,304	0.372	0.483	6,547	0.482	0.500	4,367	0.335	0.472
Dummy med. HH (40th percentile)	6,622	0.429	0.495	5,304	0.355	0.479	6,547	0.420	0.494	4,367	0.455	0.498
Dummy rich HH (20th percentile)	6,622	0.155	0.362	5,304	0.273	0.446	6,547	0.097	0.297	4,367	0.210	0.407
Dummy electricity	6,472	0.034	0.182	5,113	0.060	0.238	6,456	0.035	0.183	4,294	0.072	0.259
Dummy female headed household	6,622	0.232	0.422	5,304	0.173	0.378	6,547	0.212	0.409	4,367	0.147	0.354
No. of household members	6,622	5.484	2.532	5,304	5.799	2.455	6,547	0.537	2.126	4,367	5.694	2.312
No. of children under 5	6,622	1.661	0.871	5,304	1.696	0.872	6,547	1.710	0.796	4,367	1.707	0.861
Mothers education (years)	6,622	3.027	3.168	5,304	4.472	3.473	6,547	3.517	3.357	4,367	4.818	3.551
Marital status	6,622	0.846	0.361	5,304	0.892	0.311	6,547	0.793	0.405	4,367	0.854	0.353
Age at birth	6,622	25.886	7.054	5,304	25.628	6.610	6,547	25.812	6.802	4,367	25.736	6.663
Mother Height-for-age SD	6,543	-1.358	0.974	5,243	-1.279	0.991	6,252	-1.360	1.004	4,194	-1.269	1.025
Mother Weight-for-age SD	6,517	-0.708	0.822	5,227	-0.591	0.850	6,242	-0.708	0.848	4,183	-0.619	0.913
Mother BMI	6,548	22.001	2.951	5,237	22.276	2.840	6,252	21.928	2.900	4,194	22.181	3.109
Dummy 2004	6,622	0	0	5,304	0	0	6,547	1	0	4,367	1	0
Dummy affected	6,622	1	0	5,304	0	0	6,547	1	0	4,367	0	0
Treatment indicator	6,622	0	0	5,304	0	0	6,547	1	0	4,367	0	0