Rising Food Price, Asset Transfers, and Household Food Security

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Abstract

We study the role of food price rising and income generating assets as determinants of household food insecurity among the extreme poor in rural Bangladesh for the period 2002-2011. We do so in the context of an anti-poverty program, targeting the ultra-poor (TUP), which transferred productive livestock assets to the very poor. We find a positive significant impact of the asset transfers on household's food security irrespective of whether we use subjective or objective measures of food security. Most importantly we find that the long-term impact of the program (estimated over 2002-2011) is smaller compared to mid-term (2002-2008) and short-term (2002-2005) impacts for all the indicators. We test whether this declining program impact is driven by the steep rise in food prices in the post-2007 period. We find that in the pre-crisis period participant households benefited while in the post crisis period they affected negatively by the price shock. This result explains the declining effect of TUP program. Our analysis therefore illustrates how the external shocks can undermine the effectiveness of an otherwise well-functioning anti-poverty program.

JEL classification: O12; I30; D50

Keywords: food price rise, food security, livestock assets, poverty.

1. Introduction

Following the rise in food prices between 2005 and the first half of 2008 and the subsequent outbreak of food riots, food insecurity has played an important part in the poverty policy agenda of national and international development agencies around the world. It is estimated that around 80 million additional people became food insecure from 2007 to 2008 (Shapouri, 2009) and around 100 million people pushed into hunger (FAO, 2009a) following the crisis. Yet the status of food security among the extreme poor, households depend on irregular income from low pay daily wage labor and distress occupation (e.g. begging), are headed by often headed by females, and have limited productive assets, during the period of rising food prices has received limited attention from researchers. Irrespective of rising food prices and their implications for the very poor, food security remains an important global issue given the growing world population. With the number of undernourished people already exceeding 1 billion, ensuring food security requires a comprehensive approach to dealing with poverty in general (Charles et al., 2010). To this end, knowledge of performance of anti-poverty schemes in terms of impact on food security during times of rising food prices is important. Some researchers have used cross-country and national household survey data to investigate the impact of the crisis on households and the economy (Ivanic and Martin, 2008; Aksoy and Dikmelik, 2010; Prevel et al. 2012; D'Souza and Jolliffe, 2012a; 2012b; Miah et al. 2012; Verpoorten et al. 2013; Headey, 2013; Akhter and Basher, 2014). However, research on food price as a determinant of food security among the extreme poor is rare, let alone in the context of established anti-poverty intervention.[a]

This paper contributes to the literature by exploring the link between village food prices and household food security in the context of an anti-poverty scheme in Bangladesh. We estimate the long-run effect of asset transfer over the period 2002-2011 and evaluate the program effect in the context of food price shock. The program was particularly designed to improve food security among the very poor by means of transfers of productive livestock assets (e.g. cow, goats, chicken and etc.). In addition, basic entrepreneurship training was provided so that households could move out of low pay agricultural work into sustainable (livestock based) microenterprises. The first phase of the program was introduced in 2002 by BRAC. We use panel data on phase 1

[a] An exception is Cudjoe, Breisinger, and Diao (2010) who study the impact of food price for various household groups in Ghana. They find that the poorest of the poor, particularly those living in the urban areas, are hardest hit by high food prices.

program beneficiaries who are tracked along with non-program participants from the same villages over time. We measure food security using objective indicators of food security such as food expenditure, dietary diversity score and calorie intake along with a subjective assessment of food security status.

We use four round survey data (2002, 2005, 2008 and 2011) for subjective indicators of food security and three round survey data (2002, 2008 and 2011) for objective indicators. The treatment households are those who participated in TUP program and control households are those were willing to participate in the program but dropped out because of ineligibility. Control households are initially better off in terms of baseline characteristics than the treatment households which potentially raise the possibility of selection bias. We use multiple econometric methods to assess the impact of TUP program on household food security including difference in difference (DID), Difference in difference matched sample, the minimum-biased (MB) estimation following Millimet and Tchernis (2012).

We find that TUP program has significant positive effect on household's food security irrespective of the indicators. Most importantly we find that the long-term impact of the program (estimated over 2002-2011) is smaller compared to mid-term (2002-2008) and short-term (2002-2005) impacts for all the indicators. This pattern of declining program impact is also mirrored in changes in household livestock assets, land holding and their occupational shift, self-employment to wage labour.

We test whether the declining program impacts are caused by this is owing to the steep rise in food prices in post-2007 period. We used regression framework using pre-crisis period (2002-2008) and post-crisis period (2008-2011) data separately to assess whether food price shock effects TUP program participants households in a different way than non-TUP households. We find that in the pre-crisis period TUP households benefited while in the post crisis period they affected negatively by the price shock. This result explains the declining effect of TUP program. Our analysis therefore highlights the role of external shocks that can undermine the effectiveness of an otherwise well-functioning anti-poverty program. At the same time the research underscores the need to study poverty programs over the long-run to fully understand the circumstances in which program impact can be sustained.

The rest of the paper is organized as follows. Section 2 discusses the literature on the determinants of food security in low income country and then describes BRAC's asset transfers

program. We explain the selection criteria of program participants and the intervention package. Section 3 describes the sample and the measures of food security that we use, and presents the descriptive statistics of the key variables included in the analysis. The empirical strategy is also discussed in this section. The results are presented in Section 4. We conclude in Section 5.

2. Background

2.1. Literature review: food prices and food security among the poor

The poorer households suffer most to the effect of adverse economic shocks (Morris et al., 2002; Little et al., 2006). They are forced to sell tangible assets and experience large fall in income (Morris et al., 2002; Elbers et al., 2007; Thomas et al., 2010) which also undermine their investment in health, nutrition and education and lead to long term poverty (Hoddinott 2006; Hoddinott and Quisumbing 2003) and others cut consumption to protect valuable assets (McPeak, 2004; Carter et al., 2007) and/or withdraw children from school (Tran, 2013). Since the poor households typically have no financial savings at home, in addition to increased work hours poor households need loans from formal and informal sources (Kochar, 1999; Kazianga and Urdy, 2006 in Tran, Q.V. 2013). For extreme poor households that spend the majority of their budgets on food, large increases in food prices erode purchasing power, threatening their nutrition and health (D'Souza 2011). Therefore recent research on the household level impact of the high food prices has focused either on their effect on the poverty headcount and poverty gap (Ivanic and Martin, 2008; De Hoyos and Medvedev, 2008), or use cross-section data to look at the short-term change in welfare following an increase in tradable staple food prices (e.g. Zezza et al. 2008).[b]

Zezza et al. (2008) use Living Standard Measurement Study (LSMS) survey data from 11 countries and find that poor consumers lose more than the rich following food price rise while poor food producers gain less than rich farmers. They also find female headed households to be particularly hard hit. In particular, households in the lowest expenditure quintiles, households with little land and education, and larger households are found to be systematically associated with larger estimated percentage losses from rising food prices. Similarly De Hoyos and Medvedev (2008) analyse the impact of 2007-08 food price hike for a large number of

[b] Among others, Ahmed (2008) report exploratory evidence using aggregate data on the poverty impact for South Asian countries.

developing countries. However, they find that in 60% of the country sample, higher food price has little effect (impact less than 0.2%) on poverty headcount.[c] In about a one third of countries, impact is higher than 0.2%. They find the worst affected countries are predicted to be Indonesia, Yemen, Ethiopia, Pakistan, and Bangladesh, with more than 3.5% increases in headcount poverty.

Impact heterogeneity may be also driven by to geographic and location specific factors. Akramov, Yu, and Fan (2010) find that mountainous regions are likely to have lower food security. Among 22 countries identified by FAO as highly affected by the 2008 food crisis, many have significant mountain populations (FAO 2008a). Analysis of cross-country data confirms that mountainous countries are especially vulnerable to external shocks such as surges in global food prices (Akramov, Yu, and Fan, 2010). The findings suggest that people in remote and isolated communities are especially affected by external shocks such as surges in global food prices. Given the sizable impact of the crisis on national poverty, it is plausible to expect a significant on household level food security among the very poor, however empirical evidence is mixed. For example, the short-term impact of rice price increase on the net income of households is considered to be to negative particularly for households in bottom quintile's of income (FAO 2008b). D'Souza and Jolliffe (2012a) find that households who were able to cut consumption reduced their consumption 2.5 times higher than households who has inelastic demand of food in Afghanistan. They also find that food insecure households sacrifice quality (dietary diversity) for quantity (calorie intake). However, using panel dataset from China, Jenson and Miller (2008) find the impact of price increase is to be small. They attribute this to the fact that households are able to substitute cheaper items and domestic staple food price remained low due to government intervention.

Reliable evidence on the impact of food price rise on the very poor Bangladeshi households is limited. Miah et al (2010) find that food security of the ultra-poor households worsend following the food price increases as households consume less amount than before and switch to inferior quality food. Bouis (2008) find that a 50 percent increase in food prices in Bangladesh leads to iron intake decline among women by about 30 percent. As part of their multi-country study,

[c] These estimates are obtained by combining household survey data with a general equilibrium model.

Zezza et al. (2008) estimate the consumption cost of an increase in the price of rice equal to 1.6 percent of total expenditure in rural Bangladesh. Impact is found to be largest on the poorest (i.e. bottom 20 percent of income quintile) households. Balagtas et al. (2014) assessed the effects of the dramatic rise in agricultural commodity prices during 2007-2008 on income dynamics and poverty among rural households in Bangladesh using a nationally representative longitudinal survey of rural households in Bangladesh collected in four waves in 1988, 2000, 2004, and 2008. They mentioned that the price of a balanced basket increased by more than 50 percent during the period from 2000 to 2008 while households income increased by only 15 percent. As a result the incidence of poverty reached its average to pre-2000 level during 2004-2008.

It should be noted that most of the available research on food security focuses on the current state of poverty and/or food insecurity instead of investigating the long-term impact. In addition, it is misleading to treat food security as a fundamental need, independent of wider livelihood considerations (Maxwell and Smith, 1992). People may go hungry during a shock (e.g. a sudden rise in price of staples) to protect valuable assets. Therefore it is important to study food security in the context of livelihood security. De Wall (1991) argue that people are quite prepared to put up with considerable degrees of hunger, in order to preserve seed for planting or avoid having to sell an animal. Similarly Corbett (1988) finds that preservation of assets takes priority over meeting immediate food needs until the point of destitution, when all options have been exhausted. As vulnerability and risks faced by different livelihood groups and their coping strategies are different, it requires some sort of livelihoods approach to assess the food security. A livelihoods approach simply means interventions aimed at supporting livelihoods. On this basis, appropriate interventions need to be identified, ranging from income support program (such as food for work or its variant, cash for work) to a wide array of livelihood-support initiatives (such as agriculture support program, livestock support program or fishing support program). We discuss this further in the context of Bangladesh in the next section.

2.2. Study context – poverty and food security in Bangladesh

Bangladesh has made considerable progress in reducing income and food poverty over the past two decades. Extreme poverty in rural areas declined from 37.9% in 2000 to 21.1% by 2010 (World Bank, 2014). The observed decline in poverty has been partly due to a number of government and non-government interventions that succeeded in increasing agricultural production, improving access to finance, and directly assisting poor household's to escape extreme poverty through targeted programs. Despite this progress, about 18 percent of total population and 21 percent of the people in rural areas of Bangladesh still live below the lower poverty line (HIES 2010). Moreover, north-western part of Bangladesh suffers from seasonal hunger and extreme poverty. During the peak season (Boro season) households have better opportunity of employment than in the lean period driven by the seasonal nature of the agricultural production. As mentioned earlier, poor households in Bangladesh are also believed to have been badly hit by the global food price crisis. Particularly vulnerable are the ultra-poor households are headed by the women, widowed or abandoned. With little access to productive agricultural land, they remain net consumer of food. For these reasons, Bangladesh presents an interesting case study.

Although a large number of anti-poverty programs are in place in Bangladesh, there has been consensus that programs usually fail to reach the chronically poor (Matin and Hulme, 2003; Hashemi, 1997; Hulme & Mosley, 1996). Matin and Hulme (2003) also argue that although NGOs are committed to assisting the poorest households, in some cases they perform worse than the government. Husain (1998) finds that about 41 percent of the eligible households did not have any contact with local NGOs. Moreover, since many NGOs offer these services only with regular microfinance programs, extreme poor households also remain excluded from many social development services like health and education services because of their non-participation in microfinance activities (Rahman and Razzaque 2000).

The evidence from the household surveys does not indicate wide coverage of the SSNP programs in vulnerable regions. In the greater Rangpur region, for instance, one study finds only 10 percent of the poor households covered by various social safety net programs (Khandker et al,

2011). Only 11.58 percent in Rangpur, 1.69 percent in Kurigram and 1.67 percent of the households receive VGD and VGF cards. However, besides government programs, a large number of NGOs operate cash and in kind support schemes, particularly during the lean season. Overall their findings show that only 9.6 percent of the households get supports from various government programs while some 25.5 percent of the ultra-poor who are not beneficiaries of government scheme receives support from NGO operated programs. One such prominent program is the "Targeting the Ultra Poor" (TUP) scheme of BRAC.

2.3 Targeting the Ultra Poor" (TUP) scheme of BRAC:

The TUP program of BRAC builds on two decades of experience of the World Food Program and the Government of Bangladesh sponsored scheme to assist vulnerable families to address food security. The scheme, Income Generation for Vulnerable Group Development (IGVGD), was launched in 1986 where an integrated package of food distribution, savings, micro-credit provision and skill development training was provided to the extreme poor in Bangladesh (Halder and Mosley, 2004). Evaluation of this intervention showed that the impact was not sustainable (Hashemi, 2001; Matin and Hulme, 2003). BRAC responded by drawing up the TUP program the first phase of which was launched in 2002. The scheme targets the most vulnerable, asset-poor females which for years have been among the hardest to reach through conventional government schemes and microfinance interventions. The TUP scheme employs an effective targeting that relies on community based wealth ranking to identify the extreme poor. All the households meeting at least two of the inclusion criteria and none of the exclusion criteria are finally selected for programme participation (Annex table 2). A final round of verification is carried out by high level BRAC staff to generate the final list of households eligible for CFPR-TUP support. Similar to IGVGD, TUP adopts the approach of supervised 'graduation' from low-return livelihood strategy to income generating basic entrepreneurial activities.

This multi-component TUP program aims to improve the lives of the ultra-poor through provision of training on income generating activities to unskilled females along with a transfer of productive assets worth taka $125. Assets primarily take the form of live animals such as cows, goats and chicken. Supplementary program components include health supports, social awareness and a weekly stipend of $2.6. If any household loses assets due to various adverse consequences, a second round of support is provided (Annex table 3 explains all the component in details).

Hulme and Moore (2007) evaluate the impact of the TUP program. The authors find that while both program and non-program groups reported improvements in household livestock assets and food security, gains made by program households were significantly higher in both dimensions.[d] Other existing evaluations of the TUP programs confirm these results (see for instance Rabbani et al., 2006; and Ahmed et al., 2009). Emran, , Robano, and Smith (2014) analyses the impact of the BRAC's TUP program over 2002-2005 period and found a significant effect on food security, cash savings, livestock, housing, shoes and per capita income of the households. They found no significant effect in subjective health outcomes, productive assets, child labour and women empowerment. They used two subjective food security indicators, food security score and meals twice a day, for their analysis. Banerjee et al. (2015) evaluated similar integrated program in from 6 randomized control trail studies in different geographical and institutional context. They find a statistically significant cost-effective effect on consumption and psychological status of the targeted households. They also find that program impact last at least a year after the implementation ended.

All of these studies rely on data up to 2008 and therefore lacks post food crisis data. While they all report positive program impact on food security, none however focuses on the role of changing food prices. Although program as well as non-program households remain vulnerable to various crises, the former are expected to recover from shocks sooner given the expanded asset base. Krishna, Poghosyan, and Das (2012) evaluated the impact of TUP program over a six-year period (2002-2008). They found that impressive income gains have been achieved by the majority of program households, although negative shocks, like illnesses and house damage, has resulted in asset losses for several assisted households. They showed only 17 percent of the households suffered a loss in per capita income from 2005 to 2008.

[d] Positive impact on food security is not unique to poverty programs that focus on asset transfers. See Ahmed et al (2007) who assess the relative efficacy of food and cash transfers in improving food security and livelihoods of the ultra-poor in Bangladesh. They find that transfer sizes and the type of food offered are especially important to explaining the differences in impact of transfers on food consumption. The authors find that participation in all four programs, (1) Income-Generating VGD (IGVGD), (2) Food Security VGD (FSVGD), 3) Food for Asset-creation (FFA),and (4) Rural Maintenance Program (RMP), lead to statistically significant increases in food expenditures and calorie intake. They concluded that although these program have significant impact in the life of ultra-poor households, they cannot be sole way for sustainable poverty reduction.

3. Data and empirical methods

3.1 Survey description

The first round of the survey was carried out during June-August, 2002 before the first phase of the TUP scheme. Sample households belong to three of the poorest districts in northern Bangladesh, namely Rangpur, Kurigram and Nilphamari. The baseline survey included program as well as non-program households, the latter households representing the comparison group. The sample size for baseline survey was 5,626 households, of which 2,633 households were program households. The final round survey was conducted in 2011 which traced 4,038 households. This study is based on 4,038 households that survived through 2002-2011. A total of 1588 households were lost between 2002 and 2011. Compared to non-attrition households, attrition households live in poor household conditions, are less food secure, have fewer assets and more likely to be female headed. Whether these differences would lead to a downward bias in the impact analysis of TUP depends on the way in which sample attrition affected program and non-program households. We find that of the total households lost, 52% were treatment households. These households were poorer compared to control households in terms of education level and asset ownership. In order to test whether sample attrition was excessively concentrated in treatment sample, we regressed the attrition dummy on treatment dummy (controlling for village of location). Results indicate that the treatment dummy was never significant.

3.2 Measures of household food security

Household consumption in northwestern Bangladesh suffers from seasonal volatility. In addition consumption data from a single round of survey data risks under- or over-reporting actual food security status. We used two subjective food security indicators, food security score and always food deficit and three objective food security indicators, dietary diversity score, per capita daily calorie intake and real per capita yearly food expenditure.

Food Security Indicator	Details
Food Security Score	Food security score ranges between 1 (= always in food deficit) and 4 (= always in food surplus). This score is based on household's perception about the food security status of the households in ascending order.
Always Food deficit	Always in food deficit is dichotomous indicators.

Per capita yearly food expenditure	Household's yearly total expenditure in food is being divided by household size.
Per capita daily calorie intake	In order to calculate calorie intake, we convert the amount of consumption of different food items into standard unit of measurement (100 gram). Then, calorie intake per 100 gram of each of the different food items were multiplied by the respective amount consumed. Few food items such as salt, water, tea, and cigarette and beetle leaf were excluded from the estimation.
Dietary Diversity Score (DDS)	DDS indicates the number of food groups that a particular household consumed out of 12 food groups. The following set of 12 food groups are used to calculate the DDS: (1) cereals, (2) root and tubers, (3) vegetables, (4) fruits, (5) meat, poultry and offal, (6) eggs, (7) fish and seafood, (8) pulses/legumes/nuts, (9) milk and milk products, (10) oil/fats, (11) sugar/honey and (12) miscellaneous food items.

We measured calorie intake using self-reported household consumption of different food items in past 3 three days of survey. As food groups reflect dietary quality better than individual food items, we use food groups to estimate the dietary diversity score (DDS) following Swindale et al. (2006) for the same reference period. Lastly, we calculate real per capita food expenditure, we divided yearly per capita food expenditure by consumer price index (CPI) and adjusted for household size. Consumer price index data were collected from Bangladesh Bank with base year 1995-1996.

3.3 Sample characteristics

Table 1 summarises baseline characteristics for the treatment and control group households. The main feature of the summary is control group is significantly better-off than the treatment group. It also indicates that the asset transfer program is well targeted to the poorest of the poor (Matin and Halder, 2004).

(Table 1 about here)

Table 2 summarizes mean values of subjective and objective indicators of food security along with average food prices for various survey years. The household food security score increases from 1.55 to 1.64 between 2002 and 2011. Food security score reaches its peak in 2005 and fall afterwards. This pattern also hold for sub-group of households that differ in terms of exposure to the asset transfer program. Beneficiary households were relatively food insecure (mean score of

1.42) compared to control households (score 1.68) in 2002. While the score increased more for the program households over time, the advantage disappeared in the post food price crisis period. The long-term (i.e. post-crisis) decline is also evident when we analyse movements in objective indicators of food security such as average per day per capita calorie intake. Once again this is true for both, program and non-program households. Dietary diversity score increases from 5.56 to 5.81 from 2002 to 2011. Dietary diversity score reached to highest point at 2008 and declines after wards. Similarly, average per capita yearly food expenditure increases from 2002 to 2011 though it is highest in 2008.

(Table 2 about here)

In the baseline, food insecurity among the program households was significantly higher (60%) compared to the non-program households (42%). However, food insecurity decreased sharply in 2005 with respect to 2002 among program households. Improvement in food security is also confirmed by the analysis of per capita food expenditure. Program households had lower per capita food expenditure in 2002 compared to the non-program households. But in post food crisis periods (i.e. 2008 and 2011), chronic food insecurity increased among both program and control households.

3.4 Empirical approach

Our objective is to study household food security among the very poor with a focus on the food price crisis of 2008 and that too in the context of BRAC's anti-poverty scheme. Therefore we begin by explaining the empirical framework for studying the program impact on food security. In order to explore the relationship between food security and the asset transfer program formally, we exploit the quasi-experimental set up where data from program and non-program sample are available from pre- and post-intervention periods. To address potential bias due to the non-random nature of the data, we give a close attention to potential selection issues both from the demand and the supply sides.

The demand side selection bias arises if program participants are different from non-participants. In our study both the program participant and the non-participants were willing to participate in the program and non-participant households were excluded from the program because of ineligibility in one or multiple program selection criteria's. So self-selection issue and hence, the demand side selection bias is not a potential threat to unbiased estimation of program impact.

The supply side selection bias arises from the likelihood that lenders, BRAC, select program participants based on some unobservable. Since BRAC followed a specific inclusion and exclusion criterias in the selection process, unless the BRAC employee make personal judgement in selection, we can assume no selection bias from the supply side. BRAC employee's intention to select the most vulnerable households will lead to negative selection bias whereas intention to select the well-off households will lead to positive selection bias.

From the baseline characteristics (Table-2), we find that non-participant households are better-off in terms of observable characteristics. Under the conditional independence (CIA) of unobserved variables, we can assume that selection into treatment is random conditional on X and the average effect of the treatment is the difference of outcomes of individuals in participant and non-participant households with identical values of the covariates. We use ordinary least square (OLS) regression function to estimate difference-in-difference (DID) impact using four rounds of panel data. Since considerable differences are noticeable between the treatment and control households in the baseline in terms of various socioeconomic characteristics (see **Table 1**), the two groups of households may not have experienced the same growth trajectory overtime without the intervention. Therefore we control the baseline characteristics. The resulting regression specification is as follows:

$$FS_h = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} T_{2005} + \boldsymbol{\beta_2} T_{2008} + \boldsymbol{\beta_3} T_{2011} + \boldsymbol{\beta_4}\{\text{asset received}\} + \boldsymbol{\beta_5} T_{2005*}\{\text{asset received}\} + \boldsymbol{\beta_6} T_{2008*}\{\text{asset received}\} + \boldsymbol{\beta_7} T_{2011*}\{\text{asset received}\} + \boldsymbol{\beta_8} HH_h + \epsilon_{ht} + \epsilon_h \quad (1)$$

Where *h* denotes household, *v* denotes village, HH is a vector of household baseline characteristics and Єht denotes the unobservable fixed effect. *FS* is one of the five measures of household food security described earlier – two subjective and three objective indicators of food security.

As an alternative to DID estimator, we also estimate the difference-in-difference model with a matched sample. The difference in difference controls for time-invariant additive heterogeneity and then matching on the pre-intervention characteristics takes care of the observable differences. We use Abadie-Imbens (AI) method for estimation which use an adjustment to the large sample variance of propensity score matching (PSM) estimators to correct for first step estimation of the propensity score (Abadie and Imbens, 2012).

If the CIA fails to hold, then consistent estimation of the causal effect depends on selection of unobserved variables estimators. However, we cannot use instrumental variable approach in the absence of valid exclusion restriction condition. So we use the minimum-biased (MB) estimator following Millimet and Tchernis (2012) that utilizes functional form assumptions and heteroskedasticity for identification. The MB estimator uses selection of observed variables estimators and trims the estimation sample to minimize the bias arising from the failure of the CIA. It minimizes the bias by estimating the normalized inverse probability weighted (IPW) estimator of Hirano and Imbens (2001) using only observations with a propensity score in a neighborhood around the bias-minimizing Propensity score. The MB estimator of the ATE is formally given by

$$\hat{\tau}MB,ATE[P^*] = \frac{\sum_{i\in\Omega}\frac{Y_iT_i}{\widehat{P}(X_i)}}{\sum_{i\in\Omega}\frac{T_i}{\widehat{P}(X_i)}} - \frac{\sum_{i\in\pi}\frac{Y_i(1-T_i)}{1-\widehat{P}(X_i)}}{\sum_{i\in\pi}\frac{(1-T_i)}{\widehat{1-P}(X_i)}}$$

Where $\Omega = \{i|\widehat{P}(X_i)\epsilon C(P^*)\}$ and C (P) denotes a neighbourhood around P.

4. Main findings

4.1 Program impact

Table 3 reports the program impact for both subjective and objective indicators. We estimated short-term (2002 to 2005), mid-term (2002-2008) and long-term (2002-2011) impacts for subjective indicators. For objective indicators, we estimated mid-term (2002-2008) and long-term (2002-20110 impacts because of data unavailability in 2005. We reported DID, DID-Matching and MB estimators for all the outcome variables in the table.

(Insert Table 3 about here)

We see that DID estimators are higher for all the outcome variables than DID-Matching estimators and MD estimators. All the indicators follow a similar sign and magnitude. We see that TUP program has a significant and positive impact on household food security. We find food security score increased while the food deficit has declined in the participant households. Turning to the program impact on objective indicators of food security, we find a statistically

significant and positive impact. The effect is systematic across all the three indicators of food security. The objective food security indicators are particularly reassuring that TUP membership leads to better dietary diversity in addition to increasing food expenditure and calorie consumption.

One noticeable point in Table 3 is although the program has significant positive impact even in the long-run but the impact is systematically declining for all the subjective and objective food security indicators over the time. This suggest that program impact is not sustainable or the control households are doing better in improving the food security over the time. This pattern of declining program impact is also mirrored in changes in household livestock assets and land holdings (**Table 4**). In the pre-crisis year, program households saw significant improvement in terms asset ownership and landholding. Livestock ownership also went up in the program sample. But consistent with declining food security, there is a clear fall in household assets in post food price crisis period (i.e. 2008-2011). Given the nature of the intervention, any welfare gain in program households (in terms of food security and asset endowment) would likely to be achieved by moving households from distress occupations (such as begging and day labourer) to self-employment in agriculture. We find that female farm self-employment indeed increased significantly in the program sample in 2005 (but fell by 2008 and recovered only moderately after the food crisis by 2011) (**Table 5**). Program women's involvement in day labour decreased to 12% in 2008 (11% in 2011) from 24% in 2002. Similar trends were found in case of distressed occupations like begging and housemaid. These findings are consistent with the earlier observation that the observed short-term influence on the participants was not fully sustained in long-term. In other words, the observed changes in asset ownership, livestock and occupation shift mirror variations in measures of food security.

4.2 Declining impact analysis:

To understand whether and how the program effect varies with food price crisis, we use pre-crisis (2002 over 2008) and post-crisis (2002 over 2011) data separately. We augment the OLS model of the determinants of food security by additionally controlling for food prices at the village level and the interaction of price and treatment dummy variable. In order to ensure that this measure is not capturing village-level determinants of food security (e.g. distance to food

markets), we additionally control for village fixed effects. This specification is estimated using data on three rounds (2002, 2008 and 2011) since consumption data is not available for 2005 round. The final regression specification is as follows:

$$FS_h = \gamma_0 + \gamma_1 T + \gamma_2\{\text{asset received}\} + + \gamma_3 HH_h + \gamma_4 log\{\text{food price}_{vt}\} + \gamma_5 log\{\text{food price}_{vt} * \text{asset received}\} + \gamma_6 V_{vt} + + \epsilon_{ht} + \varepsilon_h \quad (2)$$

Where *h* denotes household, *v* denotes village, HH is a vector of household baseline characteristics and Єht denotes the unobservable fixed effect.

In table 5, the smaller impact of the asset transfers program in post-crisis period could be owing to the fact that the very poor spends most on food and were adversely affected by rise in food prices. When food prices increase, the poor have to limit their food consumption and/or shift to even less-balanced diets resulting in a worsening of dietary quality and micronutrient intake.

(Insert Table 6 about here)

We find the price level is positively correlated with dietary diversity and log of per capita expenditure.[e] There are two possible reasons for the positive association between DDS and price level. Firstly, households may not reduce the consumption of the food despite price increase. Secondly, households might switch to consumption of cheaper food items within or between food groups thereby leading to increased dietary diversity. Per capita expenditure can be positively related with price because most of the food items that ultra-poor households consume are necessary goods. This implies that price increases may lead to increased food expenditure to meet minimum consumption requirements.

The main finding from **table 6** is period price shock effects TUP households positively in 2002 to 2008 period while it effects TUP households negatively in 2008 to 2011 period. The differentiating effect of food price increases to treatment and control groups can be explained by either geographical placement of the households or by the occupation of household members. The former reason is not compelling here because both treatment and control households come from the same communities and as a result they face same prices. So the occupational difference can be a more plausible explanation. From table 6 we find the TUP households become more self-employed and less wage labour over the period from 2002 to 2011, although at a declining

[e] Prevel et al (2012) also find a positive effect on food expenditure. However this increase in their study was not sufficiently large so that they report an overall negative effect of food price shock on food security and dietary diversity.

rate. In the absence of asset transfers, control households continued in wage work. In post food crisis period, demand for agricultural labour increased and this led to an increase in wages. Coinciding with the food price shocks, the real wages in rural area escalated between 2007 and 2010. This growth in income experienced by rural wage workers is widely believed to have contributed to the nation-wide decline in rural poverty during 2005-2010 (World Bank, 2013). Since TUP members moved out of agricultural wage work in post-intervention period, the increase in wage in post crisis period exclusively benefited non-program households. World Bank (2013) report also find that from 2005 to 2008 period self-employed households benefited from the food price increase while they lose after that period. These opposing welfare changes may explain the decline in program effect following rise in food price.

5. Conclusion

This paper has examined the impact of higher food prices in the context of an innovative anti-poverty intervention of BRAC that has been widely credited as an effective way to reduce extreme poverty in low income countries by boosting productive asset base of the poor beneficiaries. In order to understand the adverse effect of the 2008 food price rise, we focused on an earlier version of the asset transfer program that was introduced in three of the poorest districts of Bangladesh long before the recent rise in food prices. Analysis of price data obtained from different sources confirms the rapid rise in food price in the sample villages during 2002-2011. Similarly, while the asset transfer scheme improved food security in pre-crisis years, its impact (relative to households left out of the scheme) becomes smaller in post-crisis period. Our analysis therefore highlights the role of external shocks that can undermine the effectiveness of an otherwise well-functioning anti-poverty program. At the same time the research underscores the need to study poverty programs over the long-run to fully understand the circumstances in which program impact can be sustained.

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Table 1: Descriptive statistics by household's treatment status in 2002

	Treatment	Control	Diff
Household Asset ownership			
Homestead land owned (decimal)	1.96	3.50	-1.55***
Cultivable land owned (decimal)	0.39	2.86	-2.47***
No. of cow/bull owned	0.05	0.20	-0.16***
No. of goat/sheep owned	0.11	0.14	-0.04**
No. of duck/hen owned	0.88	1.50	-0.62***
No. of rickshaw/van owned	0.02	0.04	-0.03***
Primary Occupation of female members of working age(15-60 years)			
Farm-self employment	0.2	0.3	-0.1
Day labour	24.2	13.3	11.0***
Non-farm salaried	1.0	0.8	0.1
Non-farm self-employment	4.4	3.2	1.2**
Begging	3.3	1.2	2.1***

Note: (a) Significance of difference is examined using a t-test. (b) ***, ** and * refer to 1%, 5% and 10% level of significance respectively. (c) Treatment and control sample comprises of 2,098 and 1,940 households respectively.

Table 2: Trends in household food security, 2002-2011

		Subjective measures		Objective measures		
	year	Food security score	Always in food deficit	Daily per capita Calorie intake	Dietary Diversity Score	Per Capita Expenditure(yearly)
All households	2002	1.55	0.52	1784	5.56	3227
	2005	2.07	0.21	-	-	-
	2008	1.95	0.25	1655	6.35	7964
	2011	1.64	0.44	1550	5.81	6840
Treatment households	2002	1.42	0.60	1728	5.44	3074
	2005	2.22	0.15	-	-	-
	2008	2.03	0.21	1697	6.54	8306
	2011	1.66	0.43	1552	5.96	6989
Control households	2002	1.68	0.42	1851	5.71	3408
	2005	1.92	0.28	-	-	-
	2008	1.87	0.29	1606	6.12	7559
	2011	1.63	0.45	1548	5.63	6663

Note: Treatment and control sample comprises of 2,098 and 1,940 households respectively.

Table 3: Program Impacts on household food security

		DID[a]	DID- Matching[b]	MB[c]
Food Security Score	2002-2005	0.559***	0.516***	0.372
		(0.0295)	(0.03)	(0.303, 0.457)
	2002-2008	0.421***	0.315***	0.194
		(0.0293)	(0.03)	(0.110, 0.266)
	2002-2011	0.276***	0.190***	0.058
		(0.0293)	(0.03)	(0.002, 0.130)
Always in Deficit(Percentage)	2002-2005	-0.316***	-0.262***	-0.132
		(0.0199)	(0.02)	(-0.191, -0.101)
	2002-2008	-0.254***	-0.170***	-0.076
		(0.0198)	(0.02)	(-0.117, -0.029)
	2002-2011	-0.192***	-0.0372	-0.031
		(0.0198)	(0.03)	(-0.095, 0.011)
Dietary Diversity Score	2002-2008	0.652***	0.529***	0.411
		(0.0548)	(0.07)	(0.258, 0.546)
	2002-2011	0.505***	0.379***	0.323
		(0.0548)	(0.06)	(0.181, 0.401)
Per Capita Calorie Intake(Kl grm)	2002-2008	0.118***	0.0617***	0.056
		(0.0203)	(0.02)	(0.006, 0.116)
	2002-2011	0.101***	0.0209	-0.010
		(0.0203)	(0.02)	(-0.049, 0.039)
Per Capita Food Expenditure(Yearly)	2002-2008	0.193***	0.131***	0.077
		(0.0194)	(0.02)	(0.044,0.132)
	2002-2011	0.153***	0.0743***	0.032
		(0.0194)	(0.02)	(-0.008, 0.085)

a).We control initial household level characteristics like female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household. We also control village level dummies.

b)We use female headship, household size, household size square, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household, maximum education square in the matching to get the probability of the participation.

c)We control female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household in minimum biased (MB) estimation. we used Θ=0.25. We use 250 bootstrap replication in the estimation.

For DID estimation parentheses consist of standard errors, in DID-matching parentheses consist of Abadie-Imbens (AI) robust standard errors and for MB parentheses consist of 95 percent bootstrap confidence intervals. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Impact on Household asset holdings

		DID[a]	DID- Matching[b]	MB[c]
Cultivated land	2002-2005	0.421	0.175	-0.258
		(0.428)	(0.34)	(-0.639, 0.316)
	2002-2008	0.917**	0.708**	0.4
		(0.426)	(0.34)	(-0.147, 0.903)
	2002-2011	0.352	0.175	-0.486
		(0.426)	(0.34)	(-1.268, 0.235)
Homestead land	2002-2005	0.590***	0.478***	0.116
		(0.202)	(0.15)	(-0.244, 0.375)
	2002-2008	0.875***	0.722***	0.515
		(0.201)	(0.18)	(-0.077, 0.834)
	2002-2011	0.564***	0.574**	0.005
		(0.201)	(0.23)	(-0.389, 0.394)
Cow	2002-2005	1.578***	1.361***	1.416
		(0.0392)	(0.04)	(1.292, 1.512)
	2002-2008	1.099***	0.946***	1.03
		(0.0390)	(0.04)	(0.902, 1.145)
	2002-2011	0.592***	0.502***	0.562
		(0.0389)	(0.04)	(0.469, 0.669)
Goat	2002-2005	0.397***	0.317***	0.326
		(0.0381)	(0.04)	(0.213, 0.439)
	2002-2008	0.385***	0.320***	0.319
		(0.0379)	(0.04)	(0.196,0.469)
	2002-2011	0.193***	0.145***	0.178
		(0.0379)	(0.03)	(0.081, 0.283)
Poultry	2002-2005	0.521***	0.344**	0.623
		(0.165)	(0.14)	(0.095, 0.939)
	2002-2008	1.911***	1.630***	1.675
		(0.164)	(0.19)	(1.073, 2.060)
	2002-2011	1.143***	0.786***	0.875
		(0.164)	(0.13)	(0.386, 1.263)

a)We control initial household level characteristics like female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household. We also control village level dummies.

b)We use female headship, household size, household size square, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household, maximum education square in the matching to get the probability of the participation.

c)We control female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household in minimum biased (MB) estimation. we used Θ=0.25. We use 250 bootstrap replication in the estimation.

For DID estimation parentheses consist of standard errors, in DID-matching parentheses consist of Abadie-Imbens (AI) robust standard errors and for MB parentheses consist of 95 percent bootstrap confidence intervals. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Program impact on primary occupation of the female working aged individuals

		DID[a]	DID- Matching[b]	MB[c]
Self-employed	2002-2005	0.511***	0.446***	0.478
		(0.0283)	(0.03)	(0.408, 0.559)
	2002-2008	0.380***	0.322***	0.397
		(0.0283)	(0.03)	(0.318, 0.492)
	2002-2011	0.0491*	0.03	0.056
		(0.0283)	(0.03)	(-0.008, 0.143)
Wage labour	2002-2005	-0.192***	-0.188***	-0.202
		(0.0316)	(0.03)	(-0.282, -0.118)
	2002-2008	-0.205***	-0.180***	-0.229
		(0.0316)	(0.03)	(-0.322, -0.125)
	2002-2011	-0.0805**	-0.0773**	-0.047
		(0.0316)	(0.03)	(-0.179, 0.024)
Beggar /Servant	2002-2005	-0.107***	-0.0605***	-0.071
		(0.0168)	(0.02)	(-0.114, -0.025)
	2002-2008	-0.106***	-0.0806***	-0.061
		(0.0168)	(0.02)	(-0.119, -0.013)
	2002-2011	-0.0366**	0.000198	-0.003
		(0.0168)	(0.02)	(-0.050, 0.043)
Household chores	2002-2005	-0.153***	-0.188***	-0.191
		(0.0288)	(0.03)	(-0.274, -0.117)
	2002-2008	0.00225	-0.0686**	-0.066
		(0.0288)	(0.03)	(-0.140, 0.015)
	2002-2011	0.157***	0.0967***	0.146
		(0.0288)	(0.04)	(0.058, 0.267)

a)We control initial household level characteristics like female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household. We also control village level dummies.

b)We use female headship, household size, household size square, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household, maximum education square in the matching to get the probability of the participation.

c)We control female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household in minimum biased (MB) estimation. we used Θ=0.25. We use 250 bootstrap replication in the estimation.

For DID estimation parentheses consist of standard errors, in DID-matching parentheses consist of Abadie-Imbens (AI) robust standard errors and for MB parentheses consist of 95 percent bootstrap confidence intervals. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Effect of price shock on food security

	Food Score		Deficit		Per capita food expenditure		Per capita calorie intake		Dietary Diversity Score	
VARIABLES	2002-2008	2008-2011	2002-2008	2008-2011	2002-2008	2008-2011	2002-2008	2008-2011	2002-2008	2008-2011
Year Dummy	0.398**	-0.303***	-0.257*	0.188***	0.259**	-0.164***	-0.305**	-0.0279**	-1.545***	-0.632***
	(0.187)	(0.0174)	(0.132)	(0.0121)	(0.130)	(0.0117)	(0.140)	(0.0128)	(0.374)	(0.0329)
tupmem	-1.375***	2.678**	0.853***	-0.6	-0.236***	0.152***	-0.0452	0.230***	-1.255***	-0.484***
	(0.0976)	(1.167)	(0.0689)	(0.810)	(0.0446)	(0.0362)	(0.0482)	(0.0396)	(0.129)	(0.102)
lnprice	-0.212	0.247	0.125	-0.103	0.634***	0.430***	0.198	0.163	2.118***	1.758***
	(0.192)	(0.274)	(0.136)	(0.190)	(0.133)	(0.148)	(0.143)	(0.161)	(0.382)	(0.415)
tup_price	0.422***	-0.660**	-0.255***	0.136	0.0788***	-0.0227**	0.0169	-0.0539***	0.439***	0.230***
	(0.0289)	(0.303)	(0.0204)	(0.211)	(0.0132)	(0.00942)	(0.0143)	(0.0103)	(0.0382)	(0.0265)
Constant	2.241***	0.931	0.11	0.708	6.532***	7.632***	7.131***	7.082***	-0.786	-0.951
	(0.548)	(1.052)	(0.387)	(0.730)	(0.378)	(0.566)	(0.409)	(0.619)	(1.091)	(1.590)
Observations	8,172	8,172	8,172	8,172	8,127	8,089	8,127	8,089	8,164	8,164
R-squared	0.15	0.086	0.138	0.072	0.557	0.152	0.098	0.107	0.148	0.11

Note: We control initial household level characteristics like female headship, household size, land holdings, number of active worker, initial asset like cow, goat, hen, radio, rickshaw, roof of the house and maximum education level in the household. We also control village level dummies. The parentheses consist of standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 1: District price of different food items by year (village level food price vs. alternative price measures), 2002-2011

		2002		2008		2011
	District	Survey estimate	Spot market price	Survey estimate	DAM price	Survey estimate
Rice Price	Rangpur	11.89	12.33	34.38	32.87	28.44
	Nilphamari	12.03	11.41	33.26	30.38	28.33
	Kurigram	12.08	11.62	32.51	30.06	29.50
	All districts	12.00	11.65	33.32	31.10	28.82
Pulse price	Rangpur	25.52	21.33	80.75	78.38	88.92
	Nilphamari	26.13	21.83	82.85	79.00	87.73
	Kurigram	28.56	20.86	72.75	69.44	81.76
	All districts	27.07	21.09	77.82	75.61	84.76
Oil price	Rangpur	46.97	44.00	118.32	102.26	131.71
	Nilphamari	51.26	41.00	119.07	101.64	130.43
	Kurigram	51.18	44.37	121.83	100.44	126.72
	All districts	49.83	43.72	119.91	101.44	129.31
Flour price	Rangpur	10.61	10.00	36.44	32.89	30.36
	Nilphamari	10.17	9.16	36.98	37.61	27.89
	Kurigram	10.28	12.23	39.68	43.00	24.93
	All districts	10.37	11.09	38.11	37.83	27.38

Note: DAM price is from Ministry of Agriculture, Government of the People's Republic of Bangladesh, http://www.dam.gov.bd/dailyprice/dhaka_wrp.pdf

Annex table 2: TUP participants' selection criteria

Five inclusion criteria's	Three exclusion criteria's
(a) Dependent upon female domestic work or begging as income source; (b) Ownership of less than 10 decimals of land; (c) No male adult active member in the household; (d) Children of school going engaged in paid work; and (e) Possession of no productive assets by the household.	(a) No adult woman in the household who is able to work; (b) Participating in microfinance; and (c) Beneficiary of government/NGO development project.

Source: Ahmed et al. (2009)

Annex table 3: Support package for the participants

Component	Beneficiaries received	Duration of support
Asset transfer	Assets for enterprise e.g. cow, goat, poultry, nursery, nonfarm assets etc. (on average Tk 6,000 per beneficiary)	One-time in the beginning
Enterprise development training	Classroom orientation and training	3-5 day training before asset transfer
	Hands-on training by enterprise management and technical supervision	2 years
Support for enterprise	All inputs required to maintain the enterprise	The first cycle of the enterprise
Weekly stipend	70 Taka	(Enterprise specific) Until start getting income from their enterprise
Health care support	Free medical treatment; training to build awareness	2 years
	Regular visits by health volunteers (Shasthyo Shebika) for preventive diseases	2 years and continues with BRAC mainstream development programme
Social development	Awareness raising training	2 year and continues with BRAC mainstream development programme
Mobilization of local elite for support	Community supports material, information, guidance	2 year and continues

Source: Ahmed et al. (2009)