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Poverty–Food Security Nexus: Evidence from a Survey of Urban Slum Dwellers in Kolkata

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Summary. — We explore the poverty–food security nexus, using an experience-based indicator of food security constructed using a cross-section sample of slum households in Kolkata, within the framework of a simultaneous ordered probit model. We find, a poor household is also likely to be food insecure. Additionally education, gender, and household composition are major drivers of food insecurity among low-income urban households, with the policy implication that anti-poverty policies should be successful in eliminating household food insecurity, however, they need to be complemented with human capital investment and gender empowerment to be most effective.

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 expenditure-based poverty rate and the prevalence of undernourishment – a calorie-based outcome indicator of food security (Meenakshi & Vishwanathan, 2003; Palmer-Jones & Sen, 2001; Radhakrishna, 2005; Ray & Lancaster, 2005; Sen, 2005; Suryanarayana & Silva, 2007). The paradox of rising undernourishment and declining poverty rates over time, originates in the context of a rapidly growing economy which is also urbanizing at a fast pace, 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 (Suryanarayana & Silva, 2007). The issue has implication for the recently passed National Food Security ACT (NFSA),[1] because any attempt to employ expenditure-based poverty rate to 'target' food subsidies to the 'needy' may end up excluding the large fraction of those 'non-poor' households who might be 'food insecure' at the same time, resulting in serious misallocation of resources. Recent studies by Masiero (2015) and Jha, Gaiha, Pandey, and Kaicker (2013) elaborate the extent of such misallocation with respect to the targeted public distribution system (TPDS) in India.

This debate is also linked to the observed discrepancy between expenditure-based estimates of poverty and calorie-based estimates of poverty, following the recently observed trend of declining calorie intake in Indian households (Basu & Basole, 2012; Chandrasekhasr & Ghosh, 2003; Deaton & Dreze, 2009; Gaiha, Jha, & Kulkarni, 2010; Li & Eli, 2010; Mehta & Venkatraman, 2000; Patnaik, 2004). As an off-shoot of this discussion, the divergence between poverty and food security was noted.

The technical concerns raised are the need to redefine the poverty line and the use of calorie intake alone as the indicator of food security. These concerns point out toward a more fundamental question – is there something inherent in poverty that drives food insecurity or are the two phenomena independent? Will the poverty–food security nexus remain relevant if we measure food security using a newly constructed experiential indicator? These are the two main questions we explore and seek to answer in the present paper.

We observe that the poverty–food security divergence noted in the Indian economy may not be so obvious and is a testable hypothesis. We propose to test it using an experiential indicator of food security. In explaining our stand we forward the following set of arguments.

First, looking at the poverty–food security nexus through the lenses of calorie-based indicators like undernourishment has a few shortcomings. 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). 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

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phenomenon that goes beyond calorie energy intake (Mason, 2003). Additionally, there exists considerable uncertainty in the estimates of prevalence of undernourishment due to two reasons: first, calorie data derived from standard Household Income and Expenditure Surveys (HIES) are subject to systematic measurement errors (Bouis, 1994; Srinivasan, 1981; Strauss & Thomas, 1995); and second, determining an appropriate threshold, to estimate the incidence of hunger and undernourishment, is 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).

Second, an attempt to explore the poverty–food security nexus using indicators like self-reported hunger indicators or anthropometric indicators capturing nutritional status, present quite contradictory evidence on the question of poverty and food insecurity trends moving in the opposite directions. In India, self-reported hunger[2] actually declined during 1983–2005 (Deaton & Dreze, 2009; NSSO, 1983, 1997, 2007b) and, despite the fact that the level of undernutrition is still unacceptably high, trends in anthropometric indicators show some improvement over time (Deaton & Dreze, 2009). The issue is further complicated by the fact that the self-reported hunger figures reported by the National Sample Survey Organisation (NSSO) are not reliable enough (Deaton & Dreze, 2009) and hence may not be suitable as a tool to test the hypothesis on poverty–food security linkage in the context of the Indian economy. As far as another indicator, nutritional status is concerned; it is a more reliable indicator in terms of having less systematic error (Mason, 2003). However, nutritional outcomes are indirect indicators of food security in the sense that they may not represent the consequence of food insecurity alone and can be caused by a whole range of other factors like the individual's past health status, availability of good drinking water and sanitation, caregivers' education status, and so forth, and therefore fail to pass the test of being the appropriate instrument to examine the poverty–food security nexus.[3]

In the light of the above discussion, we note the following gaps in the literature. First, there exists an urgent need to examine further the poverty–food security nexus in terms of an alternative indicator of food security which would overcome the concerns associated with the existing quantitative indicators. Second, we argue, the poverty–food security relationship is potentially endogenous which is not adequately addressed in the past analyses of the impact of income-poverty on household food security. Finally, the nature of the poverty–food security relationship may be very different across rural and urban settings, and India is urbanizing rapidly, with the number of urban poor growing comparatively faster than that of rural poor (GOI, 2011a). This suggests 'urbanization of poverty' (Maxwell, 1999; Ravallion, 2002) which will have implications for food security as well.

We address the first concern by constructing an experience-based food security indicator following the U.S. Household Food Security Survey Module (US HFSSM) (Hamilton *et al*., 1997), using data collected from 500 randomly sampled slum households of Kolkata in 2010–11. The second issue of potential endogeneity in the poverty–food security relationship is addressed through our modeling technique which features an ordered food security outcome and a potentially endogenous dichotomous regressor which is household poverty status. One of the standard approaches is to specify a recursive bivariate probit model with endogenous regressors. In our case, the dependent variable is ordered and the endogenous regressor is binary, therefore following Greene (2012) we employ a recursive semi-ordered bivariate probit model. However, due to the lack of suitable panel data on our variables of interest, we attempt to answer the questions using a cross-section sample.

Finally we build our model in the context of low-income urban slum households. The fact that majority of workers in the slum work in the informal sector, earn highly variable income and have limited assets (an insurance against risk), have made food access an issue of serious concern for them (Floro & Swain, 2013). Urban low-income households are dependent on market purchase for food and spend the largest fraction of their income on food (Banerjee & Duflo, 2006; Ruel, Haddad, & Garrett, 1999). Not all urban poor are residents of slums but a substantial fraction is. For example, in all major Indian cities except Indore, the percentage of poor is much higher in slums than in non-slum areas (Gupta, Arnold, & Lhungdim, 2009). Additionally, according to 2008 UN study, slum dwellers experience more hunger and disease, receive less education and have fewer job opportunities than the rest of the urban population (United Nations, 2008). We use data collected from 500 households from the slums of Kolkata.

Main findings from our study are: poverty increases the likelihood of experiential food security in low-income urban households. Household characteristics like education and gender of the household head and household composition are also significant predictors of household food insecurity. These results suggest two directions: anti-poverty policies could be successful in enhancing food security of low-income urban slum households; and poverty alleviation measures are to be combined with investment on human capital and gender empowerment to be most effective. These findings have implications not just for urban food security in India but for developing countries in general. Similar concerns have been echoed by Floro and Swain (2013) in the context of food security of low-income slum households of Bolivia, Ecuador, Philippines, and Thailand.

The rest of the paper is organized as follows: Section 2 provides the background on US HFSSM, Section 3 discusses data and method; Sections 4 and 5 present results and discussion, respectively; Section 6 discusses a few limitations of the study and Section 7 concludes by drawing some policy implications.

2. UNITED STATES HOUSEHOLD FOOD SECURITY SURVEY MODULE: AN INTRODUCTION

We employ the experiential food security measure developed by the United States Department of Agriculture (USDA) to explore poverty–food security nexus in the current setting. Experiential food insecurity as measured by the US HFSSM implies, the concept of household food insecurity not only includes hunger but also household respondent's perceptions of problems with respect to the quantity and quality of food available, uncertainty of food supply and experiences of going hungry (adapted from Carlson, Andrews, & Bickel, 1999). Experiential measures are based on the idea that the experience of food insecurity causes predictable reactions and responses that can be reported in a survey and quantified and summarized in a scale to provide an indicator of the degree of a household's food insecurity. Hence, it is a 'direct' measure of the severity of household food stress or food deprivation, as opposed to indirect measures like nutritional outcomes.

The reasons for using the US-based experiential measure are the following. First, experiential indicators have certain advantages over the standard food security indicators like food availability, calorie intake, or anthropometric indicators, because they capture dimensions which are difficult to isolate through traditional quantitative indicators – namely, cultural acceptability and vulnerability. They also underline the fact that food insecurity relates not just to insufficient 'quantity' but to inadequate 'quality' as well (Barrett, 2002, chap. 40). 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. Some of the additional advantages of experiential indicators are: they are relatively more cost effective compared with time-consuming expenditure data required to estimate calorie intake, they can be used to capture seasonality using 'hunger-gap' questions which enquire on number of months/weeks of hunger experiences in a year (Heady & Ecker, 2012) and finally, the recent innovations of experiential measures, as reflected in the development of Food Insecurity Experience Scale (FIES) by Food and Agricultural Organization (FAO) (Ballard, Kepple, & Cafiero, 2013) render it possible to capture food insecurity at individual level, relatively inexpensively.

Second, among the various self-assessed indicators, the USDA measure stands out because of certain unique features. At one end of the experiential indicators we have the simple dichotomous indicators such as the Gallup World Poll indicator, which asked whether respondents had experienced problems affording food over the previous 12 months. Other surveys include the Afrobarometer survey, the World Food Program's Comprehensive Food Security and Vulnerability Analysis (CFSVSA) survey, the World Bank's Living Standard Measurement Survey (LSMS) and some household HIES containing questions about the experience of hunger in the last 12 months (Heady & Ecker, 2012), for example, India's National Sample Survey. However, there are typical concerns associated with assessment of hunger using a single probing question. An Expert Group from India (GOI, 1993, p. 53), 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." Besides, as head of household, breadwinners often find it hard to admit that they are unable to provide even 'two square meals' to the family and this feeling of shame leads to under reporting of self-reported hunger. These concerns may explain why NSS hunger figures are too low to be believed (Mason, 2003).

The US HFSSM tries to capture the full breadth of food insecurity from purely psychological to more physical feelings of hunger through its 18 questions. As mentioned before, qualitative investigation of the phenomenon is followed by "a transformation of grounded insight into something that can be manipulated statistically, namely scales and indices" (Webb *et al.*, 2006, p. 1406). 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 (Hamilton *et al.*, 1997). Food security scales are estimated using a Rasch measurement model, a form of non-linear factor analysis, in the family of Item Response Theory (IRT) models (see Bond & Fox, 2001, for details). The IRT is commonly employed to construct educational tests intended to gauge 'ability' based on an individual's responses to progressively more difficult questions. In the food security literature, the unobservable construct of interest is household food insecurity rather than 'ability', and the items representing the underlying phenomenon describe 'severity' rather than 'difficulty' (Coates, Wilde, Webb, Rogers, & Houser, 2006).

US HFSSM has served as a model for many other experience-based food security scales in diverse countries around the world including Brazil (Melgar-Quinonez, Nord, Pérez-Escamilla, & Segall-Corrêa, 2008), Bangladesh (Coates *et al.*, 2006) and more recently FAO who constructed FIES, a tool to measure food insecurity across the globe (Ballard *et al.*, 2013). In India, shorter version of the US HFSSM has been administered in slums of Delhi (Agarwal *et al.*, 2009) and rural Orissa (Nord, Satpathy, Raj, Webb, & Houser, 2002).

3. DATA AND METHOD

(a) *Data*

The data for the study come from information collected from 500 randomly surveyed slum households of Kolkata, India. The survey was conducted in 2010–11. [4]

(i) *Sample*

We selected slum households in Kolkata for our study for two reasons. First, Kolkata is a typical representation 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, 2002, chap. 20). Second, selection of Kolkata allowed us to administer the US HFSSM to the Bengali-speaking population – the seventh most widely spoken language group in the world, which in turn allowed us to test whether the already established validity of the US HFSSM scale in Bangladesh (East Bengal) (Coates *et al.*, 2006) is robust across the Western part of Bengal (now in India) where Kolkata is located.

In designing the survey, we followed 'multistage sampling' where the selection has been done in three stages, following sampling frame outlined in Urban Frame Survey (UFS) (NSSO, 2008). In the first stage, 15 Investigating Units (IV) [5] were selected randomly out of 330 IV Units listed under the Kolkata Metropolitan Corporation (KMC) area in UFS 2002–07. The IV Units were selected by the method of 'systematic random sampling', following NSSO (2008), in which sample units are selected at specific intervals. [6] Fifteen blocks [7] with "slum areas" were selected randomly from these IV Units. 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. [8]

The sample size of 500 was selected following a special case of optimal allocation called Neyman allocation (Lohr, 1999) which samples a higher percentage of households from bigger slums. The selection was done using a margin of error of 0.5%, setting desired level of confidence at 95% (standard value of 1.96).

The data were collected during the period April 2010 to January 2011, with a break in the month of October which is the festive season in Kolkata.

At the final interviewing phase, we selected respondents on the basis of gender – the female head in case of female-headed households, otherwise the next adult female in the household;

and the adult female who is in charge of kitchen, for the male-headed households. If the female members were not available, the male head of the household was the next preference. Accordingly, in the final stage, 51% of our respondents were female, 47% were male heads and as for the remaining 2%, either the information is missing or they comprise other adult male members of the household.

(ii) *Survey instrument: questionnaire*

The primary survey instrument is the questionnaire collecting information on: (a) socio-economic and demographic profile (for assessing consumption expenditure pattern of the surveyed households), and (b) food security scale items adapted from US HFSSM. All questions were asked with a 30-day recall.

We use part A of the questionnaire to construct a few important variables – monthly per capita expenditure (MPCE) of the household and average household consumption of macronutrients which include calorie, protein, and fat. Information on the latter is being employed for external validation of the experience-based food security indicator constructed as a part of this study.

We use part B of the questionnaire to construct the food security scale which we call the Kolkata Household Food Security Scale (KFSS) henceforth. The KFSS is based on 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] All questions were asked with "yes" or "no" response options.[10]

As Table 1 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.[11]

(iii) *Variables*

The dependent variable '*finsec*' in the econometric model sketched out in Section 3(b).iii is an ordered variable with three categories: highly food secure, marginally food secure, and food insecure. The construction of this variable and the relevant categorization is explained in the following section on methodology (Section 3(b).i). Household food insecurity is categorized highly food secure if the raw score for the food insecurity scale is between 0 and 3; marginally food secure if the raw score is between 3 and 5; and food insecure if the score is five and above. For the purpose of the subsequent data analysis *finsec* is defined as follows:

$$finsec = \begin{cases} 0 \; if \; highly \; food \; secure \\ 1 \; if \; marginally \; food \; secure \\ 2 \; if \; food \; insecure \end{cases}$$

Our main explanatory variable of interest is household poverty status which is binary and potentially endogenous with respect to household food security status. A household is defined as poor if its MPCE is below the poverty line expenditure of urban West Bengal, for the year 2010–11. The line is set at Rs. 856.28 by updating the poverty line of urban West Bengal for 2004–05 (GOI, 2011b), using Consumer Price Index for Urban Industrial Workers (base 2001) with a linking factor of 5.12 for Kolkata (Labour Bureau of India, Shimla). Accordingly, we define binary poverty status as '*poor*' with values 1 if MPCE $<$ Rs. 856.28 and 0, otherwise. Thus,

$$poor = \begin{cases} 1 \; if \; poor \\ 0 \; otherwise \end{cases}$$

Apart from poverty, the other explanatory variables in the food security equation contained in the econometric model include, household size (in logarithmic form); age, gender, education, homeownership status, and religion of household head; and household composition represented by the proportion of children, working age adults and seniors in the household.[12] The above variables are consistent with the list of socio-economic indicators of food and nutrition security provided in Haddad, Kennedy, and Sullivan (1994) and Frankenberger (1992).

Table 1. *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 neighbors 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 could not afford enough food	Hungry	Consequence of reduced intake
Q12.	Adult lost weight because you did not have enough money for food	Lost weight	Consequence of reduced intake
Q13.	Adult not eat for a whole day because there was not 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 could not 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 was not enough money for food	Child skip meal	Quantity
Q19.	Child/children in the family were hungry but could not afford more food	Child hungry	Quantity
Q20.	Child/children did not eat for whole day because there was not enough money for food	Child whole day	Consequence of reduced intake
Q21.	Child/children in the household lost weight/felt weak because you could not 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.

A key explanatory variable in the poverty equation which is not included in the food security equation is household's employment status denoting 'whether a household is casual labor or not'.[13] 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* is created which classifies households into two broad categories 'casual labor' and 'others', the latter being the reference group including the remaining three categories – self-employed, regular salaried, and others.

Table 2 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.

A major variable of interest in the present analysis is household average consumption of nutrients which includes three macronutrients – calorie, protein, and fat. 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 interview. The quantity estimates of the food items consumed by a household were converted into units of calorie, protein, and fat using conversion factors appropriate to the items of food available from 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.[14] Finally, the required figure on the level of calorie, fat, and protein intake per day per person is obtained using this aggregate, dividing by household size and expressing it on a per day basis.[15] A household is designated calorie-poor or undernourished if its per capita daily consumption of calorie intake falls below the Indian Council of Medical Research (ICMR) prescribed norm of 2,100 kcal for an average person residing in urban areas (GOI, 1979).[16]

(b) *Methodology*

The following methods are used in data analysis. First we sketch the construction of the KFSS. Next, we present a cross tabulation of the poor and food insecure households to get a preliminary notion on the relationship between the two phenomenon. Finally, we test the relationship between *poor* and *finsec* econometrically, using a semi-ordered bivariate probit model.

(i) *Construction of the Kolkata Food Security Scale (KFSS) using Rasch model*

In this section we briefly describe the construction of the experiential Kolkata food security scale. The detailed methodology is available in Maitra (2014).

Responses to the questions in Table 1 are used in the estimation of the Rasch model, which is estimated by conditional maximum likelihood (CML) implemented in Stata's *Raschtest*. Based on item infit and outfit statistics,[17] poorly performing items are omitted until performance of all items meet model assumptions acceptably well, and in the final analysis we are left with nine adult items which adequately form a scale (Table 3).

On this scale, four categories of food security status are 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.[18] Accordingly, 84.6% of households in the Kolkata sample are food secure ($0 \leqslant$ raw score < 5) [including 76.2% highly food secure ($0 \geqslant$ raw score < 3) and 8.4% marginally food secure ($3 \geqslant$ raw score < 5)]; 15.4% were food insecure [including 12.8% moderately food insecure ($5 \geqslant$ raw score < 7)] and 2.6% severely food insecure households (raw score $\geqslant 7$)] (Table 4).

However, as mentioned in Section 3(a).iii, for the purpose of data analysis reported in the subsequent sections only three categories of food security status are considered: highly food secure, marginally food secure, and food insecure. Households with moderate and severe food insecurity are analyzed as a single category because only a small number of households (only 13) are present in the latter category.

Table 2. *Summary statistics of variables in the semi-ordered recursive bivariate probit model, Kolkata, 2010–11*

Variables	Definition	Mean
finsec	=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

Note: 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 3. *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] Item severity parameters in food security measurement vary as to the severity of food insecurity to which they are sensitive.

[b] 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 0.7–1.3 are acceptable (Nord *et al.*, 2002).

Table 4. *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	

Note: [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 pseudo-value based on raw score 8.5). Prevalence rates have been computed for 500 households.

The internal validity of the scale is tested by calculating Cronbach's alpha (Cronbach, 1951), Rasch reliability, sensitivity, specificity, and positive predictive value for the nine-item adult food security scale. [19]

External validation of the scale is carried out by examining *construct validity* and *criterion validity* of the scale. In order to establish construct validity, we examine association of food security status with factors considered to be causes or consequence of food insecurity, such as, income, poverty status, level of education, and gender of household head; household's employment status and asset ownership status [20]; and household composition.

Food insecurity is found to be declining with increase in the level of income and improvement in poverty status of households. Food insecurity is also found to be more prevalent in households not owning an asset (other than fan), in female-headed households, in casual labor households, in households with children, in households with higher dependency ratio, [21] and in households headed by illiterate persons (Table 5).

External validation is 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 & Basiotis, 1992; Kendall, Olson, & Frongillo, 1995) or nutritional status (Olson, 1999; Rose & 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; and a few selected food items; and household undernourishment status.

Table 5. *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[a]			
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[b]			
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 labor	58.04	8.93	33.03
Others[c]	81.65	8.01	10.34
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[d] >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

[a] Poverty line expenditure for Kolkata, for 2010–11, was determined by updating the poverty line expenditure for urban West Bengal for 2004–05, using the Consumer Price Index for Urban Industrial Workers (base 2001).
[b] Household durable assets other than fan include refrigerator, TV black and white, TV color, bicycle, mobile phone and car.
[c] 'Others' include regular salary earners, self-employed, and others.
[d] Dependency ratio is the ratio of dependents (people younger than 15 years or older than 64 years), to the working-age population (those aged between 15 and 64 years) (World Bank, 2014).

Table 6. *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 6 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 ⩽ 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.

The tetrachoric correlation [22] between binary food security status (=1 if food insecure, 0 otherwise) and undernourishment status (1 if undernourished, 0 otherwise) is positive (0.56) and significant ($p < 0.000$). Of the highly food secure households, 54% are undernourished and the proportion increases to 90%, among the food insecure households (Table 7). Based on the above results, the KFSS is taken as a valid measure of the extent of food insecurity among adults in the surveyed population and can serve as an alternative indicator of food security in the population under study.

(ii) *Poverty indicators versus experience-based food security indicator*

Table 8 shows the joint distribution of *poor* and *finsec*. A large proportion of the food insecure households, about 47%, are non-poor (36 out of 77). Alternatively, among the 433 non-poor households, about 8% are food insecure.

Table 7. *Cross tabulation of households by undernourishment status and food security status, Kolkata, 2010–11*

	Undernourished (per capita per day calorie intake <2,100 kcal)[a]	Not-undernourished (per capita per day calorie intake ⩾ 2,100 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 status 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] Calorie threshold of 2,100 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 & Hensher, 2009).

Table 8. *Cross tabulation of households by poverty status 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 (84)	20 (30)	381
Marginally food secure (3 ⩾ Raw score < 5)	36 (8)	5 (8)	41
Food insecure (raw score ⩾ 5)	36 (8)	41 (62)	77
Total	433	66	499
Polychoric[a] correlation between poverty status and food security status is 0.73 (Prob(>chi^2(1)) = .04)			

Note: $N = 499$, because in constructing the food security scale, 1 observation was deleted for missing value. Figures in parenthesis represent column percentages. Percentage figures have been rounded up.
[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 & Hensher, 2009).

For further investigation, we conduct sensitivity analysis by defining alternative specifications of the poverty line expenditure which include the following: a poverty line which is less than 50% of the current cut-off of Rs. 856.28, one which is less than 25% of the current cut-off, one which is 25% above the current poverty line and finally the one which is 50% above the current poverty line (Tables 9 and 10).

The proportion of food insecure households among the poor increases, as poverty line expenditure is revised downward (from Rs. 856.28 to Rs. 642.28 to Rs. 428.14) and decreases, as it is revised upward (from Rs. 856.28 to Rs. 1070.28 to Rs. 1284.42) (Table 9). Alternatively, the proportion of food secure households increases among the non-poor group of households as poverty line is gradually revised upward from Rs. 428.14 to Rs. 1284.42) (Table 10).

Additionally, polychoric correlation between *poor* and *finsec* is 0.73 which is also statistically significant [Prob ($>\chi^2(1) = .04$] (Table 8). On the whole, therefore the above analysis signals that there exists a strong positive association between *poor* and *finsec*.

An important feature of these results is the constant presence of a certain percentage of food insecure households among the non-poor households no matter which poverty line we specify – the proportion decreases from 15% to 3% as we move across the lowest to the highest poverty line expenditure. It is this group of food insecure households among the non-poor that are of concern to the policy makers.

A higher concentration of food insecure households (50%) is noted among the group of households just below the poverty line (Rs. 642.28 ⩽ MPCE ⩽ Rs. 856.28) (Table 9) and a significant 26% food insecure households (Table 10) among the transitioning non-poor households just above the poverty line (Rs.856.28 ⩽ MPCE ⩽ Rs. 1070.28).

We note lack of one-to-one correspondence between poor and food insecure households in the given sample. To probe deeper into the poverty–food security nexus, we conduct a more rigorous analysis which controls for the influence of other predictors of food security included in households' socio-demographic profile, and explicitly recognize the fact there is potential endogeneity in the relationship. It is a difficult task to isolate the impact of being poor on being food insecure due to the possibility of unobservable factors driving both poverty and food insecurity outcomes. There may exist omitted variables correlated with poverty and food insecurity – for example, introduction of a new legislation like the NFSA may impact *poor* and *finsec* simultaneously. Such a possibility introduces endogeneity in the relationship between the two variables.

(iii) *Poverty–food security nexus: semi-ordered bivariate probit model*

Following Greene (2012),[23] a semi-ordered recursive bivariate probit model is estimated, with food security status with three categories and the binary poverty status as the joint dependent variables, with the latter appearing as an ordinary pre-determined variable on the right hand side (RHS) of the food security equation, along with households' socio-economic and demographic characteristics. The model belongs to a general class of simultaneous equation models discussed by Heckman (1978), Maddala (1983), and Greene (2008). It is labeled 'semi-ordered' because the potentially endogenous explanatory variable *poor* appears as a binary variable on the RHS. What makes it recursive is the fact that *finsec* does not appear on the RHS of the equation on *poor*. Additionally, *poor* appears on the RHS of food security equation only as observed (Greene, 2012).

Table 9. *Percentage of households in various food security categories: Poor households under alternative specifications of the poverty-line expenditure, Kolkata, 2010–11*

Food security categories	Alternative specifications of poverty line expenditure set at					
	50% below current poverty line: MPCE < Rs. 428.14	25% below current poverty line: MPCE < Rs. 642.28	Current poverty line: MPCE < Rs. 856.28	25% above current poverty line: MPCE < Rs. 1070.28	50% above current poverty line: MPCE < Rs. 1284.42	Transitional households just below poverty line (Rs. 642.28 ⩽ MPCE ⩽ Rs. 856.28)
Highly food secure	0	10	30	43	53	39
Marginally food secure	0	0	8	13	14	11
Food insecure	100	90	62	44	33	50
Total no. of poor households	$N = 3$	$N = 20$	$N = 66$	$N = 134$	$N = 206$	$N = 46$

Note: $N = 499$, because in constructing the food security scale, 1 observation was deleted for missing value. The figure in each cell represents the percentage of household in each food security category. Percentage figures have been rounded up.

Table 10. *Percentage of households in various food security categories: Non-poor households under alternative specifications of the poverty line expenditure, Kolkata, 2010–11*

Food security status categories	Alternative specifications of poverty line expenditure set at					
	50% below current poverty line: MPCE ⩾ Rs. 428.14	25% below current poverty line: MPCE ⩾ Rs. 642.28	Current poverty line: MPCE ⩾ Rs. 856.28	25% above current poverty line: MPCE ⩾ Rs. 1070.28	50% above current poverty line: MPCE ⩾ Rs. 1284.42	Transitional households just above poverty line (Rs. 856.28 ⩽ MPCE ⩾ Rs. 1070.28)
Highly food secure	77	79	84	88	93	56
Marginally food secure	8	9	8	7	4	18
Food insecure	15	12	8	5	3	26
Total no. of non-poor households	$N = 496$	$N = 479$	$N = 433$	$N = 365$	$N = 293$	68

Note: $N = 499$, because in constructing the food security scale, 1 observation was deleted for missing value. The figure in each cell represents the percentage of household in each food security category. Percentage figures have been rounded up.

(c) *Model Specifications*

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

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

where 0, 1 and 2, respectively denote highly food secure, marginally food secure, and food insecure categories and μ is a threshold parameter, and,

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

where 0 indicates non-poor and 1 represents poor. Subscript i denotes an individual observation (household), and $i = 1, 2...499$.[24]

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 x_1 and 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 β_1 and β_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. Full efficiency in estimation and an estimate of γ are achieved by full information maximum likelihood estimation (Greene, 2012).

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

Given that the errors, ε_{2i}, in Eqn. (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 in Eqns. (3) and (4), are estimated using maximum likelihood technique. But if poverty and food security are jointly determined, estimating the ordered probit equation (Eqn. 4), as above, in isolation, will give a biased estimate of γ (Greene, 2012). If the correlation between ε_{1i} and ε_{2i} is zero, then under normality these are independently distributed. In that case, the model with Eqns. (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.

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

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 above model allows us to conduct an endogeneity test to check the potential endogeneity of *poor* and *finsec*, by testing the significance of 'ρ' The single equation ordered probit model outlined in Eqn. (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. If ρ is not significantly different from zero, one concludes that the system is recursive and single equation ordered probit estimation may be suitable for the present purpose. In more general terms, the latter specification implies that poverty is exogenously influencing food security status of a household – that is, the two economic phenomenons may not be influenced by the same set of external factors.

(d) *Identification*

The model was estimated by imposing an exclusion restriction even though it is not strictly necessary as "identification by functional form" is possible which only requires variations in the set of exogenous regressors (Wilde, 2000). The identifying variable, in our model, is *hhtype* denoting 'whether a household is casual labor or not' as casual labor households are more vulnerable to poverty, especially in the urban context (Beneria & Floro, 2006). Hence, this variable might have a direct impact on poverty status but may affect experiential food security only through its influence on the former. Thus, *hhtype* is included in the poverty equation, in vector x_1 only.

4. RESULTS

The model has been estimated using NLOGIT (version 4.10 January 1, 2012). Estimation results 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 11 reports results of NLOGIT estimation of the semi-ordered recursive bivariate probit model. The results indicate that there is an association between *poor* and *finsec* after controlling for other factors. However, parameter ρ which represents the correlation between the error terms in 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(b), for completeness. Results from both sets of models are broadly similar.

The impact of the variable household size is weak, but the sign of the coefficient is negative which suggests, an increase in household size is likely to increase the chance of being food secure. Gender of household head is found to have strong influence on the food security status. As for education of household head, households headed by persons having primary to middle-level education and those headed by persons who are graduate and above, have lower probabilities of being food insecure, compared to those headed by persons with no education. Share of working age adults in the family is a strong predictor of household food security status.

Table 11. *Results of semi-ordered recursive bivariate probit estimation, Kolkata, 2010–2011*

Variables	Coefficient	Std. error	*z*
Index function for probability model for food security status (finsec)			
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 poverty status (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 ρ (1,2)	−.158	.406	−.390
Log likelihood = −428.36353			

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

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

(a) *Marginal effects in semi-ordered bivariate probit model*

As Burnett (1997) suggested, in the context of recursive bivariate probit models it is more useful to consider the marginal effects rather than the coefficients. However, the models are highly non-linear which makes it difficult to analytically derive and compute the partial effects (Greene & Hensher, 2009).[25] Due to the computational complexities involved, none of the widely used packages like NLOGIT and Stata report the marginal effects. However, given the estimated parameters, the predicted marginal probabilities can be computed.

Given the above, we adopt a pragmatic approach to measure the effects of changes in the explanatory variables in this paper. We examine the impact of a unit change in a particular explanatory variable for changes to predicted probability of each outcome, with values of the other explanatory variables set at mean level. 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 12 shows the effects of 10% increase in some of the continuous explanatory variables in the model. For example, the impact of 10% increase in the average share of working age adults in the family (from 0.75 to 0.82) increases the reported probability of being highly food secure, for an average household, by 2.4%, decreases the probability of marginal

Table 12. *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 13. *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 14. *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 is Christianity or 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 (65 years and above)	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 is Christianity or 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 (65 years and above)	−.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 (65 years and above)	−.09	−0.9	0.37

Note: ***, **, *Implies significance at 1%, 5% and 10% level, respectively. Marginal effects for dummy variables are computed on the basis of change in predicted probability as Pr[$F|x = 1$]−Pr[$F|x = 0$].

food security by 7% and, 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. Similar result is reported for changes in household size.

For a binary dummy variable, the reported change in probability will be $P[F = j|x = 1] - P[F = j|x = 0]$ (Table 13). 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%. Similarly, if a household switches category from male-headed to female-headed, the probability of being food insecure increases by 99%. Out of the four binary variables considered, the effect of poverty status is the most pronounced.

(b) *Marginal effects in single-equation ordered probit model, Kolkata, 2010–11*

Given that expressions for marginal effect in the recursive bivariate ordered probit model are not available and also noting that the single equation ordered probit model for food security is nearly identical to the corresponding equation in the recursive model, we present marginal effects for the single equation probit model.

It is 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:

$$\delta_j(x_i) = \frac{\delta Prob(y = j|x_i)}{\delta x_i} = [f(\mu_{j-1} - \acute{\beta}x_i) - f(\mu_j - \acute{\beta}x_i)]\beta,$$

for a continuous variable; and

$$\Delta_j(D) = [F(\mu_j - \acute{\beta}x_i + \alpha) - F(\mu_{j-1} - \acute{\beta}x_i + \alpha)] - [F(\mu_j - \acute{\beta}x_i) - F(\mu_{j-1} - \acute{\beta}x_i)]$$

for a dummy variable, where D is the dummy variable in the model and α is its 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).Table 14 reports the marginal effects in the single equation ordered probit model. From Table 14, poverty has the strongest effect on food security status, both in terms of significance and magnitude, across all three categories of households, followed by the share of working age adults in the family, education of household head, gender of household head, and household size, in that order. The only deviation in pattern is noted for the marginally food secure households for whom share of working age adults in the family has a larger impact on food security status than its poverty status.

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. Additionally, poverty has the strongest influence on household food security status among all other covariates. These findings are in contrast with the recent observation of diverging poverty–food security nexus. 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.

Our study also finds food insecure households among the group of non-poor households and it is necessary to identify these households so that they do not miss the benefits of policies aimed solely at addressing poverty. Interestingly similar dichotomy has been noted with respect to the U.S. economy where Rose (1999) reports a clear lack of one-to-one correspondence between poverty and hunger, despite having strong positive association between poverty and likelihood of food insufficiency. Income-based poverty measures may not capture food insecurity as they do not take into account the special needs of certain households like those having a disabled member or those headed by single parents (Rose, 1999). Income-based measure also fails to capture the factors that affect proper absorption of food by damaging health conditions of members in the household. As Floro and Swain (2013) argue, notwithstanding the fact that official poverty statistics show a relatively small size of urban dwellers as poor, a large fraction of them live in overcrowded slum settlements characterized by poor sanitation and water, lack of secure land/housing tenure – factors which are not accounted for in official poverty estimates. Moreover, food insecurity in these non-poor households could also have been caused by worries and anxieties regarding future access to food – that is even if households are currently not food insecure they may be at risk of future deprivation. 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" (Osmani, 2003).

But how do we reconcile our result with the contradictory evidence from the Indian economy? First, the strong poverty–food security linkage 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 status, nutritional status, micro-nutrient intakes, or dietary diversity, for robustness. And finally, the poverty–food security linkage 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 (Maxwell, 1999). Experimenting with rural data set might give additional insights.

The findings regarding other predictors of food security status underline the significance of considering multiple variables for effective food security monitoring. Such concerns have motivated researchers worldwide to conduct similar exercises

– for example, Rose (1999) for U.S., Iram and Butt (2004) for Pakistan or Garrett and Ruel (1999) for Mozambique.

In our case, the finding that a large household has less chance of being food insecure corroborates findings from previous research that as the family size 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 (Ravallion & Lanjouw, 1995), which in turn may reduce the probability of being food insecure. Additionally, larger extended households are less vulnerable to shocks like death/ill health of bread winners (Lipton, 1983). Similar results have been echoed by Rashid, Smith, and Rahman (2011) in the context of identifying determinants of dietary diversity in Bangladesh. Our finding of female-headed households being more food insecure similarly confirms results of research in other developing countries like Bangladesh, Panama, or Kenya, results which strongly focus on the gender dimension of food insecurity (Fuwa, 2000; Kassie, Ndiritu, & Stage, 2014; Mallick & Rafi, 2010; Sraboni, Malapit, Quisumbing, & Ahmed, 2014). The issue of gender empowerment becomes particularly important in the context of women in informal sectors who face added disadvantage due to increased household responsibility coupled with employer's bias, constrained choice in terms of work location, and weaker bargaining power (Mitra, 2005). As Mitra (2005, p. 292) note, the women working in urban informal sectors work longer hours, receive low wages, and remain considerably underfed and undernourished by "compensating in terms of consumption for others within the household". The finding that higher educational levels generally increase the chances of a household being food secure highlights the claim that few households with at least one educated member starve (Swift, 1989 cited in Frankenberger, 1992, p. 133). In recent years Benson (2007), 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 8 years of education. 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. As noted in Messer (1989) household size or composition is not static and adjustment of household size or composition to recurrent food insecurity is a common strategy, especially among low-income households in developing economies.

Finally, a major implication of the finding on poverty–food security nexus is that it questions existing policies and programs which focus on the traditional view of 'only poor, and all poor food insecure'. The study raises concern that income-based indirect indicators like poverty might not be sensitive to food insecurity. Notwithstanding the fact that the groups of population facing social and economic deprivations in various forms – poverty, hunger, illiteracy – will intersect at some point of time – the prescription cannot be the same for all deprived groups. Indian policy makers, and so to say, policy makers in most of the developing countries tackle hunger and food insecurity using the same set of interventions which tackle poverty, completely ignoring the fact that food insecurity could be driven by a different set of factors which may require a different intervention strategy altogether. Perhaps this explains why even decades after the 1996 World Food Summit of Rome, much less success has been achieved in reduction of hunger as opposed to reduction of poverty. It is important to recognize that poverty reduction is benefiting the hungry and food insecure less than proportionately and therefore "specific measures targeted directly at ensuring access to food are indispensable components of effective hunger reduction methods" (FAO, 2006, p. 13).

6. LIMITATIONS

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 is 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, anchoring vignettes to enhance comparability of subjective assessments across countries or socio-economic groups (King, Murray, Salomon, & Tandon, 2004). 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 also remains a question. Given the scope of the present analysis, we identify these issues for future research. Future research should also consider exploring the poverty–food security relationship in terms of alternative indicators of poverty – possibly looking at multidimensional poverty.

7. 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 conceptualizing 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 newly constructed experiential indicator of food security in testing the poverty–food security nexus, but also because none of the previous studies has considered a multivariate approach to modeling the poverty–food security linkage while also recognizing the possible endogeneity in the relationship.

The findings of the study have important implications for improving food security in urban slums and informal settlements – not just for India but for other developing countries as well. In terms of policy, certain important signals emerge. First of all, the results suggest anti-poverty policies targeting the poor should be successful in addressing food insecurity. Specifically for India, we can infer, if NFSA targets the poor households in distributing the food subsidies, it should be able to reach the food insecure households as well. Given this scenario, our findings indicate cash transfer as being the appropriate type of poverty alleviation measure, with considerable focus on employment generation, for eliminating food insecurity among urban low-income households.

Second, the present findings also suggest 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. Similar suggestions are indicated by Santos, Fletschner, Savath, and Peterman (2014) who emphasize on more integrated approach to tackling food insecurity in the context of West Bengal

government's policy of microplot distribution and its long-term impact on household food security.

Third, we strongly recommend adapting the experiential household food insecurity questionnaire for less expensive and wider application. 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 hence more effective targeting. Food security being a multidimensional concept, a broader suite of indicators is necessary for food security monitoring.

Finally, 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 few 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 will be too severe in magnitude to be handled effectively, defeating the purpose of a challenging decision like the NFSA which underlines a right-based approach to providing food to millions of hungry in one of the most densely populated countries of the world.

NOTES

1. 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.

2. 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 to 2000 onward 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.

3. Let's mention at this juncture that the Indian poverty line is also subject to debate (Deaton & Kozel, 2005; Panagariya, 2008) but for the purpose of this paper we decide to adhere to the official poverty-line expenditure (GOI, 2011b), in our attempt to test the hypothesis on poverty–food security nexus.

4. Detailed methodology available upon request.

5. By convention, an Investigator Unit (IV) is a geographically compact and distinct area with a population of about 20,000 with exception in certain cases. A group of about 20–25 adjacent UFS blocks forms an IV (NSSO, 2008).

6. Systematic sampling involves a random start and then proceeds with the selection of every kth element from then onward. In this case, $k =$ (population size/sample size). It is important that the starting point is not automatically the first in the list, but is instead randomly chosen from within the first to the kth element in the list. A random start is needed as a basis for selecting the units in the sample for which we used the table of random numbers (Rand, 2001).

7. All urban areas in the country are divided into small areal units called blocks. As per the earlier guidelines of 2002–07 UFS, a norm of about 600–800 population (120–160 households) used to be adopted for formation of a UFS block (NSSO, 2008).

8. 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 & Rafi, 2010).

9. While some of the questions are direct translations of the items in the US HFSSM and some are taken from the Bangladesh module (Coates *et al*., 2006), the most important challenge in framing the questions was, keeping the expressions of food insecurity consistent with local cultural practices and food behavior.

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

11. 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.

12. However, we have only included the share of working age adults and kids in the model, to avoid collinearity.

13. 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 the head of household) (NSSO, 2007a).

14. 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.

15. Since the average estimate of calorie intake derived in the above manner may not necessarily represent the "true" level of intake of a household, the present work has employed the 'adjustment factor' suggested by Minhas (1991), to correct for the differences between calorie 'availability' and calorie 'intake'. Unadjusted calorie figures represent calorie availability and adjusted figures are closer to true intake. In the present study only 1% of households had guests during the reference period of 'last 30 days'. There was no household offering meals to 'employees'. About 11% of households had at least one member receiving free meals from employers. Thus, adjusted calorie figures are higher than the unadjusted figures for most of the households.

16. We also computed average calorie intake using adult equivalence scale. However, for the purpose of the present paper we only use the 'per person' estimate, since the poverty measure also adheres to 'per person' specification. The results on adult equivalence scale are available in Maitra and Rao (2014).

17. 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 statistics 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. The inft statistics is essentially a mean square error measure which is asymptotically distributed as chi-square (Bond & Fox, 2001). There are no underlying assumptions. However, at the item level the infit measure is approximately normally distributed which is consistent with chi-square fit. However, the real important issue is the extent to which lower discrimination (high infit) distorts the measure. The research reveals that infit within 0.7–1.3 are near enough to meeting the assumption of equal discrimination that the measure is not substantially distorted (Nord *et al.*, 2002).

18. 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 urban Indian household (see Maitra, 2014, for details).

19. Rasch reliability is the modeled variance divided by the total variance where total variance is the sum of modeled 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.

20. Majority of the slum households had fan. Household durable assets other than fan include refrigerator, TV black and white, TV color, bicycle, mobile phone, and car.

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

22. 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 & Hensher, 2009).

23. 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 McVicar and McKee (2002) for applications.

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

25. 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.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.worlddev.2015.03.006.