Rising Food Prices and Undernourishment
A Cross-Country Inquiry

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Abstract

Households' welfare in developing countries has been hit by dramatic food prices increases which occurred between 2005 and 2008. In this paper, we adopt a partial equilibrium approach to analyze the short-time effects of a staple food price increase on nutritional attainments, as a measure of welfare. The analysis consists of first approximating complete food-demand systems and then performing household level micro-simulations. Instead of focusing on a single country profile, we provide a more complete snapshot, by comparing the evidence through a cross-country assessment made possible by use of nationally representative household surveys. Comparability is assured by the adoption of the same methodological choices in the treatment of the micro data. We find that food price increase not only reduces the mean consumption of dietary energy, but also worsen the distribution of food calories further deteriorating the nutritional status of populations. We also discovered that access to agricultural land, plays a big role in assuring adequate nutritional attainments in rural areas, and surprisingly, even in urban areas.

Key Words: Food prices, food policy, calories intake, demand system, household surveys.

JEL: D12, I32, O12, Q18.

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1. INTRODUCTION

The main objective of this paper is to assess the possible consequences of a staple food price increase on households' welfare in developing countries. We adopt a partial equilibrium approach by simulating food demand response of households to a price shock, thus considering only short-time effects or direct effects on consumers and producers.

The motivation for this paper stems from the recent upward trends in global food prices, concerning overall many staple commodities between 2005 and 2008.[1] Although most food prices had fallen from their peaks, they remained well above 2005 levels. In this context, the major source of concern is clearly related to the possible reduction of consumption levels: households may be forced to reduce both their food consumption, in response to the price surge, and other longer term expenditures, such as education, in order to meet basic needs. However the impact of soaring food prices on welfare is likely to be very diverse, depending upon which commodity prices change and the structure of the economy. Governments may play a big role by setting specific market and trade policies with the aim of protecting domestic market and calming down the internal effects of price fluctuations[2]. This may come at risk of increasing international volatility. Further the overall effect of price increases on poverty depends also on the distribution of net buyers and net sellers of food among low-income households, i.e. it depends on whether the gains to poor net producers offset the adverse effects on poor consumers (Aksoy and Izik-Dikmelik, 2008).

In this kind of studies the monetary value of food consumption or total expenditure is generally used as a measure of living standards. Ul-Haq et al. (2008) and Brambila et al. (2009), for example, estimate an Almost Ideal Demand System (AIDS), which serves as a basis for their simulation exercise respectively for Pakistan and Zambia. Ivanic and Martin (2008) use an expenditure function to characterize household consumption and factor supply behavior and a profit function to represent household production activities in ten low-income countries; this yields an expression for the welfare impacts of small price changes.

In this paper we prefer to use nutritional attainments as a measure of welfare for a couple of reasons: a) from an academic point of view, nutrition is of particular interest as a proximate determinant of human growth, which may have functional consequences for health, labor productivity, cognitive development and personality, which in turn may influence socioeconomic conditions (Steckel, 1995); b) from an institutional point of view, eradication of extreme hunger is among the Millennium Development Goals set by the United Nations. Therefore the current commodities price volatility has become an important challenge for governments and international organizations that promote sustainable progress towards food security.

[1] The price of maize rose by 80% between 2005 and 2007, wheat by 70%, and rice by about 25%. Overall the FAO Cereal Price Index increased from 108 points in 2004 up to 278 points in April 2008.

[2] There is a broad literature covering this topic. We refer for instance to Ravalion and Walle (1991), Jensen and Manrique (1996), and Ravallion and Lokshin (2004).

The nutritional analysis we undertake is commonly considered as part of the food security literature, which recently has become very relevant to policy makers. Food security is a multidimensional concept and it cannot be measured by a single indicator[3]. Most of food security indicators measured at household-level are related to diet quantity and/or to diet quality[4]. In this paper we focus on undernourishment which, from our point of view, is the most relevant, and also more easily measurable. We define a household as undernourished if its dietary energy consumption (caloric intake) falls below its minimum dietary energy requirement (MDER). For exposition purposes, in this paper we interchangeably use the concepts of undernourishment and food insecurity, while acknowledging that the latter encompasses the former. Our analysis is similar to the more common poverty analysis present in literature. Both ask similar questions (who are the poor/food insecure, what are the causes and consequences of their poverty/food insecurity), both share the same approach, requiring a measure of welfare to compare households/individuals (expenditure vs. dietary energy consumption) and a threshold by means of which households can be classified (poverty line vs. energy requirement). The only difference regards the way how the caloric threshold is measured. We estimate energy requirements accounting for the household composition in terms of age, sex and presence of pregnant women. This is an added value of the analysis presented here, considering that in many of the previous studies the threshold is the same for all households[5].

Our contribution to the empirical literature is related to the novel cross-country assessment made possible by using national living standards household surveys. Instead of focusing on a single country profile, by first estimating a demand system and then performing the simulation, we provide a more complete snapshot, by comparing the evidence over an extended set of countries. In order to accomplish this task and keep consistency, we adopt the same methodological choices to treat the micro data, for instance when dealing with outliers, the accounting of food eaten away from home, dietary thresholds, and the like. Further, instead of using income elasticities from different non-comparable studies we decided to use demand parameters from the cross-country study of Seale et al. (2003), which provides comparable, “conservative” estimates, while consistent with what is found in the literature. In the case of own-price elasticities, we decided to use national level estimates provided by the same study, while we calculated cross-price elasticities following the technique suggested by Beghin et al. (2003).

The paper is organized as follows. Section 2 describes the use of household surveys for food security analysis and the main methodological choices taken. In section 3 we discuss our food price simulation approach, while in section 4 we present the food security profile of eight selected countries. We proceed by presenting simulation results and a study of the determinants of food security. Finally we provide some conclusions.

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[3] “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1996 World Food Summit)

[4] See Smith and Subandoro (2007) for a more detailed illustration of the main food security indicators.

[5] The 2100 kilocalories is the commonly used threshold.

2. METHODOLOGY

The total dietary energy consumed by individuals depends on the quantity of food consumed and its caloric content:

(1) $$E = \sum_j c_j \cdot x_j(\mathbf{p}, y)$$

Food consumption is usually measured at the household level, so we define x_j as the per-capita demand of food item *j*, c_j is the energy content of the edible part of food item *j*, and *E* is the total dietary energy intake, measured in kilocalories per capita per day. As the energy conversion factors are fixed, as they depend on the nutritional content of food, the changes in dietary energy consumption are given by the changes in food consumption.

(2) $$dE = \sum_j c_j \cdot dx_j(\mathbf{p}, y)$$

Food consumption will change as a result of food price variations, due to both a change in real income, and indirectly by changing nominal household income if the household is a producer of food.

(3) $$dx_j = \frac{\partial x_j(\mathbf{p}, y)}{\partial p_i} \cdot dp_i + \frac{\partial x_j(\mathbf{p}, y)}{\partial y} \cdot \frac{\partial y}{\partial p_i} \cdot dp_i ,$$

In (3) income *y* is the sum of the different goods and services (including labor supplied) produced by the household, valued at their market prices, that is, $y = \sum_i p_i y_i$, and hence $\partial y / \partial p_i = y_i$. We can multiply and divide terms to re-write equation (3) as:

$$d \ln x_j(\mathbf{p}, y) = \left[\varepsilon_{ji} + \gamma_i \cdot \eta_j \right] \cdot d \ln p_i ,$$

which shows that as a result of a price change of food item *i*, the percentage change in each food item *j* consumed will vary proportionally to the percentage change in the price food item *i* multiplied by the cross (or own) price demand elasticity (ε_{ji}) and the income demand elasticity η_j of food item *j* multiplied by the share in disposable income of the value of the production of the food item *i*, $\gamma_i = p_i y_i / y$.

The change in total dietary energy consumed, as a result of an increase in the price of food item *i* will be given by:

$$\frac{dE}{E} = \frac{dp_i}{p_i} \sum_j \beta_j \cdot \left[\varepsilon_{ji} + \alpha_i \cdot \eta_j \right] \quad (4)$$,

where β_j is the share of good j in total dietary energy consumption: $c_j x_j(\mathbf{p}, y) / \sum_i c_i x_i(\mathbf{p}, y)$. Equation (4) presents a key relationship; in it, the economics given by (3) get limited by the nutritional constraints given by (1). For example, for countries with a less diverse diet where the staple accounts for a large share of food consumption, the bulk of the change in dietary energy consumption will be given by the changes in the consumption of the staple foods, which account for a larger share of dietary energy intake. Even if some food items suffer large proportional changes, their impact on dietary energy will be lower than smaller proportional changes in the consumption of the staple.

Many choices have to be made in order to arrive to an empirical estimate of household and individual level dietary energy intake. These choices include: how to deal with outliers, what food composition table to use, how to add the energy equivalent of expenditures on eating away from home, etc. It is beyond the scope of this paper to explain in detail all the steps made in order to get the most comparable estimates of energy consumption. We refer the reader to Smith and Subandoro (2007) that constitutes an excellent handbook on how to use household surveys to obtain food security indicators, Sibrián et al. (2008), which is our reference manual on how to convert from food quantity to dietary energy intake, and to Anríquez et al. (2008) that describes in detail all the steps that were followed with each one of the surveys considered in this document. We highlight here the main choices.

We include all available consumption information. When the unit descriptor is missing we imputed the mode of the food item by secondary administrative unit (i.e. district or region). Outliers were measured at calories per capita per food group (i.e. cereals, meat, fruits and vegetables, etc.) level, and for each secondary administrative unit. Outliers where defined as those observations whose log values fell outside the bounds of 3 standard deviations above and below the median, and were replaced with the corresponding median (the exponential of the log-transformed median)[6]. Expenditures on food away from home was replaced by their energy content when the food item was known (i.e. tamal or hot dog sandwich); and when only expenditures were reported, these were converted to energy using estimates of kilocalories per value of food consumed in local currency unit (LCU), by household per capita expenditure quintiles. This estimate of kcal/LCU, was the weighted average of the measured kcal/LCU per food group, where the weight was the relative contribution of each food group to total dietary energy. This latter calculation was done by income/expenditure quintiles to reflect the differences in the diets of the different income groups.

The next important decision made to measure undernourishment was to agree on the relevant dietary energy threshold. This is very much a controversial choice. The main variables that will change the energy requirements are the level of physical activity

[6] We are implicitly assuming that calories per capita are distributed Log Normal. We tested this hypothesis throughout and rarely rejected it at the standard critical values.

that defines that requirement, and the physical constitution of the population, as a given threshold for a given activity level is adequate for a variety of body sizes, and inadequate for others. We followed FAO's current official methodology for calculating minimum dietary energy requirements (MDER), with the exception that we applied household level thresholds. This means that we use the age/sex-specific energy requirements as suggested by FAO (2004)[7], assuming, for adults, light physical activity level (equivalent to 1.55xBMR, basal metabolic rate), and assuming that the reference body type is given by the 5th percentile of the national body mass index (BMI) distribution[8]. This provides the lowest threshold among those used in the literature, and the counter argument that this threshold is not consistent with good health for much of the population is valid; i.e. those who have higher physical demands, or are larger than the 5th percentile of the BMI distribution, etc. However, it is better to be prudent, and we follow the standard statistical axiom of minimizing type I error, which in this case would be to identify as undernourished someone that is not. This becomes more relevant after considering the types of bias likely to enlarge type I error: under-reporting of consumption, which usually pervades consumption surveys; intra-household distribution may not be determined by needs, it is perfectly rational in conditions of stress to have unequal distributions whereby the growing child or the bread-earner gets a larger share of the available food as a household strategy.

There are additional problems with the reference dietary energy threshold usually not discussed in the literature. Weather is ignored in these calculations, but clearly the energy needs in very cold weather are different from those of a country that only has a tropical climate. Furthermore, the inclusion of the relevant national BMI distribution improves the calculations, but these ignore the fact that populations are smaller (in terms of weight to height ratio) when undernourishment is wide-spread, which causes an under-estimation of the true population needs for countries with high food insecurity.

Surveys and Countries Considered

In this study we estimate the effects of rising food prices using household surveys from 8 different countries selected from the international household survey database known as RIGA[9]. This sample of 8 countries, namely: Bangladesh, Guatemala, Nepal, Cambodia, Tajikistan, Vietnam, Kenya, and Malawi was not randomly selected, but carefully designed to represent the different developing regions, capture differences in the main tradable staple food, and its relative importance on diets, and differences in levels of development. The consumption modules from the household surveys used for the most part comply with what is current best practice in food consumption modules compatible with food security analysis. As Table 1 shows, all the surveys comply with what is perhaps the most important characteristic which is that they must include all the sources of food, that coming purchases, from own-production, that received in the form of a gift or a payment, and the food eaten away from home.

[7] These are the latest recommendations by an international panel of experts gathered by FAO, WHO, and others to define energy requirements, and should be considered the international standard.
[8] Complete details on the calculations of the household level MDERs are available in Anríquez et al. (2008)
[9] See http://www.fao.org/es/esa/riga for further information.

The design of a useful (for nutrition analysis) food consumption survey is not a science because the designer has to compete with conflicting sources of bias[10]. If the recall period is too short you run into problems of "telescoping" or attributing to the recall period recent consumption, if the recall period is too large there will be an increase in the recall error, which is why 1 or 2 weeks is standard practice for surveys that measure consumption. The optimal amount of food items to include depends on the diversity of the diets, however if too few items are included, the survey will miss consumption, if too many are included, the interviewer and interviewee will run into "diary exhaustion" and increase reporting errors. In our sample of surveys, Tajikistan is in the lower limit of what is usually considered the minimum necessary for nutrition analysis, while Cambodia is perhaps above what is normally recommended. Surveys that measure consumption are usually preferred over those that measure acquisition (purchases), because actual consumption can occur without acquisitions in the reference period, and not all the acquisitions are consumed during the reference period. This lead to acquisition surveys having higher variance of measured dietary energy intake, but nonetheless they produce remarkably close estimates of mean dietary energy intake and expenditures (Smith et al., 2006). It is generally recommended to use long reference period when measuring acquisition, both to reduce the difference between acquisition and actual consumption, as explained above, and to capture less frequently purchased items (Ohri-Vachaspati et al., 1998). The two surveys in our sample that use acquisition use 1 year as the reference period.

3. SIMULATION APPROACH

Choice of Food Demand Elasticities

As can be seen from (3) and (4), price and income elasticities play a central role in the outcome of the simulations. Of similar importance are, of course, the population and dietary characteristics contained in the household surveys, like distribution of dietary energy consumption, food consumption, demographic characteristics, etc. However, as elasticities are treated as exogenous in our analysis they need to be carefully selected.

Income elasticities obtained from food expenditure / acquisition surveys over-estimate true income elasticities[11]. Wealthier households tend to make larger purchases than what they actually consume, because the wealthy transfer some of their purchased food to lower income groups; buy food that is given to guests and pets; can afford to buy in bulk and usually do; and in all likelihood have a higher level of food wastage. The over-estimation can be large, Bouis (1994) showed that the food income elasticities obtained from food expenditure surveys are usually inconsistent with observed nutritional outcomes. It is also known, from early estimations of Engel functions that income elasticities obtained from time-series data is much lower than that observed in cross sections (Tobin, 1950; van Driel et al., 1997).

In his survey of 15 studies that described food demand elasticities across income groups, Alderman (1986) concluded that "it is widely, if not universally,

[10] See Smith et al. (2006) for a more detailed discussion of the issues and biases in food consumption surveys.
[11] See for instance Bouis and Haddad (1992); Bouis (1994); Ohri-Vachaspati et al. (1998).

acknowledged that income elasticities for food items decline with income." The voluminous work that has followed this study has not contradicted this hypothesis. The fact that food income elasticities fall with income is not the same as the well accepted Engel's law, but it is related. We expect these elasticities to be higher for lower income groups, because their consumption base is lower. Furthermore, this observation is also consistent with the stylized fact that the poor, who consume proportionally more food, devote a larger share of any additional income to buying food items.

The relation between price elasticities and income is less clear. We can start from the well-known Slutsky decomposition:

$$\varepsilon_{ii} = h_{ii} - \alpha_i \cdot \eta_i \tag{5}$$

which shows that the marshallian price elasticity (ε_{ii}) is equal to the compensated or hicksian (constant real income) elasticity (h_{ii}) minus, the share of the good in consumption (α_i) times the income elasticity (η_i) of the good. From Engel's law we know that for food overall α falls with income, and for most food items/income groups this is true also. Further, let's accept the above hypothesis relative to income elasticity and wealth, to conclude that if the compensated elasticities were constant, then marshallian elasticities should fall with income[12]. However, compensated elasticities are not constant. Timmer (1981) started a lively debate in the literature by showing that in general food demand compensated elasticities fall with income, and most of the following studies have corroborated this outcome. Thus, if both compensated and income elasticities decline with income, then marshallian elasticities would also decline with income as (5) implies[13].

However, the fact both marshallian and compensated elasticities fall with income is not a universal result. It is not uncommon to find that the poorest have lower own-price elasticities (marshallian and compensated) than middle-income groups[14]. If one observes own-price elasticities across countries of different income levels, one will discover that they clearly fall with income: Alderman (1986) does this exercise, or one can examine the cross-country elasticities of the Seale et al. (2003) study to confirm that this is the case. Further, most food price demand elasticities fall with income, but in many cases the price elasticity of the staple food in poor countries has an inverted-U shape relation with income (rice in Thailand and coarse grains in Philippines (Alderman, 1986), maize in Malawi (Zanias and Gunjal, 2008), for example). This behavior should not come as a surprise; the price elasticity is an implicit indicator of availability of substitutes. Households that are unable to satiate their energy needs would rationally react to increases in the price of the staple by

[12] We are talking about price elasticities in absolute values, as is standard practice.

[13] The fact that most demand studies do not consider quality of the goods may lead to under estimation of price elasticities of the wealthier. Prices in cross section studies are usually obtained from unit values (expenditures divided by quantity), but as wealthier households consume goods of higher quality their effective price is over-estimated, which would lead to the appearance of the wealthier as having more inelastic demand.

[14] Alderman (1986) provides a couple of examples of this behavior, Zanias and Gunjal (2008) provide a more recent example.

cutting the expenditure of more expensive energy sources, to mitigate the drop in consumption of the staple which is still the cheapest source of energy, as they do not have alternatives/substitutes. Bouis (1996) argues that the inverted-U shape is consistent with food demand being characterized as demand for characteristics (i.e. energy, variety, taste, etc.). There may be other competing explanations for the inverted-U relation found in some food demand studies, standard microeconomic theory does not provide predictions regarding this relation; but in more wealthy countries it is very improbable to find evidence contradicting the negative relation between food own-price elasticities and income.

Hence in choosing the food demand elasticities we take into account what we know about consumer behavior particularly of poor households, which are those that obviously are more vulnerable to undernourishment and sensible to the choice of elasticities in our simulations. Instead of using elasticities from different non-comparable studies we decided to use demand parameters from the cross-country study of Seale et al. (2003). In the case of income elasticities, this cross-country study does not suffer from over-estimation discussed above[15]. We account for the different income elasticities of different income groups by using predicted income elasticities. The equation used to predict income elasticities is given by the regression:

$$\underset{}{\eta_{ji}} = \underset{\substack{1.45 \\ (0.03)}}{\alpha_i} + \underset{\substack{-0.125 \\ (0.0036)}}{\beta_i} \ln(\text{GDP[PPP]/N})_j + u_{ji} \quad ,$$

which was run with 111 available country (*j*) observations, and for all 8 food groups (*i*). The eight food groups considered in the Seale et al. (2003) and in this study are: 1. cereals (Including roots, tubers, and pulses); 2. meat; 3. fish; 4. dairy; 5. oils and fats; 6. fruits and vegetables; 7. other food; and 8. beverages and tobacco. The coefficients described above represent the cereal income elasticities equation which has a fit of 91% (fits ranged between 84 an 92% for the eight food groups). We predicted income elasticities by income deciles in each country considered, and we use annualized means of per capita expenditures by decile, converted to international PPP currency, as the predictor. This exercise gave us income elasticities that lie well within what has been found in the literature. For example in the case of cereal demand income elasticities, these varied from 1.065 in the poorest decile of Tajikistan to 0.333 in the wealthiest decile of Guatemala (see Table 2).

In the case of price elasticities, we decided to use national level estimates provided by the same study. In the case of price elasticities we know that within our sample, in Malawi[16], and we assume that in Kenya too, the own-price elasticity of the poorest is not negatively correlated with income, so we can not just assume that a relation like that used for income elasticities exists. The use of the parameters from one cross-country study, in addition of providing comparable estimates done with one consistent methodology has the benefit of using national level data, and therefore providing

[15] Food demand based on consumption and not acquisition would also be more accurate with regards to income elasticities, but in the literature most food demand systems are estimated using food expenditure surveys.

[16] Cf. Zanias and Gunjal (2008)

more modest estimates of price elasticities[17], which will aid us in not over-estimating the effects of food price increases on undernourishment.

Cross-Price Elasticities

As equation (4) suggests, substitution in food consumption can play an important role in mitigating the drop in dietary energy caused by the price hike of a given good, particularly when diets are diversified and substitutes are readily available. In the absence of a complete substitution matrix, we proceed to estimate a substitution matrix consistent with the available information: food consumption patterns, and own-price and income elasticities.

We calculate cross-price elasticities following the technique suggested by Beghin et al. (2003). The proposed methodology imposes diagonal dominance, to calculate the off-diagonal elements of the Slutsky substitution matrix. The assumption of quasi-concavity of preferences translates into positive semi-definite and symmetric Slutsky matrix. The diagonal dominance means that the absolute value of each diagonal term must be at least as large as the absolute value of the sum of all off diagonal elements of the row/column (which are the same given symmetry). Beghin et al. (2003) further assume that preferences can be expressed with a LINQUAD incomplete (in that it only describes food and not total consumption) expenditure system. The conditions imposed by diagonal dominance exactly identify the set of unknown parameters of a LINQUAD expenditure system, provided that the diagonal elements are known[18]. Thus, what the proposed approach does is to jointly scale the absolute value of all cross-price effects until the concavity (of the expenditure function) sufficient condition is met.

Table 3 shows the numbers used to calculate cross-price elasticities in Malawi as an example. Elasticities need to be converted into marginal effects with information about prices and quantities. We use an updated version of the same data that Seale et al. (2003) used in their cross-country study: the 2005 round of the International Comparison Programme World Bank (2008), whose disaggregated data was generously facilitated to this study by the World Bank. In the first three columns we show yearly expenditures per capita in international dollars for the food groups used in the Seale et al. (2003) and this study; the corresponding total budget shares (out of total household expenditure), and the implicit prices[19]. The diagonal elements of the Slutsky matrix can be constructed with the own-price and income elasticities, shown in the next two columns, borrowed from the above mentioned study. With the information shown in the first five columns we proceed to calculate the full substitution matrix, and marshallian cross-price elasticity matrix following the Beghin et al. (2003) diagonal dominance methodology (using the DNLP solver of the GAMS software). The last two columns of Table 3 show the column out of the substitution matrices which is important for this study, the cross price elasticities with respect to

[17] We expand on the differences between cross-country and national cross-section estimates of price elasticities when we discuss the sensitivity of our results.

[18] Another way to impose concavity of the expenditure function is to use the Cholesky decomposition as suggested by Lau (1978).

[19] In the Appendix I we explain how we aggregated prices for the food sub-groups.

cereals[20]. The table shows that all Hicksian cross-price effects are positive as theory imposes, but all marshallian elasticities are negative. This means that negative income effects dominate, and reverse the pure substitution effects, given the large share of cereals in total consumption. The fact that cross-price Marshallian elasticities are negative is also consistent with what has been found in the literature[21], and actually should be expected for poor countries where cereal demand amounts to a large share of total household consumption. For our analysis, this means that facing price increases households actually cut the consumption of other foods in order to dampen the fall in their consumption of the staple, which is usually the cheaper source of dietary energy.

4. FOOD SECURITY PROFILES

This study identifies as undernourished those individual whose dietary energy consumption falls below the minimum dietary energy requirements (MDER). We also define as *weakly nourished* those individuals whose dietary energy consumption falls below the average dietary energy requirements (ADER) and above the MDER. The difference between the two dietary energy requirements is that, in the case of adults, the first is calculated for the individual in the 5th percentile of the national BMI distribution under light physical activity level (1.55xBMR), while the second is calculated for the median individual (50th percentile) in the national BMI distribution assuming moderate physical activity level (1.85xBMR). This study takes a conservative approach in measuring undernourishment by using MDER as the relevant threshold − when others suggest that the ADER should be used as relevant food security limit[22] − but acknowledge that the population whose consumption lies between requirements is at an exposed situation, vulnerable to food price, income or other types of shocks, hence we accordingly treat them as a separate group from those who are unambiguously food secure.

An inspection of Table 4, shows that both poverty and undernourishment are negatively correlated with national income, but this correlation is not strong. Further undernourishment and poverty are correlated; however, this correlation is also not very marked. It is important to highlight that the poverty figures presented in the table, like most poverty numbers, are based on per capita consumption/income, without using age equivalence scales. This is an important difference with undernourishment, which is based on energy requirements that vary by age and gender, and therefore are implicitly constructed using equivalence scales (in this case energy requirement equivalence). Thus countries with a high proportion of children like Guatemala and Malawi (reflected in the lower mean national dietary thresholds in the table), show large differences between undernourishment and poverty that can be partially explained by the lack of use of equivalence scales in the poverty measures. In the case of Bangladesh the large difference between poverty and measured undernourishment is partly explained by the fact that this country used the diary method to capture food consumption, which likely suffers less from under-reporting;

[20] Complete substitution matrices for all countries included in this study are available upon request from the authors.
[21] Cf. Zanias and Gunjal (2008) who estimated a food demand system also for Malawi, or Talukder (1990) for Bangladesh among others.
[22] For example WHO/FAO (2002) suggests using the median BMI, which is consistent with ADER and not MDER.

and also the cumulative distribution of consumption of calories is extremely steep at low values, as reflected by the highest share of weakly nourished in our sample of countries.

In most countries rural undernourishment is higher than urban undernourishment, as **Figure 1** shows. The exception is Bangladesh, which in spite of having higher rural poverty (53% versus 37%) has lower rural undernourishment as access to food is better in rural areas. This observation highlights that poverty and food security are not the same things, and therefore do not necessarily share the same main determinants. The figure also shows that those weakly nourished form an even larger group than the undernourished in three Asian countries over four with the exception of Cambodia. Figure 2 shows that undernourishment is, as expected, negatively correlated with per capita expenditure levels. The prevalence of weakly nourished, however, has a less marked negative correlation with welfare. Although cross-country comparisons can not be directly made, mainly because differences in the survey instrument design make measurements not fully comparable, it is remarkable how close our estimates are for the poorest quintile; in all countries roughly 4 out of every 5 individuals among the poorest 20% are either undernourished or weakly nourished. The differences between undernourishment alone are as expected much larger across countries. Also, the rate at which undernourishment falls across quintiles varies markedly across countries.

5. RESULTS

Figures 3 and 4 provide a graphical display of the effect on measured undernourishment of a 10% increase in the price of the main staple (left scale) by expenditure quintiles, together with the observed share of the staple on overall energy consumption (right scale). While Figure 3 presents the increase in undernourishment in percentage points, Figure 4 presents the percentage increase in the share of undernourished. In the latter case, it is not surprising to see that these percentage changes are lower for the poorer quintiles, because among the poor, undernourishment is already high, so all increase as a percentage of observed undernourishment appear as proportionally lower.

Figure 3 shows that only in Bangladesh, Cambodia and to a lesser extent in Vietnam the increase in undernourishment is negatively correlated with welfare levels. The increase in observed undernourishment is chiefly driven by three factors, of which only one has a definite correlation with welfare levels. First, reliance on the staple and dietary patterns in general determine the impact of the food price increase, these dietary patterns, in particular the dependence of diets on the main staple, are clearly negatively correlated with welfare levels (as shown in the figures). On the other hand, staple farm income, which helps to cushion the negative real income effects of food inflation, or even completely countervail these effects, is distributed in ways that vary across countries and is not necessarily correlated with income levels. Finally, the concentration of household and individuals around the dietary threshold, or equivalently the size of the average dietary energy surplus of individuals determines how sensitive these groups are to changes in food prices. Again, this surplus is likely to be higher for the wealthiest deciles, but this correlation does not necessarily exist in the poorer and middle income deciles.

In Table 5 the results of the simulation are further disaggregated by welfare quintiles and urban/rural areas. This differentiation is important because most food production is done in rural areas, and therefore we expect important differences in terms of the positive income effects of staple price hikes. We find that the largest increases in undernourishment occur in the middle or lowest quintiles of either rural or urban areas. This result contrasts starkly with what was found by Zezza et al. (2008), who simulated the effects of food price increase on welfare and found consistently in 11 countries that it is the poorest urban consumers who were most negatively affected. In terms of the more afflicted area, there is no clear trend in half of the countries considered the increase in undernourishment was higher in rural areas. Also, in some countries (Guatemala, Kenya, and Malawi) in urban areas, the poorest quintiles suffer an increase in undernourishment which is lower than the quintile (or quintiles in Malawi) above, which most likely is an indicator of increased importance of urban agriculture in these countries.

Decomposing Mean and Distribution Effects

We decompose the estimated increase in undernourishment into two different components; that which can be explained by a change in the mean kcal per capita consumption ([negative] growth component), and that which can be explained by changes in the distribution of dietary energy consumption following Datt and Ravallion (1992). This decomposition of the change in undernourishment between t_0 and t_1 can be described with the following equation:

$$U_{t_1} - U_{t_0} = G(t_0, t_1; r) + D(t_0, t_1; r) + R(t_0, t_1; r)$$

The change in undernourishment, using *r* as reference year (could be t_0, or t_1) can be separated into three parts. First, the growth component:

$$G(t_0, t_1; r) \equiv U(z / \mu_{t_1}, L_r) - U(z / \mu_{t_0}, L_r),$$

which represents the change in undernourishment that is attributable to a change in mean dietary energy consumption (from μ_{t_0} to μ_{t_1}) holding the distribution (represented here by the Lorenz curve L_r) of the reference year *r* constant; and keeping the energy threshold (i.e. MDER) also constant. Then the distribution component which is:

$$D(t_0, t_1; r) \equiv U(z / \mu_r, L_{t_1}) - U(z / \mu_r, L_{t_0}),$$

which represents the change in undernourishment that can be attributed to changes in the distribution, holding average food energy consumption constant. Finally, there is a residual $R(t_0, t_1; r)$, which represents that part of the undernourishment change which can not be explained by the growth and distribution effect. If the components are calculated for initial and final periods (t_0, or t_1) as reference years and then taking averages, the residual disappears, which is what we do in Table 6.

The first result that strikes from the table is that at the national level, with the exception of Guatemala that display negligible effects, the distributional effects of staple food price increases augment the effect on undernourishment. This result is probably driven by the fact that staple consumption as a share of total energy is negatively correlated with welfare and total dietary energy consumption, as shown above. This observation has important implications into the way the effects of food price spikes are modeled; it is not enough to assume that average consumption falls, unfortunately, the analyst needs to account for a further deterioration on nutritional status due to a deterioration in the distribution. The results of the simulations are mostly consistent with what has been found in the poverty literature (see Datt and Ravallion (1992); Contreras (2003), for example), which is that the distribution component explains a minor part of the changes in poverty. With the exception of Malawi, this result is mostly confirmed. However, there are important differences between urban and rural populations. In some surveys we find that the share of the growth component is larger in urban areas, while in others the opposite result. Also, at the sub national levels we find that there can be positive distributional impacts (urban Tajikistan, and rural Guatemala).

The Determinants of the Impact on Dietary Energy Consumption

To uncover which types of households are most affected by staple price hikes, we estimate a reduced form equation that explains the proportional change in per-capita calories induced by the price change:

$$\frac{\Delta x_i}{x_i} = f(\text{HH demographics}_i, \text{HH Assets}_i, \text{welfare}_i, \text{regional characteristics}_i) + u_i$$

This equation should be interpreted as a multivariate correlation, not necessarily implying causation, because in many cases the causation arrow goes both ways; for example better educated people are better fed, and because they are better fed they achieve better education. The demographic characteristics included are age of the household head, in both linear and quadratic form to allow for life-cycle hypothesis considerations; the dependency ratio separated by children and elderly (a partition justified by their very different energy requirements); the number of household members, and a dummy identifying households headed by females. We included among the assets of the households, agricultural and non agricultural assets. Among the first, we include operated land, livestock holdings, and an index of agricultural assets like machinery tools, etc. measured by principal components. With respect to non-agricultural assets, we include human capital identified by the average education of adults in the household, a measure of infrastructure / access to public goods and markets which is a principal components index of several indicators of proximity to services like, distance to school and/or hospitals, trash collection services, etc. We use as the welfare indicator, per capita expenditures, which is a questionable choice given endogeneity; that is guaranteed given that expenditures are calculated using the same food consumption we use to calculate energy intake. We therefore use predicted per capita expenditures were we use different household characteristics as instruments, but also one main instrument which is an indicator of household wealth (an index of all durables owned by the household like cars, motorcycles, refrigerators, etc.). With these predicted per capita measure we are capturing the longer-term per-capita levels as implied by their wealth (and the host of other household and regional characteristics) and not the current levels which are more affected by transient shocks.

Finally, we use district/region level dummies to control for unobservable regional characteristics; and used country specific household controls, like religion and use of indigenous language at home, but as they are country-specific we do not refer to them. The main results of these estimations are presented in Table 7 in the form of partial elasticities. The estimations were done for national, urban, and rural samples separately, for a total of 24 different regressions. The separation of samples by area is justified by the nature of the exercise carried out, where staple income is almost negligible in urban areas, and it can be of large importance in rural areas. The fit of these equations is not particularly high, with the R^2 ranging from 10 to 30%. Hypothesis testing was done with an adjusted covariance matrix, using White's heteroscedasticity consistent covariance matrix, clustered by each survey's primary sampling units. Below we discuss the salient results of a cross-country comparison of the main elasticities.

The age of head is sometimes positively correlated with the response to higher food prices of dietary energy consumption, and sometimes negatively. Given the quadratic fit, and life cycle considerations, we find this result plausible, as in older populations like the Tajikistani, age is negatively correlated with the change in consumption, while in younger populations like that of Malawi, the opposite is found (summary statistics of the main regressor is available in Appendix II). To our surprise, household size is not always negatively correlated with the response in caloric consumption. Most poverty studies find a positive correlation between household size and poverty, thus we expected a strong negative correlation between the change in energy consumption and household size; however in Tajikistan and rural Kenya, we observe a strong positive relation. Similarly surprising is the finding that the share of dependents (children and elder) are in most cases positively correlated with the proportional change in dietary energy consumption. Notable exceptions to this general result are the share of children in rural Tajikistan, and the share of elder again in Tajikistan and Vietnam. In general the gender of the head is not statistically correlated with the change in caloric consumption. However, the two countries where we observe a negative correlation, Guatemala and Vietnam, the national level results are driven by a stronger negative correlation in the rural samples. This suggests that female headship acts negatively in these countries' households by significant differences in the access to staple (and farm in general) income.

Assets, and access to assets obviously play an important role in determining the vulnerability of households to food price spikes. A first glance of Table 7 suggests that different assets have varying importance across countries and urban / rural landscapes. Human capital, measured in our analysis by the average education of adults is a key asset, not always significant, but if significant always positive. In some countries, namely Cambodia, Tajikistan and Vietnam education plays a larger positive role in rural areas, while the opposite happens in Bangladesh, Kenya, Malawi and Nepal. The ownership of livestock has varying effects on the vulnerability of households to food price spikes. This is explained by the fact that in some countries livestock herding is correlated with poverty (Malawi, Cambodia), while in other countries (Bangladesh, Guatemala) such correlation is not present. Welfare plays a very peculiar role in these dietary energy consumption change equations, with distinct urban/rural differences. In urban areas, where staple income does not play a large role, welfare is across the board positive reflecting the negative correlation (see **Figure 1**) between income and the share of the staple in dietary energy consumption. In rural areas on the other hand, where staple income may be important we observe that welfare is positively correlated with the caloric consumption change in Kenya, but negatively in Cambodia and Vietnam.

Finally, we refer to agricultural land, measured in this study as operated agricultural land. Perhaps, among the most important findings of this study we discover a very large role of agricultural land even at the national samples. In seven out of the eight national samples we discover that access to agricultural land has a positive effect on the impact of food price spikes on nutritional intake, and in five of these the relation was statistically significant. This means that access to land does not only play a large role in assuring food security in rural areas (where the elasticities are obviously larger), but it plays a role even in national food security in these developing countries. Table 7 also highlights the great heterogeneity that exists across countries, which reinforces the need for country specific studies. The simulations presented in this document uncover food vulnerability that can and should be mapped, as well as studied more in-depth considering country-specific conditions.

Determinants of the Probability of Being Undernourished and Weakly Nourished.

To identify the main determinants of the probability of being undernourished, weakly nourished, or food secure, we fit an ordered logit model. Like its relative the binomial probit and logit models, the ordered logit assumes that there exists a latent variable that is distributed logistic (or standard normal in the case of ordered probit), with relevant thresholds that determine the discrete response observed (i.e. undernourished, weakly nourished, or food secure status). As opposed to the multinomial logit, the ordered logit model assumes that the discrete outcomes follow a qualitative order; in our case nutritional status follows a clear qualitative ordering, and we assign the discrete values of 0, 1, and 2 to being undernourished, weakly nourished, and food secure respectively. Formally the ordered logit assumes that the probability of being in each category is given by:

$$\begin{aligned}
&\Pr(y=0) = 1/\left[1+\exp^{(x'\beta-\mu_1)}\right] \\
&\Pr(y=1) = 1/\left[1+\exp^{(x'\beta-\mu_2)}\right] - 1/\left[1+\exp^{(x'\beta-\mu_1)}\right], \\
&\Pr(y=2) = 1 - 1/\left[1+\exp^{(x'\beta-\mu_2)}\right]
\end{aligned}$$

where the threshold parameters μ_1 and μ_2, are estimated in the model. This ordered logit model was estimated for all 8 countries, and again for the three samples, national, urban, and rural, using the same dependent variables (vector *x* above) used while exploring the proportional change in dietary energy consumption.

Table 8 summarizes the main results of these estimations. Instead of presenting the marginal effects, which were evaluated at group means, we summarize the results in terms of accounting the amount of marginal effects by sign, and statistical significance. We do not include the results for the probability of being food secure, because by definition, in our three options ordered logit model, they are the exact mirror (with different levels though), of the probability of being undernourished. For example, household size is in all (national) cases positively and significantly correlated with the probability of being undernourished, this means by definition, that household size is in all cases negatively and significantly correlated with the probability of being food secure.

The first result that jumps out of the table, is that for the most part the determinants of being undernourished, and being weakly nourished are the same, with almost all variables having equivalent signs and significance level (obviously the magnitude of the marginal effects differ). Thus, the data suggests that in most countries, with the minor exceptions in Bangladesh, Malawi, and Tajikistan, both groups have similar determinants. We find that household demographics have very defined correlations with the probability if being undernourished and weakly nourished. Households with older heads are more likely to be undernourished, while household size, like in most poverty probits, is found to be positively correlated with undernourishment. Surprisingly we find that the share of dependents is negatively correlated with undernourishment. In the case of children this can be explained by their lower energy requirements. Gender of the head of household is sometimes a determinant of undernourishment, but on others a determinant of being weakly nourished, as suggested by the summary statistics (see Appendix II).

All assets, with the exception of education are strongly negatively correlated with undernourishment. If we look at the regressions by area, we observe that human capital does play a role in diminishing the probability of being undernourished, but in urban areas. Education is less of a key asset to explain the reduction of the probability in rural areas, where other assets like infrastructure and agricultural assets play a larger role. Again, we are surprised at the large role that agriculture has in diminishing the probability of undernourishment even at national levels: in 7 of the 8 countries considered (and significantly in 5), access to agricultural land diminishes the probability of being undernourished; and in all countries (significantly in seven) access to agricultural land diminishes the probability of being weakly nourished.

6. CONCLUSIONS

Global estimates suggest that there are about 1 billion people undernourished in the world, a sobering number which has seen a sharp increase in the last years FAO (2009). One of the main reasons for this increase has been the sharp increase observed in food prices in the period 2005-08. Although most of food prices had fallen in 2009, many experts believe that priced will stabilize at higher real levels (see for example OECD-FAO (2009)). Under this outlook for food prices, it is sensible to implement social protection policies that tackle nutritional aspects, a good understanding of the determinants of the determinants of undernourishment and the target groups of these policies is necessary.

In this paper we have assessed the possible consequences of staple food price increases on households' welfare in eight developing countries. We have undertaken a nutritional analysis by first estimating energy requirements that account for the household composition, instead of using a fixed threshold for all households as it is often done in the literature. Then for our simulation approach we used demand parameters from the cross-country study of Seale et al. (2003), which provided also national level estimates of own-price elasticities. While we estimated cross-price elasticities following the technique suggested by Beghin et al. (2003).

The novel methodology adopted in this study can provide a policy relevant micro-level instrument for food security analysts and policymakers in developing countries. The results evidence the fact that an increase in staple food-prices does not have an equivalent impact on consumption across households. Saying that the poorest are the most affected may not always be true. At the same time, though, the results highlight that the poor urban/non-farm households with a high share of food expenditures are the most vulnerable. The land-tenure-based policies and investments for increasing agricultural productivity have a crucial role for reducing household food insecurity in the developing countries considered in this study. In fact, among the most important findings of this study we discovered access to land, here measured as operated agricultural land, plays a big role in assuring adequate nutritional attainments in both urban and rural areas. Moreover, a bigger production will have a calming effect for food prices in domestic markets. Access to infrastructure and partially livestock holding are also important determinants of the vulnerability of households to food price spikes. While surprisingly the share of dependents (children and elder) does not affect significantly proportional changes in dietary energy consumption.

Finally the heterogeneity in the results presented in this cross-country approach shows clearly that the country-specific socio-economic, geographic, and institutional factors have to be considered before providing locally relevant policy conclusions.

REFERENCES

Aksoy, M.A. and A. Izik-Dikmelik (2008), "Are low food prices pro-poor? Net food buyers and sellers in low income countries," *Policy Research Working Paper #4642* Washington D.C., World Bank.

Alderman, H. (1986), *The Effect of Food Price and Income Changes on the Acquisition of Food by Low-Income Households*, Washington DC, IFPRI.

Anríquez, G., S. Daidone, P. Karfakis and E. Mane (2008), "Methodological Note: Estimating the Nutritional Impacts of Soaring Food Prices at the Household Level," Rome, FAO.

Beghin, J. C., J.C. Bureau and S. Drogué (2003), "The Calibration of Incomplete Demand Systems in Quantitative Analysis," *CARD Working Papers* Center for Agricultural and Rural Deveolopment, Iowa State University.

Bouis, H. E. (1994), "The Effect of Income on Demand for Food in Poor Countries: Are Our Food Consumption Databases Giving Us Reliable Estimates?," *Journal of Development Economics*, **44**(1): 199-226.

Bouis, H. E. (1996), "A Food Demand System Based on Demand for Characteristics: If There Is 'Curvature' in the Slutsky Matrix, What Do the Curves Look Like and Why?," *Journal of Development Economics*, **51**(2): 239-66.

Bouis, H. E. and L.J. Haddad (1992), "Are Estimates of Calorie-Income Elasticities Too High? A Recalibration of the Plausible Range," *Journal of Development Economics*, **39**(2): 333-64.

Brambila, J., F. Caracciolo and D. Depalo (2009), "Poverty Impact of Commodity Price Boom Using Household Survey. The Case of Maize in Zambia," *SSRN Working Paper Series*.

Contreras, D. (2003), "Poverty and Inequality in a Rapid Growth Economy: Chile 1990-96," *Journal of Development Studies*, **39**(3): 181-200.

Datt, G. and M. Ravallion (1992), "Growth and Redistribution Components of Changes in Poverty Measures: A Decomposition with Applications to Brazil and India in the 1980s," *Journal of Development Economics*, **38**(2): 275-95.

FAO (2004), *Human energy requirements. Report of a joint FAO/WHO/UNU Expert Consultation. Rome, 17-24 October 2001*, Rome, FAO.

FAO (2008), "High Food Prices and Food Security - Threats and Opportunities", *The State of Food Insecurity in the World* 2008, FAO.

FAO (2009), "Economic Crises - Impact and Lessons Learned", *The State of Food Insecurity in the World* 2009, FAO.

Ivanic, M. and W. Martin (2008), "Implications of Higher Global Food Prices for Poverty in Low-Income Countries," *Policy Research Working Paper* Washington DC, World Bank.

Jensen, H. and J. Manrique (1996), "Disaggregated Welfare Effects of Agricultural Price Policies in Urban Indonesia," *CARD publications, WP #173* Ames, Center for Agricultural and Rural Development (CARD) at Iowa State University.

Lau, L. J. (1978), "Testing and Imposing Monotonicity, Convexity, and Quasi-Convexity Constraints," *Production Economics: A Dual Approach to Theory and Applications, Volume I: The Theory of Production* M. Fuss and D. L. McFadden, Eds., Amsterdam: North-Holland.

OECD-FAO (2009), *OECD-FAO Agricultural Outlook 2009* Paris, OECD.

Ohri-Vachaspati, P., B. L. Rogers, E. Kennedy and J. P. Goldberg (1998), "The Effects of Data Collection Methods on Calorie-Expenditure Elasticity Estimates: A Study from the Dominican Republic," *Food Policy*, **23**(3-4): 295-304.

Ravalion, M. and D. van de Walle (1991), "The impact of poverty on food pricing reforms: A welfare analysis for Indonesia," *Journal of Policy Modeling*, **13**(2): 281-99.

Ravallion, M. and M. Lokshin (2004), "Gainers and Losers from Trade Reforms in Morocco," *World Bank Policy Research Working Paper 3368* Washington DC, World Bank.

Seale, J. Jr., A. Regmi and J. Bernstein (2003), " International Evidence on Food Consumption Patterns," Washington, DC., Economic Research Service, USDA.

Sibrián, R., S. Ramasawmy and J. Mernies (2008) "Measuring Hunger at Sub National Levels From Household Surveys Using the FAO Approach", Statistics Division Working Paper Series ESS/ESSGA/5, FAO of the UN, Rome.

Smith, L. C., H. Alderman and D. Aduayom (2006), *Food Insecurity in Sub-Saharan Africa. New Estimates from Household Expenditure Surveys*, Washington DC, IFPRI.

Smith, L. C. and A. Subandoro (2007), *Measuring Food Security Using Household Expenditure Surveys*, Washington DC.

Steckel, R. (1995), "Stature and the Standard of Living," *Journal of Economic Literature*, **33**(4): 1903-40.

Talukder, R. K. (1990), "Food Consumption Parameters in Bangladesh - Implications for Food Policy.," *Bangladesh Journal of Agricultural Economics*, **XII**(1 & 2): 43-66.

Timmer, C. P. (1981), "Is There "Curvature" in the Slutsky Matrix?," *Review of Economics and Statistics*, **63**(3): 395-402.

Tobin, J. (1950), "A statistical demand function for food in the U.S.A.," *Journal of the Royal Statistical Society*, **Series A, 113**(Part II): 113-41.

Ul-Haq, Z., H. Nazli and K. Meilke (2008), "Implications of high food prices for poverty in Pakistan," *Agricultural Economics*, **39**(s1): 477-84.

van Driel, H., V. Nadall and K. Zeelenberg (1997), "The Demand for Food in the United States and the Netherlands: A Systems Approach with the CBS Model: Reply," *Journal of Applied Econometrics*, **12**(5): 530-32.

WHO/FAO (2002), *Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases*, Geneva, Draft 28 March 2002.

World Bank (2008), *Global Purchasing Power Parities and Real Expenditures. 2005 International Comparison Program*, Washington DC, World Bank.

Zanias, G. P. and K. R. Gunjal (2008), "Food Demand Analysis and Food Aid Requirements in Malawi and Mozambique. Final report" Rome, FAO.

Zezza, A., B. Davis, C. Azzarri, K.A. Covarrubias, L. Tasciotti and G. Anriquez (2008), "The Impact of Rising Food Prices on the Poor," ESA Working Papers N. 08-07, FAO of the UN, Rome.

Table 1. Characteristics of Food Modules in the Household Surveys Used

Country	Year	Acquisition / Purchases	Recall Period	Reference Period	Food Items	Sources of Food Included†
Bangladesh	2000	Consumption	1 Day	1 Day	135	P; O; GP; A
Cambodia	2004	Consumption	Month	7 Days	193	P; O; GP; A
Guatemala	2000	Acquisition	15 Days	15 Days	99	P; O; GP; A
Kenya	2005	Consumption	7 Days	7 Days	157	P; O; GP; A
Malawi	2004	Consumption	7 Days	7 Days	112	P; O; GP; A
Nepal	2003	Consumption	1 Year	Month*	65	P; O; GP; A
Tajikistan	2003	Consumption	7 Days	7 Days	32	P; O; GP; A
Vietnam	2002	Acquisition‡	1 Year	Month**	57	P; O; GP; A

Notes: † Sources of food are: Purchased (P); From Own Production (O); Received as Gift or Payment (GP); and Eaten Away From Home (A).
§ Diary method. 119 items are measured daily (4 times in a 2 week period) and 18 less frequently consumed items are measured weekly.
‡ Includes consumption during main annual holidays.
* Typical month, ** Average month

Table 2. Cereal Demand Elasticities

Country	Own Price Elasticity	Income Elasticities		
		Minimum	Median	Maximum
Bangladesh	-0.423	0.554	0.716	0.808
Cambodia	-0.414	0.647	0.895	1.042
Guatemala	-0.423	0.333	0.563	0.699
Kenya	-0.471	0.446	0.671	0.831
Malawi	-0.479	0.558	0.749	0.865
Nepal	-0.415	0.495	0.706	0.818
Tajikistan	-0.487	0.793	0.946	1.065
Vietnam	-0.414	0.507	0.690	0.788

Notes: Cereal own-price elasticity for Cambodia and Guatemala is missing in Seale et al. (2003). We deemed respectively Vietnam and Paraguay as surrogates for these countries.

Table 3. Food Expenditure and Demand elasticities in Malawi.

Food Group	Household Expenditure[†1]	Total Budget Shares[1] (%)	Prices[1]	Elasticities[2] Own-price	Income	Elasticities With Respect to Cereals[3] Hicksian	Marshallian
Cereals/ Bread	75.12	10.39	0.606	-0.479	0.592	-0.418	-0.479
Meat	1.82	0.25	1.607	-0.670	0.828	0.042	-0.046
Fish	0.49	0.07	0.978	-0.801	0.991	0.050	-0.055
Dairy	4.17	0.58	0.930	-0.748	0.925	0.047	-0.052
Oils/Fats	0.97	0.13	0.868	-0.490	0.606	0.031	-0.034
Fruits/Vegetables	8.83	1.22	2.883	-0.551	0.681	0.035	-0.038
Other Food	72.07	9.97	1.031	-0.667	0.825	0.042	-0.046
Beverages/Tobacco	16.44	2.27	1.859	-1.243	1.538	0.078	-0.086

Sources: 1. Authors' calculations using basic heading PPP data from the 2005 round of the World Bank ICP project. 2. Seale et al. 3. Authors' calculations.
Notes: † In per-capita international dollars of 2005 per annum.

Table 4. Poverty and Food Security Indicators.

Country	Year	GDP per capita	Poverty Headcount	Under-nourished	Weakly nourished	Dietary Energy Thresholds MDER	ADER
Bangladesh	2000	901	49.8	15.6	38.2	1,720	2,158
Cambodia	2004	1,296	35.0	31.2	31.4	1,746	2,212
Guatemala	2000	3,966	56.2	18.1	14.2	1,622	2,015
Kenya	2005	1,346	45.8	53.7	17.9	1,728	2,163
Malawi	2004	650	52.4	26.3	19.0	1,678	2,088
Nepal	2003	926	30.8	19.0	26.8	1,702	2,138
Tajikistan	2003	1,402	*82.8*	*18.3*	33.8	1,845	2,116
Vietnam	2002	1,780	28.9	12.5	31.5	1,789	2,278

Notes: [†] In per-capita international dollars of 2005. [‡] % of population. [*] From World Bank Poverty Assessments using the same surveys this study uses. [§] In kilocalories per capita per day.

Table 5. Simulate Undernourishment Impact by Welfare Groups and Urban/Rural Area

	Bangladesh		Cambodia		Guatemala		Kenya	
Rural Quintiles	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Poorest	85.7	6.9	75.0	5.2	48.3	0.8	44.6	1.2
2nd	83.5	4.8	70.9	5.3	45.0	1.4	40.4	1.5
3rd	81.3	3.8	67.6	5.1	40.6	0.8	36.1	1.6
4th	79.2	1.7	63.2	2.6	35.3	0.9	31.9	1.8
Wealthiest	73.6	0.7	56.7	1.9	28.1	-0.1	26.4	0.7
Rural Average	80.6	3.6	66.7	4.0	39.5	0.7	35.9	1.4
Urban Quintiles	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Poorest	81.1	9.8	64.4	5.0	35.2	0.9	33.5	1.5
2nd	77.4	7.6	54.3	2.8	25.5	1.5	28.2	1.7
3rd	72.5	4.8	45.2	2.8	23.8	0.2	24.8	1.2
4th	67.0	3.0	33.3	1.3	19.1	0.0	22.0	0.3
Wealthiest	60.2	2.1	30.5	0.9	11.8	0.0	15.5	1.4
Urban Average	71.6	5.5	45.5	2.5	23.1	0.5	24.8	1.2
	Malawi		**Nepal**		**Tajikistan**		**Vietnam**	
Rural Quintiles	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Poorest	69.0	2.0	46.1	2.4	59.4	0.6	75.1	3.8
2nd	62.5	2.1	45.9	1.3	59.0	1.2	69.7	3.1
3rd	58.5	1.5	45.1	1.4	58.8	1.5	64.7	1.6
4th	54.1	0.6	44.1	1.4	56.2	0.1	59.3	1.7
Wealthiest	47.5	0.4	43.0	0.2	53.9	0.6	49.0	0.7
Rural Average	58.3	1.3	44.8	1.3	57.4	0.8	63.6	2.2
Urban Quintiles	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Poorest	62.8	1.6	53.3	4.2	60.7	2.2	62.8	3.5
2nd	55.5	3.4	48.6	3.5	60.0	1.5	48.1	3.2
3rd	50.5	3.4	42.4	3.3	56.8	1.3	40.8	0.6
4th	45.2	1.3	38.4	0.8	51.9	0.1	31.4	0.7
Wealthiest	35.2	0.0	30.2	0.4	46.6	0.1	21.7	0.1
Urban Average	49.8	2.0	42.6	2.4	55.2	1.0	41.0	1.6

Notes: (1) Share (%) of Main Staple in consumption; (2) Change in Undernourishment (% points).

Table 6. Decomposition of the Simulated Change in Undernourishment

Country	Change in Undernourishment *National*	Components: Growth Change % points	Growth (%) of Total Change	Redistribution Change % points	Redistribution (%) of Total Change
Bangladesh 2000	3.94	3.55	90.2	0.39	9.8
Cambodia 2004	3.80	3.46	91.0	0.34	9.0
Nepal 2003	2.44	2.23	91.4	0.21	8.6
Vietnam 2002	2.05	1.75	85.5	0.30	14.5
Tajikistan 2003	0.90	0.84	93.2	0.06	6.8
Kenya 2005	1.33	1.32	99.6	0.01	0.4
Malawi 2004	1.39	1.02	73.1	0.37	26.9
Guatemala 2000	0.66	0.67	101.4	-0.01	-1.4
	Urban				
Bangladesh 2000	5.45	5.36	98.3	0.09	1.7
Cambodia 2004	2.55	2.17	85.4	0.37	14.6
Nepal 2003	3.92	3.14	80.2	0.78	19.8
Vietnam 2002	1.62	1.21	74.6	0.41	25.4
Tajikistan 2003	1.06	1.25	117.5	-0.19	-17.5
Kenya 2005	1.22	1.23	100.5	-0.01	-0.5
Malawi 2004	1.95	1.65	84.5	0.30	15.5
Guatemala 2000	0.52	0.52	99.6	0.00	0.4
	Rural				
Bangladesh 2000	3.56	3.20	89.8	0.37	10.2
Cambodia 2004	4.03	3.78	93.8	0.25	6.2
Nepal 2003	2.19	2.02	92.3	0.17	7.7
Vietnam 2002	2.18	1.80	82.8	0.37	17.2
Tajikistan 2003	0.84	0.76	89.5	0.09	10.5
Kenya 2005	1.35	1.33	98.5	0.02	1.5
Malawi 2004	1.32	0.93	70.3	0.39	29.7
Guatemala 2000	0.75	0.81	107.6	-0.06	-7.6

Table 7. Estimated Percentage Change in Caloric Intake (Partial Elasticities)

	Bangladesh 2000	Cambodia 2004	Guatemala 2000	Kenya 2005	Malawi 2004	Nepal 2003	Tajikistan 2004	Vietnam 2002
National Sample								
Age of Head	0.021	0.029 *	-0.098 *	0.057 **	0.064	-0.002	-0.043 **	-0.010
Household Size	-0.231 ***	-0.029	-0.085 **	0.021	0.084	-0.107 **	0.373 ***	-0.153 ***
Share < 15	0.058 **	0.040	0.049 *	0.035 **	0.114 ***	-0.003	0.141 ***	0.011
Share > 60	0.018 **	0.023 ***	0.004	0.022 ***	0.014 **	0.034 **	-0.022 ***	-0.002
Female Head	-0.005	0.006	-0.034 ***	0.005	0.019 **	0.001	-0.007	-0.021 ***
Education Average (Adults)	0.013	0.185 ***	-0.001	0.121 ***	0.002	0.105 ***	-0.076	0.117 ***
Predicted Expenditures per capita	0.145 **	0.167 **	0.151 ***	0.150 ***	0.194 ***	0.030	0.539 ***	-0.007
Infrastructure Index	0.009 *	0.000	0.000	0.001 ***	-0.001	-0.011	-0.007 ***	-0.004
Land operated/Owned	0.163 ***	0.037 *	0.000	0.052 ***	0.236 ***	0.125 ***	0.061 ***	0.230 ***
Livestock in Tropical Units	0.126 ***	-0.023	0.002	0.001	-0.021 ***	0.424 ***	-0.010	0.013 ***
Rural	0.105 ***	-0.059	0.101 ***	0.006	0.318 ***	0.209 ***	0.263 ***	0.255 ***
Rural Sample								
Age of Head	0.014	0.007	-0.154 *	-0.042	0.065	-0.041	0.165 ***	-0.038
Household Size	-0.265 ***	-0.642 **	-0.197 ***	0.252 ***	0.073	-0.100	-0.770 ***	-0.232 ***
Share < 15	0.065 **	-0.049	0.061	0.127 ***	0.129 ***	-0.035	-0.534 ***	-0.006
Share > 60	0.027 **	0.030 ***	0.010	0.026 ***	0.012	0.021	0.093 ***	-0.005
Female Head	-0.005	-0.008	-0.047 ***	0.006	0.016	0.004	0.015 ***	-0.021 ***
Education Average (Adults)	-0.003	0.373 ***	0.002	0.004	-0.002	0.103 ***	1.591 ***	0.146 ***
Predicted Expenditures per capita	0.002	-0.957	0.090 **	0.570 ***	0.189 *	-0.057	-2.668 ***	-0.254 ***
Infrastructure Index	0.000	0.000 **	0.000	0.011 ***	0.000 **	0.001	0.000	-0.004 ***
Land Operated/Owned	0.237 ***	0.041 *	-0.001	0.062 ***	0.217 ***	0.189 ***	0.113 ***	0.294 ***
Livestock in Tropical Units	0.178 ***	-0.030	0.001	0.000	-0.021 ***	0.478 ***	0.109 ***	0.020 ***
Urban Sample								
Age of Head	0.036 ***	0.038	-0.030	0.111 ***	0.015	0.040	-0.068 **	0.049 **
Household Size	-0.203 ***	-0.195 *	0.002	0.050 **	0.041	-0.138 *	0.301 **	-0.070 *
Share < 15	0.040	0.068	0.043 *	0.041 **	0.056 *	0.013	0.196 ***	0.004
Share > 60	0.000	0.026 *	-0.003	0.005	0.019 ***	0.059 ***	0.000	0.001
Female Head	-0.003	-0.006	-0.012	0.015 **	0.024 *	-0.003	-0.031 ***	-0.016 **
Education Average (Adults)	0.099 ***	0.096	0.007	0.138 ***	0.181 ***	0.143 **	-0.268	-0.002
Predicted Expenditures per capita	0.253 ***	0.062	0.180 ***	0.197 ***	0.149	0.119 ***	0.821 ***	0.283 ***
Infrastructure Index	-0.005 ***	0.000	0.000	-0.015 ***	-0.001	-0.001 **	0.000	-0.003
Land operated/Owned	0.031 **	0.100 ***	0.000	0.013 **	0.247 ***	0.022 **	-0.005 ***	0.061 ***
Livestock in Tropical Units	0.020 **	-0.023	0.004 **	0.002	-0.007	0.183 ***	0.005	0.003

Notes: Values significant at the *** 1%, ** 5%, and * 10% level.

Table 8. Ordered Logit Estimates of the Probability of being of Nutritional Status Undernourished and Weakly Nourished

Probability Undernourished	**National**		**Rural**		**Urban**	
	+	**-**	**+**	**-**	**+**	**-**
Age of Head	(8) / 8	(0) / 0	(7) / 8	(0) / 0	(7) / 7	(1) / 1
Household Size	(8) / 8	(0) / 0	(7) / 7	(0) / 1	(7) / 8	(0) / 0
Share < 15	(0) / 0	(8) / 8	(0) / 0	(8) / 8	(0) / 0	(7) / 8
Share > 60	(1) / 1	(7) / 7	(0) / 1	(7) / 7	(0) / 2	(5) / 6
Female Head	(1) / 5	(2) / 3	(2) / 3	(3) / 5	(1) / 5	(1) / 3
Education Average (Adults)	(2) / 2	(3) / 6	(3) / 5	(3) / 3	(2) / 3	(0) / 5
Predicted Expenditures per capita	(0) / 0	(8) / 8	(0) / 0	(8) / 8	(0) / 0	(8) / 8
Infrastructure Index	(2) / 5	(3) / 3	(1) / 2	(3) / 6	(1) / 3	(2) / 5
Land operated/Owned	(0) / 0	(6) / 8	(0) / 0	(6) / 8	(0) / 2	(1) / 6
Livestock in Tropical Units	(0) / 0	(6) / 8	(0) / 0	(6) / 8	(1) / 3	(3) / 5
Rural	(2) / 3	(2) / 5				
Probability Weakly Nourished						
Age of Head	(8) / 8	(0) / 0	(7) / 7	(1) / 1	(6) / 7	(1) / 1
Household Size	(7) / 8	(0) / 0	(6) / 6	(1) / 2	(7) / 8	(0) / 0
Share 15	(0) / 0	(7) / 8	(1) / 1	(7) / 7	(0) / 0	(7) / 8
Share 60	(1) / 0	(7) / 8	(1) / 2	(6) / 6	(0) / 1	(6) / 7
Female Head	(1) / 4	(1) / 4	(2) / 4	(3) / 4	(1) / 5	(1) / 3
Education Average (Adults)	(2) / 0	(3) / 8	(3) / 4	(3) / 4	(1) / 3	(0) / 5
Predicted Expenditures per capita	(0) / 0	(7) / 8	(1) / 1	(7) / 7	(0) / 0	(8) / 8
Infrastructure Index	(1) / 1	(2) / 7	(2) / 2	(2) / 6	(2) / 5	(1) / 3
Land operated/Owned	(0) / 0	(6) / 8	(1) / 1	(5) / 7	(0) / 2	(1) / 6
Livestock in Tropical Units	(0) / 0	(7) / 8	(0) / 1	(6) / 7	(1) / 3	(3) / 5
Rural	(1) / 2	(2) / 6				

Note: Each column indicates for each sample (national, urban, or rural) how many marginal effects are of sign (positive or negative), and of those how many are statistically significant at 10% are indicated in parentheses.

Figure 1. Undernourishment by Urban/Rural Area

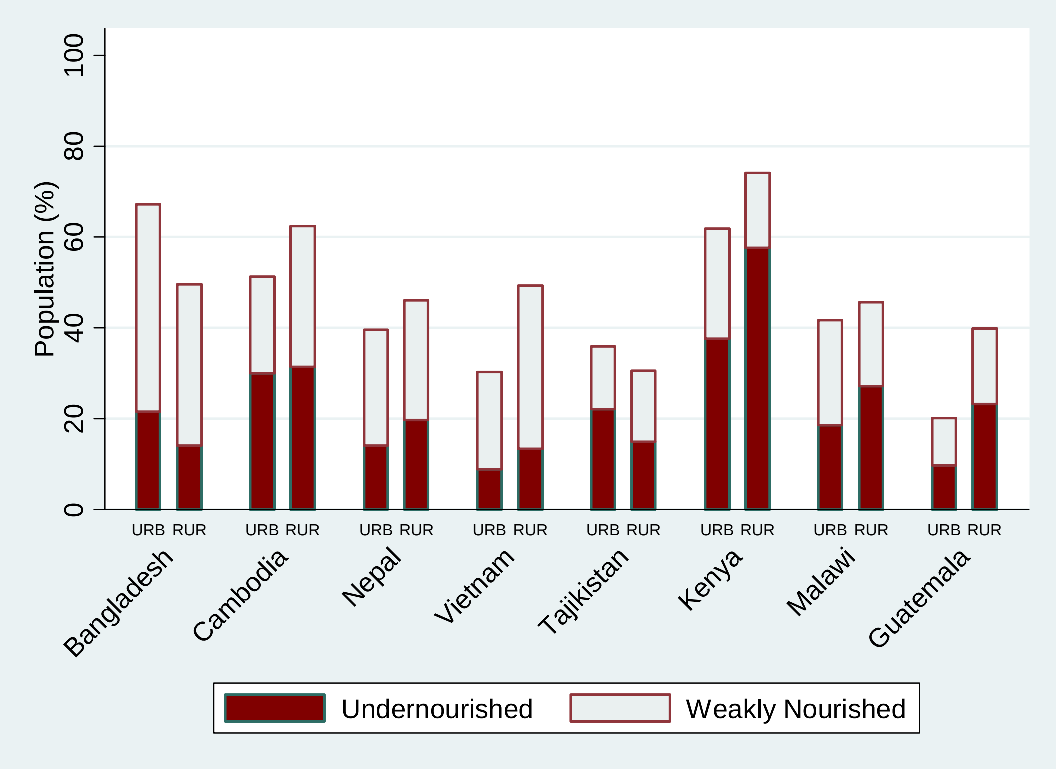


Figure 2. Undernourishment by Welfare Quintiles

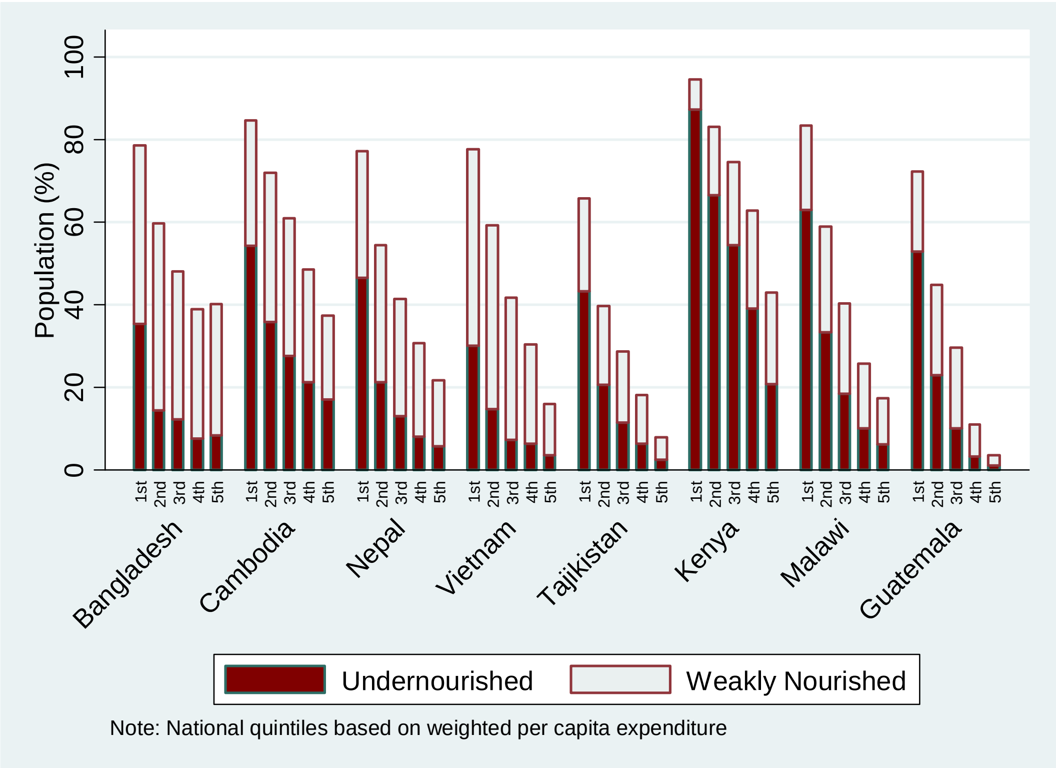


Figure 3. Simulated increase in undernourishment rate

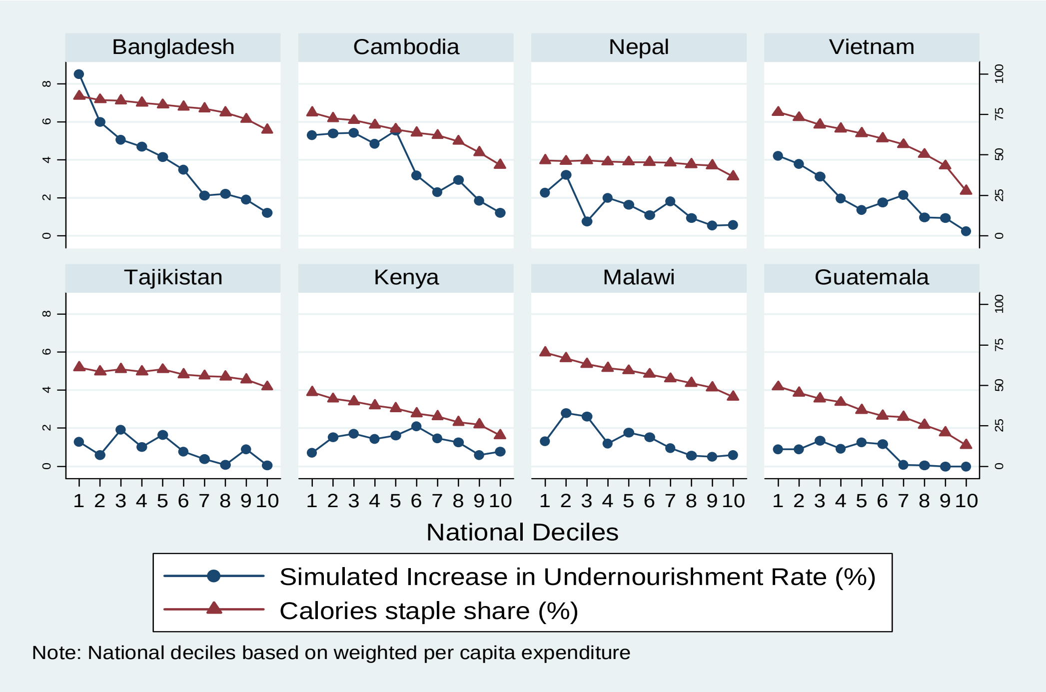
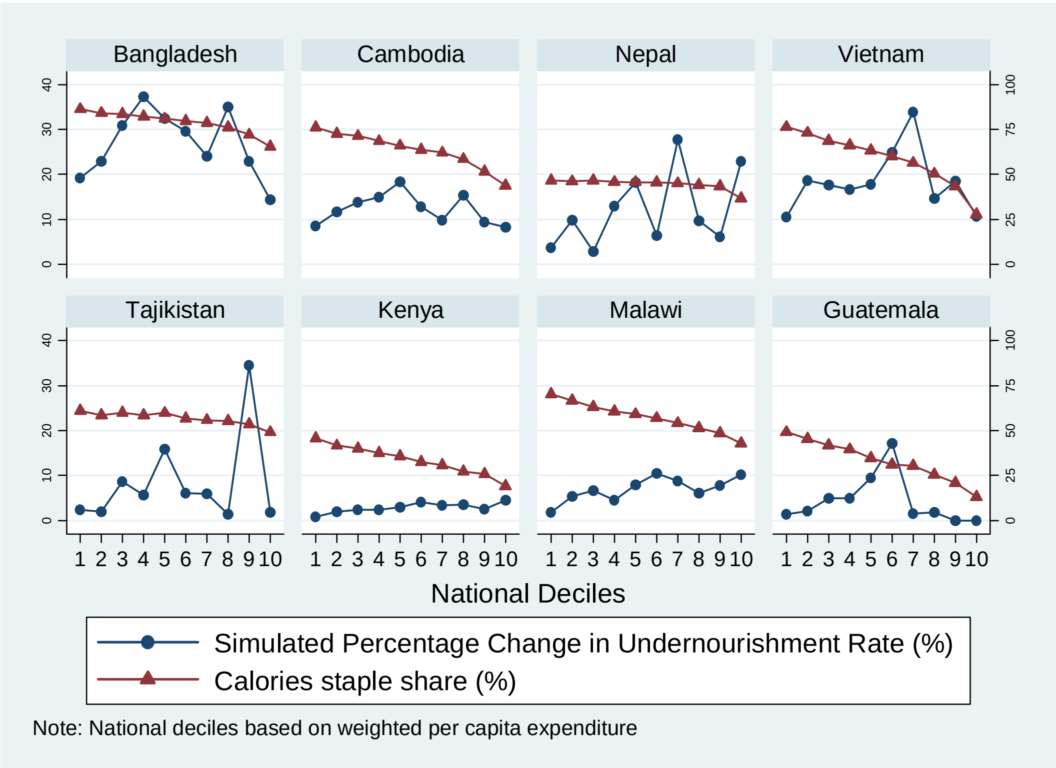


Figure 4. Simulated percentage change in undernourishment rate



APPENDIX I: Aggregation of Prices for the Food Groups

The disaggregated data obtained through the World Bank's International Comparison Program (ICP 2005) include: Basic Headings Purchasing Power Parities (PPPs), Basic Headings Nominal Expenditures, Official Exchange Rates and Population. Therefore, deciding how to incorporate the price data into the demand system is not trivial for a series of reasons. First, prices denominated in national currencies cannot be used in a cross-country assessment since they represent different units of measurement, i.e. one Euro is different from one USD. Second, the use of the official exchange rates to convert the data into a single currency would not be a good solution since we need to account for the fact that goods and services are cheaper in the less developed countries. Finally, in order to estimate elasticities in the demand system the data need to be aggregated at the level of each food expenditure group. This aggregation can be done only if the additivity condition in the data holds. This means that the total group expenditure equals the sum of the individual food items composing that group. The use of the purchasing power parity data solves the first two problems regarding the units of measure but it may not maintain satisfy the additivity condition during the aggregation.

In this study, we use the Geary-Khamis procedure, which is the same used in the Seale et al. (2003) paper. Based on this method, we calculated the price of the food group *j* in country *c* using the following equation:

$$P_{cj} = \frac{\sum_i E_{cji} / \pi_{cji}}{\sum_i V_{cji}},$$

where: E_{cji} represents the per capita expenditure in national currency of country *c* for the food item *i* which is part of the food group *j*; V_{cji} is the per capita expenditure in USD; and, π_{cji} is the purchasing power parity.

Appendix II. Summary Statistics.

	Bangladesh 2000		Cambodia 2004		Guatemala 2000		Kenya 2005	
National Sample	M	SD	M	SD	M	SD	M	SD
Age of Head	44.48	13.41	44.84	13.73 ---	44.27	15.01 ---	44.89	15.65 ---
Household Size	5.14	2.19 ---	4.97	2.00 ---	5.18	2.53 ---	5.04	2.73 ---
Share < 15	0.36	0.22 +++	0.33	0.22	0.38	0.25 ---	0.36	0.25 ---
Share > 60	0.08	0.17 +++	0.08	0.18 +++	0.10	0.23 +++	0.08	0.21 +++
Female Head	0.09	0.28	0.22	0.41 +++	0.18	0.39 +++	0.29	0.45 +++
Education Average (Adults)	3.05	3.34	4.09	2.86 +++	4.29	4.02 +++	6.63	3.66 +++
Predicted Expenditures per capita	11,047	7,673 +++	338,015	302,328 +++	649	610 +++	43,652	54,425 +++
Infrastructure Index	0.00	1.00	0.00	1.00 +++	0.00	1.00 +++	0.01	1.01 +++
Land operated/Owned	0.27	0.56 +++	0.93	2.15	2.97	10.86 +	0.60	1.18 ---
Livestock in Tropical Units	0.44	0.74 +++	0.89	1.05 ---	0.61	4.98	1.68	20.96 --
Rural	0.80	0.40 +++	0.85	0.36 ---	0.57	0.50 ---	0.75	0.43 ---
Rural Sample								
Age of Head	44.61	13.65	44.53	13.83 ---	44.06	15.04 ---	47.21	15.87
Household Size	5.16	2.23 ---	4.95	2.00 ---	5.64	2.63 ---	5.40	2.73 ---
Share < 15	0.37	0.21 +++	0.34	0.22	0.42	0.24 ---	0.38	0.24 ---
Share > 60	0.08	0.17 +	0.08	0.19 +++	0.09	0.22 ++	0.10	0.22 +++
Female Head	0.09	0.28	0.21	0.41 +++	0.15	0.36 ++	0.31	0.46 +++
Education Average (Adults)	2.58	3.01 +	3.76	2.60 +++	2.49	2.48 +++	5.91	3.42 ++
Predicted Expenditures per capita	9,269	4,576 +++	1,070,455	518,100 +++	356	252 +++	23,805	14,120 +++
Infrastructure Index	0.00	1.00 +++	0.00	1.00 +++	0.00	1.00 +++	0.00	1.00 +++
Land Operated/Owned	0.33	0.59 +++	1.02	2.28	3.15	10.92	0.78	1.28 ++
Livestock in Tropical Units	0.53	0.78 +++	0.98	1.05 --	0.92	6.39 ++	2.20	24.21 -
Urban Sample								
Age of Head	43.94	12.40	46.53	13.06 ---	44.54	14.97 --	38.04	12.72 ---
Household Size	5.04	2.05 ---	5.12	1.98 ---	4.58	2.25 ---	3.97	2.44 ---
Share < 15	0.33	0.21	0.29	0.22	0.33	0.25 ---	0.29	0.25 ---
Share > 60	0.06	0.15 +++	0.08	0.17	0.11	0.24 ++	0.03	0.14 +++
Female Head	0.10	0.30	0.24	0.42	0.23	0.42 +++	0.23	0.42 +++
Education Average (Adults)	4.92	3.90 +++	5.97	3.48 +++	6.64	4.41 +++	8.77	3.54 +++
Predicted Expenditures per capita	18,251	11,816 +++	2,319,306	1,681,138 +++	1,024	738 +++	96,847	78,584 +++
Infrastructure Index	0.00	1.00 +++	0.00	1.00 +++	0.61	0.97 +++	0.02	1.00 +++
Land operated/Owned	0.05	0.28 +	0.41	0.94 ---	1.93	10.48	0.08	0.62
Livestock in Tropical Units	0.08	0.34 +++	0.40	0.91 ---	0.19	1.90	0.17	1.97

National Sample	Malawi 2004 M	SD	Nepal 2003 M	SD	Tajikistan 2003 M	SD	Vietnam 2002 M	SD
Age of Head	42.40	16.42 ---	45.58	14.16	48.91	14.86 ---	47.72	13.58 ---
Household Size	4.47	2.32 ---	5.23	2.56 ---	6.25	3.08 ---	5.12	1.87 ---
Share < 15	0.39	0.24 ---	0.35	0.22 ---	0.36	0.22 +++	0.29	0.21
Share > 60	0.08	0.21 +++	0.09	0.20 +++	0.09	0.20 +++	0.09	0.18
Female Head	0.23	0.42 +++	0.20	0.40	0.20	0.40 ++	0.21	0.40 +++
Education Average (Adults)	4.50	3.47 +++	3.22	3.40 +++	9.83	2.40 +++	7.19	3.10 +++
Predicted Expenditures per capita	25,499	20,701 +++	18,330	23,206 +++	52	21 +++	3,769	3,003 +++
Infrastructure Index	0.00	1.00 +++	0.00	1.00 +++	0.00	1.00 +++	-0.07	0.95 +++
Land operated/Owned	0.55	0.53	0.60	1.00 +++	0.16	0.29 +++	0.54	0.91 ---
Livestock in Tropical Units	0.29	0.83	1.41	1.33	1.24	2.35 +++	43.62	83.14 ---
Rural	0.88	0.32 ---	0.83	0.37 ---	0.66	0.47	0.77	0.42 ---
Rural Sample								
Age of Head	43.08	16.69 ---	45.63	14.15	49.35	14.94 --	47.04	13.55 ---
Household Size	4.51	2.31 ---	5.32	2.59 ---	6.91	3.08 ---	5.18	1.85 ---
Share < 15	0.40	0.24 ---	0.36	0.22 --	0.38	0.20 +++	0.31	0.21 ++
Share > 60	0.09	0.22 +++	0.09	0.20 +++	0.08	0.17 +++	0.09	0.19 ++
Female Head	0.24	0.43 +++	0.20	0.40	0.14	0.35	0.16	0.37 +++
Education Average (Adults)	4.05	3.17 +++	2.56	2.75 +++	9.54	2.06	6.67	2.88 +++
Predicted Expenditures per capita	22,176	11,905 +++	13,103	8,742 +++	47	15 +++	2,758	1,249 +++
Infrastructure Index	0.00	1.00 +++	-0.30	0.53 +++	0.00	1.00 ---	0.00	0.98 +++
Land Operated/Owned	0.60	0.53 +	0.66	1.01 +++	0.23	0.34 +++	0.67	0.97 +++
Livestock in Tropical Units	0.32	0.88	1.61	1.33 +++	1.76	2.63 +++	51.47	83.74 +++
Urban Sample								
Age of Head	37.40	13.28 ---	45.34	14.25	48.06	14.69 ---	49.97	13.45 ---
Household Size	4.23	2.31 ---	4.78	2.33 ---	4.97	2.64 ---	4.94	1.93 ---
Share < 15	0.34	0.24 ---	0.26	0.22 --	0.32	0.24	0.24	0.20
Share > 60	0.04	0.15	0.09	0.19 ++	0.10	0.25 +	0.09	0.17
Female Head	0.15	0.36	0.19	0.39	0.30	0.46 +++	0.35	0.48 +++
Education Average (Adults)	7.81	3.79 +++	6.53	4.28 +++	10.40	2.86 +++	8.93	3.16 +++
Predicted Expenditures per capita	50,882	45,997 +++	44,252	42,736 +++	62	27 +++	7,009	4,532 +++
Infrastructure Index	0.00	1.00	0.01	1.00 +++	0.00	1.00 +++	-0.08	1.01 +++
Land operated/Owned	0.20	0.36	0.29	0.88	0.02	0.06	0.14	0.48 ---
Livestock in Tropical Units	0.04	0.19	0.42	0.83	0.24	1.16	17.70	75.55 ---

Notes: Test of the difference of the mean between food secure group and other: --- Negative at 1%, -- Negative at 5%, - Negative at 10%, +++ Positive at 1%, ++ Positive at 5%, + Positive at 10%. Predicted expenditures per capita in Local Currency Unit.

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