Poverty-Food Security Nexus: Evidences from a Survey of Urban Slum Dwellers in Kolkata

Chandana Maitra[a,*i] and D.S Prasada Rao[b]

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[a] School of Economics, University of Queensland (UQ).

[i] Permanent Postal Address: UQ, School of Economics, St Lucia, QLD 4072, Australia. E-mail: c.maitra@uq.edu.au; chandana.maitra@uqconnect.edu.au.

[b] School of Economics, UQ, St Lucia, QLD 4072, Brisbane, Australia.

E-mail: d.rao@uq.edu.au.

*Corresponding Author.

Present Postal Address: School of Economics, UQ, St Lucia, QLD 4072, Brisbane, Australia.

Telephone: +61 7 3878 5657; Mobile No.: (+61) 043436072.

Fax: +61 7 336 57299

E-mail: c.maitra@uq.edu.au; chandana.maitra@uqconnect.edu.au.

Abstract

In view of the apparent divergence between the indicators of poverty and food security in the rapidly growing Indian economy, in recent years, this paper explores the poverty-food security nexus, in terms of an experience-based indicator of food security, in a cross section sample of urban slum households in Kolkata, within the framework of a simultaneous ordered probit model. Results indicate that a poor household is also likely to be food insecure, with the policy implication that poverty alleviation measures would be effective in eliminating food insecurity. There is also need for multi-pronged intervention in eliminating food insecurity.

Key words: food security, poverty, simultaneous probit, experiential scales, urban slums

1. Introduction

A striking feature of India's growth process has been the apparent divergence between the indicators of poverty and food security, observed in the Indian economy over the past few decades. Several authors have noted a growing dissociation between the prevalence of undernourishment[1] – a calorie-based outcome indicator of food security and the expenditure-based poverty rate (Palmer Jones and Sen, 2001; Radhakrishna, 2005; Meenakhshi and Viswanathan, 2003; Ray and Lancaster, 2005; Ray, 2007; Sen, 2005; Suryanarayan and Silva, 2007), leading to the paradox of rising undernourishment and declining poverty rates over time, in the context of a rapidly growing economy[2] which is also urbanizing at a fast pace. The obvious dichotomy of the situation has been summarized by Suryanarayan and Silva (2007) as "the set of food insecure is larger than the set of poor in India", with the policy implication that, in targeting the poor anti-poverty policies might lose sight of the food insecure, nested in apparently non-poor households. The issue has implication for the recently passed National Food Security Bill[3], because any attempt to use expenditure-based poverty rate to "target" food subsidies to the "needy", implicit in the Bill, would be seriously misleading if a large section of the "non-poor" households are food insecure, as reflected in the recent trends in undernourishment.

While previous literature has attempted to address the issue, the discussion originated in a different context - in terms of the discrepancy between expenditure-based estimates of poverty and calorie-based estimates of poverty, in view of the recently observed trend of declining calorie intake in Indian households.[4] As an off-shoot of this discussion, the divergence between poverty and food security was noted. While this approach of dealing with the issue has generated a rich body of literature (Radhakrishna, 2005; Dutta and Ramaswami, 2001; Mehta and Venkatraman, 2000, Ray and Lancaster, 2005; Sen, 2005; Suryanarayan and Silva, 2007; Patnaik, 2004; Li and Eli, 2010; Deaton and Dreze, 2009; Gaiha et al. 2010a;

Basu and Basole, 2012), technical concerns related to the need to redefine the poverty line and the consequent focus on calorie intake alone as the indicator of food security, have left unexplored a somewhat deeper aspect of the problem – is there something inherent in poverty that drives food insecurity or are the two phenomena independent? And what happens to the poverty-food security nexus if we adopt a broader perspective in looking at the concept of food security by defining it in terms of an experiential measure? These are the questions we explore and seek to answer in the present paper.

We offer a fresh approach to the much discussed issue by arguing that undernourishment is a narrow way of looking at food security because food insecurity is not just calorie shortfall. Going by its most acceptable definition, food security is a situation that exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO,1996). This is a concept incorporating four major components - availability, access, utilization and vulnerability. Any discussion on poverty-food security nexus should therefore be based on an indicator which would adhere to this broader definition and recognize the fact that food insecurity is a phenomenon that goes beyond calorie energy intake (Mason, 2003). Also embedded in this definition are the elements of quality of food, cultural and social acceptability (Barrett, 2002). No single indicator can capture all these dimensions but one can always experiment with alternative indicators which would try to capture as many dimensions as possible. This provides the first motivation behind our attempt to construct an experiential measure of food security, which we believe, will allow a closer look at the poverty-food security nexus.

The second motivation comes from the fact that the poverty-food security divergence is not very obvious if we look at it from the perspective of undernourishment alone. First, because calorie data is subject to systematic measurement errors (Srinivasan 1981; Bouis,

1994; Strauss and Thomas, 1995; 1998) and it is quite likely that these errors will be transmitted to the estimates of prevalence of undernourishment too. Moreover, in recent years, there has been an increasing tendency to 'eat out', especially in the urban context (Gaiha et al.. 2010b) and in majority of cases calories coming from the meals taken outside home remain unaccounted for, leading to underestimation of actual calorie intake (Smith, 2013). If all these errors could be properly dealt with, it is quite likely that calorie data would not exhibit such a sharp decline (Smith, 2013). Moreover, determining an appropriate threshold, to estimate the incidence of hunger and undernourishment, is also problematic because of inter- and intra-individual variations in nutrient requirements – based on genetics, activity levels, health status and so forth (Kakwani, 1989; Srinivasan, 1992; Higgins and Alderman, 1997). This incorporates considerable uncertainty into the estimates of prevalence of undernourishment. Together, these observations imply that declining calorie intake and rising undernourishment may not be as obvious as it seems. At this point, it may be important to mention that throughout this discussion we assume that the poverty figures have been estimated accurately, because the fact of the matter is, even the Indian poverty estimates are subject to debate – both in terms of data and methodology (Panagariya, 2008; Deaton and Kozele, 2005; Patnaik, 2007).

Second, even if calorie intake is declining it may or may not be a sign of distress, in view of the recent nutritional transition in India. In recent years, we observe two kinds of substitution in the consumption basket of Indian consumers - i) substitution of food items by non-food items, especially health care, rent and education (Radhakrishna, 2005; Sen, 2005; Basu and Basole, 2012), and ii) within the food basket, substitution of cereals – the cheapest and the main source of calories in Indian diet - by more expensive sources of calories like meat, fish, egg, fruits (Radhakrishna and Ravi, 1992). These observations have led to one set of opinion that Indian consumers are voluntarily switching away from calories (Sen, 2005;

Banerjee and Dufflo, 2011). There exists another strand of the literature which holds a contradictory view and interprets declining calorie intake as welfare loss (Mehta and Venkatraman, 2000; Chandrasekhar and Ghosh, 2003; Patnaik, 2004; 2010), but we would not go into the details of the Indian calorie debate. All we are trying to emphasize at this point is, declining calorie intake may or may not be a sign of rising food insecurity – at least the issue is debatable.

Third, an interesting observation pertains to the trend in self-reported hunger[5] in India, which actually declined between 1983 and 2005 (NSSO 1983; 1994; 2007b; Deaton and Dreze 2009), thus posing quite contradictory evidence on the question of poverty and food insecurity moving in the opposite direction. Given above, it is not surprising that Deaton and Dreze (2009) find calorie shortfall and self-reported hunger to be uncorrelated. We particularly refer to their observation that, "this lack of correlation might be taken as casting further doubt on the validity of the hunger questions, or on the relevance of the calorie norms, or even both" (Deaton and Dreze 2009, page 12). It may also mean that hunger and calorie shortfall are not the same. Finally, nutritional status has improved even though the level of undernutrition is still unacceptably high (Deaton and Dreze, 2009).Taken together, all of the above observations lead us to think that the issue of divergence between poverty and food insecurity is a phenomenon which is not obvious – it is a testable hypothesis.

Specifically, we note the following gaps in the literature. First, as mentioned above, the poverty-food insecurity relationship has been examined mostly in terms of undernourishment which underlines a confined approach in looking at food security because nutritional deprivation is just one aspect of the phenomenon. Second, to date, multivariate analyses of the impact of poverty on food security, which would take into account the effects of the other influencing socio-economic factors, while recognizing the possible endogeneity in the relationship – is limited. Finally, the dynamics of the poverty-food security relationship may

be very different across rural and urban settings and therefore need to be examined separately. More so, because, India is urbanizing rapidly, with the number of urban poor growing relatively faster that of rural poor (GOI, 2011). This suggests 'urbanization of poverty' (Maxwell, 1999) which will have implications for food security as well.

We address the first, by testing the hypothesis of poverty-food security divergence, by constructing an experience-based indicator following the U.S. Household Food Security Survey Module (US HFSSM) (Hamilton et al., 1997), using data collected from slum households in the megacity of Kolkata, India, in 2010-11. As mentioned before, National Sample Survey Organisation (NSSO) has attempted, in past, to measure food insecurity in terms of self-reported hunger, but the results are far from reliable,[6] which makes it worthwhile to construct a measure of hunger based on a wider range of questions attempting to capture hunger at different levels of severity, as reflected in the US HFSSM (Hamilton et al., 1997). Previously Rammohan et al. (2012) have attempted to estimate the determinants of self-reported food security in the context of rural India, but they did not explicitly consider the relationship between poverty and food security status. The US HFSSM based experiential indicator takes into account the elements of vulnerability and uncertainty in food insecurity and also underlines the fact that food insecurity relates not just to insufficient 'quantity' but to inadequate 'quality' as well (Barrett, 2002). Besides, the U.S. measure builds on the notion of 'adequacy in relation to need' (Mason, 2003) which is a concept difficult to express using the calorie-based indicator because of the problems associated with identifying an appropriate cut-off to estimate the incidence of undernourishment.

We address the second issue of possible endogeneity in the poverty-food security relationship, through our modelling technique. In exploring the nature of the association between poverty and food security, we account for the presence of endogeneity by assuming joint occurrence of the two events, tested by the application of a simultaneous ordered probit

model, with three categories of food security status and binary poverty status as the two dependent variables, while controlling for households' socio-economic and demographic characteristics. This modelling technique also provides a framework for monitoring food security, by identifying the determinants of food insecurity and hence facilitating identification of the vulnerable groups. However, given the limitation of availability of panel data on our variables of interest, we attempt to answer the questions in the context of a cross section sample.

Finally we build our model in the context of low income urban households. As Atkinson (Atkinson, 1995, page 152) notes, given current trends, the question of urban food security could become the "greatest humanitarian challenge of the next century". The urban poor spend a relatively larger portion of their income on food, thus being 'net buyers' of food, which broadly means, the poverty problem gets translated to a food-insecurity problem (Maxwell, 1999). In India, the headcount ratio of urban poverty has declined steadily over the decades, but its rate of decline has lagged behind that of rural poverty in recent decades (GOI, 2011). The urban poverty scenario also suffers from rising inequality as evidenced by the fact that the Gini coefficient for consumption is not only higher for cities and towns compared to the inequalities in the rural areas, but it has risen continually since 1983 and, the urban poverty gap also continues to be deeper when compared to poverty in the rural areas (GOI, 2011). The present work is based on a survey in the slums of Kolkata. Not all urban poor are residents of slums but a substantial portion is. In all major Indian cities except Indore, the percentage of poor is much higher in slums than in non-slum areas (Gupta et al., 2009).

Given the above, main results of our analysis are as follows: poverty increases the likelihood of experiential food security in the urban slum households and household characteristics like education and gender of the household head and household composition are also significant predictors of household food insecurity. These results strongly suggest the need for multi

sectoral intervention in food security monitoring – anti-poverty policies to be combined with investment on human capital and gender empowerment. To what extent the results can be generalized in the broader context of urban India, remains a question of future research.

The rest of the paper is organized as follows: Section 2 briefly discusses data and the methodology of construction of the experiential food security indicator; Section 3 presents the empirical model; Sections 4 and 5 present results and discussion, respectively; and Section 6 concludes by drawing some policy implications and providing directions for future research.

2. Constructing an Experiential Food Security Indicator for Kolkata

The experience-based food security indicator measures economic access to food and was constructed by adapting the US HFSSM, in the context of slum households in Kolkata, India. It is a "direct" measure of the severity of household food stress or food deprivation, based on self-reported behaviours and experiences collected by interviewing one member of each household using a standardized survey instrument, the US HFSSM. Two measures of household food security can be computed from the core module data: Household Food Security Scale which is a continuous measure and Household Food Security Status which is a categorical measure (Bickel, 2000). Scales are estimated using a Rasch measurement model, a form of non-linear factor analysis, in the family of Item Response Theory (IRT) models. In this section we briefly describe the construction of the Kolkata experiential food security scale. The detailed methodology is available in Maitra (2014).

a) Data

The survey was conducted in the slums of Kolkata, India in 2010-11. One of Kolkata's most striking characteristics is prevalence of slums and squatter settlements, characterised by

pollution, inadequate sanitation and overcrowding – typical of slums in modern day mega cities in the developing economies where urbanization has been driven mostly by poverty induced migration of rural poor to urban informal sectors rather than due to growth induced expansion of the urban economy (Mukherji, 1993). These slums are often the centres of misery and food insecurity (GOI, 2011).

The survey design is "multistage sampling" where the selection has been done in three stages, following sampling frame outlined in Urban Frame Survey (UFS) (NSSO, 2008) conducted by Field Operations Division (FOD) of NSSO. In the first stage, 15 Investigating Units (IV) were selected randomly, out of 330 IV Units listed under Kolkata Metropolitan Corporation (KMC) area in UFS 2002-07. The IV Units were selected by the method of "systematic random sampling" in which sample units are selected at specific intervals. Fifteen blocks with "slum areas" were selected randomly from these IV Units and in the final stage, a sample of 500 households was drawn from these slum areas, stratified by gender of household head - 426 male headed and 74 female headed households.[7] The final selection of households was preceded by a complete listing of all households in each selected slum. Since the slums were of unequal size, in drawing the final sample of households from each slum, due consideration was given to the fact that a higher percentage of households are to be selected from the bigger slums. This was done using a special case of optimal allocation - Neyman allocation (Lohr, 1999).[8]

b) The Questionnaire

The survey questionnaire has two main sections - the first part collected information on socio-economic, demographic and environmental characteristics of the slums and also on details of the consumption expenditure pattern of the surveyed households which allowed us to calculate intakes of calorie, protein and fat following NSSO (2012). The second part contains the food security scale items which were adapted from the US HFSSM.

(Table I here)

The food security scale is based on the items Q1 to Q21 in Part B of the questionnaire, excluding Q2 and Q9, which are not scale items. All questions were asked in the local language, Bengali.[9] As Table I shows, 19 items are identified as candidates for assessment - 11 of them relate to conditions at the household level, among adult members of the household, and eight of them relate to food conditions of children below 15 years of age. However, we present results for the adult scale only.[10]

The scale questions were referenced to the previous 30 days, rather than the previous 12 months, to improve recall accuracy. All questions were asked with "yes" or "no" response options.[11]

c) The Kolkata Food Security Scale

(Table II here)

Rasch model was estimated by conditional maximum likelihood (CML) implemented in Stata's *Raschtest*. Based on item infit and outfit statistics,[12] poorly performing items were omitted until performance of all items met model assumptions acceptably well, and in the final analysis we were left with nine adult items which adequately formed a scale (Table II).

(Table III here)

On this scale, four categories of food security status were identified - highly food secure, marginally food secure, moderately food insecure and severely food insecure, based on cut-offs corresponding to raw scores three, five and seven respectively.[13]Accordingly, 84.6% of households in the Kolkata sample were food secure including 76.2% highly food secure and 8.4% marginally food secure; and 15.4% were food insecure, including 12.8% moderately food insecure and 2.6% severely food insecure households (Table III).

The internal validity of the scale was tested by calculating Cronbach's alpha (Cronbach, 1951), Rasch reliability, sensitivity, specificity and positive predictive value for the nine-item adult food security scale.[14]

External validation of the scale was carried out by examining construct validity and criterion validity of the scale. In order to establish construct validity, we examined association of food security status with factors considered to be causes or consequence of food insecurity, such as, income, poverty status, education and gender of household head and so forth. Three categories of food security status were considered: highly food secure ($0 \leq$ raw score <3), marginally food secure ($3 \geq$ raw score <5) and food insecure (raw score ≥ 5). Households with moderate and severe food insecurity were analysed as a single category because only a small number of households (only 13) were present in the latter category. A household was defined as poor if it fell below the poverty line expenditure of urban West Bengal, for the year 2010-11, which was set at Rs.856.28 by updating the poverty line expenditure of urban West Bengal for 2004-05, using Consumer Price Index for urban Industrial Workers (base 2001). Thus poverty status is a binary variable which takes the value of 1 if Monthly Per Capita Expenditure (MPCE) < Rs. 856.28 and 0, otherwise.

(Table IV here)

Food insecurity was found to be declining with increase in the level of income and improvement in poverty status of households. Food insecurity was also found to be more prevalent in households not owning an asset, in female headed households, in casual labour households, in households with children, in households with higher dependency ratio,[15] and in households headed by illiterate persons (Table IV).

(Table V here)

External validation was also conducted in terms of criterion validity which involves comparing the test with other measures or outcomes (the criteria) already held to be valid or

known as "gold standard." Criterion validation is not generally feasible for food security measures since food security is a latent trait. However, the standard practice in the literature is to conduct a test against the traditional indicators of food security - dietary intake (Cristofar and Basiotis, 1992; Kendall et al., 1995; Rose and Oliveira, 1998) or nutritional status (Olson 1999; Rose and Bodor, 2006). Since we have not collected information on the latter, we tested criterion validity in terms of intake of three nutrients – calorie, protein and fat[16] – and a few selected food items. Table V presents a simple description of the data - intake of calorie, fat, protein and selected food items for two categories of food security status – food secure ($0 \leq$ raw score <5) and food insecure (raw score ≥ 5). It reveals, average consumption of all nutrients and food items are much higher for the food secure households compared to the food insecure households and the differences are statistically significant.

(Table VI here)

The tetrachoric correlation[17] between binary food security status (=1 if food insecure, 0 otherwise) and undernourishment (1 if per capita per day calorie intake < 2100 kcal, 0 otherwise) was positive (0.56) and significant ($p<0.000$). Of the highly food secure households, 54% were undernourished and the proportion increased to 90%, among the food insecure households (Table VI). Based on the above results, it was concluded that the Kolkata food security scale is a valid measure of the extent of food insecurity among adults in the surveyed population and the newly constructed experiential measure can serve as an alternative indicator of food security in the said population.

3. The Relationship between Poverty and Experiential Food Insecurity

Central to the idea of the perception-based direct measure of food security is the notion of "lack of resources" driven by poverty. Thus, all of the items in the questionnaire, explicitly

condition the event or behaviour identified as, due to financial limitation (such as "because there wasn't enough money to buy food").

(Table VII here)

Table VII shows the empirical distribution of the two dependent variables - poverty status and self-reported food security status. Of the 77 food insecure households, a large proportion, about 47% (36 out of 77), are non-poor. Alternatively, one can see, among the 433 non-poor households, about 8% (36 out of 433) are food insecure. We also wanted to examine whether a higher concentration of food insecure households is noted among the households which were closer to poverty line – for example, those with Rs.856.28≤ MPCE≤ Rs.950 - and found that the share of food secure households was in fact higher within this group - 57% as opposed to 43% food insecure. These results imply, there may not be a one-to-one correspondence between poverty and food insecurity. Polychoric correlation between poverty status (binary) and food security status (three categories) was found to be 0.73 and it was statistically significant [Prob ($> \chi^2(1) = .04$], indicating strong association between the two variables. However, to isolate the influence of poverty on food security status, a more rigorous analysis accounting for other predictors of food insecurity is needed. The proposed model in the next section attempts to empirically quantify the relationship between poverty and food security, recognizing the possible endogeneity in the relationship. In this case, the endogeneity is more likely to stem from unobserved heterogeneity where the same set of unobserved variables, e.g, political instability or structural change in the economy, might be influencing both poverty status and food security status.

a) Econometric Model

A recursive (semi-ordered) bivariate ordered probit model (Greene and Hensher, 2009)[18] was estimated, with three categories of food security status and the binary poverty status as

the joint dependent variables, with the latter appearing as an ordinary pre-determined variable in the food security equation, along with households' socio-economic and demographic characteristics. The fact that the binary endogenous variable poverty status appears on the right hand side of the food security equation only as observed, makes the system recursive (Greene, 2012). That is, we want to identify the impact of actually being poor on food security status of a household rather than the propensity of being poor (Blundell and Smith, 1993).

i) The Model

The observed variables for a household's subjective food insecurity (*Fi*) and poverty (*Pi*) are related to the corresponding latent variables as F_i^* and as, P_i^* ,

$$F_i = \begin{cases} 0 & if\ F_i^* \leq 0 \\ 1 & if\ 0 < F_i^* \leq \mu \\ 2 & if\ \mu < F_i^* \end{cases} \quad (1)$$

Where 0, 1 and 2 respectively denote highly food secure, marginally food secure and food insecure categories. And,

$$P_i = \begin{cases} 0\ if\ P_i^* \geq 0 \\ 1\ if\ P_i^* < 0 \end{cases} \quad (2)$$

Where 0 indicates non-poor and 1 represents poor.

The underlying model consists of two equations relating the latent food insecurity (F_i^*) and poverty status (P_i^*) to background characteristics of the households, represented by vectors $\boldsymbol{x_1}$ and $\boldsymbol{x_2}$ respectively.

$$P_i^* = x_{1i}\beta_1 + \varepsilon_{1i} \quad (3)$$

$$F_i^* = \gamma P_i + x_{2i}\beta_2 + \varepsilon_{2i} \quad (4)$$

where $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ are column vectors of unknown parameters, γ is an unknown scalar which measures the effect of poverty on food security, ε_{1i} and ε_{2i} are the error terms assumed to be distributed standard normal and subscript i denotes an individual observation (household), and i = 1, 2....499.[19]

The explanatory variables in the model are assumed to satisfy the condition of exogeneity such that $E(x_{1i}\varepsilon_{1i}) = 0$ and $E(x_{2i}\varepsilon_{2i}) = 0$.

The model has only one unknown threshold, μ, in the food insecurity equation, assuming there's a constant term in vector x_{2i}.[20] Given that the errors, ε_{2i}, in Equation 4, are distributed normally with zero mean and unit variance, the following probabilities apply for the single equation ordered probit model,

$$P(F_i = 0) = \varphi(-\gamma P_i - x_{2i}\beta_2)$$

$$P(F_i = 1) = [\varphi(\mu - \gamma P_i - x_{2i}\beta_2) - \varphi(-\gamma P_i - x_{2i}\beta_2)$$

$$P(F_i = 2) = \varphi(\mu - \gamma P_i - x_{2i}\beta_2)$$

where φ is the distribution function of the standard normal distribution. Parameters of the model are estimated using maximum likelihood technique. But if poverty and food security are jointly determined, estimating the ordered probit equation (Equation 4), as above, in isolation, will give a biased estimate of γ (Greene, 2012). If the correlation between ε_1 and ε_2 is zero, then under normality these are independently distributed. In that case, the model with Equations 3 and 4 becomes recursive. Hence significance of the correlation is critical. The possible joint determination of P_i and F_i are accounted for by allowing the errors ε_{1i} and

ε_{2i} to be distributed according to a standard bivariate normal distribution with correlation as shown below:

$$E(\varepsilon_{1i}) = E(\varepsilon_{2i}) = 0$$

$$Var(\varepsilon_{1i}) = Var(\varepsilon_{2i}) = 1$$

$$Cov(\varepsilon_{1i,}\varepsilon_{2i}) = \rho$$

Given this model, the conditional probabilities are more meaningful for analysis.

$$Prob\big(F_i = j \big| P_i = k, x_{1i,}\, x_{2i}\big) = \frac{P(F_i = j, P_i = k \ |x_{1i}, x_{2i})}{Prob(P_i = k \ |x_{1i}\,)}$$

For example, for $k = 1$ and $F_i = 0$, we can interpret the above as the probability of being highly food secure, given the household is poor.

The single equation ordered probit model outlined in Equation 4 is a special case of the bivariate semi-ordered probit with $\rho = 0$. Starting with the latter model, the restriction $\rho = 0$ is then tested. The bivariate ordered probit model is analogous to the Seemingly Unrelated Regression (SUR) model for the ordered probit case (Roodman, 2009). Full efficiency in estimation and an estimate of γ are achieved by full information maximum likelihood estimation (Greene, 2012).

ii) Identification

The model was estimated by imposing an exclusion restriction even though it is not strictly necessary, as "identification by functional form" (Wilde, 2000) is possible. The identifying variable, in our model, is 'whether a household is casual labor or not',[21] as casual labor households are more vulnerable to poverty, especially in the urban context. 'Casualization' of labor, caused by poverty-induced rural-urban migration, has emerged as a

serious threat to poverty in recent years (Mukherji, 1993). Urban casual workers suffer when food prices increase or money wages or employment rates decrease significantly because they do not have adequate access to financial and social insurance to mitigate risk (Barrett, 2002). Thus, this variable might have a direct impact on poverty status but may affect experiential food security only through its influence on the former. The survey has collected information on 'household type' which considers four types of occupations for urban areas: self-employed, regular salaried, casual labor and others. Out of these four categories, the binary dummy variable *hhtype* was created which classified households into two broad categories 'casual labor' and 'non-casual labor', the latter being the reference group including the remaining three categories - self-employed, regular salaried and others. Thus, the variable denoting 'whether a household is casual labor or not', has been included in the poverty equation, in vector $\boldsymbol{x_1}$ only.

iii) The Variables

Apart from poverty, the binary endogenous variable, the other variables included in the vector $\boldsymbol{x_2}$, in the food security equation, are household size, age, gender, education, religion and home ownership status of household head, and household composition represented by the share of kids, working age adults and seniors in the family. Most of these variables come from the list of socio-economic indicators of food and nutrition security discussed in Haddad et al. (1994) and Frankenberger (1992).

As mentioned before, the vectors of explanatory variables $\boldsymbol{x_1}$ and $\boldsymbol{x_2}$ are not exactly identical, as, in addition to the above set of explanatory variables, $\boldsymbol{x_1}$ also includes households' employment status (*hhtype*) as an identifying variable in the poverty equation (Equation 3).

(Table VIII here)

Table VIII reports summary statistics of the variables. About 16% of households in the sample are food insecure, while 13% are poor. About 19% of households in the sample are female headed and a large proportion (33%) of households are headed by illiterate (or below primary) persons. Finally, 22% of households in the studied sample are casual labor households, a sizable proportion, implying concentration of employment in the informal sector.

4. Results

The model has been estimated using both Stata (version 12) and NLOGIT (version 4.10 January 1, 2012), for robustness. Estimation results from NLOGIT are presented below. The command structure requires the prior estimation of the two univariate models to provide starting values for the iterations. The third command then fits the bivariate model.

(Table IX here)

Table IX reports results of NLOGIT estimation of the semi-ordered recursive bivariate probit model. The results indicate that there is an association between a household's poverty status and food security status, when other influencing factors are controlled for. The co-efficient for poverty index, γ, in the equation for food security is a significant 1.69. But, interestingly, the parameter ρ, which represents the correlation between the error terms of the two equations, is not significantly different from zero. This suggests that the system is recursive and standard ordered probit may be suitable for the present purpose, results for which are presented in Section 4.d, for completeness. Results from both sets of models are broadly similar with no significant sign variations between the two models. However, the following analysis draws on the results obtained from the recursive semi-ordered bivariate probit model sketched in Section 3.a.

a) Determinants of Food Security Status

i) Poverty and Food Security

The coefficient of poor is positive and significant which suggests that difference between poor and non-poor households in terms of food insecurity is not negligible when other factors are controlled for. In the context of an ordered probit model this implies, as a household switches category from 0 to 1, that is from non-poor to poor, probability of being highly food secure (*Prob*[*F* = 0]) decreases and the probability of being food insecure (*Prob*[*F* = 2]) increases. The sign of the co-efficient in the middle category (*Prob*[*F* = 1]) is ambiguous but usually there should be a sign change in the intermediate category, consistent with "single crossing effect".[22]

ii) Other Determinants of Food Security Status

The impact of the variable household size is somewhat weaker in this model, the coefficient being significant at 10% level only. But the sign of the coefficient is negative which suggests, an increase in household size is likely to decrease the probability of being food insecure, holding constant the influence of all other covariates.

Gender of household head is found to be strongly influencing the food security status of a household. The positive sign of the co-efficient implies, the probability of food insecurity increases as a household switches category from male-headed (0) to female-headed (1), once influence of other factors are controlled for.

As for education of household head, the sign of the co-efficient for both categories – household head having primary to secondary level education and household head being a graduate or post graduate - are negative and both are significant. However, the impact of the latter category is weaker in this model. The negative sign of the coefficient implies, probability of being food insecure is lower for households headed by persons having primary

to middle level education and those headed by persons who are graduate and above, compared to households headed by illiterate persons, given other variables stay at mean.

Share of working age adults in the family is a strong predictor of household food security status. The co-efficient is negative and significant suggesting, an increase in the share of working age adults in the household will decrease the probability of being food insecure, once other factors affecting food security status are controlled for.

The variables age, religion and home ownership status of household head are not significant in the present model.

b) Marginal Effects in Recursive Bivariate Ordered Probit Model

As Burnette (1997) suggested, in the context of recursive bivariate probit models, it is more useful to consider the marginal effects. The bivariate semi-ordered probit model has two equations and the models are highly non-linear which makes it difficult to analytically derive and compute the partial effects (Greene and Hensher, 2009).[23] Due to the computational complexities involved, none of the widely used packages like NLOGIT and Stata compute the marginal effects. However, given the estimated parameters, the predicted marginal probabilities can be computed.

Given the difficulty in computing the partial effects in the model, a pragmatic approach to measure the effects of changes in the explanatory variables is used in the paper. We examine the impact of a unit change in a particular explanatory variable on the predicted probability of each outcome, for given values of the other explanatory variables (conventionally at mean). This can provide some indication of the direction and magnitude of change associated with a particular predictor variable on the food security status of a slum household with average characteristics.

(Table X here)

Table X shows the effects of 10% increase in some of the continuous explanatory variables in the model, on food security status of a given household. For example, the impact of 10% increase in the average share of working age adults in the family (from 0.75 to 0.82) would increase the reported probability of being highly food secure, for an average household, by 2.4%, holding constant all other variables at mean. This also causes the reported probability of food insecurity to drop by 8%. Note here, the magnitude of change in these three probabilities adds up to zero.

(Table XI here)

For a binary dummy variable, the reported change in probability will be P [$F = j \mid x = 1$] − P [$F = j \mid x = 0$] (Table XI). For example, if a household switches category from non-poor to poor, the predicted probability of being in the category highly food secure falls by 75%, and the probability of being food insecure rises by 708%, holding constant all other variables at mean. If a household switches category from male-headed to female-headed, the probability of being food insecure increases by 99%.

c) Marginal Effects in Single-Equation Ordered Probit Model

It is much simpler to compute marginal effects in a single equation ordered probit model. Following Greene and Hensher (2009), in a standard ordered probit equation $y_i^* = x_i\beta_i + \varepsilon_i$ ($\mu_{j-1} < y^* < \mu_j$, $j = 0, 1 \ldots n$), the partial effects are given by the following expressions:

$\delta_j(x_i) = \frac{\delta Prob(y=j|x_i)}{\delta x_i} = [f(\mu_{j-1} - \boldsymbol{\acute{\beta} x_i}) - f(\mu_j - \boldsymbol{\acute{\beta} x_i})]\boldsymbol{\beta}$, for a continuous variable; and

$\Delta_j(D) = [F(\mu_j - \boldsymbol{\acute{\beta} x_i} + \alpha) - F(\mu_{j-1} - \boldsymbol{\acute{\beta} x_i} + \alpha)] - [F(\mu_j - \boldsymbol{\acute{\beta} x_i}) - F(\mu_{j-1} - \boldsymbol{\acute{\beta} x_i})]$, for a dummy variable, where D is the dummy variable in the model and α is the dummy variable coefficient. The expression would measure the effect of a change in D from 0 to 1 with all other variables held at the values of interest (perhaps their means).

As in our recursive bivariate semi-ordered probit model, the estimated 'rho' is close to zero and the estimated parameters in single and simultaneous models are very close, the marginal effects from the single equation ordered probit model can be used as close approximation.

(Table XII here)

From Table XII, the marginal effect for 'poor' is negative and significant for the 'highly food secure' category and positive for the other two categories, results having similar interpretation as before. Of the remaining variables only household size, share of working age adults and, education and gender of household head, are found to affect food security status significantly. Other things remaining the same, an increase in household size decreases the probability of food insecurity by 0.0008, and the variable has a relatively stronger influence now. Regarding education of household head too, the earlier results are corroborated, except that the impact of the category 'graduate and above' is stronger now. Holding all other factors constant at mean, the probability of being a female-headed household increases the probability of food insecurity.

5. Discussion

In general, the results suggest that compared to a non-poor household, a poor household is more likely to be food insecure when the influence of other covariates is taken into account. This result is in contradiction with the recent observation of diverging trends in the indicators of poverty and food insecurity, in the Indian economy. Our result provides support to the notion that there is something inherent in poverty that drives food insecurity. We may seek to look for an answer in Sen's notion of capability (Sen, 1985) - being poor is limiting the choice set of the individuals residing in the household, making it less capable and food insecure, or in terms of 'entitlement failure' where adverse shift in exchange entitlement of food may be caused by a person's inability to convert his or her "endowments" - assets or

resource including labor power (Sen, 1981). In the present case the adverse effect originates from poverty. This is also consistent with the particular characteristic of urban poverty which is intensified by the migration of rural poor into the already saturated urban informal sector, in the absence of alternative employment opportunities in the rural or urban skilled sector.

Given above, one can still find food insecure households among the group of non-poor households (8% in the raw data) and it is necessary to identify these households so that they do not miss the benefits of policies aimed solely at addressing poverty. Food insecurity in these non-poor households could have been caused by worries and anxieties regarding future access to food (households may be vulnerable) or by improper utilization of food. The deprivation in question may also relate to the existence of food deprivation as perceived by the people - "Any qualitative evaluation of people's perception of deprivation is influenced by their relative position in the society. Even if energy intake is adequate, and people do not feel the pangs of hunger, they may still suffer from an acute sense of food deprivation if what they eat is considerably inferior in quality and quantity relative to the average standard prevailing in the society in which they live" (Mason, 2003).

But how do we reconcile our result with the contradictory evidences from the Indian economy? First, the positive and significant poverty-food security relationship which is valid in the current cross-section context may not be valid in a time-series context. This is an issue which can only be addressed by examining panel data. Second, the poverty-food security nexus may be sensitive to the choice of indicator. It is therefore important to repeat the same exercise with respect to other indicators of food security, e.g. undernourishment, nutritional status or micro-nutrient intakes, to check for robustness of the relationship across various outcomes of food insecurity. And finally, the relationship may be valid in the context of an urban sample, because by its very nature urban food insecurity gets manifested as a combination of poverty and malnutrition. Urban poor spend a major proportion of their

budget on food and hence poverty alleviation measures help them to earn their livelihood thus providing greater access to food. These factors might have influenced the results. Experimenting with rural data set might give additional insights.

Regarding the other predictors of food insecurity, a large household is found to be leading to declining food insecurity. The result may seem counter intuitive at first, but is quite plausible. As Ravallion and Lanjaouw (1995) put it, a large household may make at least some members better off. For example, it may allow for a more secure and easily supervised labor force for own-production activities, or it may offer greater security in old age. Besides, as the number increases, economy of size may play a role and the proportionate increase in food costs may decline which would free more resources for the households, leading to a decrease in the probability of being food insecure.

Female headed households are found to be more food insecure, in conformity with evidences from the literature (Sen, 1990; Fuwa, 2000; Mallick and Rafi, 2010). The female headed households are said to be more vulnerable to food insecurity due to the "triple burden" (Mallick and Rafi, 2010, pp. 593) : (i) the female head, who is the main income earner, faces various disadvantages in the labor market; (ii) she is also responsible for maintaining the household including household chores and child care in addition to working outside, and thus she is "activity burdened", and (iii) she might face a higher dependency ratio for being the single income earner (Fuwa, 2000). Interestingly, the variable relating to gender of household is insignificant in the poverty equation. This is in conformity with studies which suggest that the economic vulnerability of female headed households is a fact that goes beyond income (Fukuda-Parr, 1999).

The finding that higher educational levels generally increase the chances of a household being food secure reflects those of Benson (2007) who, while researching in the slum areas of urban Bangladesh, found that most food secure households were headed by a literate head

who, in most cases, had attained more than eight years of education. This finding is in conformity with other evidences from the literature (Faridi and Wadood, 2010; MSSRF 2002, 2010; Tawodzera, 2011). In urban areas, education and its attendant skills are associated with improved employment prospects and earning capacity. The somewhat weaker impact of the variable 'whether household head is graduate or above could be a degree of freedom problem. However, it is reassuring that the direction of effect is similar.

A larger share of working age adults in the household implies less dependency burden, hence greater earning capacity for the household, which will have implications for food security as well. There are enough evidences in the literature, of such of effects of household composition on poverty and food security (Chung et al, 1997; Baulch and McCulloh, 2002; Tawodzera, 2011).

The variables age, religion and home ownership status of household head, are not significant in the present model. Similar results have been reported by Mallick and Rafi (2010) and Faridi and Wadood (2010) for Bangladesh. It is not surprising that religion does not have any impact on food security status in the present sample. As has been pointed out by Bennett and Mitra (2011), beyond a certain point there's not much difference in economic status of low income Hindu and Muslim households, in terms of income alone. It's only by including other dimensions of poverty like housing, sanitation, drainage, cooking medium, education and so forth, one would be able to differentiate between Hindu and Muslim households in extreme poverty (Bennett and Mitra, 2011). This gets reflected in the food security status too. As for households belonging to Christianity and other religions, lack of statistical significance can be attributed to very small share of households belonging to this category in the sample, only 3.81%.

Regarding home ownership status, it seems, it is explained more by historical factors rather than by economic factors in the context of the age-old Kolkata slum dwellers. Majority of the

tenants are found to be living in a particular residence for generations, paying very low rents and almost earning the status of home owners. Besides, in majority of cases the home owners in slums do not have property rights which do not allow them to enjoy the economic benefit associated with an increase in asset price. Undocumented ownership with no legal title also prevents them from applying for mortgage. This implies, the typical advantages associated with home ownership may not be present in the context of the slum dwellers of Kolkata.

On the whole, the findings of the model generally underline the concept of "capability" (Sen, 1985) which focuses on the notion that a person's standards of living should not only focus on the goods, its characteristics or the utility it provides but should consider the capability of the person, which refers to the freedom the person has in terms of choice of functioning. What is more important is the range of choice the person has rather than the choice of the best, which is the mainstay of welfare economics. In the present context, being poor or being a woman or being uneducated is limiting the choice set of the individual belonging to a particular household, making it less capable and more food insecure.

6. Conclusion

In view of the apparent divergence between the indictors of poverty and food security in the rapidly growing Indian economy in recent years, the present paper aimed at looking into the association between the two variables by defining the latter in terms of an experiential indicator which embraces a broader approach in conceptualising food security, by going beyond the much dominated method of measuring food insecurity in terms of calorie shortfall. The analysis offers a fresh look at this much debated issue, not only because it employs a broader definition of food security, but also because none of the previous studies has considered a multivariate approach in modelling the relationship between poverty and food security status while also recognizing the possible endogeneity in the relationship.

In general, the results suggest, anti-poverty policies targeting the poor should generally be successful in addressing food insecurity. Specifically, we can infer, if National Food Security Bill targets the poor households, in distributing the food subsidies, it should be able to reach the food insecure households as well. However, in the ultimate analysis, the implication of this relationship is not just in increased poverty causing increased food insecurity, but also in contemplating how the urban poor organize their activities to protect access to food and how such activities can influence interventions to urban poverty (Maxwell, 1999). Given this scenario, our result gives some indication to cash transfer as being the appropriate type of poverty alleviation policy suitable for the population in question, with considerable focus on employment generation, particularly in order to release the pressure on urban informal sector.

The findings of the study also suggest that, apart from poverty, government policy should target households with higher dependency ratio (lower share of working age adults), female headed households and households headed by persons with no education, for enhancing the overall food security status of the relevant population. In summary, the results point out to the need for multisectoral intervention in effective monitoring of food security – anti-poverty policies to be complemented by gender empowerment and investment on human capital.

At this stage, we identify some of the limitations of the study. First we used a cross section sample while the original study hypothesis would have been best evaluated using a panel dataset. Second, the sample size was small. To obtain greater reliability in results a large sample size is needed, especially because models such as the bivariate semi-ordered probit model work best in large samples. Third, reporting bias and other standard concerns associated with subjective assessment, may be present in our case too, suggesting scope for further refinement of the subjective measure in future, for example, using anchoring vignettes to enhance comparability of subjective assessments across countries or socio-economic

groups (King et al., 2004). Given the scope of the present analysis we suggest the above exercises as issues which future research can address.

Given the fact that our study sample was low income urban slum households in Kolkata, to what extent the results can be generalized in the context of the broader setting of urban India remains a question. Agrawal et al. (2009) attempted to construct this experience-based indicator in a setting of urban slum households in Delhi and found greater food insecurity in households with lower socio-economic index. Results point out to similar direction in the present case. Building such cumulative evidence–base is essential in order to reach a definite conclusion. We recommend further development of this experiential measure of food security so that it can be used in conjunction with the existing food security indicators like calorie intake and nutritional status, for better understanding of the poverty-food security nexus and more effective targeting. Food security being a multidimensional concept, a broader suite of indicators is necessary for food security monitoring. Future research should also consider exploring the poverty-food security relationship in term of alternative indicators of poverty – possibly looking at multidimensional poverty. In this context, we also draw attention to the importance of building a rich database for food security monitoring which will provide information on various indicators of food security from the same source, tracking the same individuals or households over time. At present food security research is largely constrained by the lack of appropriate data, especially longitudinal data, making it difficult to translate research into policy.

Notwithstanding the limitations, this study has an important contribution to the development literature, in general, in terms of generating some thoughts on the link between research and policy. If there is no consensus on an appropriate indicator of poverty or food security and additionally, if there is no consensus on the link between poverty and food security, then policy makers should think twice before targeting the food subsidies on the basis of poverty

status of households. Otherwise, misallocation of resources, resulting from errors of wrong exclusion or wrong inclusion, will be too severe in magnitude to be handled effectively, defeating the purpose of a challenging decision like the National Food Security Bill, which underlines a right-based approach to providing food to millions of hungry in one of the most densely populated countries of the world.

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Notes

[1] The status of a person whose average minimum food energy intake is less than a pre-determined threshold. This also corresponds to the FAO measure of 'hunger' where the threshold is country specific and is measured in terms of the number of kilocalories required to conduct sedentary or light activities (FAO, 2008). The threshold for India, as recommended by the Indian Council of Medical Research, correspond to 2100 kcal per capita per day, for an urban person and 2400 kcal per capita per day, for a rural person (GOI, 1979).

[2] Growth in real GDP per capita reached 8.4% both in 2009-10 and 2010-11. However, the growth rate has slowed down in recent years to around 6.2% and 5% in 2011-12 and 2012-13 respectively (GOI, 2013).

[3] The National Food Security Act, 2013 (or Right to Food Act) was signed into law on September 12, 2013, retroactive to July 5, 2013. This law aims to provide subsidized food grains to approximately two thirds of India's 1.2 billion people.

[4] This happened because the Indian poverty line used to be defined in terms of normative calorie requirements of an average person in India which corresponds to 2100 kcal per capita per day for an urban person and 2400 kcal per capita per day for a rural person. Despite the large growth in real expenditure and positive calorie-expenditure elasticities, calories consumed per person in India has been declining continuously during the last few decades – a phenomenon termed as 'calorie consumption puzzle' by Chandrasekhar and Ghosh (2003). As Li and Eli (2010) note, understanding the source of these "missing" calories is critical for our understanding of poverty and food security in India as this would mean a divergence between the calorie-based food security indicator and the expenditure-based poverty indicator.

[5] National sample Survey Organisation (NSSO) has been including a question on food adequacy in its consumption surveys since 1983. In 1983 and 1993-94 the question was whether everyone in the household got "two square meals a day" and from 1999-00 the question was revised as "whether everyone in the household got enough food every day." Going by this question, self-reported hunger has declined in both rural and urban India between 1983 and 2004-05.

[6] An Expert Group (GOI 1993), for example, while evaluating the suitability of use of subjective hunger data, commented: "It has to be kept in mind that the information regarding the adequacy or inadequacy of food for consumption, elicited through a single probing question, may not always be free from subjectivity and at the same time may not be adequately

precise and objective. For instance the size of 'square meal' would differ not only from person to person but also from place to place."

[7] We attempted to get a sample where there would be a minimum representation of female headed households because female headed households might behave differently as far as household food security is concerned. On one hand, a female-headed household may be more food secure because there are evidences in the literature that income controlled by women is more likely to be spent on food consumption than that controlled by men (Kennedy, 1991). On the other hand, female headed households are likely to be more prone to financial deprivation, which would eventually lead to less food security for the family (Mallick and Rafi, 2010).

[8] Details of survey methodology are available upon request.

[9] While some of the questions were direct translations of the items in the US HFSSM and some were taken from the Bangladesh module, the most important challenge in framing the questions was, keeping the expressions of food insecurity consistent with local cultural practices and food behaviour.

[10] External validation of the child scale could not be not implemented due to lack of separate information on nutrient intake and anthropometry of children. This information could not be collected, in the survey, due to time and resource-constraint.

[11] With the exception of three questions – Q5, Q12 and Q21, for all other questions "yes" responses were followed up with "How often?" asking about the frequency of occurrence of the event. However, we present results ignoring the frequency of occurrence responses.

[12] The item infit statistic is an information-weighted chi-square-like measure of the extent to which an item discriminates more or less sharply than the average item in the module. Items with average discrimination have an infit of 1, and higher infit statistic indicate less strongly discriminating items. Item outfit statistics are similar to infit statistics except that they are not information-weighted, and are therefore particularly sensitive to erratic or improbable responses. See Bond and Fox (2001) for technical details. Infits in the range of 0.8 to 1.2 are considered to be good (Smith et al., 1998) and 0.7 to 1.3 are acceptable for food security assessment (Nord et al., 2002).

[13] These cut-offs corresponded to items "worried food would run out", 'not getting two square meals a day' and "adult skipping meal" respectively – describing the experience of marginal, moderate and severe food insecurity in a typically low income Indian household (see Maitra (2014), for details).

[14] Rasch reliability is the modelled variance divided by the total variance where total variance is the sum of modelled variance and error variance (standard statistical meanings, as one would find in any analysis of variance). Sensitivity is the proportion of those truly insecure that are measured as insecure and specificity implies the proportion of those truly secure measured as secure. Positive predictive value (calculated as the ratio of true positives over true positives plus false positives) indicates the probability that a household identified as food insecure (screened positive) by the scale actually is food insecure.

[15] Age dependency ratio is the ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64 (World Bank, 2014).

[16] Data were collected on the quantity and value of food items consumed by the households during a period of last 30 days preceding the date of inquiry. The quantity estimates of the food items consumed by a household were measured in units of calorie, protein and fat after application of conversion factors appropriate to the items of food, using the Nutrition Chart provided in NSSO (2012). The estimates of total nutrient equivalent of all food consumed by the household during the reference period is derived by aggregation over different groups (components) of food. The eight major food groups that have been considered are: cereals, pulses and soybean, milk & milk products, vegetables and fruits, sugar and honey, meat-egg-fish, edible oil and miscellaneous food products. Finally, the required figure on the level of calorie, fat and protein intake per day per person was calculated by sub-dividing this aggregate by the product of total number of members in the family and the duration of the reference period which was 30 days.

[17] If two ordinal variables are obtained by categorizing a normally distributed underlying variable and those two unobserved variables follow a bivariate normal distribution then the (maximum likelihood) estimate of that correlation is the polychoric correlation. If each of the ordinal variables has only two categories, then the correlation between the two variables is referred to as tetrachoric (Greene and Hensher, 2009).

[18] It should be noted that the semi-ordered bivariate probit estimator is a special case of the bivariate ordered probit estimator and does not require modifications to the likelihood function. See Armstrong and McVicar 2000); Mcvicar and Mckee (2002) for applications.

[19] We have 499 households because in constructing the scale, one household was dropped due to missing data.

[20] NLOGIT estimation assumes a constant term in the model while Stata assumes "no constant" and reports two unknown threshold parameters instead.

[21] Whether a household is casual labor household or not is decided by the employment status of the household according to household income during the last 365 days from occupations pursued by the household members (may not be the occupation of by the head of household) (NSSO, 2007a).

[22] In discrete choice models, set of partial derivatives will change sign exactly once in the sequence from *0* to *J*, a property that Boes and Winkelmann (2006) label as the 'single crossing' characteristic. For a positive coefficient, *k*, the signs moving from *0* to *J* will begin with negative and switch once to positive at some point in the sequence.

[23] Interested readers are referred to pages 223 and 224 in Greene and Hensher (2009) for the formula for computing marginal effects in a bivariate ordered probit model. The partial effects for the semi-ordered bivariate probit model can be derived from it. In a recursive structure, if a variable appears in both equations the reported effects will be added.

Table I Candidate food insecurity scale items and their abbreviations by hypothesized conceptual domain.

Item No.	Item description	Item abbreviation	Domain
Q1.	worried that food would run out before you could buy more?	worried	anxiety, insecurity
Q3.	food stored in home ran out and there was no money to buy more	ran out	anxiety, insecurity
Q4.	borrowed food from relatives or neighbours to make a meal	borrowed food	acceptability
Q5.	cooked "bhalo mondo" ("rich food" such as shemai, paish, or polao)	rich food	quality
Q6.	had to eat the same kind of food every day	same food	quality
Q7.	adults could not eat at least two square meals a day	two square meals	quantity
Q8.	personally ate less food so that there would be more for the rest of the family	ate less	quantity
Q10.	adult skipped entire meal so that there would be more food for the family	skip meal	quantity
Q11.	adults were hungry but did not eat because you couldn't afford enough food	hungry	consequence of reduced intake
Q12.	adult lost weight because you didn't have enough money for food	lost weight	consequence of reduced intake
Q13.	adult not eat for a whole day because there wasn't enough money for food	whole day	quantity
Q14.	child/children had to rely on only a few kinds of low-cost food	low cost food	quality
Q15.	child/children in the family couldn't eat at least three square meal each day	child three square meals	quantity
Q16.	child/children couldn't be given a varied and healthy diet	child varied and healthy	quality
Q17.	child/children were not eating enough	child not eat enough	quantity
Q18.	skipped child's/children's meal because there wasn't enough money for food	child skip meal	quantity
Q19.	child/children in the family were hungry but couldn't afford more food	child hungry	quantity
Q20.	child/children didn't eat for whole day because there wasn't enough money for food	child whole day	consequence of reduced intake
Q21.	child/children in the household lost weight/felt weak because you couldn't afford enough food	child lost weight	consequence of reduced intake

Note: Q2 and Q9 in the main questionnaire are not scale items and hence not included in this table. Q1-Q13 are adult food security related items and Q14-Q21 are child food security related items.

Table II Item Severity Parameters and Fit Statistics, Nine-Item Adult Food Security Scale (N=406), Kolkata, 2010-11.

Item	Severity Parameter[a]	Std. Error	Infit[b]	Outfit[c]
Never cooked rich meals	0.48	0.41	1.02	5.00
Worried food would run out	5.53	0.21	1.05	0.75
Had to eat same kind of food every day	-	-	-	-
Adult lost weight	6.03	0.22	0.78	0.42
Ate less so there would be more for others	6.15	0.22	0.88	0.95
Food ran out	6.44	0.22	1.30	0.46
Adult could not eat two square meals	6.90	0.22	0.80	0.62
Borrowed money for food	-	-	-	-
Adult skipped meals	9.74	0.30	0.89	1.11
Adult hungry but didn't eat	10.87	0.44	1.05	0.26
Adult did not eat for whole day	10.87	0.44	0.70	0.16

Note: Estimation method: Conditional Maximum Likelihood. No. of groups: 10 (8 of them are used to compute the statistics of test). Number of individuals: 499 (1 household removed for missing values). Number of households with null or perfect score is 93 and these households are omitted from the psychometric analysis. Conditional log-likelihood: - 275.405. Reported item severities have been obtained by adding seven to severity parameters reported by Stata. [a]The item severity parameters in food security measurement vary as to the severity of food insecurity to which they are sensitive. [b] The item infit statistic is an information-weighted chi-square-like measure of the extent to which an item discriminates more or less sharply than the average item in the module. Items with average discrimination have an infit of one. [c] Item outfit statistics are not information-weighted, and are, therefore, particularly sensitive to erratic or improbable responses. Infits in the range of 0.8 to 1.2 are considered to be good (Smith et al., 1998), and 0.7 to 1.3 are acceptable (Nord et al., 2002).

Table III Household Scale Scores, Food Security Status Categories and Prevalence Rates According to the 9-item Adult Food Security Scale, Kolkata 2010-11.

Raw Score	Severity[a]	Frequency	Percentage Households (N=500)	Cumulative Percent	Category
0	Not defined	87	17.4	17.4	Food Secure (76.2%)
1	3.57	260	52.0	69.4	
2	5.03	34	6.8	76.2	
	5.43	Threshold Marginally Food Secure			Marginally Food Secure (8.4 %)
3	5.84	22	4.4	80.6	
4	6.54	20	4.0	84.6	
	6.93	Threshold Moderately Food Secure			Moderately Food insecure (12.8%)
5	7.32	18	3.6	88.2	
6	8.54	46	9.2	97.4	
	9.26	Threshold Severely Food Insecure			Severely food insecure (2.6%)
7	9.98	5	1.0	98.4	
8	11.09	2	0.4	98.8	
9	12.59	6	1.2	100	

Notes: [a]Household severity parameters are continuous interval-level measures of the extent of food insecurity or hunger in the household. The zero point on the Rasch Scale is arbitrary. Reported household severities have been obtained by adding seven to severity parameters reported by Stata. The severity of food insecurity with raw score zero and nine is unknown. The tables for raw score 9 was calculated as if for raw score 8.5. Food security scale has a measured range of 7.52 logistic units - 3.57 to 11.09 (12.59 not considered, being a kind of pseudo-value based on raw score 8.5). Prevalence rates have been computed for 500 households.

Table IV Food Security Status by Households' Socio-Economic & Demographic Characteristics, Kolkata 2010-11

	Highly Food Secure (0 ≤ raw score <3)	Marginally Food Secure (3 ≥ raw score <5)	Food Insecure (raw score ≥ 5)
Expenditure Group			
Lowest 25%	41.6	12.8	45.6
Middle 50%	74.4	12.8	12.8
Top 25%	94.78	3.61	1.61
Poverty Status			
Poor (MPCE < Rs.856.28)	30.3	7.58	62.12
Non-poor (MPCE ≥ Rs. 856.28)	83.37	8.31	8.31
Asset Ownership			
Zero or only fan	39.68	7.94	52.39
At least one asset other than fan	81.65	8.26	10.1
Employment Status			
Casual labour	58.04	8.93	33.03
Others (self-employed, regular salaried etc.)	81.65	8.01	10.34
Participation in Government Program			
Ration card	77.46	8.92	13.62
No ration card	69.86	4.11	26.03
Household Composition			
Household with kids (members <15 years of age	72.14	8.02	19.85
Households without kids	81.01	8.44	10.55
Households with dependency ratio>1	73.39	8.56	18.04
Households with dependency ratio<1	81.98	7.56	10.46
Gender of Household Head			
Male	79.95	6.93	13.12
Female	61.05	13.68	25.26
Education of Household Head			
Illiterate	60.74	12.27	26.99
Primary-Middle	82.13	7.22	10.65
Graduate & above	95.56	0	4.44

Note: Poverty line expenditure for Kolkata, 2010-11, was determined by updating the poverty line expenditure for urban West Bengal, 2004-05, using the Consumer Price index for urban Industrial Workers (base 2001).

Table V Average Intake of Nutrients and Selected Food Items and Food Adequacy by Food Security Status, Kolkata 2010-11.

Nutrients and Food Items	Mean Consumption		
	Food Secure (N=422)	Food Insecure (N=77)	t
Calorie (kcal per person per day)	1968.7	1370.4	8.61
Fat (gm. per person per day)	47.16	20.96	4.43
Protein (gm. per person per day)	55.61	33.72	9.5
Cereals (gm. per person per day)	286.41	239.58	3.48
Vegetables (gm per person per day)	276.05	201.75	5.11
Fish (gm per person per day)	32.48	13.74	4.97
Meat (gm per person per day)	27.58	10.36	4.57
Milk (gm per person per day)	89.47	27.56	5.1
Oil (gm per person per day)	23.98	14.77	5.43

Table VI Cross Tabulation of Households by Undernourishment and Food Security Status, Kolkata, 2010-11.

	Undernourished (per capita per day calorie intake < 2100 kcal)[a]	Not-undernourished (per capita per day calorie intake ≥ 2100 kcal)	Total
Highly Food Secure (0≤ raw score <3)	209 (54.86)	172(45.14)	381
Marginally Food Secure (3≥ Raw score <5	29 (70.73)	12(29.27)	41
Food Insecure (raw score ≥5)	70 (90.91)	7(9.09)	77
	308	191	**499**

The tetrachoric[b] correlation between food security status and undernourishment is 0.56 (p< 0.000).

Note: N=499, because in constructing the food security scale, 1 observation was deleted for missing value. Figures in parenthesis represent row percentage. [a]The calorie threshold of 2100 kcal per capita per day, for an average urban Indian, was recommended by the Indian Council of Medical Research (GOI, 1979). [b] If two ordinal variables are obtained by categorizing a normally distributed underlying variable and those two unobserved variables follow a bivariate normal distribution then the (maximum likelihood) estimate of that correlation is the tetrachoric correlation provided both variables have only two categories (Greene and Hensher, 2009).

Table VII Cross Tabulation of Households by Poverty and Food Security Status, Kolkata, 2010-11.

	Non-Poor (MPCE ≥ Rs. 856.28)	Poor (MPCE < Rs. 856.28)	Total
Highly Food Secure (0≤ raw score <3)	361	20	381
Marginally Food Secure (3≥ Raw score <5)	36	5	41
Food Insecure (raw score ≥5)	36	41	77
Total	433	66	499

Polychoric[a] correlation between poverty and food security status is 0.73 (Prob (> chi2(1)) = .04.

Note: N=499, because in constructing the food security scale, 1 observation was deleted for missing value. [a] If two ordinal variables are obtained by categorizing a normally distributed underlying variable and those two unobserved variables follow a bivariate normal distribution then the (maximum likelihood) estimate of that correlation is the polychoric correlation (Greene and Hensher, 2009).

Table VIII Summary Statistics of Variables in the Semi-ordered Recursive Bivariate Probit Model, Kolkata, 2010-11.

Variables	Definition	Mean
FI	=0 if household highly food secure	0.76
	=1 if household marginally food secure	0.08
	=2 if household food insecure	0.16
poor	=1 if poor, else 0	0.13
lnhhsize	logarithm of household size	1.37 (0.54)
hage	age of household head,	47.86 (13.77)
gender	=1 if female, else 0	0.19
dwelling	=1 if owns home, else 0 (hired or encroached)	0.33
relig0	omitted base group, household belongs to Hinduism	0.52
relig1	= 1 if household belongs to Islam, else 0	0.44
relig2	=1 if household belongs to 'Christianity or Others, else 0	0.04
headlit0	omitted base group, household head illiterate or below primary level education	0.33
headlit1	=1 if household head has primary to middle level education, else 0	0.58
headlit2	=1 if household head is graduate and above, else 0	0.09
kids	omitted base group share of kids (below 15 years) in the household	0.18(0.20)
workadult	share of working age adults (15 years and above and below 65 years) in the household	0.75(0.23)
senior	share of seniors (65 years and above) in the household	0.07(0.16)
hhtype	=1 if casual labor household, else 0	0.22

Total number of households is 499, because in constructing the food security scale, 1 observation was deleted for missing value. Standard errors in parenthesis are reported for continuous variables only.

Table IX Results of Semi-ordered Recursive Bivariate Probit Estimation, Kolkata, 2010-2011.

Variables	Coefficient	Std. Error	z
Index function for Probability Model for Food Security			
Constant	.998*	.603	.650
Age of household head	-.007	0.007	-1.040
Household is poor (γ)	1.691**	.681	2.480
Household size	-.332*	.192	-1.730
Household head is female	.383**	.188	2.040
Religion of household head is Islam	-.079	.161	-.490
Religion of Household head Christianity & Others	-.343	.524	-.660
Household head owns home	-.140	.163	-.860
Household head has primary to high secondary level education	-.426**	.209	-2.030
Household head is graduate & above	-.967*	.537	-1.800
Share of working age adults (15 years and above and below 65 years)	-1.180***	.442	-2.670
Share of seniors (65 years and above)	-.451	.644	-.700
Threshold Parameters for Probability Model for Food Insecurity μ	.400***	0.062	6.470
Index function for Probability Model for Poor			
Constant	-.505	.566	-.890
Age of household head	-.009	.008	-1.100
Household size	.751***	.218 3	.440
Household head is female	.365	.227	1.610
Religion of household head is Islam	-.088	.200	-.440
Religion of Household head Christianity & Others	.783	-1.060	-.832
Household head owns home	.173	.197	.880
Household head has primary to high secondary level education	-.742***	.197	-3.770
Household head is graduate & above	-1.004	.640	-1.570
Share of working age adults (15 years and above and below 65 years)	-1.561***	.534	-2.920
Share of seniors (65 years and above)	-.691	1.023	-.680
Casual labor household	.598***	.192	3.110
Disturbance Correlation RHO (1,2)	-.158	.406	-.390
Log likelihood= -428.36353			

Note: ***, **, * implies significance at 1%, 5% and 10% level, respectively.

Table X Effect of 10% increase in Continuous Variables on Predicted Probabilities of Food Security [P(*Fi = j*)], Kolkata , 2010-11.

Average share of working age adults	X (=0.75)	x*1.1 (= 0.82)	% Change
Prob (F=0))	0.7622032	0.7804145	+2.38
Prob (F=1)	0.07771	0.07250	-6.70
Prob (F=2)	0.160086	0.147081	-8.12
Logarithm of household size	X (=1.37)	x*1.1 (= 1.50)	% Change
Prob (F=0))	0.7622032	0.7720584	+1.29
Prob (F=1)	0.0777099	0.0731093	-5.92
Prob (F=2)	0.1600869	0.1548323	-3.28

Table XI Effect of Changes in Discrete Variables on Predicted Probabilities of Food Security [P (*Fi = j*)], Kolkata, 2010-11.

	Non-Poor (=0)	Poor (=1)	% Change
Prob (F=0)	0.846389	0.209891	-75.20
Prob (F=1)	0.070963	0.121976	+71.89
Prob (F=2)	0.082648	0.668133	+708.41
	Male Headed (=0)	Female Headed (=1)	% Change
Prob (F=0))	0.794547	0.624658	-21.38
Prob (F=1)	0.070835	0.106948	+50.98
Prob (F=2)	0.134619	0.268394	+99.37
	Illiterate (=0)	Primary to Middle (=1)	% Change
Prob (F=0))	0.606882	0.819899	+35.10
Prob (F=1)	0.104169	0.070788	-32.04
Prob (F=2)	0.288949	0.109313	-62.17
	Illiterate (=0)	Graduate and above (=1)	% Change
Prob (F=0))	0.606882	0.95171	+56.82
Prob (F=1)	0.104169	0.026628	-74.44
Prob (F=2)	0.288949	0.021662	-92.50

Note: Predicted probabilities are calculated as P [F =j | x = 1] − P [F = j | x = 0].

Table XII Marginal Effects in Single Equation Ordered Probit Model, Kolkata 2010-11.

Variables	Partial effects	z	Prob.|z|>Z*
[Partial effects on Prob[Highly Food Secure] at means]			
Age household age	.00	1.39	0.16
Household is poor (***γ***)	-.50***	-7.65	0.00
Household size (log)	.08**	2.09	0.04
Household head is female	-.12**	-2.24	0.03
Religion of household head is Islam	.02	0.63	0.53
Religion of Household head Christianity & Others	.09	0.97	0.33
Household head owns home	.04	0.88	0.38
Household head has primary to high secondary level education	.14***	3.17	0.00
Household head is graduate & above	.19***	5.19	0.00
Share of working age adults (15 years and above and below 65 years)	.35***	3.26	0.00
Share of seniors (above 65 years)	0.14	0.9	0.37
[Partial effects on Prob[Marginally Food Secure](at means)			
Age household age	0.0	-1.39	0.16
Household is poor (***γ***)	.08***	9.44	0.00
Household size (log)	-.03**	-2.09	0.04
Household head is female	.04**	2.53	0.01
Religion of household head is Islam	-.01	-0.63	0.53
Religion of Household head Christianity & Others	-.03	-0.88	0.38
Household head owns home	-.01	-0.87	0.38
Household head has primary to high secondary level education	-.04***	-3.36	0.00
Household head is graduate & above	-.08***	-4.55	0.00
Share of working age adults (15 years and above and below 65 years)	-.12***	-3.25	0.00
Share of seniors (above 65 years)	-.05	-0.9	0.37
[Partial effects on Prob [Food Insecure] (at means)			
Age household age	.00	-1.39	0.16
Household is poor (***γ***)	.42***	6.06	0.00
Household size (log)	-.05**	-2.08	0.04
Household head is female	.08**	2.11	0.03
Religion of household head is Islam	-.02	-0.63	0.53
Religion of Household head Christianity & Others	-.05	-1.04	0.30
Household head owns home	-.02	-0.89	0.37
Household head has primary to high secondary level education	-.09***	-3.05	0.00
Household head is graduate & above	-.11***	-5.53	0.00
Share of working age adults (15 years and above and below 65 years)	-.23***	-3.23	0.00
Share of seniors (above 65 years)	-.09	-0.9	0.37

Note: ***, **, * implies significance at 1%, 5% and 10% level, respectively. M.E-s for dummy variables are computed on the basis of change in predicted probability as Pr[F|x=1]-Pr[F|x=0].