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Estimating the Range of Food-Insecure Households in India

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Estimating the Range of Food-Insecure Households in India

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Abstract

This study provides a quantitative assessment of food security using a large household-level expenditure survey conducted by the Government of India during 2004/05. The analysis tests the impact of several key assumptions required to estimate actual calories consumed from the expenditure data. The authors found significant differences in the estimates of calories consumed and the number of food-insecure people under alternative plausible assumptions for computing the calorie content of nonprocessed foods, processed foods, and meals eaten outside the household. The measurement errors were largest in accounting for calories consumed by the highest and lowest income households. Overall, the difference between the highest and lowest estimate of the number of people consuming an average of less than 2,100 calories per day was equivalent to about 17 percent of India's population, or 173 million people in 2004/05. Given the significant measurement error in estimating calories consumed, it is important to consider not only consumption surveys, but also aggregate food availability studies and survey data on anthropometric measures that accompany undernourishment—such as growth stunting—in assessing food insecurity.

Keywords: Food insecurity, calorie consumption, nutrition, household survey, development, India

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Contents

Summary iii

Introduction 1

Data 3

Estimation of Calorie Consumption From Household Expenditures . . . 4

Baseline Estimates of Calorie Consumption 5
Calories From Processed Foods 6
Calories From Whole Meals Received or Given 7
Total Calories Purchased per Household Member 9

Results Using Alternate Assumptions 12

Adding It All Up: Implications for Counting the Food-Insecure Population 18

Comparison With Direct Response Method Estimates of Household Food Security Status 20

Conclusions 21

References 23

Appendix 1. Conversion of household size to effective number of young adults 25

Appendix 2. Processed food items for which calorie counts could not be determined 26

Summary

What Is the Issue?

Policymakers and researchers are increasingly concerned with assessing the worldwide food-insecure population and the ways it may be changing. A common denominator in different approaches to assessing food insecurity is the measurement of calories consumed. The ability to measure food consumption is basic not only to gauging food insecurity, but also for targeting and evaluating policies aimed at alleviating it, such as the U.S. Government's Feed the Future initiative. This report examines problems in measuring calorie consumption and the food-insecure population, even when extensive household survey data are available, and finds that the extent of food insecurity varies markedly according to how it is measured. The analysis focuses on India, the country with the largest food-insecure population in the world, using a large household data set compiled by the Government of India for tracking household food security.

What Did the Study Find?

The authors found significant differences in estimates of the size of India's food-insecure population—comprising people who consumed less than 2,100 calories per day—across three major assessment methodologies: (1) The aggregate production and consumption approach used in the annual global food insecurity assessment by the U.S. Department of Agriculture (USDA); (2) the household expenditure survey approach; and (3) the survey of direct responses to questions on household food security status. Each of the methods, summarized briefly, describes a different but important aspect of food security:

- **Aggregate production and consumption approach**—Food production and trade statistics are used to determine a country's total food availability, which can then be used to estimate the number of food-insecure households through data on income distribution. Based on this approach, USDA's 2005 global assessment estimated India's food-insecure population at 217 million people.
- **Household expenditure survey approach**—Household responses to the Indian Government's National Sample Survey allow estimation of calories derived from food purchased or produced by households and also provide information on the characteristics of these households. Using these data and appropriate weighting factors to expand to the entire population, the authors found a baseline estimate of 508 million food-insecure people in India for 2004/05. However, the estimates ranged from 404 million to 577 million, depending on alternative plausible assumptions on the calorie content of foods and of meals consumed outside the home.
- **Survey of direct responses to questions on household food security**—This approach relies on survey questions that ask respondents about the adequacy of food consumption for household members. The authors found that estimates based on a specific question on household food security in India's National Sample Survey gave an estimate of 19 million food-insecure people in 2004/05, sharply lower than for the alternative methods. The authors note, however, that the Indian survey instrument differs

significantly from the carefully designed, multi-question modules used in the United States and elsewhere.

India's household expenditure survey data may have the potential to provide the most accurate assessment of food insecurity, because they contain the most detail on household food availability. In analyzing the data, the authors found a large spread in estimates of the food-insecure population in India when they used alternative assumptions for estimating calories consumed. The highest and lowest counts of calorie intake resulted in an estimated difference of about 173 million food-insecure people in 2004/05. Specific measurement issues raised by the analysis are:

- Difficulty in determining calories in processed foods, an increasingly important component of diets across Indian households. Because of the wide range of nutritional content within various categories of processed foods, it is not possible to reliably discern calorie content from the survey data.
- Errors in estimating the calorie content of meals consumed outside the home and meals provided to nonhousehold members—growing trends in Indian diets—for which calories cannot be precisely estimated from the survey data. Miscounting calories from these sources, as well as those from processed foods, can distort estimates of food insecurity rates across income groups and survey years.
- Potential errors associated with estimating consumption of processed foods and meals outside the home, which vary with household characteristics such as income and, therefore, are nonrandom sources of error. In this analysis, we find that the errors are largest when accounting for calories consumed by the highest and lowest income households.
- Conflicting sources of information on the calorie content of unprocessed foods. The calorie conversion factors used by the Government of India and FAO differ substantially for some foods.

How Was the Study Conducted?

Household data collected in the 2004/05 round of India's National Sample Survey, a survey of approximately 125,000 households conducted every 5 years, provide quantity and expenditure information for approximately 152 different food items for each household. Baseline estimates of calories purchased in the form of nonprocessed foods were calculated by multiplying quantities purchased by the average amount of calories per unit of quantity, using calorie conversion information from a source used by the Government of India. The baseline estimates of consumption of nonprocessed food calories were adjusted to account for household purchases of processed foods, calories included in the number of meals eaten outside the home, and meals given to nonhousehold members (such as to guests). The sensitivity of these baseline estimates of calorie consumption was then tested by perturbing the baseline assumptions, including (1) using an alternate source of information on the calorie content of foods from the Food and Agriculture Organization of the United Nations, (2) using alternate assumptions on the cost of calories from processed foods, and (3) accounting for the error involved in estimating the calories included in meals consumed outside the home or given to nonhousehold members.

Introduction

Despite India's rapid income growth over the past two decades, current estimates of the number of food-insecure people derived from aggregate production, trade, and income distribution data suggest that the country accounts for nearly 40 percent of the world's food-insecure population (e.g., Shapouri et al., 2011). This estimate is corroborated by a high prevalence of anthropometric indicators that accompany undernourishment, such as being underweight (e.g., Deaton and Dreze, 2008). Even though there is overwhelming evidence that a large share of the Indian population does not have adequate access to food, quantifying the extent of the problem and its change over time remains problematic not only in India, but also in other developed and developing countries (Nord et al., 2008; Barrett, 2010).

Three alternative approaches are commonly used to assess national food security status:

1. Computing average calorie consumption from aggregate food supply and use balances.
2. Using household survey data on food expenditures to estimate household-level food consumption and food security status.
3. Using survey data on household members' assessments of the adequacy of food availability to determine their food security status.

Policymakers often focus on estimates of calories consumed in the first two approaches. Each of these methods describes a different but important aspect of food security. Aggregate production and trade statistics better describe food availability, which can then be used to derive estimates of the number of food-insecure households by using information on the distribution of incomes (Shapouri et al., 2011). Household-level consumption survey data, by comparison, generally do not provide information on the sources of consumption (e.g., domestic versus imported food), but allow policymakers to identify which individual households are food insecure, along with the location and other characteristics of those households. Household survey data also generally allow for a more complete and detailed accounting of food items purchased, resulting in somewhat more precise estimates of the nutritional content of food consumed by each individual household (Deaton and Subramanian, 1996).

The third approach for assessing food consumption and food insecurity involves using a carefully designed and administered survey module to ask respondents directly about the adequacy of food consumption for household members (National Research Council, 2006). This is the approach used by USDA for assessing food security in the United States. It has also been used in local or national surveys in other countries, including Argentina, Bangladesh, Brazil, India, and Uganda, and is being developed for use by the U.S. Agency for International Development to track food security conditions in developing countries (Nord et al., 2002; Deitchler et al., 2011). This method bypasses the data problems of estimating the nutritional content of foods consumed, but it does not provide information on food sources or

diet composition and may yield different results in different cultural settings (Saxena, 2011).

The Government of India regularly generates estimates of food security status for policymakers, using survey-based estimates of caloric intake. This report, taking advantage of these data, focuses on the calorie consumption of individual Indian households using a household-level survey. There have been a number of estimates of calorie purchases in India using similar data (e.g., Deaton and Subramanian, 1996; Deaton and Dreze, 2008; National Sample Survey Organization, 2007; Tandon and Landes, 2011). While estimates of calorie purchases are based on the sum of calories in nonprocessed and processed food items, adjusted for calories contained in meals given to nonhousehold members and consumed in meals outside the home, these estimates require a number of important assumptions that, according to our findings, can significantly affect the precision of the results.

Next, we briefly describe the survey used to estimate calorie consumption throughout this report. We then explain the methods we used to estimate calorie consumption from the survey and calories consumed by each household. Subsequently, we examine the sensitivity of the baseline estimates to the use of alternative assumptions for three key components of the estimates: (1) the calorie content of nonprocessed foods, (2) the calorie content of processed foods, and (3) the calories in meals consumed outside the home and provided to nonhousehold members. Finally, we assess the overall findings and provide comparisons with food insecurity estimates from alternative approaches.

Data

Household-level expenditure data are collected annually by India's National Sample Survey Organization (NSSO). The NSSO conducts annual surveys on a range of topics and conducts a more detailed survey of both consumer expenditures and employment every 5 years. These surveys are the official source of household data used by the Indian Government to monitor and study poverty and food security in the country. For the consumer expenditure surveys, a sample of approximately 125,000 households is surveyed in each round, and the data collected include quantity and value of purchases of approximately 152 separate food items, along with the sources of each item (e.g., home-produced, purchased, etc.). The survey also reports the number of meals consumed outside the household and provided to nonhousehold members. In addition to household consumption, the survey reports a range of household and individual characteristics, including the number of household members, the household location, and the education and age of household members. The 61st round of the NSSO Consumer Expenditure Survey used in this study reports detailed expenditure data for 124,536 households collected during 2004-05.[1]

The NSSO Consumer Expenditure Survey is not a random sample of Indian households. Rather, the sample is geographically dispersed and stratified into rural and urban portions and further stratified based on measures of income. Portions of rural villages and urban towns are randomly selected to sample households and, within these regions, households of particular income groups and sectors (e.g., rural or urban) are randomly sampled. Thus, the sample becomes representative of the entire country only when the data for the households in the survey are properly weighted based on their prevalence in the entire country.[2]

[1]Surveys for 124,624 households were reported, but only 124,584 could be matched to probability weights, which are needed to estimate purchases for the entire Indian population from the sample. Furthermore, 48 households were excluded where household size could not be calculated. We also conducted robustness checks to exclude households with possible recording errors. In particular, the expenditure on processed food items listed in the appendix, which is a subset of total food expenditure, is greater than the total food expenditure for 1,041 households. These households have been excluded from the analysis. We also exclude sample households with implausibly high consumption and households where expenditures on nonprocessed food were equal to zero but consumption of nonprocessed calories was positive. In all, these adjustments exclude 1,648 of the original 124,536 households, leaving a total of 122,888 households.

[2]Probability weights are calculated using the multipliers provided by the NSSO, which are the number of households in the entire population represented by the household in the sample. We first multiply the multiplier by the size of the household, which gives us the number of people that are represented by the household members, and then divide by the total population to get the weights used in the calculations. Results are qualitatively identical if households are treated as the level of observation, with weights equal to the multiplier divided by the total number of Indian households estimated in the 2001 Indian census.

Estimation of Calorie Consumption From Household Expenditures

We first estimate household calorie consumption using an approach developed by Deaton and Subramanian (1996) for estimating calorie consumption from household expenditure data. It is important to note that the calorie consumption estimates are derived from the NSSO data that include both expenditures on purchases outside the household and food produced at home. The estimates do not, however, account for food losses that may occur at the household level. The estimation strategy involves three steps:

- Estimation of calories consumed from nonprocessed foods, such as particular types of rice, fruits, or vegetables. In order to estimate calories consumed from each source, we follow Deaton and Subramanian and use the estimated calories contained in quantities of each food, based on a nutritional study of a broad array of Indian foods conducted by the Government of India (Gopalan et al., 1989).
- Estimation of calories consumed from processed foods such as salted snacks, cakes, and pastries. Because of the wide variety of items in this category, it is difficult to estimate the actual number of calories in each item.[3] Given this variety, Deaton and Subramanian based their estimates on the value of expenditures on processed foods and used the simplifying assumption that calories from processed foods are purchased at a premium over nonprocessed foods. Specifically, they calculated the average calories purchased per rupee spent for each household and assumed that households received 50 percent fewer calories per rupee spent on processed foods than they did from nonprocessed foods.
- Estimation of calories consumed in meals outside the household and in meals given to nonhousehold members.[4] The NSSO survey provides information on the number of such meals for each household, but it is necessary to impute the number of calories associated with these meals. Deaton and Subramanian accomplished this by econometrically estimating the relationship between the total nonprocessed and processed calories purchased by each household, the numbers of home meals, meals given, and meals outside the home. Those results are then used to derive estimates of the calories associated with each type of meal. Under restrictive assumptions, this methodology provides an estimate of calories contained in each type of meal.

Once the baseline estimates of total calorie consumption are calculated, calorie intake totals for individuals are computed to permit comparisons with individual consumption benchmarks. This computation must account for both size and composition of households. To achieve this, we use the age and gender of children and adults to adjust total household size to "young adult equivalents," for which the benchmark consumption level—used in the 2005 USDA Food Security Assessment to define a food-insecure person—is 2,100 calories per day.[5,6]

[3]See appendix 2 for a complete list of food items for which calorie information was too difficult to infer.

[4]Previous research suggests that meals consumed outside the household might be particularly important to poorer households and thus significantly affect estimates of calorie consumption (e.g., Minhas, 1991).

[5]See appendix 1 for a table describing how each household member translates into the effective number of young adults requiring 2,100 calories per day. In the sample of 122,888 households, the effective household size was 4.68. On the other hand, some studies report per capita consumption (e.g., Deaton and Subramanian, 1996; Deaton and Dreze, 2008), while others try to account for differing calorie requirements by counting each child as half a household member (e.g., Hicks, 2009). The household size in each of these scenarios is 4.94 and 4.88 respectively, which would result in a slightly smaller per capita consumption and higher food-insecure population when this consumption is compared with a consumption benchmark of 2,100 calories.

[6]The benchmark daily calorie consumption used in this analysis (2,100 calories per day) differs from NSSO (2007) estimates. NSSO uses different benchmarks for rural and urban households—2,400 calories/day for rural, 2,100 calories/day for urban. Previous research has suggested that the actual benchmark chosen significantly changes estimates of food insecurity (e.g., Meenakshi and Vishwanathan, 2003). However, the primary point of this analysis is to demonstrate the changes in estimates of food security in response to changing assumptions. When different benchmarks are used for rural and urban areas, the main result stands that there is a large difference in the estimated number of food-insecure individuals.

Baseline Estimates of Calorie Consumption

The first step in generating the baseline estimates is computation of calories derived from the nonprocessed foods itemized in the survey household data, using the conversion factor found in Gopalan et al. (1989). The results for calories from nonprocessed foods are shown in table 1.

Table 1 also summarizes information on expenditures on processed foods, the number of meals consumed outside the home, and meals given to nonhousehold members, all of which will be accounted for to derive an estimate of total calories purchased or home-produced. In the case of processed foods, for which only value information is available in the NSSO data, household members spent an average of 3.79 rupees per day. This is equivalent to about 9 percent of daily food expenditures, although it is substantially larger for some households. Meals consumed outside the home—including meals paid for, received from employers, consumed at school, and a residual category of "other meals received" (including meals at weddings, birthdays, and other ceremonies)—do not appear to constitute a large category, on average, but some households do consume a large number of these types of meals. The number of meals provided to nonhousehold members also appears small for the average household, but again, the values become large for some households.

The results for nonprocessed calories purchased can also be broken out both by food category and the income groups identified in the NSSO survey (table 2). Column 1 in table 2 shows summary statistics for households with income in the top 10th percentile, and column 2 presents summary statistics for all other households, labeled as "middle income and poor," with results pooled across both urban and rural sectors.[7] The differences in column 3 indicate that poorer households purchase an average of 315 fewer calories than their more affluent counterparts and also purchase significantly less expensive calories, as indicated by the 51 fewer calories received per rupee spent.

Regardless of income level, the majority of nonprocessed calories purchased are derived from grain products. Despite the difference in total nonprocessed calories purchased between poorer and richer households, richer households are shown to purchase nearly identical amounts of grains—statistically, the hypothesis that grain purchases are equal between the two groups cannot be rejected at the 10-percent significance level. However, more affluent households purchased significantly more of every other food category, with the exception of calories from alcohol. This difference in purchases of foods that

[7]A rural household is classified as affluent by the NSSO if it owns a motor vehicle, mechanized farm equipment, or electrical appliances, if any family member is a highly paid professional such as a doctor, if the household owns a sufficient amount of land, or if it owns at least 10 head of cattle and/or buffalo.

Table 1
Summary of data used in constructing estimates of household calorie consumption

Variable	Average	Std. deviation	Minimum	Maximum	Observations
Nonprocessed calories purchased per household member	2,107	845.4	0	68,993	122,888
Rupees spent by entire household on processed food items per day	3.79	4.46	0	181.3	122,888
Meals eaten outside by the entire household per day	.529	.984	0	21.3	122,888
Meals given by household to nonmembers per day	.021	.366	0	32.2	122,888

Source: Estimates calculated by authors using the 61st round of the National Sample Survey.

are more expensive partially accounts for the substantial difference between rich and poor households in rupees spent per calorie purchased.[8,9]

Calories From Processed Foods

Processed foods comprise a broad array of products of varying nutritional content for which the NSSO survey provides only expenditure—but not quantity—data. Processed food categories in the survey include items such as "salted refreshments," "cake/pastry," and residual categories such as "other milk products" and "other processed food," for which it is difficult to assign calorie values.[10] For our analysis, rather than attaching a calorie value to a quantity purchased, it is necessary to attach a calorie value to household expenditures on these processed foods. The baseline estimates follow Deation and Subramanian (1996) by assuming that the cost of calories from processed foods is twice the cost of calories from nonprocessed foods.

Table 2
Summary statistics of nonprocessed calories purchased per day by income group

Variable	Affluent households	Middle-income and poor households	Difference (column 1– column 2)
	1	2	3
Calories purchased per household member per day	2,356 (6.29)	2,041 (2.51)	315.1*** (9.52)
Calories per rupee spent	228.8 (.841)	279.8 (.480)	-51.0*** (1.51)
Source of nonprocessed calories			
Calories from grains	1,420 (3.77)	1,424 (1.83)	-4.96 (6.80)
Calories from pulses	116.6 (.597)	87.6 (.205)	29.0*** (1.05)
Calories from butter/oils/sugar	333.8 (1.95)	239.9 (.566)	93.9*** (2.87)
Calories from meat	25.5 (.308)	18.3 (.157)	7.18*** (.653)
Calories from vegetables	104.4 (.504)	89.3 (.252)	15.1*** (.775)
Calories from fruits and nuts	79.1 (1.09)	39.9 (.352)	39.2*** (1.69)
Calories from eggs	7.64 (.091)	4.97 (.03)	2.67*** (.172)
Calories from dairy	267.3 (1.61)	133.7 (.638)	133.5*** (3.61)
Calories from alcohol	2.28 (.186)	2.88 (.108)	-.594*** (.221)
Observations	25,730	97,158	

Standard errors clustered by district are reported in parentheses.
***Denotes significance at the 1% level; **Denotes significance at the 5% level;
*Denotes significance at the 10% level.

Source: Estimates calculated using the 61st round of the National Sample Survey.

[8]It is interesting to note that, although richer households consumed more meat, the number of meat calories is much smaller than any other food category and has a very small standard error. Thus, richer households generally substitute more towards nonmeat food groups.

[9]These estimates of sources of nonprocessed foods are similar to estimates presented in the NSSO (2007).

[10]See appendix 2 for a complete list of food items that are included as "Processed Foods."

Following this approach, the cost of calories from nonprocessed foods is computed for each household and then doubled to convert each household's expenditures on processed foods to a calorie equivalent.

Although each household has different values for both calories purchased per rupee and rupees spent on processed foods, the sample averages are 3.79 rupees per household spent on processed foods per day and a cost of 269 calories of nonprocessed foods per rupee. Applying the assumption that processed calories cost twice as much as nonprocessed calories, the average household purchases approximately 508 processed calories per day, or 114 calories per household member per day. It is important to note, however, that there does not appear to be a strong basis for assuming that the average processed calorie costs twice as much as the average nonprocessed calorie. It is possible that processed foods vary widely in caloric content and cost and that the composition of purchases of processed foods varies across households based on such factors as occupation (agricultural versus nonagricultural), location (rural versus urban), and income level.

Calories From Whole Meals Received or Given

The NSSO data provide information on the number of meals consumed outside the household and meals provided to nonhousehold members, so it is necessary to impute estimates of the calories associated with those meals to make the required additions and subtractions to household calorie totals. Following the methodology introduced by Deation and Subramanian (1996), the baseline of calories contained in various types of meals is estimated with following specification:

$$Calories_{ir} = \tau_r + \beta_1 HomeMeals_{ir} + \beta_2 MealsGiven_{ir} + \beta_3 MealsReceived_{ir} + ControlVars_{ir} + \varepsilon_i$$

$Calories_{ir}$ denotes the total amount of calories purchased over the past 30 days, both processed and nonprocessed, by household i in district r; τ_r denotes a district fixed effect to help absorb unobserved characteristics shared by all households within a district; *HomeMeals* denotes the total number of meals eaten by household members at home over the past 30 days; *MealsGiven* denotes the total number of meals the household served to nonhousehold members over the past 30 days; *MealsReceived* denotes the total number of meals consumed by household members outside of the home over the past 30 days, which is the sum of meals received from school, employers, other sources, and on payment; and *ControlVars* denotes a number of household characteristics that are used as control variables to help absorb unobserved variation in calories purchased.[11,12]

Although this approach requires strong assumptions, the coefficients from this specification can be used to adjust calories purchased to account for each different type of meal. The coefficient β_2 provides an estimate of the number of the total calories purchased that were consumed by nonhousehold members for each meal, and β_3 provides an estimate of the number of calories consumed by household members in meals they ate outside the household.

Estimates of the specification are presented in table 3. Column 1 provides the estimates for a sparse specification, excluding the district fixed effects and

[11]Control variables include the amount of money spent on paan (a nut and spice mixture wrapped in betel leaf, for chewing), tobacco, intoxicants; fuel; the monthly per capita expenditure for the household; the effective number of young adults in the household; an indicator for whether the household is rural, and an indicator for whether the household is reporting insufficient food sources during the year.

[12]This approach differs from the methodology reported by NSSO (2007), which provides the number of calories used to estimate the calories contained in meals eaten outside of the household, meals given to nonhousehold members, and calories contained in processed foods. However, NSSO does not provide an explanation of the source of these values.

control variables. Relative to all other estimated coefficients, the estimated coefficient for meals consumed at home has a narrow 95-percent confidence interval of approximately 11.0 calories; the coefficient for *Meals Given* is also statistically significant, but has a much larger 95-percent confidence interval.[13] On the other hand, *Meals Received* is not statistically significant and has an implausibly small magnitude for calories consumed in a meal.

To investigate whether this is true for all types of meals received outside the household, column 2 shows the variable broken down into the number of meals received at school, from employers, and from other sources and meals received for payment. The coefficients on meals eaten at home and meals given to nonhousehold members are essentially unchanged. On the other hand, coefficients on meals from school, received for payment, and received from other sources are statistically significant. However, the signs on the coefficients differ. Meals from school have the expected sign and suggest that each meal consumed at school could contain approximately 400 calories, which is the resulting decrease in calorie purchases for the household per school meal.

The signs on the coefficients of meals received for payment and meals from other sources are the opposite of what would be expected when holding all other factors fixed, and the coefficient is likely picking up the effects of some omitted variables on the total calories purchased. For example, given that these meals include meals at ceremonies such as weddings, it could be that primarily richer households receive these meals at ceremonies, and thus the coefficient is partially capturing the effects of income on calories purchased. Or perhaps receiving a meal from another household requires the household to provide a meal to that guest in return on some other occasion.

The results in columns 3 and 4 try to account for some unobserved heterogeneity by estimating specifications, including fixed effects and control variables. The coefficients on types of meals received vary significantly in magnitude and, in one instance, even change signs. Given these changes, it is difficult to identify the number of calories contained in meals received outside the home. However, the estimates of the amount of calories associated with meals given by households seem to be stable in magnitude and statistically significant across specifications.

Thus, when adjusting the calories purchased by individual households in response to meals eaten outside the home and meals given to nonhousehold members, we use the estimated coefficient on meals given in column 4 (664 calories per meal). However, it should be noted that, in that estimation, one cannot reject the hypothesis that true calorie content of a meal is anything between 221 and 1,107 calories at the 5-percent significance level.[14,15]

[13]The bounds of the confidence interval were calculated by multiplying the estimated standard error of the coefficient estimate (7.84) by 1.96 and adding and subtracting the value from the coefficient estimate.

[14]The bounds of the confidence interval are again calculated by multiplying the estimated standard error of the coefficient estimate (225.6) by 1.96 and adding and subtracting the value from the coefficient estimate.

[15]These estimations suggest considerable uncertainty in the calorie content of whole meals. This is especially true of meals received outside the home. However, this pattern suggests that the confidence interval should be even larger than suggested above and bolsters the argument that uncertainty in calorie content of these types of meals leads to uncertainty in calories available for consumption by households.

Table 3
Calories purchased per meal consumed

Type of meal	Dependent variable: Total household calories purchased			
	1	2	3	4
Meals at home	694.6*** (7.84)	701.2*** (8.03)	696.2*** (6.98)	370.1*** (7.93)
Meals given	827.0*** (269.9)	818.3*** (268.8)	818.8*** (265.1)	664.7*** (225.6)
Meals received	49.2 (34.3)			
Meals received from school		-401.2*** (65.1)	-327.9*** (37.2)	-158.0*** (35.9)
Meals received from employer		-135.5 (96.7)	-188.4*** (50.1)	-178.8*** (52.7)
Meals received for payment		207.0** (99.8	378.8*** (52.8)	-111.4* (67.6)
Meals received from other sources		349.9*** (42.1)	365.9*** (27.3)	49.8** (22.4)
District fixed-effects	N	N	Y	Y
Control variables	N	N	N	Y
Observations	122,888	122,888	122,888	122,888

Notes: * Denotes significance at the 10% level; ** Denotes significance at the 5% level; *** Denotes significance at the 1% level. Standard errors are reported in parentheses.

Source: Estimates calculated using the 61st round of the National Sample Survey.

Total Calories Purchased per Household Member

Based on the estimation strategies described above, table 4 presents summary statistics of household calorie consumption by source. The vast majority of calories are obtained from nonprocessed foods. Other sources contribute to overall calorie consumption but constitute a much smaller share. However, some households consume a large number of calories from these other sources, suggesting that calories from processed foods, meals eaten outside the household, and given in meals to nonhousehold members are important to any estimate of food insecurity.

Accounting for calories consumed from all sources in table 4, table 5 provides estimates of total calorie consumption (column 1) and the share of all households in the sample consuming below 2,100 calories per capita per day (column 2). Columns 3 and 4 estimate the same parameters for the entire Indian population using probability weights. The estimate of average daily calories consumed per household member in the sample is approximately 2,303 (column 1). Of this total, approximately 114 calories on average were obtained from processed foods and approximately 85 calories from meals eaten outside the household.

According to these baseline estimates, approximately 47.2 percent of the households in the sample consumed less than 2,100 calories per person day, the consumption level used to define a food-insecure person in the USDA's Food

Table 4
Summary statistics of calories consumed per day by source

Variable	Average	Std. deviation	Minimum	Maximum	Observations
Nonprocessed calories per household member	2,107	845	0	68,993	122,888
Processed calories per household member	114	302	0	76,730	122,888
Calories consumed in meals outside the household per household member	85	198	0	3,988	122,888
Calories given to nonhousehold members per household member	3.6	80	0	16,817	122,888

Source: Estimates calculated by authors using the 61st round of the National Sample Survey. Each cell reports unweighted summary statistics from the entire sample of 122,888 households.

Table 5
Baseline estimate of average calories consumed

	All sample households		Total country estimates	
	1	2	3	4
Variable	Avg. per capita cal./day	Share of sample that is food insecure	Avg. per capita cal./day	Share of food-insecure households
Total calories consumed	2,303 (2.59)	.472 (.001)	2,225 (4.27)	.495 (.003)
Number of households	122,888			

Note: Standard errors are reported in parentheses.

Source: Estimates calculated using the 61st round of the National Sample Survey. Population estimates are constructed using National Sample Survey Organization (NSSO) multipliers to calculate population weights.

Security Assessment for 2005 (Meade et al., 2006).[16] If we extrapolate this result to all of India, the average person consumes approximately 2,225 calories (column 3), and approximately 49.5 percent of households consume fewer than 2,100 calories per person per day. This share of households translates to approximately 508 million people according to the 2001 Indian Census.[17] The differing results for the sample households (columns 1 and 2) and the country totals (columns 3 and 4) reflect the use of weights in the national totals to compensate for the NSSO sampling procedure, in which richer households are oversampled relative to their prevalence in the entire population.[18]

Figure 1 provides the histogram of average daily per capita calorie purchases and describes the entire distribution of the estimated calorie purchases. The distribution is centered at the mean calorie purchases of 2,303 calories

[16]There is some uncertainty as to what level of calorie purchases will actually result in a consumption of 2,100 calories. Wastage in calories purchased would imply that purchasing 2,100 calories would result in a lower level of consumption. However, the point of this analysis is to show how the assessment changes when assumptions change rather than simply reporting the raw numbers of the food insecure. Furthermore, the choice of 2,100 calories purchased can therefore be interpreted as more severe food insecurity than 2,100 calories consumed.

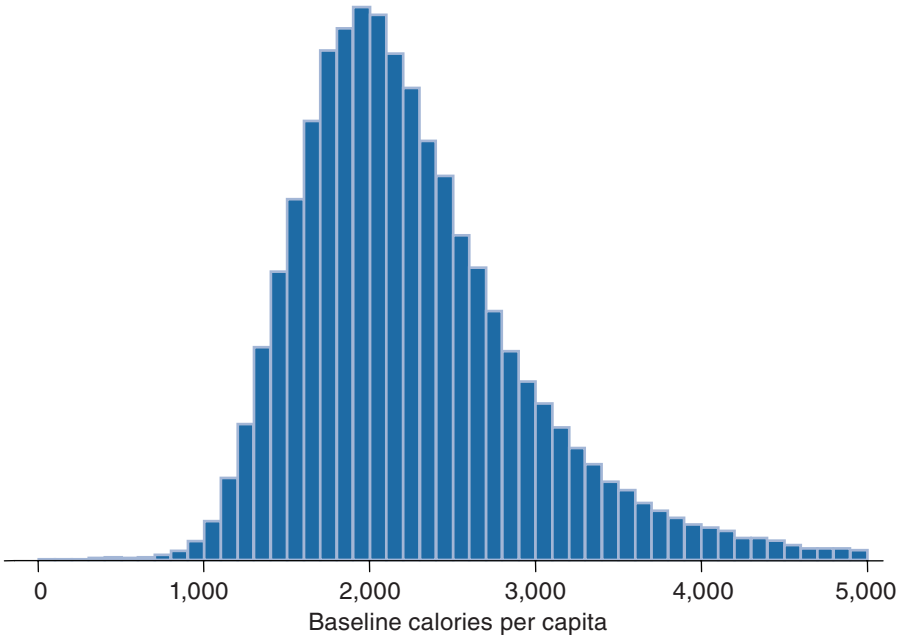
[17]This estimate is derived by multiplying the estimate of the share of all Indian households purchasing less than 2,100 calories by the number of households in the 2001 Indian Census, multiplied by the average household size in the 2001 Indian Census.

[18]There are no significant differences in the amount of measurement error in rural and urban households, and thus for simplicity, we report estimates for the sample pooled across rural and urban sectors.

per day presented in table 4 and is skewed slightly to the right-hand side, implying that there are more people consuming well above the average calories than well below the average.

Figure 1

Distribution of daily per capita calories purchased



Source: Estimates calculated using the 61st round of the National Sample Survey.

Results Using Alternate Assumptions

The next step in the analysis is to evaluate the impacts on the individual baseline caloric intake estimates of using alternative plausible assumptions for deriving those estimates. Each step in computing the baseline calorie estimates required assumptions or methods that are potential sources of error in the results. In this section, the baseline assumptions are replaced with other plausible assumptions, one by one, to examine the impact on the estimates of calories purchased and the food-insecure population. The assumptions and methods used in each of the three steps of the baseline calculations are examined by:

- Using alternative sources of data on the calorie content of nonprocessed foods.
- Using alternative assumptions on the costs of calories from processed foods.
- Accounting for the large confidence intervals around the econometric estimates of calories associated with meals eaten outside the household and given to nonhousehold members.

Adjustment 1. The effect of alternative sources of data on the calorie content of nonprocessed food.

Estimating calorie consumption from household survey data requires the use of conversion factors for converting food quantity data into calorie equivalents. The baseline estimates of nonprocessed calories consumed per household member are based on the nutritional information for Indian foods contained in the *Nutritive Value of Indian Food* (NVIF) (Gopalan et al., 1989). To evaluate the sensitivity of these results to the choice of conversion factors, calorie consumption was also calculated using the conversion factors employed by the Food and Agriculture Organization of the United Nations (FAO) for estimating aggregate calorie availability for South Asian countries.[19]

The two sources differ in the types of food categories for which nutritional information is provided. NVIF provides nutritional information for more disaggregated food items than the FAO source, which applies average calorie information for a number of different food items.[20] Neither source will yield unambiguously higher estimates of total calories purchased. NVIF lists higher calorie information for 59 food items, FAO provides higher calorie information for 40 food items, and 53 items have the same calorie value. The net effect of using one source over the other depends on which food items are more common in a household's food purchases.

Although NVIF is somewhat more detailed, the comparison with FAO sources is informative for two reasons. First, FAO estimates the number of food-insecure people in India (e.g., FAO, 2011), and it is important to assess the possible reasons why estimates might differ between sources. Second, the comparison can demonstrate whether averaging across food items might obscure the numbers of food-insecure households in a country.

[19]This concordance is available online at http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368; we accessed the site in August 2010. For food items in the NSSO survey that have no link to the food items in the FAO list, the calorie value from NVIF was used to make the two sources of calorie information as similar as possible.

[20]To illustrate the difference between the two sources: The NSSO survey records purchases of 9 different types of pulses, NVIF reports nutritional information for 19 distinct types of pulses, and FAO reports nutritional information for only 3 types. Thus, 9 of the 19 pulse items reported in NVIF are matched to the NSSO categories, while 1 of the 3 FAO calorie values are matched to each of the 9 different food categories. In both instances, the calorie counts are relatively close, with the average calories in a kilogram of pulses from the NVIF and FAO measured at 3,418 and 3,511.4, respectively.

To examine the sensitivity of the results to the alternative sets of conversion factors, the total nonprocessed calories consumed are computed using the two sets of calorie information. We then estimate the following empirical specification:

$$NonprocessedCalories_{ir} = \tau_r + \beta FAONonProcessedCalories_{ir} + \varepsilon Controls_{ir} + \varepsilon_i$$

where $NonprocessedCalories_{ir}$ denotes the total number of nonprocessed calories consumed in household i and district r when calories are calculated using NVIF conversions, and *FAONonprocessedCalories* denotes the same measure with calories calculated using the nutritional information provided by FAO. The symbol τ denotes fixed effects, introduced to account for time-invariant differences between districts, and *Controls* denotes a number of household variables that are used to control for the effects of observable household characteristics on calories consumed.[21] With this approach, the resulting estimates of the coefficient β will describe how nonprocessed calories consumed differ between the two sources. Estimates of calorie consumption using the nutritional information in NVIF will be higher if the value of β is greater than 1 (β>1) and, conversely, will be lower if β is less than 1(β<1).

The results are shown in table 6. Column 1 presents estimates for a sparse specification of the model with no fixed effects or control variables; column 2 presents estimates when the district fixed effects are added; and column 3 presents estimates when both district fixed effects and household control variables are included. Because the estimates of β are greater than 1 and the p-value from the hypothesis test of β=1 is essentially 0 in all specifications, the results indicate that using the FAO conversion factors yields lower estimates of nonprocessed calories consumed than those derived using the NVIF factors. The results in column 3, the most complete estimation model, suggest that increasing the FAO calories consumed by one calorie is associated with an increase in NVIF calories by 1.031, a difference of 3.1 percent.

[21]Control variables include the amount of money spent on paan, tobacco, intoxicants, and fuel, the monthly per capita expenditure for the household, the effective number of young adults in the household, an indicator for whether the household is rural, and an indicator for whether the household is reporting insufficient food sources during the year.

Table 6
Correlation between calories consumed using NVIF nutritional information and FAO nutritional information

	Dependent variable: Nonprocessed calories purchased using NVIF		
	1	2	3
Nonprocessed FAO calories	1.034*** (.003)	1.033*** (.003)	1.031*** (.006)
Fixed effects	N	Y	Y
Control variables	N	N	Y
P-value of test coefficient on FAOCal=1	.0000	.0000	.0000
Observations	122,888	122,888	122,888

NVIF=*Nutritive Value of Indian Foods* (Gopalan et al., 1989); FAO=Foreign Agriculture Organization.
*** Denotes significance at the 1% level; **Denotes significance at the 5% level; * Denotes significance at the 10% level. Standard errors are reported in parentheses.
Source: Estimates calculated using the 61st round of the National Sample Survey.

Table 7 shows the estimates of average total calorie consumption and the share of households purchasing less than 2,100 calories per day using both the NVIF (column 1) and FAO (column 2) conversion factors. Column 3 indicates that per capita calorie consumption is approximately 63 calories lower when using FAO conversion factors to calculate nonprocessed calories consumed rather than the NVIF conversion factors. As a consequence, the estimated share of food-insecure households is about 3.6 percent higher when using the FAO conversion factors. These estimates from the sample are mirrored by estimates for the entire population in columns 4 through 6. For the population as a whole, the FAO calorie information increases the estimate of food-insecure households by 5.1 percent, which translates into approximately 53 million people according to the 2001 Indian Census (column 6).[22]

Adjustment 2. Using alternate assumptions on the cost of calories from processed foods

Following the estimation strategy used by Deaton and Subramanian (1996), the baseline estimates of household calorie consumption assumed that calories from processed food in each household are twice as expensive as the calories from nonprocessed food. This assumption has both desirable and undesirable properties. In particular, the assumption implies that poorer households also purchase cheaper processed foods than richer households, which is a plausible characterization of actual consumption behavior. However, there does not appear to be a strong rationale supporting the assumption that processed calories should be exactly twice as expensive as nonprocessed calories, making it a source of uncertainty in the resulting estimates of household calorie purchases.

The importance of the assumed calorie content of processed foods is assessed by analyzing alternate scenarios. First, we assume that calories purchased in processed foods are the same price as those purchased in nonprocessed foods, and then we assume that processed food calories are four times more expensive. Although these assumptions are simplistic, many varieties of processed

[22]The primary driver of this difference appears to be the calories contained in certain types of cereals and pulses. In each food category, the NVIF has approximately 300 more calories contained in a particular type of cereal and approximately 200 more calories in a particular type of pulse. These two food items account for a large amount of calories purchased, and thus NVIF results in a larger estimate of calorie consumption.

Table 7
Comparison of calorie consumption using alternate sources of nutritional information

	All sample households			Total country estimates		
	1	2	3	4	5	6
	Calories purchased using NVIF	Calories purchased using FAO	Difference	Calories purchased using NVIF	Calories purchased using FAO	Difference
Average calorie consumption	2,303	2,240	63.3***	2,225	2,147	77.7***
	(2.59)	(2.53)	(.375)	(4.27)	(4.06)	(.736)
Share of food-insecure households	.472	.508	-.036***	.495	.546	-.051***
	(.001)	(.001)	(.001)	(.003)	(.003)	(.001)

NVIF=Nutritive Value of Indian Foods (Gopalan et al., 1989); FAO=Foreign Agriculture Organization.
Notes:
1. Standard errors clustered at the district level are presented in parentheses.
2. *** Denotes significant at the 1% level; **significant at the 5% level; * significant at the 10% level.
3. Columns 1 and 4 calculate the estimate of calories purchased using NVIF nutritional totals and the share of households that purchased fewer than 2,100 calories. Columns 2 and 5 calculate the same totals using FAO nutritional tools. Columns 3 and 6 present the difference between the two, subtracting columns 2 and 5 from columns 1 and 4, respectively.

Source: Estimates calculated using 122,888 households from the 61st round of the National Sample Survey. Population estimates are constructed using National Sample Survey multipliers to calculate population weights.

foods purchased by the average household are both more and less expensive than these bounds, and these likely represent only a fraction of the processed food items available to Indian consumers. The bounds chosen are intended to illustrate a range of possibilities rather than a best estimate of calories consumed from processed foods. Until household data can identify what processed foods households are actually purchasing and their caloric content, there will be a large confidence interval on any estimate of calories purchased from processed foods.

The results show that the alternate assumptions on the cost of processed food calories have a significant impact on the estimates of per capita calorie consumption and the food-insecure population (table 8). The difference between assuming that processed calories are four times as expensive as those in nonprocessed foods and assuming they are the same price as for nonprocessed foods is an average of 171 calories per capita (column 3). That translates into a 9.5-percent difference in the share of the sample households with per capita daily purchases less than 2,100 calories (column 3). If we extrapolate to the entire population in column 6, the estimated difference in the number of people purchasing less than 2,100 calories per day is over 98 million people based on the 2001 Indian Census.

Because of the potential errors introduced by oversimplified assumptions about the nutritional content of processed foods, it would be valuable for future studies to combine the NSSO consumption data with other data sources that better describe the processed foods most consumed by various categories of Indian households, as well as the calorie content of those foods. For example, Euromonitor International reports total expenditures on all packaged foods sold by grocery retailers, as well as totals by subcategories, such as "salted snacks," that correspond to some of the NSSO codes of

Table 8
Comparison of calorie consumption using alternate assumptions for the cost of processed foods

	All sample households			Total country estimates		
	1	2	3	4	5	6
Variable	Consumption assuming processed and nonprocessed foods cost the same	Consumption assuming processed foods cost four times as much as nonprocessed foods	Difference	Consumption assuming processed and nonprocessed foods cost the same	Consumption assuming processed foods cost four times as much as nonprocessed foods	Difference
Average calorie consumption	2,417	2,246	171.2***	2,325	2,174	150.5***
	(3.05)	(2.44)	(1.29)	(4.85)	(4.12)	(2.09)
Share of food-insecure households	.410	.504	-.095***	.433	.528	-.095***
	(.001)	(.001)	(.001)	(.003)	(.003)	(.002)

Notes:
1. Standard errors are presented in parentheses. 2. *** Denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level. 3. Columns 1 and 4 estimate the average calories purchased and the share of households that purchased less than 2,100 calories using an estimate of calorie consumption that assumes processed foods are the same price as nonprocessed foods. Columns 2 and 5 calculate the same totals using an estimate of calorie purchases that assumes processed foods are four times as expensive as nonprocessed foods. Columns 3 and 6 present the difference between the two, subtracting columns 2 and 5 from columns 1 and 4, respectively.

Source: Estimates calculated using 122,888 households from the 61st round of the National Sample Survey. Population estimates are constructed using NSS multipliers to calculate population weights.

processed foods.[23] The same source also reports the shares of each of these subcategories captured by particular brands, which may permit collection of more precise information on prices and nutritional content.

Adjustment 3. Accounting for the large confidence limits around estimates of calories in meals eaten outside the household or given to nonhousehold members

As discussed earlier, adjusting household calories purchased for meals consumed outside the household and meals given to nonhousehold members requires estimation of the calories consumed per meal. The NSSO expenditure surveys do not provide information needed to directly compute calories consumed in such meals, and the econometric procedures used by others (e.g., Deaton and Subramanian, 1996) yield imprecise estimates and introduce potential errors.

To evaluate the importance of this problem, we assess the impacts of a range of alternate assumptions about the calories in meals consumed outside the household or given to nonhousehold members by accounting for the uncertainty in the regression techniques used to estimate the calories contained in both types of meals. The regression estimate of the calories included in both types of meal is approximately 664 calories (table 3), but if we require a 5-percent significance level, we cannot rule out a true calorie value anywhere inside the 95-percent confidence limits of this estimate, or between 221 and 1,107 calories per meal.

Table 9 provides estimates of average calories consumed and the share of food-insecure individuals for the sample and population, when we use the upper and lower bound confidence limits around the econometric estimate of calories per meal. These results indicate that the difference between using the upper and lower bound limits has an impact on the share of food-insecure households similar to that from using alternate sources of caloric conversion

[23]Euromonitor International provides a list of processed foods along with prices and quantities available in India. The data were accessed at http://portal.euromonitor.com/Portal/ResultsList.aspx on 10/12/2010. Analyzing just a few of many options available to consumers in the types of processed foods listed in appendix 2, we found that calories purchased per rupee averaged 47.9, with a minimum of 4.7 and a maximum of 348.8. The hypotheses that processed foods are the same price as nonprocessed foods (269 calories per rupee, on average) and that processed foods are four times as expensive (67.25 calories per rupee, on average) are within this range.

Table 9
Comparison of calorie purchases using alternate assumptions for meals eaten outside the household

	All sample households			Total country estimates		
	1	2	3	4	5	6
Variable	Consumption using upper bound limit for meal estimate	Consumption using lower bound limit for meal estimate	Difference	Consumption using upper bound limit for meal estimate	Consumption using lower bound limit for meal estimate	Difference
Average calorie consumption	2,357	2,248	108.9 ***	2,279	2,170	108.8***
	(2.63)	(2.60)	(.813)	(4.28)	(4.34)	(1.23)
Share of food-insecure households	.437	.504	-.067***	.458	.532	-.074***
	(.001)	(.001)	(.001)	(.003)	(.003)	(.001)

Notes:
1. Standard errors are presented in parentheses.
2. *** Denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.
3. Columns 1 and 4 calculate the estimate of calories purchased and the share of households that purchased less than 2,100 calories using the upper bound of the estimate of calories contained in meals eaten outside the household. Columns 2 and 5 calculate the same totals using the lower bound of the estimate of calories contained in meals eaten outside the household. Columns 3 and 6 present the difference between the two, subtracting columns 2 and 5 from columns 1 and 4, respectively.

Source: Estimates calculated using 122,888 households from the 61st round of the National Sample Survey. Population estimates are constructed using NSS multipliers to calculate population weights.

information. The difference in the share of the population that is food insecure between estimates of calorie purchases using the upper and lower bound confidence limit is approximately 7.4 percent (column 6), which translates into nearly 76 million people according to the 2001 Indian Census.

Adding It All Up: Implications for Counting the Food-Insecure Population

The preceding sections provided baseline estimates of average caloric intake levels and the size of the food-insecure population, along with plausible alternative estimates for the key components of those calorie totals—nonprocessed foods, processed foods, and meals eaten or given outside the home—that suggest scope for substantial error in the baseline estimates. Each of the alternative scenarios yielded outcomes that are significantly different from each other. Based on the scenario findings, it is possible to construct "High" and "Low" estimates of India's food security status consistent with the NSSO data by combining the scenarios that yield the lowest and highest estimates of individual calories consumed. The following specific assumptions are made in constructing the High and Low estimates of calories consumed:

- *High-calorie estimate:* Uses the calorie conversion factors provided in the list used by the Indian Government, the *Nutritive Value of Indian Foods* (NVIF), to estimate calories in nonprocessed food purchases; assumes that processed calories are the same price as nonprocessed calories; and uses the upper bound of the estimate of calories consumed in meals outside the home and given to nonhousehold members.
- *Low-calorie estimate:* Uses the calorie conversion factors used by the Food and Agriculture Organization of the United Nations to estimate calories in nonprocessed food purchases, assumes that processed calories are four times the price of nonprocessed calories, and uses the lower bound of the estimate of calories consumed in meals outside the home and given to nonhousehold members.

The results show a wide range of estimates of average calories consumed and the size of the food-insecure population (table 10). There is an average difference of approximately 280 calories purchased per capita between the High and Low estimates (column 3), which translates into a difference in the share

Table 10
Comparison of high and low scenarios for calories consumed

	All sample households			Total country estimates		
	1	2	3	4	5	6
Variable	High-calorie estimate	Low-calorie estimate	Difference	High-calorie estimate	Low-calorie estimate	Difference
Average calorie consumption	2,471	2,191	280.2***	2,379	2,120	259.2***
	(3.09)	(2.46)	(1.52)	(4.88)	(4.20)	(2.49)
Share of food-insecure households	.376	.536	-.160***	.395	.563	-.168***
	(.001)	(.001)	(.001)	(.003)	(.003)	(.002)

Notes:
1. Estimates calculated using 122,888 households from the 61st round of the National Sample Survey. Population estimates are constructed using NSS multipliers to calculate population weights. Standard errors clustered at the district-level are presented in parentheses.
2. *** Denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.
3. Columns 1 and 4 calculate the estimate of calories purchased using the 'High Calorie' estimate described above and the share of households that purchased less than 2,100 calories. Columns 2 and 5 calculate the same totals using the 'Low Calorie' estimate. Columns 3 and 6 present the difference between the two, subtracting columns 2 and 5 from columns 1 and 4, respectively.

Source: Authors' calculations (see note 1).

of food-insecure households in the Indian sample of 16 percent (column 3). If we extrapolate to the entire country, the difference in the share of food-insecure households in India is 16.8 percent, which translates into 173 million people according to the 2001 Indian Census. The largest contributor to the difference between the High and Low estimates is the uncertainty about how many calories are contained in processed foods.

Table 11 presents the differences in the share of total households in India that are within various ranges of calorie purchases. The results indicate that the difference in average consumption between the High and Low calorie estimates in table 10 is accompanied by relatively large differences in households purchasing less than 1,500 and more than 2,400 calories per capita per day. Thus, although the primary sources of uncertainty in calorie consumption are largest for relatively richer households, households experiencing severe food insecurity are also affected.

Table 11

Changes to the depth of food security between the high and low scenarios for calories consumed

	Share of all Indian households in the food security range:		
	1	2	3
Food security range	High-calorie estimate	Low-calorie estimate	Difference (column1 minus column 2)
Cal<1,500	.064 (.001)	.151 (.002)	-.087*** (.002)
1,500<Cal<1,800	.133 (.002)	.198 (.002)	-.065*** (.002)
1,800<Cal<2,100	.198 (.002)	.213 (.002)	-.015*** (.002)
2,100<Cal<2,400	.196 (.002)	.167 (.002)	.029*** (.002)
Cal>2,400	.408 (.003)	.270 (.002)	.138*** (.001)

Notes:

1. Estimates calculated using 122,888 households from the 61st round of the National Sample Survey. Estimates are constructed using NSS multipliers to calculate population weights. Standard errors clustered at the district level are presented in parentheses.
2. *** Denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.
3. The first column calculates the share of all Indian households in each range of total calories purchased using 'High Calorie' estimates described above. Column 2 calculates the share of households in each range of total calories purchased using the 'Low Calorie' estimates. Column 3 presents the difference between the two shares.

Source: Authors' calculations (see note 1).

Comparison With Direct Response Method Estimates of Household Food Security Status

A third methodology for assessing food security status is based on survey instruments that ask direct questions on food availability and food access for household members. This approach is used in the United States with a survey instrument, the Household Food Security Survey Module (HFSSM), which administers up to 18 questions to elicit information on food security conditions, with the data then used to place households on a food security scale (National Research Council, 2006). The U.S. Agency for International Development has developed a modification of this approach for assessing food security conditions in developing countries, using a simplified three-question module to place households on a 3-point Household Hunger Scale (HHS) of "Food Secure," "Food Insecure Without Hunger," and "Food Insecure With Hunger" categories (Deitchler et al., 2011).

The NSSO survey used for our study administers a single direct question on household food security status: "Do all members of your household get enough food every day?"[24] Responses to this question in the 2004/05 survey indicated that just 19 million people—or about 1.9 percent of the population—had inadequate access to food in at least 1 month of the previous year, sharply below what other information on India's food security would suggest. However, given the simplicity of the NSSO instrument, this 2004/05 result may not be a credible application of the direct response methodology.

Unfortunately, other Indian surveys using more complete versions of the HFSSM or HHS than the NSSO also do not provide results that can be readily compared with our national estimates based on aggregate production and consumption or household calorie consumption methods. Agarwal et al. (2009) surveyed 410 adult females in a Northeast Delhi slum using a 4-item variant of the HFSSM and found 51 percent of respondents to be food insecure. Gopichandran et al. (2010) studied 130 urban households in Vellore, Tamil Nadu using the HFSSM and found 61.5 percent of respondents to be food insecure with hunger and 13.1 percent to be food insecure without hunger. A survey of 282 low-income households in a backward area of Orissa reported by Nord et al. (2002), also using a variant of the HFSSM, found 92 percent of households to be food insecure and 57 percent to be food insecure with hunger. The narrow geographic scope, differing time periods, and nonrandom nature of the samples used in each of these studies make it impossible to compare the results using the direct response methodology with our results. A recent study provided validation of the internal consistency of results using the HHS methodology across several countries, but it did not provide external validation of HHS-based results against other methods and measures, such as household expenditure, food consumption, or nutritional status (Deitchler et al., 2010).

[24]Response choices are: (1) Yes: Every month of the year; (2) Some months of the year; (3) No: no month of the year. Households choosing either (2) or (3) are counted as food insecure.

Conclusions

We find that estimates of the number of households classified as food insecure vary significantly with alternate plausible assumptions. Overall, when accounting for the three sources of error examined in this report, the share of India's population consuming less than 2,100 calories per day ranges from 39.5 percent (404 million people) to 56.3 percent (577 million people), for a difference of approximately 173 million people.[25] By contrast, USDA's Food Security Assessment for 2004/05 (Meade et al., 2006) estimated the world's total food-insecure population, using the same 2,100 calorie per day benchmark, at 775 million people and India's share at 217 million. Thus, the potential error in one country is equivalent to about 22 percent of the total food-insecure population of 70 developing countries in 2004/05. Although the low estimates derived here suggest the possibility that India's food situation could be better than indicated by some assessments based on household data, even the most conservative estimates in this analysis indicate that nearly 40 percent of the population is food insecure based on the 2,100 calorie per capita daily standard.

We are required to make a number of assumptions to estimate calories consumed per household member, even when using detailed household expenditure data. Assumptions regarding the amount of calories from each source, calories contained in nonprocessed and processed foods, and calories contained in meals eaten outside the household and given to nonhousehold members all have the potential to introduce error in estimates of calories purchased by households. In particular, the estimates of calories purchased are sensitive to assumptions accounting for calories contained in processed foods. These factors can result in estimates of calorie purchases that are different than the true values and that, in turn, affect the analysis of researchers concerned with the efficacy of programs designed to improve food security.

In estimating calories consumed in India—the country with the largest number of food-insecure individuals in the world—we find important characteristics in the consumption patterns among India's most vulnerable population. Although it is commonly thought that processed foods are important primarily for more affluent consumers in developing countries, the poorest households in India devote a nontrivial share of their purchases to such foods. Furthermore, relative to more affluent households, the poorest households purchase significantly cheaper sources of calories, primarily composed of grains, rather than a more diversified diet. This pattern is consistent with the persistently high rates of malnutrition in India.[26]

The approach in this study to estimating actual calorie consumption is in contrast to methods that assess food security by administering a survey module that asks respondents directly about the adequacy of food consumption for household members. The single question administered in the NSSO survey yielded a sharply lower estimate of the food-insecure population than other measures, but the instrument may be too simplistic to represent a credible application of this method. Other studies in India using the direct response approach all used localized, nonrandom samples in different years, so it is not possible to compare them with the national results using either

[25]The population estimates are based on sample weights linked to India's 2001 Indian Census and are not strictly comparable to the USDA estimates for 2004/05.

[26]Malnutrition rates estimated by the World Health Organization are available at http://www.who.int/nutgrowthdb/database/ countries/en/ (Accessed January 2011).

the aggregate production and consumption or household consumption survey methods. Additional work may be needed to strengthen the direct response survey methodology used for national surveys in India, as well as to provide more external validation of results using the direct response approach against results using the other methods.

In addition to obfuscating the actual number of food-insecure people in the sample, the potential measurement error introduced in estimating calories consumed has important implications for any empirical analysis of calorie consumption. For example, some studies have found that calorie consumption in India has been decreasing over time (NSSO, 2007; Deaton and Dreze, 2008). Researchers have also noted, however, that consumption of processed foods and meals outside the household have been increasing (Kumar et al., 2007). Given that the data do not indicate the number of calories in those sources, it is also possible that, if calories from those sources have been systematically underestimated, calorie consumption might not actually be decreasing and could even be increasing for a subset of the population. Without a better understanding of the nutritional content of all sources of calories, it is very difficult even to identify trends in calorie consumption over time.[27]

These issues suggest that researchers and policymakers should rely on a number of different indicators of calorie consumption and food security beyond those based on household consumption surveys. Additional measures could include information on observable health indicators, such as emaciation or stunted growth, that are associated with low calorie consumption, as well as studies of aggregate food availability.[28] Finally, more attention might be given to strengthening survey enumeration methods to reduce key sources of error in computing calorie purchases.

[27]There are other concerns in using calories purchased per household member as a dependent variable in any empirical analysis. In particular, in the construction of the variable, we used household size, the amount of money used to purchase food, and a number of other household-level variables. We cannot consistently estimate the relationship between total calories purchased as the dependent variable and any of these variables, or even variables constructed using them, given the possibility of division bias (Borjas, 1980). In these instances, even if the true correlation between the variables is precisely zero, the mechanics of constructing the variables can cause a spurious correlation.

[28]In addition, policymakers should focus on the response of food security and calories consumed to policy interventions and income and production shocks that cause exogenous variation in the independent variables of interest.

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Appendix 1. Conversion of household size to effective number of young adults

We used the following conversions, which were used by NSSO (2007), when converting each household member into the effective number of young adults:

Age in completed years	Male	Female
(1)	(2)	(3)
less than 1	0.43	0.43
1-3	.54	.54
4-6	.72	.72
7-9	.87	.87
10-12	1.03	.93
13-15	.97	.80
16-19	1.02	.75
20-39	1.00	1.71
40-49	.95	.68
50-59	.90	.64
60-69	.80	.51
70+	.70	.50

Appendix 2. Processed food items for which calorie counts could not be determined

The following is a list of food items (NSSO code in parentheses) for which only values of household expenditure are given or for which it is too difficult to estimate the number of calories purchased:

Other Rice Products (106), Other Wheat Products (114), Other Cereals (122), Other Pulse Products (153), Other Milk Products (167), Other Edible Oils (174), Others: birds, crab, oyster, tortoise, etc. (186), Other Vegetables (224), Other Fresh Fruits (247), Other Dry Fruits (257), Cold Beverages (295), Fruit Juice and Shake (296), Other Beverages (298), Biscuits (300), Salted Refreshment (301), Prepared Sweets (302), Cake/Pastry (304), Sauce (306), Other Processed Food (308).