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Sonia, Akter and Syed Abul, Basher

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Sonia Akter[a*] and Syed Abul Basher[b]

[a]Department of Economics, Helmholtz Centre for Environmental Research – UFZ, Permoserstraße 15/04318, Leipzig, Germany.

[b]Department of Research & Monetary Policy, Qatar Central Bank, PO Box 1234, Doha.

[*]Corresponding author's e-mail: sonia.akter@ufz.de, phone: +493412351846, fax: +493412351836.

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Abstract

This paper presents the first household-level study to examine the combined impacts of the global food and financial crises on household food security and economic well-being in a developing country. Using longitudinal survey data of 1,800 rural households from 12 districts of Bangladesh over the period 2007–2010, we estimated a three-stage hierarchical logit model to identify the key sources of household food insecurity. A difference-in-difference estimator was then employed to compare pre- and post-crises expenditure for those households who experienced acute food shortages and those who managed to avoid the worst impacts of the crises. On the basis of our results we conclude that: (1) the soaring food prices of 2007–2008 unequivocally aggravated food insecurity in the rural areas of Bangladesh in 2008; (2) there was some weak evidence to suggest that the global economic downturn, which followed the global food crisis, contributed towards worsening food insecurity in 2009; (3) the adverse impacts of these crises appeared to have faded over time due to labor and commodity market adjustments, regional economic growth, and domestic policy responses, leaving no profound, long-lasting impacts on households' economic well-being; and (4) although the immediate adverse consequences of rising food prices were borne disproportionately by the poor and farming communities, the longer term consequences were distributed more evenly across the rich and poor and, in general, were favorable for the farming community.

1. Introduction

The combination of soaring international food grain prices in 2007–2008 and the global financial meltdown in 2008–2009 have been claimed to be the likely causes of the sharp increase in hunger in low income countries in recent years (FAO, 2009a, 2009b). Three arguments lie at the core of this claim. First, since most households in low-income countries are net food buyers, higher food prices during 2007–2008 are likely to have reduced households' access to staple foods. Second, the global economic downturn led by the financial crisis reduced employment opportunities and remittance income through contraction in exports and foreign capital inflows (including foreign investment and development aid), thereby further limiting households' ability to purchase food at higher prices. Finally, the traditional crisis coping strategies such as the selling of productive assets and indebtedness may have forced households into longer-term post-crises destitution.

The validities of these claims and their core point of contention have not been widely tested by empirical studies. Most of the existing analyses that offer scientific basis for these hypotheses rely on simulation approaches (e.g., Ivanic and Martin, 2008; de Hoyos and Medvedev, 2011). The appeal of the simulation approach stems from its cost- and time-effectiveness as opposed to survey-based and real-time data which are time and cost intensive. Generally, simulation based studies employ multi-country household survey data from the immediate pre-crisis years (i.e., 2005–2006) assuming a full rate of price transmission from international to domestic markets. Further, these studies do not take into account household, market, and national-level responses to food price shocks (e.g. adjustments to wages, production, and consumption; export bans; abolition of import tariffs; food subsidies) (de Janvry and Sadoulet, 2010). The key messages of these analyses are that the poverty and food security consequences of higher food prices have been substantial and

adverse, resulting in an additional 80 million to one billion people being classed as food insecure during 2008–2009 (USDA, 2009; FAO, 2009a).

The findings of these partial simulations require cautious interpretation. Critiques argue that the core underlying assumptions of these analyses (i.e., full price transmission and no response to price shocks) may have resulted in an overestimation of the negative consequences (Headey and Fan, 2010; Swinnen and Squicciarini, 2012; Headey, 2013). Empirical evidence suggests that price transmission can be incomplete and heterogeneous across countries and commodities so the full rise in food prices may not have been transmitted to all households (de Hoyos and Medvedev, 2008; de Janvry and Sadoulet, 2010). Further, as the majority of the world's poor are engaged in agriculture, increases in agricultural commodity prices are likely to be beneficial to many poor households (Swinnen and Squicciarini, 2012). Labor markets are also likely to adjust in response to price shocks, both inside and outside agriculture, thereby benefitting households across the income spectrum (Jacoby, 2013). Households may also respond to price shocks through increases in production and substitutions in consumption. Finally, in many countries the national government intervened through micro- and macro-economic measures. For example, China, India, Indonesia, and Vietnam enacted export restrictions on grain during 2007–2008, while Bangladesh, India, Indonesia, and Mexico implemented cash and food transfer programs for the most vulnerable groups (FAO, 2009b). These interventions are likely to insulate domestic economies against the adverse impacts of the global crises.

The cross-country variations in price transmission rates and responses to price shocks make food security a context-specific phenomenon. This notion is reinforced by the recent studies examining the 'food crisis and food security' nexus undertaken by Headey (2013) and Verpoorten et al. (2013). Headey's analysis of the Gallup World Poll data from 69 low- and

middle-income countries during 2005–2008 revealed a surprising positive trend of increasing global food security; as an additional 132 million people were recorded as food secure in 2008 compared to 2005–06. Likewise, Verpoorten et al. (2013) found between 5 and 12 million people in 18 Sub-Saharan African countries became more food secure over the period 2005–2008. However, the findings appear highly country specific with regards to the way global impacts permeated at the local level. In Headey's study, a large number of African and South American countries were reported to become less food secure while India's food security rose 4 percentage points between 2007 and 2008. In Verpooten et al.'s study, self-reported food security improved in 8 of the sample countries and worsened in the 10 other countries. These studies concluded that the impacts of the global food crisis on food security are, therefore, highly context specific. Thus, the true impact of the crisis can only be known when household surveys from the affected countries are analyzed (Harttgen and Klasen, 2012).

Given this background, this paper presents the first empirical household-level study of the simultaneous effects of the global food and financial crises on the food security of low-income rural communities in Bangladesh. In doing so, we employed longitudinal survey data of 1,800 rural households from 12 districts of Bangladesh over the period of 2006/07–2009/10. The longer time span of our data compared to the data used by previous studies allows us to capture both the immediate, as well as longer-term, consequences of these two consecutive crises. Further, the richness of the data set allows us to estimate a three-stage hierarchical logit model which provides an assessment of self-assessed food security responses by accounting for the spatiotemporal dynamics of the shock. The model also controls for the observable impacts of the global financial crisis through annual remittance inflows during 2007–2009 and, at the same time, enables the testing of hypothesis related to unobservable effects through scale heterogeneity. In addition to the self-assessed indicator,

we also examine household food security using an objective indicator, i.e., per-adult equivalent expenditure growth between 2006/07 and 2009/10. To perform this analysis, we employ a difference-in-difference estimator by controlling for fixed and time-varying household-level heterogeneity.

The rest of the paper is organized as follows. Section 2 discusses the key macroeconomic parameters of Bangladesh in the recent crises, followed by a description of the data used in the empirical analysis in Section 3. Section 4 presents descriptive statistics for the key variables of interest. Section 5 identifies the determinants of the self-assessed food security indicator by estimating a three-level hierarchical logit model. Section 6 discusses the objective food security indicator and analyzes the welfare impacts by comparing per-capita consumption expenditures before and after the crises. Section 7 discusses the main results and concludes the paper.

2. The Context: Macro-economic Indicators of Bangladesh during the Global Food and Financial Crises

Bangladesh is one of the poorest countries of the world. Approximately 75 percent of the country's population of 160 million lives in rural areas, earning an average of US$1,300 per household per year (BBS, 2011). Bangladesh is an agrarian country and a net importer of food. Rice is the staple food accounting for over 70 percent of the total calorie intake. Rice is also the dominant agricultural crop occupying two-thirds of the total arable land. Agriculture contributes to 20 percent of the GDP and employs more than half of the total labor force (BBS, 2011). Following the service sector, industry is the second largest contributor to GDP (30% share). This sector accounts for 90 percent of the country's total export earnings, of which the ready-made garment industry's share is nearly 80 percent (Bangladesh Bank, 2012). Bangladesh is the second largest South Asian country in terms of international labor

supply and the sixth largest source of global immigration (World Bank, 2011). Net exports and foreign remittances make up 20 percent of Bangladesh's gross national income (BBS, 2011).

In 2008, Bangladesh witnessed the second highest transmission rate of international rice prices to local markets in Asia. A 95 to 135 percent increase in world rice market prices led to a 52 percent increase in rice prices in local markets (Demeke et al., 2009). In addition to the international price hike, Bangladesh's local rice market was further affected by substantial crop damage caused by two consecutive and catastrophic natural hazards in 2007 (monsoon floods in July and September, and Cyclone Sidr in November) as well as food export restrictions imposed by India in October 2007 (Raihan, 2013). Consequently, the share of the population recorded as food insecure was estimated to increase by up to 20 percent in 2008 (an additional 12 million people) (FAO, 2009b). In April–May 2008, around a third of the country's population was reported to be consuming less than three meals per day (FAO, 2009b). Bangladesh's labor market responded to this shock with a 12 percent rise in nominal wages between 2007 and 2008 in all sectors of the economy. The nominal wage rose by a further 33 percent in 2009 and 44 percent in 2010 (relative to 2007). The increase in nominal wages was highest for agricultural laborers (53%) (BBS, 2011).

The impacts of the global financial crisis on the Bangladesh economy were somewhat mixed. The key channels through which the first order effects of the crisis could transmit were export earnings, foreign remittances, foreign direct investment (FDI), overseas development assistance (ODA), and import taxes (FAO, 2009c). There was also potential for second order effects operating through a lowering of GDP growth, payment and budgetary imbalances, as well as micro effects on local employment and domestic remittances. In the immediate aftermath of the financial crisis, i.e., in Fiscal Year (FY) 2009, Bangladesh's GDP, export,

and import growth all fell, while ODA, FDI, and remittances grew strongly (Bhattacharya et al., 2012). Real GDP grew at an annual rate of 5.7 percent during FY2009, a 0.6 percentage point lower than the average of the previous two years. Exports and imports grew at an annual rate of 10 and 4 percent respectively in FY2009, as opposed to 16 and 26 percent in FY2008 (Bhattacharya et al., 2012). The growth rates of ODA, FDI, and foreign remittance inflows were 20, 25, and 62 percent respectively in FY2009 compared to 3.6, 24.5, and -3 percent in FY2008. A combination of strong remittances, fairly resilient exports, and weak imports resulted in a record current account surplus of 3 percent of GDP in FY2009 (Bangladesh Bank, 2012).

However, low import volumes negatively affected government revenue leading to a budget deficit of 4 percent of GDP in FY2009. Lower revenue collection weakened the government's ability to finance the expansionary fiscal policies that were rolled out to insulate the domestic economy from the negative effects of the global crises. In addition to cash incentives to export-oriented small and medium sized enterprises, increased access to agricultural credit, and diesel and fertilizer subsidies, the most costly fiscal measure undertaken during the crises periods was the Public Food Distribution System (PFDS) which assisted 30 million poor and vulnerable people throughout the country in FY2008 (Demeke et al., 2009). The PFDS's assistance was administered through various social safety net schemes including 'open market sales', 'vulnerable group development', 'vulnerable group feeding', and 'food for work'. Aside from the open market sales, the other safety net schemes did not generate income and thus required a constant flow of public money. As a result, these support programs faced significant financing challenges in the face of shrinking government revenues and a widening budget deficit.

3. Data

We used the longitudinal household income and expenditure survey (HIES) data from the Chronic Poverty and Long Term Impact Study in Bangladesh, collected by the International Food Policy Research Institute (IFPRI) (IFPRI, 2012). This dataset covers the period from 1996–2010 and includes over 1,810 households from 12 districts across Bangladesh. The panel survey builds on two separate, yet related, impact evaluation studies: (i) the introduction of new agricultural technologies in 1996/97; and (ii) the provision of food or cash for education (FFE/CFE) in 2000. Around 1,000 households from 4 districts were interviewed for Study 1 and 600 households from 10 districts were interviewed for Study 2. The household and village samples were not selected to be strictly representative of rural Bangladesh although the sample is reasonably large and covers a significant portion of the country (Appendix A). In 2006/07, the samples of studies 1 and 2 were linked through a joint follow-up survey that targeted all baseline households (excluding 2 districts of Study 2) as well as local split-off households. An additional follow-up of the 2006/07 surveys was conducted in 2009/10 using the same approach. These two subsequent survey rounds (i.e., 2006/07 and 2009/10) were used in the present study by constructing a longitudinal data set in which the 2006/07 survey round served as the baseline.

The HIES questionnaires included standard modules on food and non-food expenditure, land and non-land assets, income, employment, remittance flows, out-migration, and negative and positive shocks. In addition, the 2009/10 survey round included an additional module on self-assessed food security (see Appendix B). This type of subjective-qualitative technique is commonly used in combination with standard objective-quantitative indicators such as anthropometry, food consumption, income, and wealth. Such practices aim to capture the multi-faceted nature of the food security concept (FAO, 2003). Conceptually, food security is

considered to have four distinct but overlapping dimensions—availability, access, utilization, and vulnerability (FAO, 2006). Availability refers to the total available food supply through domestic production or imports. Accessibility refers to the monetary and non-monetary resources needed for acquiring the appropriate foods for a nutritious diet. The utilization dimension emphasizes the importance of non-food inputs in food security such as clean water, sanitation, and health care. While vulnerability (also known as stability) refers to the risk of losing access to food in the future due to sudden shocks in food supply (e.g., an economic or climatic crisis) or cyclical events (e.g., seasonal food insecurity).

A large variety of qualitative and quantitative indicators and measurement methodologies are applied in the literature to assess the four dimensions of food security. A considerable debate persists about the superiority of qualitative versus quantitative measures in the face of their weak empirical correlation (Migotto et al., 2006). Research has shown, for example, that subjective indicators are susceptible to overestimation bias (Devereux, 2003; Heady, 2013). In particular, the simple and widely used consumption adequacy questions (i.e., 'Concerning your family's food consumption over the past one month, which of the following is true? (i) Less than adequate; (ii) Just adequate; (iii) More than adequate), were found to depend on a household's position in society relative to others and the respondent's perception of the household's changing status over time. Despite concerns over such biases, subjective food security indicators have gained popularity due to their relatively low procurement cost compared to time-consuming expenditure or anthropometric data (for example USDA, 2005). Proponents of subjective indicators claim that the biases can be eliminated by developing sophisticated context-specific modules through in-depth research and extensive field testing (Migotto et al., 2006; USDA, 2005).

In light of these concerns, the subjective food security module used in the IFPRI 2009/10 survey clearly goes beyond the simple consumption adequacy format. The first five questions of the module attempt to identify the month and year of the worst incidence of food shortage experienced by the household during 2007–2009. Food shortage is characterized by an event triggered by the absence of both food and financial reserves. Once the timing of the worst episode is identified, a set of follow-up questions were asked about the quality and quantity of foods consumed during the worst incidence of food shortage to gather some objective perspective of the event.

In addition to the self-assessed indicators, the dataset includes a range of quantitative indicators that are commonly used as measures of objective food security (or accessibility), such as income and expenditures (Migotto et al., 2006). These indicators are also frequently used as measures of economic well-being (or welfare) (Meyer and Sullivan, 2003). For both food accessibility and welfare measures, expenditure is preferred over income since it is less vulnerable to under-reporting bias and temporary fluctuations due to transitory events (Meyer and Sullivan, 2003). Further, expenditure can be divided into food and non-food items and therefore, provides a clearer picture of food accessibility than income. The panel nature of the data offers the opportunity to compare the pre- and post-crises expenditure profiles of the sampled households and thereby evaluate the longer-term impacts of the crises in terms of changes in households' welfare status.

The longitudinal HIES data was combined with observed retail food prices in 2007–2009. We collected spatially disaggregated monthly retail price data from the record of the Department of Agriculture Marketing of the Ministry of Agriculture, Government of Bangladesh (2013). This department is responsible for procuring wholesale and retail prices of the key agricultural commodities from local markets on a daily basis.

4. Descriptive Statistics of the Key Indicators: 2007–2009

4.1. Food Prices in the Study Areas

Figure 1 presents the price trends of the four most commonly consumed food commodities that are important sources of macronutrients in Bangladesh. Rice is the major source of carbohydrate, while lentils (Masoor and Kheshari are superior and inferior varieties of lentil, respectively) and soybean (oil) are important sources of protein and fat. The average price of (coarse) rice was 50 percent higher in 2008 compared to 2007. The price of soybeans was 30 percent higher in 2008 than the 2007 price level. Prices of Masoor and Khesari increased by 30 and 70 percent respectively in 2008. Although prices of rice and soybean returned to 2007 levels by 2009, the Kheshari price remained substantially higher and the Masoor price showed no sign of stabilization. As expected, the price trends of these four commodities were significantly positively correlated, reflecting a strong synchronicity in their upward and downward movements (rice and soybean: r=0.90, p<0.001; rice and Khesari: r=0.53, p<0.001; rice and Masoor: r=0.30, p<0.001). Commodity prices varied across districts. In particular, the mean and median prices of rice in the two north-western districts (Nilphamari and Naogaon) were significantly lower than the rest of the districts included in the study (Mann-Whitney U test, p<0.008).

INSERT FIGURE 1 HERE

4.2. Sampled Households' Remittance Income

Inflows of remittances (cash and in-kind) increased during 2007–2009 both in terms of the number of recipient households and their size. However, the growth rate was lower in 2009 compared to 2008. The number of households receiving remittances increased from 14 percent in 2007 to 18 percent in 2008 and 21 percent in 2009. The average remittance size

increased from Tk. 62,000 (US$895) in 2007 to 66,000 (US$964) in 2008 and 2009. The total volume of cash and in-kind remittances in 2007 was approximately Tk. 18 million (US$265,000). This increased by 60 percent (Tk. 29 million or US$424,000) in 2008 and 20 percent (Tk. 35 million or US$508,500) in 2009. The sources of remittances were migrant family members living inside and outside the country. While a majority of households received remittances from domestic migrants, the proportion of households receiving foreign remittances grew from 37 percent in 2007 to 42 percent in 2008 and 46 percent in 2009.

4.3. Self-assessed Food Security

Almost half (45%) of the 1,810 households interviewed during the 2009/10 survey stated that they experienced food shortages at least once during 2007–2009. This number is consistent with the FAO estimate of 64 million food insecure people (43% of the total population) in Bangladesh in 2008 (FAO, 2009b). Almost two-thirds (63%) of the worst food crisis incidents occurred in 2008. A quarter of them took place in 2009 and the remainder (13%) occurred in 2007. Using 2007 as the base year, self-assessed food insecurity appears to be four times higher in 2008. The distribution of the stated food shortage incidences across years and months shows a clear pattern of seasonality around March–April and September–October (Figure 2). This pattern closely corresponds with the agricultural lean periods characterized by phases of fewer wage earning opportunities in rural areas. Seasonal unemployment can be more acute during the dry season lean period (i.e., March–April) than the wet season lean period (i.e., September–October) depending on the availability and cost of irrigation in different parts of the country.

INSERT FIGURE 2 HERE

Half of the affected households (20% of the sample) cut back the number of meals per day and over three quarters (31% of the sample) reduced the quantity of food per meal. These

findings were also consistent with the FAO estimates which suggested at least a third of the country's population were consuming less than the adequate amount of food in 2008 (FAO, 2009b). Around a third of affected households (30%) switched to less preferred foods 'sometimes' during the period, over a third (40%) consumed less preferred foods 'often' during the period, and 12 percent consumed less preferred food 'all the time'.

To develop an objective understanding of the extent of self-assessed food insecurity, we constructed a simple index combining the three food crisis indicators available in our data. First we computed the deviation between the number of meals consumed during a good month and the worst month. We then added the frequency at which the quantity and quality of meals was reduced. These two later indicators are qualitative measures with a range of five possible values: 0=never, 1=a few times, 2=sometimes, 3=often, 4=all the time. The sum of these three indicators generated an ordered 'severity index' which varied from 0 to 34. The distribution of the index across years and months (as shown in Figure 3) reveals that the greatest proportion of the worst food crisis occurred in 2008 and the nature of the crisis was significantly more severe than those of 2007 and 2009.

INSERT FIGURE 3 HERE

4.4. Coping Measures

Expenditure adjustment was the most commonly adopted coping measure found in the survey (78% of cases) followed by changing labor supply decisions (47% cases), i.e., working extra hours. An additional household member (who was not working before the crisis) joined the labor force in 10 (for female) and 20 (for male) percent of cases. Four percent of affected households took children out of school and sent them to work. Over two-thirds (69%) of affected households borrowed money from microfinance institutions, local money lenders, and friends and relatives. Forty percent of households depleted their savings and around a

quintile sold some of their assets. Over a quarter (28%) of affected households received help from the government and the local community during the crisis. Less than a third (28%) of affected households bought food from government-operated subsidized outlets. On average, each household accessed a subsidized outlet 12 times during the period (median=5), purchasing 13 kilograms of rice (median=5kg) during each visit. The most commonly stated reasons for not accessing subsidized outlets were that the outlet was too far (25%) and that there was a long queue (25%).

5. Explaining Variations of Self-assessed Food Security

In this section we identify the determinants of the stated responses of food shortages by testing the correlation with observed food prices, remittance flows, and other relevant explanatory variables. Our dependent variable is the response to the question relating to the year and month of the worst food shortage episode (see Question#5 in Appendix B). In the next sub-section we discuss the econometric model used to analyze the data followed by the estimation results in the succeeding sub-section.

5.1. The Econometric Model

The self-assessed food security question (#Q5) can be viewed as a multilayered nested choice problem (see Figure 4). The top level of the nest (Level 3) offers two choices as to whether food shortages were experienced during the period: *i=1(Yes), 2(No).* The second level (Level 2) offers three choices to those who chose *i=1 (Yes)* in Level 3 to indicate the year of the worst shortage, i.e., *j= 1 (2007), 2 (2008), 3(2009)*. The month of the worst food shortage is then selected in the final stage (Level 1). In our bimonthly setting, this level offers six choices: *k= 1 (Jan–Feb),……,6 (Nov–Dec)*. In total, each respondent had 19 alternatives to choose from. The probability of selecting one of the 19 alternatives can be estimated by modeling this problem in a discrete choice framework. A hierarchical or nested logit (NL)

model—an extended form of the widely used multinomial logit (MNL) model—is the most suitable technique to analyze such multilayered discrete choices. The advantage of the NL model over the simple MNL model is its ability to allow (or test) for the possibility that the standard deviations of the random and unobserved error components are different across groups of alternatives in the choice set (Hensher et al., 2005). The need for such a test or provision arises because the determinants of the choice of an alternative may not be fully captured by the observable components of the choice function. This situation is particularly relevant for our choice model because of the prevalence of the likely second order effects of the food and financial crises. Hence, it is important to allow the standard deviations of the unobservable components to vary across the crises by partitioning the elemental alternatives (i.e., the bimonths) across the years of the corresponding crisis (i.e., 2008 for the food and 2009 for the financial crisis).

INSERT FIGURE 4 HERE

In practice, the three-level NL model can be decomposed into three separate, yet linked, MNL models through Equation (1):

$$P_{(k,j,i)} = P_{k|j(i)} . P_{j|i} . P_i \qquad (1)$$

The probability of experiencing food shortages in general, P_i is modeled by the binary logit model. The second MNL model captures the conditional probability of experiencing a food shortage during a particular year $P_{j|i}$: 2007, 2008, or 2009. The conditional probability of the bimonth of the worst food shortage, i.e. $P_{k|j(i)}$, is the third MNL model.

The underlying structural model encompassing the discrete choice behavior is called the random utility maximization (RUM) model. Due to unobservable effects, utility (choice function in our case) is partitioned into an observable (V) and an unobservable part (ε) (for each alternative (k). Thus:

$$U_k = V_k + \varepsilon_k \quad (2)$$

Alternative 1 is chosen over alternative 2 if and only if:

$$U_1 > U_2 \quad (3)$$

Thus:

$$P(U_1) > P(U_2) \quad (4)$$

In a multilayered choice problem, it is assumed that the elemental alternatives (k) influence the choice of the composite alternatives, i.e. j and i. A NL model links the layers of the elemental and composite alternatives by an index known as the inclusive value (*IV*). *IV* is equal to the log of the denominator of the MNL model associated with the elemental alternatives. That is:

$$IV_j = log\ \{ exp(V_{Jan-Feb|j} + \ldots\ldots\ldots + V_{Nov-Dec|j})\} \quad (5)$$

This *IV* index is included in the choice function of the relevant composite alternative as an additional explanatory variable such that:

$$U_j = V_j + IV_j + \varepsilon_j \quad (6)$$

The parameter estimate of the *IV* index is the ratio of the scale parameters (λ) of the composite to the elemental alternatives (Hensher et al., 2005). The scale parameter is measured as $\lambda = \sqrt{\frac{\pi^2}{6\sigma_\varepsilon^2}}$ where pi-squared (π^2) is a constant and σ_ε is the standard deviation of the unobserved effects (ε). In the MNL model all the standard deviations (hence the scales) are constant (λ=1.283 for each alternative) and identically distributed. A NL model allows the scale parameter to vary thus allowing for the possibility of differences (or similarities) in the unobserved effects across groups of alternatives within a nest (Hensher et al., 2005). The test for differences in scales between the levels is the extent to which the scale parameters of elemental and composite alternatives are statistically different. If the parameter estimate of *IV* (i.e. λ_j) is equal to 1, then the variances at Levels 1 and 2 are equal. This means greater independence and less correlation among the alternatives for unobserved reasons.

5.2. Results

Table 1 (Model 1) presents full information maximum likelihood estimates of a three-level degenerate NL model as described in Figure 4. We also present the MNL results (Model 2) for comparison. The results were obtained using the NLOGIT Version 5 package. The first segment of Table 1 presents the factors that influenced the choice of the elemental alternatives, i.e. the bimonths. We estimated the following choice function:

$$U_k = \beta_1 \, Price_k + \beta_2 \, Lean\ 1_k + \beta_3 \, Lean\ 2_k + \varepsilon_k \qquad (7)$$

Where β_s are the coefficients to be estimated.

Price refers to the average bimonthly price of rice. Due to the high positive correlations between the food prices discussed in Section 4.1, we only used the price of rice in our model. The spatially segregated nature of the rice price data controls for the spatial heterogeneity of the shock, while the bimonthly price controls for its temporal dynamics. As expected, there was a significant positive relationship between rice price and the likelihood of selecting a bimonth in both Models 1 and 2, implying that higher rice price was a significant determinant of the stated food shortage regardless of the choice of econometric approach.

Lean 1 and *2* in Equation (7) are dummy variables which take the value 1 for dry and wet season lean periods respectively and zero otherwise. The estimated coefficients of both *Lean 1* and *2* in Model 1 were positive and significantly different than zero implying that, all else equal, the likelihood of experiencing a food shortage is significantly higher during these two phases compared to other times of the year. The coefficient of *Lean 1* is also significantly higher ($Z=35$, $p<0.001$) than the coefficient of *Lean 2* which implies that households are significantly more vulnerable to food shortages during the dry season than the wet season lean period.

INSERT TABLE 1 HERE

The second segment of Table 1 presents the factors that contributed to the choices of years. Annual remittance flows, unexpected positive events, and 'loss & damage' experienced due to negative shocks were the key independent variables for this segment of the model:

$$U_j = \gamma_1 Ln\,(Rem)_j + \gamma_2 Ln\,(Loss\&Dam)_j + \gamma_3 Positive_j + \gamma_4 IV_j + \varepsilon_j \qquad (8)$$

Where γs are the coefficients to be estimated. γ_4 is the scale parameter which is equal to $\frac{\lambda_{j|k}}{\lambda_k}$ where λ_k is set to 1 for all elemental alternatives irrespective of their location in a specific composite alternative (RU1 normalization). Unexpected positive events were accounted for by a dummy variable that represents events such as receiving an inheritance, a dowry receipt, an education stipend, or a new job. Negative shocks refers to economic loss and damage incurred due to covariate as well as idiosyncratic shocks such as income loss due to sickness or death of a family member, unforeseen medical expenses, dowry payments, death of livestock and poultry, and crop and non-crop damage caused by flood and non-flood events. The coefficients of remittance of all years are negative in both Models 1 and 2 implying that a higher remittance income during a particular year decreased the likelihood of experiencing starvation during that year. All the coefficients of remittance variables are significant at the one percent level in Model 2 while only the coefficient of Rem 2008 is significant at the five percent level in Model 1. The coefficients of loss & damage were significant determinants of choice for years 2008 and 2009 in Model 1. Positive event was a significant determinant of choice for years 2007 and 2009 in Model 2.

The final segment of Table 2 presents the determinants of household specific characteristics (at the baseline) of the choice of food shortage (=1) versus no food shortage (=0) by estimating the following equation:

$$U_i = \delta_1 Asset_i + \delta_2 Expenditure_i + \delta_3 Ag\ Land_i + \delta_4 Net\ Buyer_i + \delta_5 Occupation t_i$$
$$+ \delta_6 Female\ HH_i + \delta_7 Religion_i + \delta_8 Divisions_i + \delta_9 IV_i + \varepsilon_i \qquad (9)$$

Where δs are the coefficients to be estimated and $\delta_9 = \frac{\lambda_i}{\lambda_j / \lambda_k}$ is the scale parameter at Level 3.

Unlike Levels 1 and 2, the signs of the coefficients and their significance do not vary much across Models 1 and 2. The coefficients of per-capita (non-land) asset, expenditure, and cultivable land are negative and significant at the one percent level. This suggests that poorer households were significantly more likely to assess themselves as food insecure than other households. The coefficient of *Net Buyer* (i.e., the proportion of rice purchased from the market relative to home grown production) is significant and positive implying that lower food self-sufficiency increased the likelihood of being assessed as food insecure.

Self-assessed food security varied significantly across occupations. Households directly engaged in crop farming were significantly more likely to state themselves as food insecure compared to salaried individuals and traders, regardless of the nature of involvement (i.e., self-employed farmer, share cropper, or day laborer). *Divisions 1*, *2* and *3* are dummy variables representing the three coastal divisions of the country (Khulna, Chittagong, and Barishal). These variables capture unobserved inter-regional heterogeneities (e.g., level of government intervention, labor market efficiency, economic opportunities, and infrastructure) that affect food security. The mean value of these coefficients are significant and negative implying that households living in the coastal divisions were significantly less likely to assess themselves as food insecure compared to households living in the inland divisions (Dhaka and Rajshahi). Religion and gender of the head of the household (female=1, male=0) were not significant determinants of self-assessed food security.

λ_{2007}, λ_{2008}, λ_{2009} are the scale (or *IV*) parameters at Level 2. They are significantly different than zero but not significantly different than 1. This means that the choices among the elemental alternatives (i.e. the bimonths) in each nest (i.e. 2007, 2008, 2009) are completely independent of each other. In other words, there is no significant correlation between the

unobservable components of choices across alternatives. The scale parameter at Level 3 is also not significantly different than one. Although this implies that an MNL model would be as efficient as an NL model, the NL model appears to be superior than the MNL model with regards to model fit statistics (i.e. Log Likelihood values, Pseudo R-squared, and AIC). Further, the signs of some of the MNL estimated coefficients for the Levels 2 and 1 variables (Lean 2, Loss & Dam 2007, Loss & Dam 2009) are not theoretically consistent. This means that the NL model is also superior in terms of construct validity. Construct validity refers to the extent to which economic theory explains the variations in empirical behavior or choice.

Table 2 presents the price elasticity of food shortage, i.e. the percentage change in the probability of experiencing food shortage when rice price increases by one percent. The elasticities estimated from the NL model are between 2.6 and 4.6 percent (average 3.6%) as opposed to the MNL model which estimated elasticities of less than 2 percent.

INSERT TABLE 2 HERE

6. Welfare Consequences of the Food and Financial Crises

In this section, we examine the welfare consequences of the food and financial crises. The simplest way to assess welfare impacts is to compare the welfare outcome before (2006/07) and after (2009/10) between the affected and non-affected households. This is the well-known difference-in-difference estimate. Our key welfare outcome is household expenditure which is the sum of both food and non-food expenditures. These expenditures were adjusted for food and non-food inflation using the food and non-food CPI for rural areas (BBS, 2011). The expenditure data were further used to estimate head count poverty rates following the poverty line expenditure data released by the Bangladesh Bureau of Statistics (2011). Appendix C presents the food and non-food CPIs and the poverty line expenditures.

6.1. Pre- and Post-crises Food and Non-food Expenditures

Table 3 presents the average of per-adult (15+) equivalent pre- and post-crises expenditures of the overall sample. Figure 5 presents their (kernel density) distributions. Per-adult equivalent expenditures were compared instead of per-capita expenditures because of the large size of the infant population in the 2009/10 data. Between 2006/07 and 2009/10, the population size under four years grew by 250 percent in the sample. The outcomes of a comparison of per-capita expenditure were therefore likely to be dictated by the difference in the number of children per household rather than the impacts of the food and financial crises. As shown in Table 3, per-adult equivalent expenditure increased slightly in real terms after the crises. The overall increase, which is not significantly different than zero, was dominated by a significant increase in non-food expenditure and an insignificant decline in food expenditure. Disaggregating these changes across four mutually exclusive groups: (1) no food shortage during 2007–2009; (2) a food shortage in 2007; (3) a shortage in 2008; and (4) a shortage in 2009; reveals a similar trend in most cases (except for 2007), i.e., no significant change in the total or food related expenditures and a significant increase in the non-food expenditure. The trends across different groups were consistent for both means and distributions (see Appendix D).

INSERT TABLE 3 HERE

INSERT FIGURE 5 HERE

Although the average per-adult equivalent expenditures before and after the crises were not significantly different, the head count (upper) poverty rate increased significantly in the overall sample (Chi square=39, $p<0.001$) (Table 4). The percentage of households below the upper poverty line increased from 6 percent in 2006/07 to 17 percent in 2009/10. The highest increase in the poverty rate (17.8%) was in the group that experienced a food shortage in

2007. No significant difference in the poverty rate was observed across the other three groups.

INSERT TABLE 4 HERE

6.2. Determinants of Expenditure Growth

This section investigates the deterministic nexus of the 'food and financial crises and household welfare'. We define $lnE_{t+1,t}$ as the natural logarithm of per-adult equivalent expenditure in period t (i.e., 2006/07) and $t+1$ (i.e., 2009/10). $X_{t+1,t}$ is a vector of observed household characteristics that change between t and $t+1$. $F_{t+1,t}$ and $H_{t+1,t}$ are sets of variables representing the impacts of the food and financial crises respectively. μ is the unobserved household characteristics and η represents unobserved regional (structural) characteristics influencing the growth path. ϵ is idiosyncratic error. The standard solution to control for unobserved heterogeneity bias is to assume that they are not time varying. Therefore, they can be controlled with fixed household and regional effects. The difference-in-difference specification for expenditure growth equation thus takes the following form:

$$\Delta lnE_{t+1,t} = \alpha + \beta X_{t+1,t} + \theta F_{t+1,t} + \tau H_{t+1,t} + \mu + \eta + \epsilon_{t+1,t} \qquad (10)$$

in which $\Delta lnE_{t+1,t}$ is the expenditure growth and α, β, θ *and* τ are coefficients. An OLS regression approach was applied to estimate Equation 10. The results are presented in Table 5.

INSERT TABLE 5 HERE

The first section in Table 5 presents the mean coefficients of the variables representing the food security treatment. The mean coefficients of the dummy variables *FS 2007* and *FS 2009* are not statistically significant at the 10 percent level but negative implying that, on average, households who were food insecure in 2007 and 2009 experienced negative expenditure growth after the crises. Interestingly, the coefficient of *FS 2008* is positive although not

statistically significant indicating that, on average, those households who experienced acute food shortage in 2008 witnessed a positive expenditure growth. The variables *Loan* and *Asset Sale* are dummy variables representing food crisis coping measures. The mean coefficient of these variables is not significantly different than zero either. Nevertheless, their signs deserve some attention. As expected, the mean coefficient of *Asset Sale* is negative, due to the detrimental impact of asset depletion on growth potential. Conversely, the mean coefficient of *Loan* is positive, refuting the conventional narrative about the negative effects of indebtedness on economic growth. *Remittance Growth* is the treatment variable for the financial crisis. The coefficient is positive implying higher remittance growth leads to higher expenditure growth. The coefficient is not significantly different than zero.

Female Head is a time varying household characteristic that controls for changes in the head of the household's gender between *t* and *t+1*. The household head's gender may change due to marriage/divorce or death of the previous household head. The mean coefficient of *Female Head* is negative and significant at the five percent level. This means that those households which had male heads at period *t* but female at period *t+1*, experienced a significantly lower expenditure growth. *Flood* and *Non-Flood Damage* control for covariate (flood and cyclone) shocks while *Medical Expense* refers to idiosyncratic shocks occurring between 2006/07 and 2009/10. The means of these coefficients are negative as expected (higher loss and damages leads to lower expenditure growth) but they are not significantly different from zero.

We also controlled for a large number of fixed (baseline) household characteristics (i.e., land and non-land assets, household head's age and education level, religion, occupation status, food self-sufficiency). Household head's age and female members' higher education were significant positive determinants of expenditure growth. In terms of occupation, agricultural laborers; salaried individuals; and households engaged in fisheries, livestock, and poultry

experienced significantly higher expenditure growth than traders and agricultural farmers. Finally, structural heterogeneity was controlled by using district dummies. The baseline district was Manikganj which was the closest district from the capital (50km). All of the district dummies were found to be significantly different than zero and negative (except for Jessore, the district bordering India).

7. Discussions and Conclusions

Our study contributes to the on-going intellectual debate over the 'nexus among the global food, financial crises, food security, and poverty' by presenting the first household-level survey-based evidence from one of the poorest countries in the world. We examined the contemporary narrative and its core economic arguments which claimed that the combined effects of the global food and financial crises increased food insecurity and led to deteriorating economic well-being in low-income countries.

Our findings reveal strong negative impacts of the global food price hike on household food security in the rural areas of Bangladesh in 2008. Both the nature and the extent of food insecurity were significantly more severe than the pre- and post-crisis years. In addition to the price shock, agricultural seasonality emerged as a strong predictor of the incidences of starvation in rural villages of Bangladesh. Thus, even in the absence of any price shock, rural households were at significant risk of experiencing hunger, particularly during the dry season lean period. This finding emphasizes the need for government interventions aimed at widening and deepening the social safety net programs in rural areas to curb seasonal food insecurity.

Remittance income was a significant determinant of self-assessed food insecurity in 2007, 2008 and 2009 in the MNL model. The NL model showed a significant relationship between remittance income and food security only for 2008. Since the NL model was proven to be the

superior model in terms of model fit statistics and construct validity, the evidence against the null hypothesis of 'no link between food security and financial crisis' appears to be rather weak. However, the significant negative relationship between remittance income and food insecurity in 2008 detected by the NL model supports the general argument of food insecurity being a likely second-order effect of the global economic downturn. Apparently, the negative effects of lower remittance growth in 2009 were somewhat diminished by the accompanying decline in food prices. Hence, the net effect on households' real income was perhaps not profound enough to generate a significant adverse impact on food security in 2009.

We found a significant deterministic relationship between food insecurity and the economic loss and damages caused by covariate and idiosyncratic shocks. This finding points out the absence of an effective risk sharing mechanism in the rural villages of Bangladesh. Despite Bangladesh's overwhelming success in microcredit over the past decades, the availability and penetration of microinsurance against covariate and idiosyncratic losses has been remarkably low. Even the insurable (idiosyncratic) risks are managed via informal social institutions through non-binding, reciprocity based contracts (Akter, 2012). These arrangements are evidently failing to smooth out consumption across good and bad years.

No statistically significant difference was identified in the distributions of pre- and post-crises expenditures and poverty incidences between households most and least affected by the crises. While post-crises poverty incidences were significantly higher than the pre-crises period, worsening poverty could not be attributed to the first order (e.g., food shortage, remittance growth) or second order (asset sale, indebtedness) effects of the global food or financial crises. This implies that although the immediate effects of the price hike on food security was unequivocally adverse, the relatively longer term consequences appeared to have

faded due to labor and commodity market adjustments, regional economic growth, and domestic policy responses.

The welfare impacts of the global food crisis were substantially different than their impacts on food security. The most important case of distinction was the heterogeneous impacts on different occupational and income groups. The direct and first-order impacts of the price shock (i.e., food shortages) were borne disproportionately by the poorer households and farming communities. However, in the longer term, as the labor, input, and commodity markets adjusted to the shock, the indirect and second-order impacts were redistributed more evenly across the rich and poor, and the occupational groups.

Agricultural laborers (who belonged to the poorest segment of society with the lowest average per-capita expenditure in 2006/07) and salaried individuals were among the winners as nominal wages increased by 40 percent against a 26 percent increase in commodity prices between 2006/07 and 2009/10 (BBS, 2011). Households engaged in fish, poultry and livestock industry were the biggest winners, witnessing the highest expenditure growth (15%) following a 47 percent increase in meat, dairy and fish prices between 2006/07 and 2009/10 (BBS, 2011). On average, self-employed farmers and share croppers witnessed positive post-crises growth although it was not significantly different than zero. This could be due to the higher agricultural wages and the sharp rise in fuel and electricity prices which resulted in a 50 percent increase in the cost of irrigation between 2005/06 and 2008/09 (IFPRI, 2012). The increased cost of production seemed to have overshadowed farmers' economic gains from increased agricultural commodity prices.

Regional differences were significant determinants of both food security and economic growth. These findings were expected given the inter-regional variations in growth and poverty profiles in Bangladesh (Zohir, 2011). The principal sources of regional differences

are geography, culture, politics, infrastructure and the communication network, political economy led biases in resource allocation, as well as development policy interventions among regions. Heterogeneity also prevails in regional labor markets in terms of the speed and magnitude of wage adjustments (Zohir, 2011). It is not surprising that these regional differences are manifested in heterogeneity in food security and economic well-being across regions. In particular, proximity to the national capital appeared to play a significant role in expenditure growth as closer proximity offered higher economic opportunities. Households who lived along the district bordering India (Jessore) also appeared to have benefitted from the spillover effects of the economic growth of the neighboring nation.

Finally, our study presents new empirical evidence in relation to the validity of qualitative indicators as a food security measure. The estimated NL model results present a construct validity test by examining the self-assessed indicator's correlation with theoretically expected explanatory variables. The results demonstrate strong evidence of construct validity as the coefficients of the explanatory variables had the theoretically expected signs and statistically significant values (in most cases). Furthermore, unlike previous studies, we did not find any evidence of an upward bias in our self-assessed food security indicator, as poorer households were significantly more likely to assess themselves as food insecure. These findings demonstrate that subjective indicators can be a valid measure of food (in)security, at least in an intra-country assessment context.

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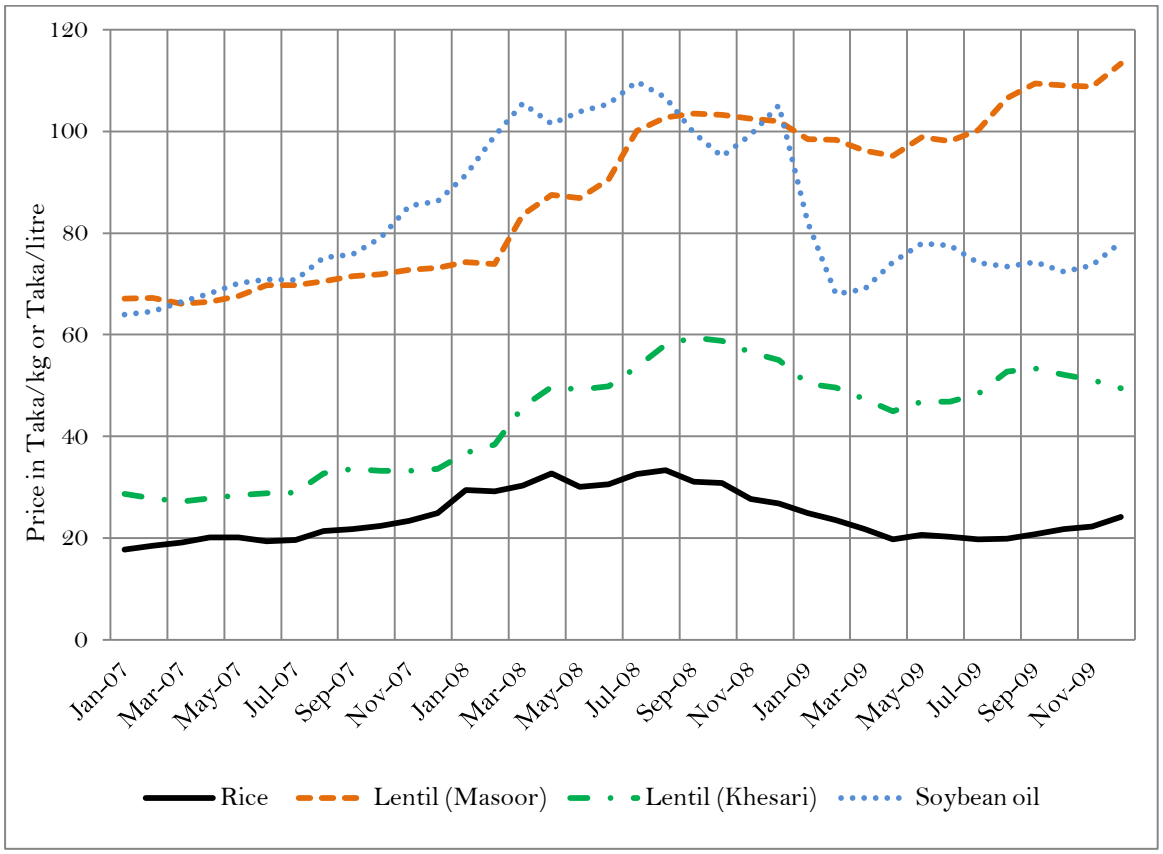
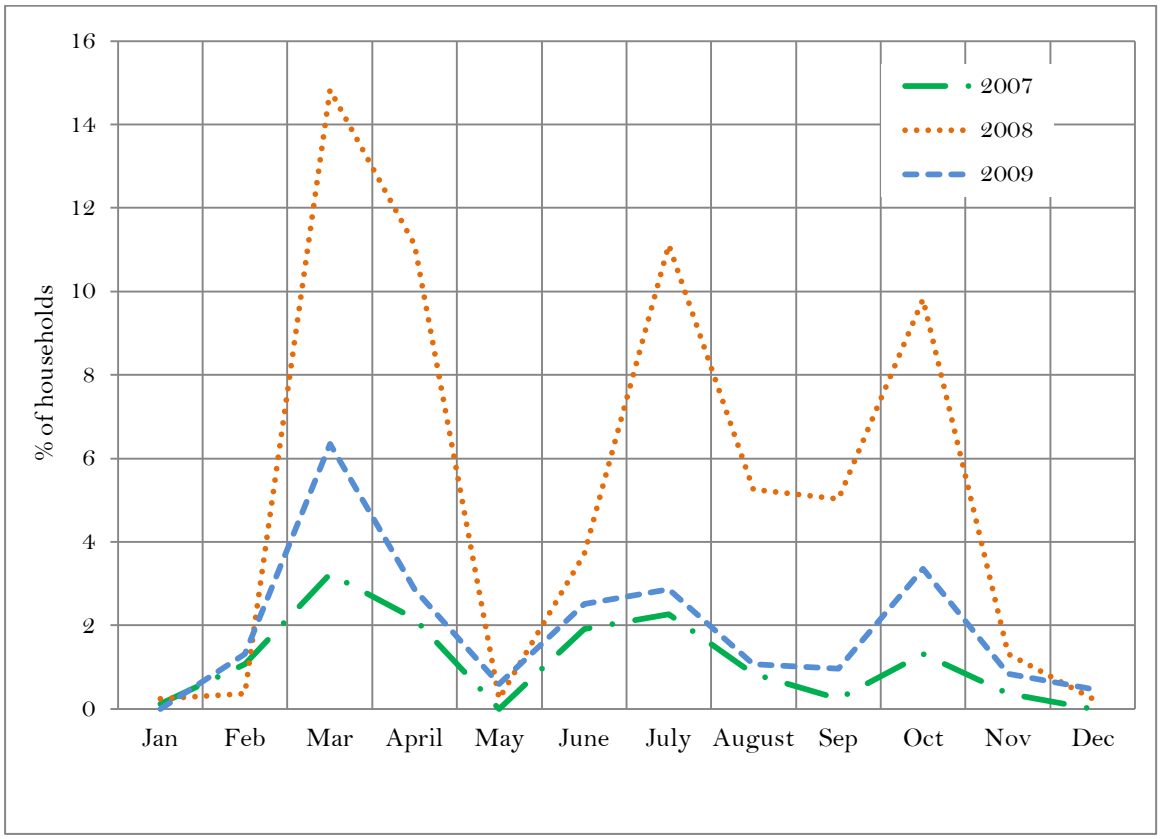
Figure 1. Food price trends during 2007–2009



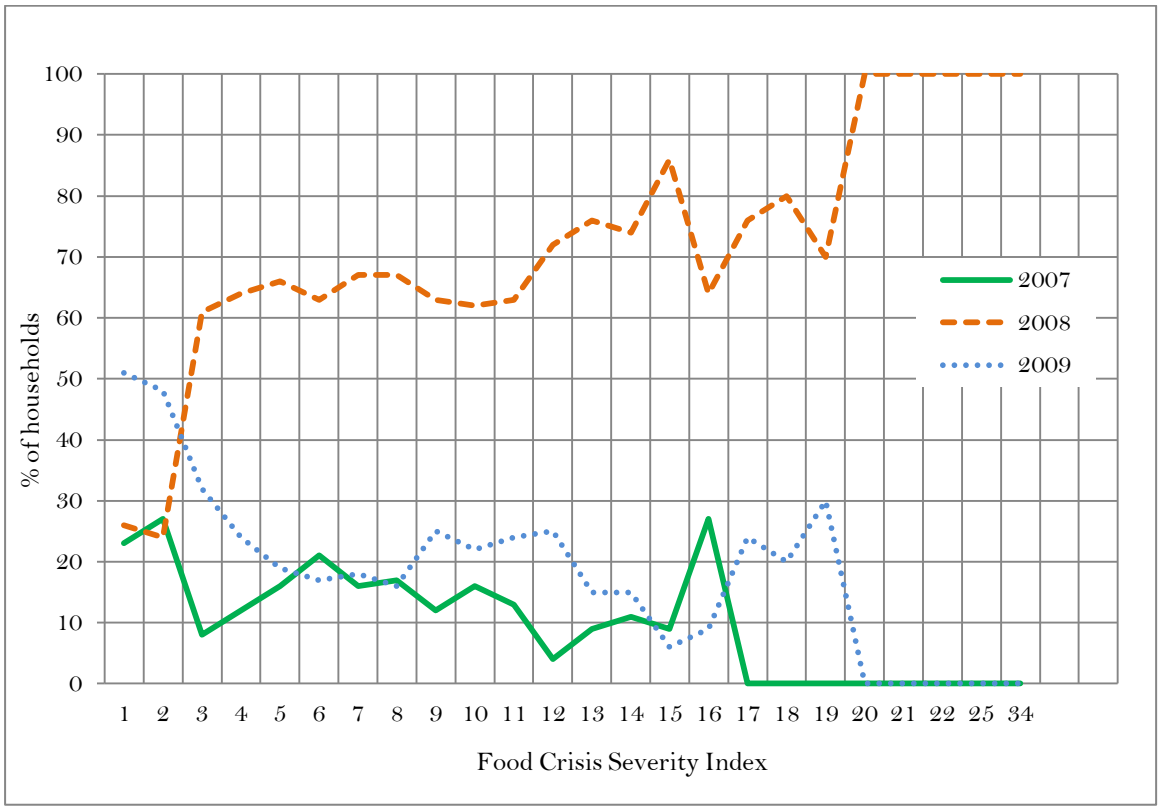
Source:
Department of Agriculture Marketing of the Ministry of Agriculture, Government of Bangladesh (2013)

Figure 2. Distributions of incidences of the worst food crisis across months and years



Source:
Household Income and Expenditure Survey data 2009/10 (IFPRI, 2012)

Figure 3. Distributions of food crisis severity across months and years



Source:
Household Income and Expenditure Survey data 2009/10 (IFPRI, 2012)

Figure 4. Descriptors for the three-level nested logit tree

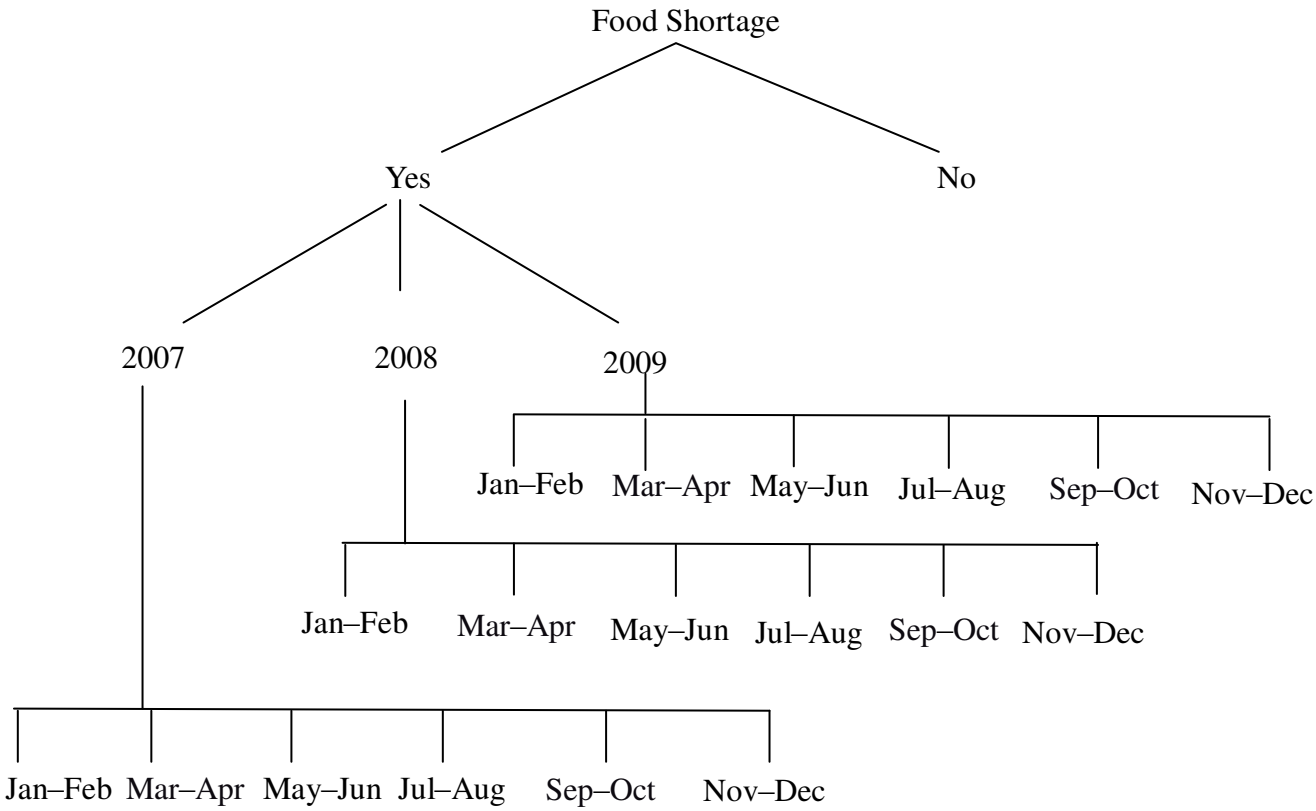
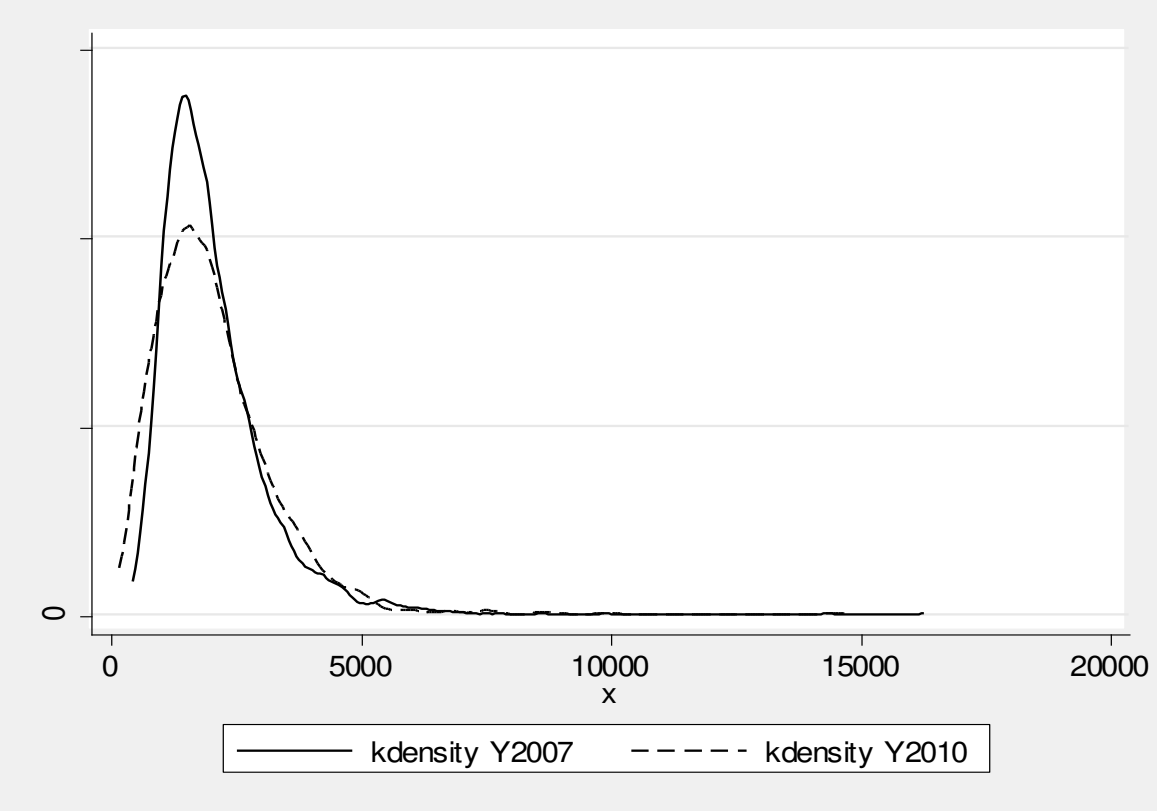


Figure 5. Kernel density estimation of per-adult (15+) equivalent monthly expenditures: 2006/07 and 2009/10



Notes:
Y2007= per-adult equivalent monthly expenditures 2006/07
Y2010= per-adult equivalent monthly expenditures 2009/10

Source:
Household Income and Expenditure Survey data 2006/07 and 2009/10 (IFPRI, 2012)

Table 1. Determinants of self-assessed food security: Nested and multinomial logit regression results

Explanatory variables		Mean Coefficient (Standard Errors)	
Names	Descriptions	Model 1: NL	Model 2: MNL
Level 1			
Price	Bimonthly average price of per kg rice from Jan–Feb 2007 till Nov–Dec 2009 (in Taka)	0.14*** (0.02)	0.06*** (0.005)
Lean 1	Dry season lean period (March–April=1, Otherwise=0)	1.40*** (0.08)	0.09 (0.06)
Lean 2	Wet season lean period (Sep–Oct=1, Otherwise=0)	0.73*** (0.10)	–0.63*** (0.08)
Level 2			
Rem 2007	Natural log of remittance income in 2007 (in Taka)	–0.034 (0.04)	–0.26*** (0.03)
Rem 2008	Natural log of remittance income in 2008 (in Taka)	–0.06** (0.03)	–0.13*** (0.015)
Rem 2009	Natural log of remittance income in 2009 (in Taka)	–0.04 (0.03)	–0.20*** (0.02)
Loss & Dam 2007	Natural log of loss and damage incurred due to negative shocks in 2007 (in Taka)	0.06 (0.04)	–0.09** (0.04)
Loss & Dam 2008	Natural log of loss and damage incurred due to negative shocks in 2008 (in Taka)	0.05** (0.02)	0.05*** (0.015)
Loss & Dam 2009	Natural log of loss and damage incurred due to negative shocks in 2009 (in Taka)	0.04* (0.02)	–0.06*** (0.02)
Positive 2007	Household experienced positive event in 2007 (Yes=1, Otherwise=0)	–0.57 (1.11)	–1.90* (1.03)
Positive 2008	Household experienced positive event in 2008 (Yes=1, Otherwise=0)	0.14 (0.36)	0.26 (0.27)
Positive 2009	Household experienced positive event in 2009 (Yes=1, Otherwise=0)	0.14 (0.34)	–0.60* (0.30)
Level 3(all variables measured at the baseline: 2006/07)			
Asset	Value of per-capita non-land asset (in '000 Taka)	–0.04*** (0.01)	–0.04*** (0.007)
Expenditure	Per-capita household expenditure (in '000 Taka)	–0.07*** (0.02)	–0.04*** (0.015)
Land	Size of cultivable land (in hectare)	–0.002*** (0.00)	–0.002*** (0.0007)
Religion	Muslim=1, Otherwise=0	0.004 (0.20)	0.12 (0.20)
Female Head	Female headed household (Yes=1, Otherwise=0)	-0.11 (0.18)	-0.05 (0.17)
Net Buyer	Proportion of food purchased from the market relative to home-grown production	0.64*** (0.13)	0.82*** (0.105)

Farmer	Self-employed farmer=1, Otherwise=0[a]	0.48***	0.58***
		(0.14)	(0.13)
Share Cropper	Share cropper =1, Otherwise=0[a]	0.91***	1.05***
		(0.23)	(0.22)
Day Laborer	Agricultural day laborer=1,	0.78***	0.90***
(Agri)	Otherwise=0[a]	(0.16)	(0.15)
Fish, Poultry	Fish, poultry and livestock farmers=1,	0.27	0.30
and Livestock	Otherwise=0[a]	(0.18)	(0.18)
Salaried	Salaried employment=1, Otherwise=0[a]	–0.40**	–0.37**
		(0.16)	(0.16)
Division 1	Barishal=1, Otherwise=0[b]	–1.31***	–1.44***
		(0.36)	(0.35)
Division 2	Chittagong=1, Otherwise=0[b]	–2.10***	–2.16***
		(0.29)	(0.29)
Division 3	Khulna=1, Otherwise=0[b]	–0.46***	–0.23**
		(0.14)	(0.116)
IV parameters	Wald test for IV parameter=1		
δ_9	Z=1.07 (p=0.14)	2.20	–
		(1.12)	
λ_{2007}	Z=0.74 (p=0.23)	1.71	–
		(0.96)	
λ_{2008}	Z=0.78 (p=0.21)	1.60	–
		(0.77)	
λ_{2009}	Z=0.81 (p=0.20)	1.77	–
		(0.94)	
Model fit statistics			
Log likelihood function		–3053	–8606
McFadden Pseudo R-squared		0.15	0.03
Observations (N)		1810	1810
AIC information criteria		6168	17265
AIC/N		3.41	10

Notes:
*, ** and *** denotes statistical significance at the 10%, 5% and 1% level, respectively.
[a] Baseline category = Traders
[b] Baseline category = Inland divisions (Dhaka and Rajshahi)

Table 2. Price elasticity of food insecurity[a] 2007–2009

Months, Year	Price elasticity NL Model	Price elasticity MNL Model
Jan–Feb, 2007	2.58	1.13
Mar–Apr, 2007	3.29	1.22
May–June, 2007	2.84	1.22
Jul–Aug, 2007	2.99	1.28
Sep–Oct, 2007	3.57	1.42
Nov–Dec, 2007	3.73	1.51
Jan–Feb, 2008	4.08	1.78
Mar–Apr, 2008	4.41	1.87
May–June, 2008	4.15	1.80
Jul–Aug, 2008	4.61	1.96
Sep–Oct, 2008	4.29	1.93
Nov–Dec, 2008	3.84	1.69
Jan–Feb, 2009	3.75	1.54
Mar–Apr, 2009	3.57	1.32
May–June, 2009	2.95	1.28
Jul–Aug, 2009	2.88	1.25
Sep–Oct, 2009	3.29	1.36
Nov–Dec, 2009	3.45	1.44

Note:
[a] Price elasticity of food insecurity refers to the change in the probability of experiencing food shortage for 1% change in rice price (all else equal).

Table 3. Per-adult (15+) equivalent monthly expenditures in 2006/07 and 2009/10

	Mean 2006/07 (Taka (US$))	Mean 2009/10 [deflated] (Taka (US$))	Difference in means[a]
Full Sample (N=1810)			
Total expenditure	2078 (30)	2096 (30.38)	18 (0.38)
Food expenditure	1488 (21.6)	1467 (21.3)	–21 (–0.30)
Non-food expenditure	589 (8.54)	629 (9.11)	40 (0.58)***
Households with No Food Shortage (N=1000)			
Total expenditure	2270 (34.35)	2320 (33.60)	–50 (–0.72)
Food expenditure	1589 (23.03)	1593 (23.10)	10 (0.07)
Non-food expenditure	681 (9.87)	726 (10.52)	45 (0.65)**
Households Experienced Food Shortage in 2007 (N=107)			
Total expenditure	1814 (26.30)	1714 (24.85)	–100 (–1.5)
Food expenditure	1330 (19.30)	1237 (18)	–93 (–1.35)
Non-food expenditure	484 (7)	477 (6.90)	–7 (–0.10)
Households Experienced Food Shortage in 2008 (N=515)			
Total expenditure	1786 (25.88)	1792 (26)	6 (0.12)
Food expenditure	1328 (19.25)	1302 (18.90)	–26 (–0.40)
Non-food expenditure	457 (6.60)	490 (7.10)	33 (0.5)**
Households Experienced Food Shortage in 2009 (N=191)			
Total expenditure	2004 (29)	1968 (28.5)	–36 (–0.5)
Food expenditure	1481 (21.5)	1383 (20)	–98 (–1.4)
Non-food expenditure	524 (7.60)	585 (8.5)	61 (0.90)**

Notes:
*, ** and *** denotes statistical significance at the 10%, 5% and 1% level, respectively.
[a] Paired *t*-test.

Source:
Household Income and Expenditure Survey data 2006/07 and 2009/10 (IFPRI, 2012)

Table 4. Poverty dynamics between 2006/07–2009/10 (% of households below the upper poverty line)

	Poor in 2006/07	Out of Poverty in 2009/10	Became poor in 2009/10	Total poor in 2009/10	Difference in poverty
Full Sample (N=1815)	6.20	3.80	14.60	17.00	10.70
No Food shortage (N=1000)	3.50	2.50	12.80	13.80	10.30
Experienced food shortage in 2007 (N=107)	8.20	2.80	20.60	26.20	17.80
Experienced food shortage in 2008 (N=515)	11.00	6.80	17.80	22.00	11.00
Experienced food shortage in 2009 (N=191)	6.30	3.10	11.50	15.00	8.40

Source:
Household Income and Expenditure Survey data 2006/07 and 2009/10 (IFPRI, 2012)

Table 5. Determinants of per-adult (15+) equivalent expenditure growth

Explanatory variables		Mean Coefficient (Standard Error)
Name	Description	
Indicators of Global Food Crisis		
FS 2007	Households experienced acute food shortage in 2007 (Yes=1, Otherwise=0)[a]	–0.09 (0.06)
FS 2008	Households experienced acute food shortage in 2008 (Yes=1, Otherwise=0) [a]	0.007 (0.04)
FS 2009	Households experienced acute food shortage in 2009 (Yes=1, Otherwise=0) [a]	–0.05 (0.05)
Asset	Sold asset to cope with food crisis (Yes=1, Otherwise=0)	–0.06 (0.05)
Loan	Borrowed money to cope with food crisis (Yes=1, Otherwise=0)	0.04 (0.03)
Indicators of Global Financial Crisis		
Rem Growth	Growth in remittance income between 2006/07 and 2009/10 (in %)	0.005 (0.003)
Time-varying Heterogeneity		
Flood Damage	Flood related damage and losses incurred between 2006/07 and 2009/10 (in '000 Taka)	–0.01 (0.01)
Non-flood Damage	Damage and losses incurred due to reasons other than flooding between 2006/07 and 2009/10 (in '000 Taka)	–0.003 (0.004)
Medical Expense	Unforeseen medical expenses incurred between 2006/07 and 2009/10 (in '000 Taka)	–0.0002 (0.0004)
Female Head	Household head is female at t=1 but was male at t=0 (Yes=1, Otherwise=0)	–0.11** (0.05)
Fixed Heterogeneity (measured at the baseline: 2006/07)		
Age	Household head's age (in years)	0.002* (0.001)
Education	Head of household's education (in years)	0.001 (0.003)
Female Education	Highest education of female household member (in years)	0.013** (0.004)
Religion	Religion (Muslim=1, Otherwise=0)	–0.015 (0.05)
Land	Size of cultivable land (in hectare)	–0.0001 (0.0001)
Asset	Value of non-land asset (in '000 Taka)	–0.00001 (0.0002)
Net Buyer	Proportion of food purchased from the market relative to home-grown production	0.03 (0.03)
Farmer	Self-employed farmer=1, Otherwise=0[b]	0.04 (0.03)
Share Cropper	Share cropper =1, Otherwise=0[b]	0.07 (0.06)

Agricultural Day Laborer	Agricultural day laborer =1, Otherwise=0[b]	0.10**
		(0.04)
Fish, Poultry and Livestock	Fish, poultry and livestock farmer=1, Otherwise=0 [b]	0.15***
		(0.05)
Non-agricultural Day Laborer	Non-agricultural day laborer=1, Otherwise=0[b]	–0.003
		(0.05)
Salaried Employment	Salaried employment (Yes=1, Otherwise=0)[b]	0.10***
		(0.04)
	Fixed structural heterogeneity	
District 1	Pakundia =1, Otherwise=0[c]	–0.23***
		(0.06)
District 2	Sherpur =1, Otherwise=0[c]	–0.50***
		(0.07)
District 3	Madhupur =1, Otherwise=0[c]	–0.52***
		(0.06)
District 4	Gaffargaon =1, Otherwise=0[c]	–0.40***
		(0.05)
District 5	Jessore =1, Otherwise=0[c]	0.20***
		(0.04)
District 6	Nayagati =1, Otherwise=0[c]	–0.32***
		(0.07)
District 7	Agoiljhara =1, Otherwise=0[c]	–0.30***
		(0.10)
District 8	Hazigonj =1, Otherwise=0[c]	–0.20**
		(0.08)
District 9	Chakaria =1, Otherwise=0[c]	–0.25***
		(0.08)
District 10	Nilphamari=1, Otherwise=0[c]	–0.40***
		(0.07)
District 11	(Mohadevpur=1, Otherwise=0)[c]	–0.30***
		(0.07)
Constant		–0.15**
		(0.06)
Model fit statistics		
R-squared		0.18
Adjusted R-squared		0.16
Observations		1808
F(*df*=34)		11
		p<0.0001

Notes: *, ** and *** denotes statistical significance at the 10%, 5% and 1% level, respectively.
[a] Baseline category = no food crisis.
[b] Baseline category = Traders.
[c] Baseline category = Manikganj (the closest district from the capital Dhaka)

Appendix A. Distribution of the sample across districts and survey rounds

		Number of households	
	Districts	2006/07	2009/10
FFE/CFE Study[a]	Nilphamari	70	82
	Naogaon	66	67
	Sherpur	71	73
	Tangail	67	65
	Narail	64	68
	Barishal	58	56
	Chandpur	58	56
	Cox's Bazar	58	58
MCG Study[b]	Manikganj	409	438
	Mymansingh	166	187
	Kishorganj	214	246
	Jessore	448	458
	Total 2006/07	1748	1853
	Dropped out	-71	
	Split	139	
	Total 2009/10		1816

Source:
Household Income and Expenditure Survey data 2006/07 and 2009/10 by the International Food Policy Research Institute (IFPRI, 2012)
Notes:
[a]Impact evaluation study on 'food/cash for education'.
[b]Impact evaluation study on 'agricultural technology adoption'.

Appendix B. Self-assessed food security module used during the 2009/10 survey round

Section xx. Consumption patterns since the last survey round
Administer this to the female respondent
Respondent ID:____

1. Are there any months in a **typical year** when the household runs out of food AND money to buy food? *[WE ARE INTERESTED IN SEASONAL PROBLEMS, NOT EXCEPTIONAL YEARS, THE ISSUE IS TO KNOW WHEN STOCKS TYPICALLY GET DEPLETED.]* **Code (a)** *IF YES, list all of the months in a typical year it usually happens. If NO, go to next question]*		Month [___] Month [___] Month [___] Month [___] Month [___] Month [___] Month [___] Month [___]	
2. How many months since 2007 did you have problems satisfying the food needs of the household?			
3. Did this happen in the last 12 months**? Code (a***) IF YES*, list the months during which it happened?		Month [___] Month [___] Month [___] Month [___] Month [___] Month [___] Month [___] Month [___]	
If No to 1, 2 AND 3, skip to next section			
4. In each of the following years, which month was the shortage of food most acute for your household? (*Record month as 1-12. If household did not experience any food shortage, skip to 7.)*	*2007* Month [___]	*2008* Month [___]	*2009* Month [___]
5. Of the three months mentioned above, which was the worst? *(Record month and year)*			
Questions 6-11d refer to the month and year identified as the worst in Question 4			
6. Compared to your usual diet, did you eat foods that you ordinarily would not eat, "less preferred foods"? **(Code b)**			
7. Compared to your usual diet, did you cut back quantities served per meal to adult males? **(Code b)**			
8. Compared to your usual diet, did you cut back quantities served per meal to adult females? **(Code b)**			

9. Compared to your usual diet, did you cut back quantities served per meal to boys **(Code b)**	
10. Compared to your usual diet, did you cut back quantities served per meal to girls **(Code b)**	
11a. During the worst month, how many times a day did adult males in your household eat?	
11b. During the worst month, how many times a day did adult females in your household eat?	
11c. During the worst month, how many times a day did boys or male children in your household eat?	
11d. During the worst month, how many times a day did girls or female children in your household eat?	
12a. During a good month, how many times a day did male adults in your household eat?	
12b. During a good month, how many times a day did female adults in your household eat?	
12c. During a good month, how many times a day did boys or male children in your household eat?	
12d. During a good month, how many times a day did girls or female children in your household eat?	

Source:
Household Income and Expenditure Survey data 2009/10 by the International Food Policy Research Institute (IFPRI, 2012)

Appendix C. Differences in distributions: Per-adult equivalent expenditures across different groups of households between 2006/07 and 2009/10

	Difference in distributions (Wilcoxon signed-rank)
Full Sample (n=1808)	
Monthly expenditure per capita	Z=0.8, p<0.50
Monthly food expenditure per capita	Z=1.2, p<0.25
Monthly non-food expenditure per capita	Z=5, p<0.001
No Food shortage (n=1000)	
Monthly expenditure per capita	Z=0.57, p<0.60
Monthly food expenditure per capita	Z=0.59, p<0.60
Monthly non-food expenditure per capita	Z=3.3, p<0.001
Experienced food shortage in 2007 (n=107)	
Monthly expenditure per capita	Z=0.16, p<0.90
Monthly food expenditure per capita	Z=0.55, p<0.60
Monthly non-food expenditure per capita	Z=0.90, p<0.40
Experienced food shortage in 2008 (n=515)	
Monthly expenditure per capita	Z=0.63, p<0.60
Monthly food expenditure per capita	Z=0.75, p<0.50
Monthly non-food expenditure per capita	Z=3.3, p<0.001
Experienced food shortage in 2009 (n=191)	
Monthly expenditure per capita	Z=0.55, p<0.60
Monthly food expenditure per capita	Z=0.51, p<0.60

Source:
Household Income and Expenditure Survey data 2006/07 and 2009/10 by the International Food Policy Research Institute (IFPRI, 2012)

Appendix D. Poverty line expenditures and food and non-food CPI

	2006/07	2009/10
Upper Poverty Lines Expenditures for Rural Areas		
Food poverty Line	Tk 636 (US$9)	Tk 953 (US$14)
Non-Food allowance	Tk 323 (US$5)	Tk 358 (US$5)
Upper poverty line	Tk 959 (US$14)	Tk 1311 (US$19)
Consumer Price Index, Rural (Base : 1995-96=100)		
General	177	223
Food, beverage and tobacco	182	236
Non-food	169	202

Source:
Household Income & Expenditure Survey (BBS, 2011)