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ABSTRACT

How much do calorie requirements vary across households and how do they affect food consumption patterns? Since caloric intake is a widely-used indicator of poverty and welfare, investigating changes in caloric requirements and food consumption patterns is important, especially for the poor. Combining anthropometric and time-use data for India, we construct a quantitative measure of individual and household caloric requirements. We then link our estimates of caloric requirements with consumption data to examine how caloric requirements coupled with household expenditures shape food demand. Our applications include the measurement of hunger and the role of caloric requirements in explaining food consumption puzzles related to household-scale and changes in caloric intake over time.

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1. Introduction

There is a long tradition of using food consumption patterns to infer household welfare dating back to Ernst Engel's pioneering household budget studies (Engel (1895)). As households become richer, we expect them to spend a lower share of their budgets on food, to consume more calories (up to satiation), and to consume more expensive types of food. Recent work in the literature has focused on using food consumption patterns to measure inflation (Costa (2001), Hamilton (2001)), international price-differences (Almas (2012)), and hunger (Logan (2009), Jensen and Miller (2010))[1]. The cost of buying a set number of calories (and other nutrients) has also been used to construct absolute poverty lines used to measure progress in poverty reduction and as eligibility thresholds for government assistance.

While food consumption patterns clearly contain useful information, their relationship to household welfare is not always straightforward. Several recent studies have documented "puzzles" or "paradoxes" in food consumption. Deaton and Dreze (2009) document a decline in caloric intake for Indian households between 1983 and 2005 despite real expenditure growth. Deaton and Dreze (2009) show that the decline occurs both because households at a given expenditure level spend less on food and because within food they spend less on staples that are cheaper sources of calories. Similar patterns have been documented by Du et al. (2002) and Clark et al. (1995) for China and Great Britain during the Industrial Revolution. Deaton and Dreze (2009) suggest that improvements in the disease environment and lower physical activity levels may have lowered calorie requirements, thereby decreasing calorie and food demands for a given level of income and prices. This would be consistent with modest gains in height and BMI observed over this period despite falling caloric intake. Duh and Spears (2013) explicitly test whether the disease environment is related to food consumption patterns and find some supporting evidence. Deaton and Dreze (2009) do not argue for a large role of relative food vs. non-food prices but acknowledge that other factors may play a role, including changing consumption possibilities. [2] In a different context, Deaton and Paxson (1998) show that larger households

[1]Older applications of calorie Engel curves include the construction of equivalence scales and poverty measures (see Statistics Canada (2009), Barten (1964), and Deaton and Muellbauer (1986))

[2]Gupta (2013) argues that conspicuous consumption (Veblen goods) may play some role in these patterns for India. Basu and Basole (2013) argue that the decline is caused by rising expenditures on health, education and transport, which have squeezed food from limited budgets, as well as a decline in home food production. Smith (2013) argues that there may have been no decline in intake at all,

spend less on food per capita than smaller households with the same per capita expenditures. They argue that their finding is puzzling since larger households can economize on shareable goods, making them able to afford more private goods such as food. Deaton and Paxson (1998) suggest plausible explanations for their findings, including that households have certain "caloric overheads" or fixed costs that would lower the caloric requirements per capita of larger households.[3]

In this paper, we use data on individuals in India to measure variation in caloric requirements across households and to examine how this variation affects food consumption patterns. Our first main contribution is to provide a quantitative measure of individual and household caloric requirements for a developing country. To do this, we combine anthropometric data, which enables us to estimate basic metabolic requirements, with detailed time-use data matched to FAO activity-level measures, which enables us to estimate activity levels. We then link our estimates of caloric requirements with consumption data to examine how caloric requirements and total household expenditures together shape food demand through the following: 1) the budget share of food; 2) the staple share of calories; and 3) caloric intake. We then explore to what extent differences in caloric requirements can explain differences in food consumption patterns for India between 1983 and 2005, and between smaller and larger households in a cross-section.

To measure caloric requirements, we follow the methodology adopted by the FAO/UNU/WHO Export Consultation (1985,2001) and the Indian Council of Medical Research (1989,2009). This requires estimating the Rest or Basal Metabolic Requirements for each individual using data on height and weight from India's National Family Health Survey (2005) and National Nutrition Monitoring Bureau. Combined with age, gender, and regression formulas calculated based on laboratory measurements, we estimate these metabolic requirements for individuals at rest. We then combine these estimates with data on individual activity-levels using a detailed time-

providing evidence that India's household surveys severely underestimate food consumed away from home which has been increasing over the period studied.

[3]The pattern observed by Deaton and Paxson (1998) for several countries has also been found for the historical United States (Logan (2008)) and Poland (Gardes and Starzec (1999)). Some of the potential explanations considered in Deaton and Paxson (1998) have been explored already, including Gibson (2002) and Gibson and Kim (2007) who argue that measurement error and recall bias are correlated with household size, Perali (2001) who argues that the finding is driven by restrictive functional forms, Horowitz (2002) who argues that economic theory can be consistent with the empirical findings so they are not a puzzle, and Abdulai (2003) who argues that bulk-discounting can explain part of the decline.

use survey conducted in 1998-1999 by India's National Sample Survey Organization. Despite some limitations, our estimates of caloric requirements provide a useful starting point for analysis given the lack of direct measures.[4]

While our procedure for measuring caloric requirements adheres closely to the one used by the WHO/FAO/UNU report and the ICMR, our goal is different. We are not calculating a normative "recommended daily intake." Instead, our goal is to determine how differences in calorie requirements across different types of households interact with total expenditure to shape food consumption patterns. Thus, we rely on common variables, which include household composition, occupation and work patterns, and socioeconomic status, to match individual and household caloric requirements to household-level consumption outcomes in India's National Sample Survey.

We find that our measure of caloric requirements has substantial predictive power for caloric intake and food consumption patterns. While our measures of activity-levels and household-caloric requirements display fairly intuitive patterns – richer, more educated and more sedentary individuals displaying lower caloric requirements – we also find some patterns that are less obvious. For example, we find that caloric requirements do not vary greatly with household expenditure. We find a higher intake-requirement elasticity for richer households than poorer ones, evidence that appears inconsistent with a short-term calorie-based poverty trap.[5] We also find that the share of staples within the food budget suggested by Jensen and Miller (2010) offers a better prediction of household caloric deficiency and hence hunger than real

[4]We are aware of only two studies, both from the medical literature, that directly estimate caloric requirements in India using the most reliable technique for free-living adults, the doubly labeled water method. Borgonha et al. (2000) use the technique on 18 individuals – 6 urban slum dwellers, 6 students, and 6 rural residents – in Bangalore while GK Krishnaveni et al. (2009) use the technique on 8-9 year old middle-class children. Given the expense of accurately measuring caloric requirements using direct methods, collecting a large representative sample sufficient for the type of analysis we perform may be prohibitive. Our measures of activity-levels for India can also be compared to a recent paper by Ng and Popkin (2013) who use less detailed data to estimate a 2.3% decline in activity-levels between 2000 and 2005 – we find a decline of 2.55% for rural males and 1.04% for rural females over the corresponding period. Their results are based on Schedule 10 NSS data compiled and cleaned by the ILO, with occupations matched to average weekly hours and activity-levels, combined with gender-specific estimates of domestic, travel, and leisure activities from Chinese data during a period of similar per capita GDP at PPP.

[5]As discussed later, this is because the simultaneity implied by a two-way relationship between caloric intake (income) and caloric requirements (work) would generate an upward bias but not for the richer individuals for whom additional food consumption fails to yield additional productivity and income.

expenditure or the share of food within the total budget.

We provide two applications of our measure that are relevant for the "consumption puzzles" for India and other developing countries described above. First, we examine household scale economies and find that larger households have lower caloric requirements even when controlling for age/gender composition and per capita expenditure. Thus, we confirm the conjecture of Deaton and Paxson (1998) that larger households economize on "physical effort" through multiple channels. Over certain household size ranges, the decline in caloric requirements in household size is similar in magnitude to the decline in caloric intake or food expenditure observed. Overall, declining caloric requirements per member plausibly explains up to half of the decline in observed caloric intake per member for larger households.

Second, we examine the decline in caloric intake over time in India documented by Deaton and Dreze (2009). We find that caloric requirements have only fallen modestly for rural households and mainly for those at the top of the expenditure distribution. This is because in spite of substantial declines in activity-levels (almost 6% for rural adult males between 1983 and 2005), the average household in 2005 had a higher share of adults (who have higher basal requirements and activity-levels than children), which offset much of the decline in activity levels. This offset is largest in urban areas where the shift towards less labor-intensive occupations was also smaller. We also examine the direct effect of education, occupation, and domestic/farm activities along with relative prices and energy usage (e.g. electricity and fuel sources that might replace physical effort) on caloric intake using Oaxaca-Blinder decompositions. This avoids the need to estimate caloric requirements but allows these variables to affect food consumption through other channels. The results are similar in that changes in demographic variables mostly offset changes in work variables in rural areas and more than offset them in urban areas. We find fairly large effects of energy variables and relative prices on caloric intake, particularly for rural households. Altogether our results indicate that falling activity levels due to work cannot account for more than about 25% of the decline in caloric intake in rural areas (and less in urban areas), which suggests an important role for some of the other explanations offered in the literature (e.g. improving disease environment, changes in consumption opportunities and prices, shifts in preferences, and non-classical measurement error in food consumption data).

Our paper relates to a vast literature on food demand and consumption patterns.

Our main contribution is to provide a quantitative measure of caloric requirements – an important "demand-shifter" for food – and examine how requirements affect the relationship between total household budgets and food consumption patterns. To the best of our knowledge, our paper is the first to estimate variation in *household-level* caloric requirements using time-use and anthropometric data for this or any purpose in the economics literature.[6]

Compared to indirect approaches that only correlate household attributes with food consumption patterns, quantification of caloric requirements allows us to assess how much of this correlation operates through physiological channels versus others. For example, occupation or demographic differences may be associated with different prices, tastes, or intra-household bargaining beyond their effects on caloric requirements. While our findings have implications for food consumption patterns in rich countries, they are especially relevant to debates about poverty and welfare measurement in developing countries where food takes up a large share of household resources, food prices and security weigh heavily in policy debates, and there is larger variation in activity levels across households and over time.

Our paper proceeds as follows. Section 2 describes our data, our procedure for estimating caloric requirements at the individual and household level, and our estimates of caloric intake. Section 3 provides an analysis of how caloric requirements affect food consumption patterns across households. Section 4 provides our application to differences in food consumption across different household sizes. Section 5 examines changes in caloric requirements and food consumption over time, and section 6 concludes.

2. Data

2.1. Caloric Needs

Since our contribution is to construct measures of caloric requirements, we provide a detailed discussion of their construction below. We calculate caloric needs/total energy expenditure at the individual level using the World Health Organization (WHO) factorial method. This involves multiplying two components: resting energy expen-

[6] Other researchers have estimated population-level caloric requirements to examine the rise of obesity in the West (Cutler et al. (2003)), whether children are a net drain on household resources Lee and Kramer (2004), and the economic returns to slavery Fogel and Engerman (1974).

diture (REE), which measures the body's energy expenditure at a complete state of rest, and an activity level (AL), which measures the physical intensity of different activities relative to a state of rest.

2.1.1. Basal Energy Expenditure (BEE)

Resting energy expenditure (REE) can be accurately measured in a laboratory environment using various methods. Nutrition researchers typically measure a related concept – Basal energy expenditure (BEE) – which is similar to REE but about 10% lower due to strict testing conditions including 8 hours of sleep and 12 hours of fasting immediately preceding measurement in a reclining position. The difference is largely due to dietary thermogenesis (i.e. the fact that metabolizing food uses additional energy).

Predictive formulas for BEE have been developed based on linear regression, where the dependent variable is laboratory measured BEE and the typical independent variables are age, height, weight, and gender. The estimated formulas often generate an excellent in-sample fit with R^2 over 0.7 (Jeor and Stumbo (1999)). However, there are substantial differences in the formulas estimated on different sample populations. We use the Henry (2005) equations that include height, weight, age and gender to predict BEE because they are based on the largest international sample and make use of all of the information available in our data (age, gender, height and weight).[7]

To apply the Henry (2005) formulas, we need data on height and weight. For adults over 18, we use micro data on individual heights and weights from the Na-

[7]The original Harris-Benedict equations developed in 1918 are still used today. These appear to overestimate BEE by 5% to 15% in modern populations, leading some researchers to advocate for the Mifflin-St Jeor equations developed more recently (Jeor and Stumbo (1999)). The FAO/WHO/UNU report (FAO/WHO/UNU Expert Consultation (2001)) uses the equations developed by Schofield et al. (1985) despite criticism that the sample subjects (almost half based on Italian men sampled in the 1930s and 1940s) had much higher metabolism than most Europeans and especially subjects from tropical climates (Henry (2005)). In response, Henry (2005) developed formulas called the *Oxford Equations* using a broader sample of populations and these typically imply a lower BEE than the Schofield et al. (1985) equations. There have been laboratory measurements of BEE in India but none on a large or representative sample of individuals and none generating predictive equations. Ferro-Luzzi et al. (1997) attempt a validation of the FAO/WHO/UNU equations on Indian data and find a reasonable fit. Based on a single study by Shetty et al. (1986), the Indian Council for Medical Research (Indian Council of Medical Research (2009)) adopts a BEE based on the Schofield equation (for weight, age and gender but not height) with a 5% downward adjustment for adults. The mean household BEE we estimate with Henry (2005)'s "Oxford Equation" is within 2% of the ICMR and Mifflin-St Jeor formulas but substantially lower (up to 6%) than the Schofield equations.

tional Family Health Survey (NFHS) third wave conducted in 2005.[8] We use age, gender, height and weight to directly calculate the BEE for each sample individual within the available age range. Because we want to match this BEE with the activity levels in the Time-Use data, we regress the formula based BEE from the NFHS on a set of variables common to both the NFHS and the time-use data set. These include a cubic in age, dummies for five levels of educational attainment (below primary, primary, middle, secondary, post-secondary), a cubic in household size, household gender/age composition ratios (males and females aged 0-2,3-4,5-9,10-14,15-17,18-60,61+), household educational attainment ratios (none, some primary, primary, middle, secondary, post-secondary), gender and age of household head, head of household occupation (NCO1968 2-digits), and primary work status (classified as student, domestic, or working). We then use the actual individual and household variables in the Time-Use data set together with the regression formula estimated on NFHS data to impute a predicted BEE for each individual in the Time-Use data set. For individuals outside of the sample age range (younger than 15 or older than 49) we calculate their predicted BEE as if they were 15 or 49, and then apply a scaling factor using the BEE calculated using the Oxford equation and the average height/weight for age for males and females taken from the National Nutrition Monitoring Bureau (NNMB) (reported in Indian Council of Medical Research (2009)). The NNMB data for calculating the BEE ratios for younger/older individuals come from the rural areas of 16 Indian states measured during 2000-2002; while these are slightly lower than those in the 2005 NFHS for the common age ranges (0-4 and 15-17), they provide the only population-level anthropometric measurements we could find for age ranges not covered by the NFHS and we only use them for scaling the predicted BEE from the NFHS. The NFHS regressions used for imputation are estimated separately for men and women and for rural and urban areas.

The major difference between our measure of BEE and the one adopted in Indian Council of Medical Research (2009) is that our predictive equations are based on the average body size of the Indian rural and urban populations around the year 2005 while the BEE used by the Indian Council of Medical Research (2009) to generate "recommended daily caloric intake" is based on the 95th percentile of the rural population sampled by the NNMB.[9]

[8]The 1998 survey only records height and weight for ever-married women aged 15-49, while the 2005 survey included all women aged 15-49 and all men aged 15-54.

[9]Note that estimating minimal metabolic requirements also requires accounting for the effects of

2.1.2. Activity Level

The second component for calculating total energy requirements is a measure of the physical activity levels of each individual. The only direct measurement of activity levels in free-living Indian adults comes from Borgonha et al. (2000), who find activity levels of 1.79, 1.54 and 1.9 for 6-person samples of urban students, urban slums/undernourished and rural male adults. Indian Council of Medical Research (2009) suggests activity levels of 1.53, 1.8 and 2.3 for sedentary, moderate and heavy work respectively, which is a downward revision from factors of 1.6, 1.9, and 2.5 recommended in an earlier report Indian Council of Medical Research (1989) and falls within the current FAO/WHO/UNU Expert Consultation (2001) ranges of 1.4-1.69, 1.7-1.99, 2.0-2.40. While these categorizations provide guidance about plausible values (e.g. physical activity levels above 2.4 are possible for short periods but difficult to maintain over a full work day), they do not translate easily to household data. Households differ in many ways, such as the (physically) intensive and extensive margin of hours spent on market work, home production, and travel.

Our approach is to calculate physical activity levels at the individual level using data from the National Sample Survey Organization's Time-Use survey. The survey was conducted from July 1998 to June 1999 for six Indian states. The survey collected 24-hour recall data for all household members aged 6 or older in 20 minute

dietary thermogenesis, which accounts for most of the difference between measured BEE and REE. There are two common approaches to accounting for this difference. The first is to simply multiply BEE by a 1.1 factor, the approach adopted in Cutler et al. (2003) and Jeor and Stumbo (1999). This allows for a comparison of the theoretical caloric content of food with a complete measure of energy expenditure. An alternative is to subtract the thermic effect of food on the caloric intake side. This allows for some adjustments due to the type of calories consumed. Clinical studies have estimated that protein (20%-30%) and alcohol (10%-20%) require more energy to metabolize than carbohydrates (5%-10%) or fats (0%-3%), so the 10% figure often used is subject to variation due to dietary composition (Westerterp (2004)). There is also some debate about the role of dietary fiber and "whole" vs. "processed" foods in thermogenesis but the evidence is more mixed. Barr and Wright (2010) find that a "whole food" sandwich had a dietary induced thermogenesis effect of 20% vs. 10% for a "processed food" sandwich with similar caloric content. On the other hand, et al. (1994) find that high-fiber meals increase fullness but actually lower thermogenesis. There is also some evidence that chilli – an integral part of most Indian diets – increases thermogenesis (Clegg et al. (2013)). As the thermic effect of food is mostly tied to calories consumed rather than activity levels or basal metabolism it could make sense to account for it on the intake side when possible, as recommended in FAO/WHO/UNU Expert Consultation (1985). However, in results not reported here but available by request we calculated thermic factors for each household and found that while these decline with per capita expenditure (elasticity 0.002) and over time (from 1.121 to 1.116) the effects were too small to be worth considering. Thus our approach is to use theoretical caloric intake, and to use BEE together with activity levels that already account for dietary thermogenesis.

intervals. Each 20 minute period is coded as one of 154 activities.[10] Appendix table 9 provides rural and urban average time-use for selected aggregated categories. We match each activity code to a value for that activity's energy intensity relative to BEE. There are many sources of data on the energy requirements of different activities but we focus on the one provided in Annex 5 of FAO/WHO/UNU Expert Consultation (2001), as these provide the best match to the activities in the time-use survey. We also tried factors from et al. (2000) which were used in Cutler et al. (2003) and factors we matched to a popular website (www.caloriesperhour.com). All of the factors are highly correlated across the 154 activities, e.g. the et al. (2000) measure has a raw and rank correlation of 0.84 and 0.87 with the FAO measures but the two alternate matches yield slightly lower or higher activity levels overall. Appendix table 15 provides the time-use survey codes, descriptions, fraction of minutes for rural and urban households for each code, and the matched activity level and description from FAO/WHO/UNU Expert Consultation (2001) and et al. (2000). The match is not always exact and some judgment is required. Appendix Table 10 provides a sense for how different data sources might generate differences in caloric requirements and how different formulas or imputation methods might affect BEE calculations. The most problematic activities to match are those recorded as "related activities," which we set equal to the (time-weighted) mean for the broad activity heading, and "travel" activities, which do not list the mode of transport. For travel activities we pick a value of 3 which in the range of "walking slowly" and "driving a motorcycle" in the FAO/WHO/UNU Expert Consultation (2001) Annex 5 and lies between less intense activities like "sitting on a bus/train" (1.2), "driving a car/truck (2.0), "walking around/strolling" (2.1) and more intense activities like "carrying a 20-30kg load on head" (3.5), "walking quickly" (3.8), "cycling" (5.6). This procedure allows us to calculate a 24-hour activity levels for each individual over 6. For boys and girls under age 6 we assign the mean value at age 6 that we observe in the data. As car ownership is very low in India and many other forms of transport (including bicycles, motorcycles, animal-carts and public transit) are fairly energy intensive, we view this as a reasonable approximation – to the extent that richer households use forms of transport other than walking, this will still be reflected in our imputations through the number of minutes spent on travel (i.e. the travel "extensive" margin).

[10] Households were also asked about "variant" days, e.g. market days or weekends, and how many days in the last week they spent on these. Our results are based on individual averages that include "normal" and variant days.

2.1.3. Adjustments

After multiplying the imputed BEE for each individual by the activity levels for that individual, we also add additional calories to children under 18 due to the energy cost of observed weight gain associated with average growth for their age/gender, which we take as 2Kcal/g (FAO/WHO/UNU Expert Consultation (2001)). Theoretically, any additional caloric intake above these requirements would lead to weight gain and potentially additional growth in undernourished children. The one correction we are not able to make given lack of data is the additional caloric intake required for pregnant mothers which is estimated at 150-350 calories per day (Indian Council of Medical Research (2009)).

2.2. Caloric intake

We use the "thick" National Sample Survey rounds to compute caloric intake between 1983 (38th round) and 2004-2005 (61st round). The survey is a 30-day recall based survey where quantities consumed from the market, home production, and other sources are recorded for a detailed list of goods.[11] The level of detail is such that some goods – particularly processed foods and beverages – are difficult to match to calorie data because the classification is vague and/or the quantity units are not reported, e.g. "cooked meals," "prepared sweets," "cold/beverages bottled/canned," or "salted refreshments." We proceed by first generating a consistent set of goods across the NSS survey rounds, which involves combining some goods together. For the majority of goods we follow previous studies and use the caloric values reported in Gopalan et al. (2004), which we supplement with additional data on caloric content of foods from Karan and Mahal (2005) and the MedIndia web-site.[12] We include calories from alcohol. For "other" goods and those with missing units in categories other than beverages or processed food, we convert expenditures to calories using the regional mean calories per rupee for that category. This procedure covers between 91% to 97.5% of expenditures across the NSS round/sector in our data, with lower match rates in urban areas and later years. For processed foods and beverages other than tea

[11]The 55th round for 1999-2000 used an additional 7-day recall period which seems to make it somewhat non-comparable to earlier and later rounds. It also differed due to no data on meals given to non-household members and no domestic activities recorded for men in Schedule 10. While we include it in the later section on changes over time our results extending to the 61st round are robust to dropping the 55th round entirely.

[12]http://www.medindia.net/calories-in-indian-food/index.asp

and coffee, we assume that calories per rupee are equal to 50% of the calories/rupee that can be directly converted across all goods, which makes them approximately as cheap per calorie as milk. Deaton and Subramanian (1996) use a similar procedure for "cooked meals" and use a 66% factor, implying a 50% markup over the "average food basket" for cooked meals.[13] The other concern when calculating caloric intake is how to account for meals given to guests and others. These meals must be subtracted from the recorded household food consumption. In addition, free meals received from employers, schools, and other households need to be added to household food consumption since they are not already included.[14] Deaton and Subramanian (1996) resolve this issue by regressing the measured caloric intake on the number of meals given to guests at ceremonies, to guests at other occasions and to employees as well as the number of meals consumed by household members. They find that meals given to guests generate about twice the calories per meal as compared to meals given to employees and household members. However, it is not possible to make an equivalent calculation for meals received and the later NSS rounds only record "meals to non-household members." Instead, we opt for a simple adjustment factor based on the formula "adj. factor = (meals at home + meals away from home free)/(meals at home + meals to others)."[15] We therefore assume that households that consume more calories per meal at home give and receive free meals that are symmetrical and proportionately higher in calories.

We drop households for which the adjustment factor is greater than 2 or less than 0.5 as these are not likely to be very informative. Eliminating these observations in

[13]The data we could find indicates ingredient costs make up 40% of the sale price at large Indian restaurants (Federation of Hotel and Restaurant Associations of India (2004)) and the value for richer countries is typically in the 20-35% range. A value of 50% puts the calories/rupee of processed foods, beverages and cooked meals roughly equal to the dairy category, while a value of 66% puts it equal to pulses or sugar. The results for rural households are not very sensitive to this assumption as these goods make up a small share of expenditures throughout but rural-urban differences and urban changes over time are more sensitive.

[14]Note that meals given to others are not recorded in the 55th NSS round. In addition, beginning in the 66th round, meals received for free from others (and their imputed value) are recorded in the detailed list of goods.

[15]Note that the NSS also separately records meals away from home on payment for each individual. In principle these should already be included in the detailed consumption schedule as "cooked meals" although the latter should be higher as it also includes cooked meals purchased and provided to non household members. In practice the detailed "cooked meals" measure is usually higher than the "meals away from home on payment" although the two measure are highly correlated. In the adjustment factor above our "meals at home" also includes the number of meals away from home on payment, and is intended to capture differences in free calories received and calories given away relative to the total calories calculated from the detailed food schedule.

any given round reduces our sample size by less than 1.1%. We also trim the 1% tails of the caloric intake distribution. In practice, this means we exclude households with a daily per capita caloric intake that is less than 1000 or more than 5000.

2.3. Net caloric balance and weight change

For the six states in the 1998-1999 Time-Use Survey (Haryana, Gujarat, Madhya Pradesh, Meghalaya, Orissa and Tamil Nadu), Panel A of Table 1 presents the following: 1) our main estimates of activity levels (AF); 2) basal metabolic rates (BEE); 3) and total caloric requirements (AF x BEE). We present the means for adult men (aged 18 or older), adult women, and households in rural and urban areas. The activity levels that we calculate for adult males are in line with those calculated directly in Borgonha et al. (2000), who found average activity levels of 1.54 (students) to 1.79 (slum dwellers) for urban males and 1.9 for rural males. Rural females have higher activity-levels than urban females. Average activity levels are lower for households than for adult individuals because younger children report lower activity levels.

While activity-levels are higher in rural areas than in urban ones, basal energy expenditure is actually higher in urban areas because individuals in urban areas are taller and heavier on average. The activity-level effect dominates overall, so caloric requirements are typically higher in rural areas, by about 300 for adult males, 100 for adult females, and 75 for the typical household.

Panel B presents our main estimates of caloric intake for the six Time-Use states in 1993-1994. To derive these estimates, we take into account all of our adjustments as well as component that we compute most directly based on quantity conversions from Gopalan et al. (2004)). We also report the share of food expenditures covered by this direct component as well as the adjustment factor for free meals away from home and meals to guests. We do not observe intake for individuals in households. However, we report intake for single male and female households even though these are likely to be quite different than the typical adults in Panel A. Our household measures are quite comparable to those calculated in Deaton and Dreze (2009) for the same NSS round despite using only a subset of the states, and are fairly similar to their calculations for the 55th survey round (1999-2000) as well.

Interestingly, our imputations imply a much greater dispersion of caloric intake than requirements across households. One reason for this may be our inability to capture idiosyncratic variation in metabolism across households. However, it seems likely that food intake features both larger real shocks (e.g. festivals and holidays) and random noise due to the 30 day recall period and the unboundedness of measured quantities (even though we bound caloric intake between about 1000 and 5000). The time-use data is bounded by the 24 hours in a day and the maximum activity-level factors.

Are our estimates of caloric intake and requirements plausible given observed weight gain patterns? Given the numerous assumptions required to get to this point, a direct level comparison is difficult. Notwithstanding the still unresolved controversies over adaptation to caloric deficits (see Dasgupta and Ray (1987)) and weight loss, which are likely to be relevant in our setting given continued under-nutrition and low BMI in India, the widely cited formula is that a 7700 calorie surplus (deficit) leads to 1KG of weight gain (loss) (see Jeor and Stumbo (1999)).[16]

How much weight does the average Indian adult gain each year? We do not have a direct estimate, but comparing men and women of different ages (and hence cohorts) in the 2005 NFHS data suggests an average weight gain of 0.17/0.43 KG per year for rural/urban men and 0.18/0.35 KG per year for rural/urban women. Using the 1998 NFHS data we can look at (approximately) the same cohort of rural/urban women who gained on average 0.14/0.41 KG year between 1998 and 2005. These numbers correspond to approximately 8 excess calories per day for urban residents and 4 excess calories per day for rural residents. This is much smaller than the excess calories in our data of 121 and 71 calories per day for urban and rural residents although those figures include children (whose growth requirements are already factored into our caloric requirement figures). The pattern of weight gain is at least consistent with greater excess calories we observe in urban areas.

While these results suggest either underestimation of requirements or overestimation of intake, we have no particular reason to favor one interpretation over the other and the fact that tiny differences in excess calories lead to large weight changes over time suggests both that the standard formula is unrealistic and that any reasonable attempt to reconcile caloric intake and requirement in levels is likely to fail.[17] We

[16]The controversy arises in part because all three components of energy requirements (basic metabolism, activity levels, and thermogenesis) are likely to respond to "shocks" to a previously weight-stable adult.

[17]Historically the FAO/WHO actually used caloric intake to measure caloric requirements under the assumption that most humans were weight stable; this only changed with the landmark FAO/WHO/UNU Expert Consultation (1985) study that tried to measure caloric requirements requirements.

could increase imputed caloric requirements by using slightly higher activity levels or a different BEE formula. Or, we could decrease imputed caloric intake using lower conversion rates for foods that are missing direct conversion factors. However, any overall scaling we do will not affect our main results which concern the percentage differences in caloric intake or requirements across households.

3. Caloric Requirements and Food Consumption Patterns

We begin our analysis of the relationship between caloric requirements and food consumption patterns by examining how these measures vary across commonly classified variables in the National Sample Survey and Time Use data sets such as industry[18] and household type.[19] Table 2 presents sample means for rural areas in the six Time-Use states in 1998-1999 (first three columns) and 1993-1994 (next four columns) (for urban areas see appendix table 11). Columns 1-3 contain estimates of caloric requirements, BEE, and activity levels, respectively. Columns 4-6 measure caloric intake, food share of expenditures, and grain share of food expenditures, respectively. Column 7 contains real monthly expenditure per capita, which are henceforth deflated using a survey unit-value based price index allowing for comparisons over time and across locations.[20]

Panel A of Table 2 groups households by industry type using one-digit National Industry Classification (NIC) code. Agriculture and construction have the highest

[18] We use the 1-digit NIC classification which is agriculture, mining, manufacturing natural materials, manufacturing non-natural materials, utilities, construction, wholesale/retail/hotel/restaurants, transport, finance/insurance/real estate/business services, community/personal/social services, and other

[19] The NSS classifies household "types" as self-employed, casual labor, and "other" which includes salaried individuals and those pension or other income.

[20] Specifically, we use survey unit values for all goods with unit values in the data. We apply a "first-round" quality correction by estimating the unit value elasticity with respect to expenditures within villages/urban blocks and calculating the predicted unit value at the sample median expenditure. We then take median unit values in each state/sector relative to rural Maharashtra in 1993-1994, which serves as our base and calculate a Tornqvist price index. Since most of our results are within-village/block – where households face the same prices – this correction is often unnecessary, but may be important when looking at changes in caloric intake over time conditional on "real" expenditure. We have also used the official India price indexes for urban workers and rural agricultural laborers. These tend to show slower real expenditure growth, so while the results are qualitatively similar, the size of the unexplained decline over time is larger using our survey based measure.

caloric requirements and activity levels, and mining has the second highest levels. Retail, transport, services, and manufacturing of non-natural materials have the lowest caloric requirements. Despite having the lowest real expenditures, agricultural households have middling levels of caloric intake, which is partly due to the fact that they allocate a higher share of their budgets to food and grains. The overall pattern suggests that per capita expenditure is the main predictor of caloric intake but that caloric requirements also play a role.

Panel B of Table 2 displays the means by household type based on the NSS classification. Casual laborers have the lowest expenditure but highest caloric requirements, while those in the "other" category have high expenditure but low caloric requirements. Panel C of Table 2 divides households by the educational attainment of the household head. The results indicate that while per capita expenditure and caloric intake increase monotonically in education, caloric requirements decline monotonically as expected. Appendix Table 11 presents the equivalent figures for urban households.

As one of our goals is to directly relate caloric requirements to the allocation of budgets on calories, food and grains, we next impute caloric requirements for the households that have detailed NSS consumption data. To do this, we first regress individual-level caloric requirements measured in the 1998-1999 TUS on a series of variables that are common to the TUS and the NSS Employment (Schedule 10) surveys.[21] The list of common individual-level variables includes the following: a cubic in age, a triple interaction of primary status, industry and education [22], indicator variables for home production (collecting wood, food, or water, husking paddy, grinding grain, preparing dung cakes, and gardening) and for rural areas only we include a cubic in land owned and indicator variables for agricultural tasks (plowing, planting, weeding, other manual tasks, animal husbandry, fishing, forestry). The list of common household-level variables include the following: cubic in real per capita expenditure, cubic in household size, cubic in age of head, sex of head, scheduled caste/scheduled tribe status, religion, the fraction of household members in each male/female age cell (0-2,3-4,5-9,10-14,15-17,18-60,61+), and the triple interaction of household one digit NIC, household type and household head education code. We

[21] Note that our caloric requirement estimates in the TUS already involve the imputation of basal metabolism based on age, gender and common socioeconomic variables in the NFHS, combined with direct assignment of activity-levels based on reported time-use.

[22] Primary status categories: self-employed, casual worker, salaried employee, other employment, unemployment, in school, domestic work, retired/pensioner. Industry and education categories are given in Table 2.

fit log caloric requirements (or activity levels) on these variables separately for rural/urban, male/female, and over 18/under 18 cells, using village/urban block fixed effects to control for prices and other common factors. The fit of these regressions on the time-use data is good with R^2 in the 0.5 to 0.8 range, lower for urban households and higher for rural households and children.

We then aggregate these individual-level imputed caloric requirements up to the household level. As NSS rounds after 1994 do not survey the same households for detailed consumption and employment, for later years we can only use household-level work variables for imputing caloric requirements if we are interested in caloric intake (i.e. the variables available in NSS Schedule 1). Alternatively we can use detailed individual-level matching but then we can only look at the food and grain share variables (i.e. the variables available in NSS Schedule 10). In the time-use data, the correlation of between actual household caloric requirements and caloric requirements predicted by the common variables is 0.83 when using individual and household-level variables (then aggregating individuals) and 0.66 when using household-level variables only.

We focus on the 1993-1994 NSS survey round and the six states in the time-use data as this provides our best match of intake and requirement data. Figure 1 presents plots of caloric intake, caloric requirements and activity levels against real per capita expenditures.[23] Panel A plots the data for rural households using a locally linear regression, documenting that caloric intake is monotonically increasing in expenditures while caloric requirements are fairly flat and activity levels exhibit an inverse U-shape. The sharp decline in activity levels for better off households is counteracted by higher metabolic requirements, but even this decline in average activity-levels is an order of magnitude smaller than the increase in caloric intake. This can be seen more clearly in Panel B where we use a combined sample of rural and urban households and partial out both household demographic variables[24] and village/urban block dummies. The decline of activity-levels in expenditure is about an order of magnitude smaller than the increase in caloric intake, and the slope of caloric requirements overall is close to zero. Thus to a first approximation, net caloric intake

[23]Note that per capita caloric requirements differ from (unweighted) average activity levels due to differences in the basal metabolisms that multiply each household members activity-levels, and that our approach allows for differences in metabolisms due to age and gender as well as socioeconomic characteristics.

[24]These are a cubic in household size, cubic in age of head, sex of head, and fraction of household members in each male/female age cell (0-2,3-4,5-9,10-14,15-17,18-60,61+)

(intake minus requirements) is monotonically increasing in per capita expenditure for this population and conditioning on caloric requirements will not dramatically change the slope of the calorie-expenditure relationship.

There is still however substantial variation in caloric requirements within a given set of rich or poor households. Conditional on a similar budget, how do differences in caloric requirements translate into food consumption patterns? While we expect households with lower requirements to typically have lower intake for a given budget, due to lower spending on food and especially staple foods, what is less obvious is whether this effect is stronger or weaker for poor households. A standard implication of a calorie-based poverty trap model is reverse causality from caloric intake to requirements but only for poor households – consuming more calories allows for more and harder work but this effect will be largest for the undernourished. Thus a calorie-based poverty trap featuring simultaneity would tend to increase the slope of the caloric intake-caloric requirement relationship, particularly for the poor. On the other hand, poor households may have little ability or desire to adjust their food budget due to other pressing needs. For example, a wealthy athlete may choose to consume an enormous amount of calories but a poor athlete may be unable to do this without sacrificing other basic needs.

To explore these relationships, Table 3 presents results from regressions of log caloric intake on log caloric requirements and log per capita expenditure. We include dummy variables for village/urban block to ensure we are comparing households facing similar prices and retail environments. In some columns we also include controls for demographic characteristics to isolate variation in caloric requirements coming from activity-levels and socioeconomic height/weight differences, and in others we also include the interaction of caloric requirements and total consumption expenditures. Both total expenditures and caloric requirements are positively associated with caloric intake as expected regardless of demographic controls (columns 1 and 2). The interaction between caloric requirements and per capita expenditures is positive and statistically significant. This can be interpreted either as higher "pass-through" of caloric requirements to caloric intake for rich households, or as a higher income elasticity of caloric intake for households with higher requirements. Appendix figures 6 and 7 capture this relationship more flexibly by estimating the elasticity of caloric intake to requirements separately for each expenditure decile or head of household education category and shows a similar pattern with higher elasticities for richer or more educated households.

Although the overall magnitude of the calorie intake-requirement elasticities we estimate are low, we view this as plausible in light of measurement error. At the household level our caloric requirement measure features substantial classical measurement error due to multiple OLS-based regression imputations – the clinical formulas for basal metabolism based on age, gender, height, and weight have R^2 in the 0.7-0.8 range, the formulas for predicting metabolism based on age, gender, and socioeconomic variables have R^2 in the 0.14-0.37 range, and the formulas predicting individual activity-levels based on NSS Schedule 10 variables have R^2 around 0.8. This is beyond the limitations inherent to the time-use survey, our assignment of activity levels to time-use categories, or unobserved variation in metabolic requirements due to genetics or other environmental factors. We thus view these elasticities as a lower bound for the unmeasurable elasticity of caloric intake to caloric requirements, but the lower bound is still potentially informative for differences between rich and poor households.[25] In appendix table 12 we present some selected coefficients on demographic, education and industry variables where intake or requirements are the dependent variable. The estimated coefficients in these regressions are less subject to measurement error. Examining the coefficients on education and work variables side-by-side, the magnitudes are similar enough to be consistent with an average "pass-through" of requirements to intake of close to one although this is less true of demographic variables.

Table 3 columns four through nine present similar regressions using the share of food in the total budget or the share of grains in the food budget as dependent variables. As expected the food and grain shares decline in expenditures holding requirements constant, and increase in requirements holding expenditures constant. The interaction of expenditures and requirement is positive in both cases, which is consistent with the notion that the consumption patterns of rich households are more sensitive to variation in caloric requirements than those of poor households who may be constrained both in terms of food composition and their ability to divert expenditures from non-food to food.

While the allocation of a fixed budget clearly respond to caloric requirements, a related question is whether budget allocations are themselves directly informative

[25] E.g. With classical measurement error in requirements the ratio of elasticities for rich and poor households would still be correct.

about the net nutritional status of the household. Jensen and Miller (2010) suggest that the staple share of calories offers a useful revealed preference approach to measuring hunger, and the literature using Engel's law to measure bias in price indexes and household equivalence scales makes a similar assumption that the budget share of food is informative about the satisfaction of basic needs. Our data allow us to see how net caloric intake – intake minus predicted requirements – is related to the measures proposed in the literature. Figure 2 provides a local linear regression estimate of the % caloric gap (defined as log intake minus log requirements) on real per capita expenditure, the food budget share, the share of grains in the food budget and the share of grain calories in total calories. As expected given the previous discussion, net calories are monotonically increasing in per capita expenditure, with a slightly higher real per capita expenditure required in urban areas than rural areas to achieve a zero deficit. Perhaps more surprising is that the food share, which ranges from 0.36 to 0.85 between the 1st and 99th percentile of households, is not a monotonic predictor of net calories. While urban households exhibit the expected decline in net calories as the food share increases, net calories are actually increasing for rural households over this range. This contrasts markedly with the results using the grain share of the food budget or the grain share of total calories, both of which have a sharp negative relationship with net calories that becomes flat at a similar threshold for rural and urban households (about 0.4 for the grain share of the food budget and 0.75 for the grain share of calories). Grain shares at or above these thresholds appear to be excellent predictors of a behavioral budgetary response to hunger, with decreases in grain shares from these thresholds indicative of caloric satiation. The food share does not seem useful (on its own) for identifying calorie-deprived households. Real expenditure is predictive of net calories but has two drawbacks: the constant slope makes it hard to identify the zero net calorie threshold, and the level of real expenditures that corresponds to zero net calories is somewhat different for rural and urban areas, suggesting that relative prices, alternative consumption opportunities and even different preferences make it less useful for identifying hunger in different locations. These insights strongly support the view of Jensen and Miller (2010) that choices about how the food budget is allocated across different types of food are more informative about nutritional status than the overall budget or the allocation of this budget to food.[26]

[26] An alternative exercise we have also pursued is to ask how well we can predict our "predicted caloric requirements" using data on total expenditures and one food consumption data point, either caloric intake, the food share, or the grain share of food. This is essentially the inverse of Table 3.

These findings also suggest that a reduction in caloric requirements holding expenditures constant is more likely to show up through declining grain shares of food than a decline in the food budget share.

4. Household Size and Food Consumption

Deaton and Paxson (1998) consider "caloric overheads" as one plausible explanation for the drop in food expenditure per capita for larger households with similar demographic composition and per capita expenditures. For example, there are many activities that may be undertaken by a household but can be shared among household members, such as gathering fuel and water, travel related to the purchase and sale of goods, and certain domestic chores or economic activities that generate income and consumption opportunities. These activities are more common in developing countries, consistent with Deaton and Paxson (1998)'s finding that the drop in food expenditure they document is largest there. To assess the quantitative importance of this mechanism, we examine how caloric requirements vary with household size. This would be very difficult without detailed individual time-use data as much of the "sharing" may happen along margins that are otherwise not observable.

We restrict our analysis to that have between 2 and 8 household members, which make up approximately 90% of the sample households.[27] For food consumption we use the 50th NSS round and states that are also in the time-use data; for caloric requirements we use the time-use survey as well as our imputations for the 50th NSS round. We proceed by regressing log calories per capita, log food share, and log caloric requirements per capita on household size dummies as well as numerous controls including a cubic in log expenditure per capita, village/urban block dum-

We find that caloric intake is the best predictor of caloric needs ($R^2 = 0.308$) relative to the food share ($R^2 = 0.256$), the grain share of food expenditure ($R^2 = 0.265$) or the grain share of calories ($R^2 = 0.263$). As calculating caloric intake requires more detailed data and may be difficult in some settings, our results here confirm those of figure 2 that the grain (or other staples) share of food expenditure in conjunction with total expenditures may offer the best predictor of caloric requirements across households with different demographics and activity-levels. When also conditioning on demographics the differences in predictive power of the different food measures are less pronounced but the ordering is similar with the grain shares outperforming the budget share of food as a predictor of caloric requirements.

[27]One person households make up 5.4% of the 27,075 households in our sample but are problematic for reasons that are clear in table 1. Measuring their caloric intake is difficult due to very high shares of cooked meals and processed foods. Households with more than 8 persons make up the remainder.

mies, and our basic demographic composition variables (cubic in age of head, sex of head, scheduled caste/scheduled tribe status, religion, and the fraction of household members in each male/female age cell (0-2,3-4,5-9,10-14,15-17,18-60,61+)).[28]

In Figure 3, we report the coefficients on household size dummies where a household with two members is the omitted category – the coefficients correspond to percent deviations in the dependent variable relative to a two-person household. Note that variation in log food share conditional on per capita expenditure is equivalent to variation in per capita food expenditure, the outcome considered in Deaton and Paxson (1998). Like them, we find that food expenditures decline with household size. The decline is about 2% over the 2 to 8 person range. We observe an even larger decline for caloric intake, up to 8%, which appears to contradict the possibility that bulk-discounting – the ability to convert a given food expenditure into more calories – can explain the decline.

Looking at caloric requirements in the 1998-1999 Time-Use Survey or imputed to the 50th NSS round, we find a substantial decline in caloric requirements for larger households of about 2% going from 2 to 8 person households. Like the decline in food expenditures, the effect is concentrated between 2 and 5 and levels off after that. [29] The similarity of the magnitude and pattern of declines in log food expenditures and caloric requirements is striking, but it is only about 1/4 to 1/3 of the magnitude of the decline in caloric intake. However, if we only consider households between 3 and 6 persons, which make up 65% of the sample, the magnitude of the decline in caloric intake and caloric requirements per capita are virtually identical.

In Table 4 we present regression results for a specification similar to Deaton and Paxson (1998) with log household size as the variable of interest. Over the 2 to 8 person size range, the elasticity of caloric requirements per capita with respect to household size is about -0.024. This is a bit less than half the magnitude of the elasticity of caloric intake with respect to per capita expenditures of -0.057. The magnitude of the decline in food share in this log linear specification (column 5) is only -0.015,

[28]Note that by construction it is impossible to hold demographic ratios constant over certain comparisons of household size (e.g. going from 2 to 3 members unless they are all in the same cell). Larger households are likely to be different in many ways and in particular would typically have more children than adults and lower expenditures per capita, but here we simply follow the literature and use additive and linear controls.

[29]When we do not allow larger households to have higher BEE due to greater height and weight this decline is closer to 3%. These results are available by request.

which is actually *smaller* than the decline in caloric requirements. [30]

What drives our finding that caloric requirements decline in household size (holding per capita expenditures constant)? Table 5 explores this by documenting how BEE and activity levels vary across households of different sizes with otherwise similar demographic features. Column 1 shows that BEE rises in household size because members of larger households typically have higher heights and weights (conditional on per capita expenditures and demographics). In column 2 we calculate BEE using only age/gender data to omit these effects and find this effect substantially reduced – to the extent we still find effects it is because of age variation of household members within the age cells we use as demographic controls. Column 3 shows that activity levels fall substantially for larger households, with an elasticity of about 0.05, similar to what we observe for caloric intake.

To see where the differences in activity levels come from, columns 4 to 8 of Table 5 present results for log minutes per capita spent on market production (which includes work of the self-employed), domestic work (which includes both free collection and other types of domestic labor), leisure, free collection (food, water, fuel, and other materials) and travel. Holding per capita expenditures constant, larger households spend less time on market production and much less time on home production. While the decline in home production time has an obvious interpretation in terms of "caloric overheads" and shareable tasks, the decline in market time is more surprising. We view the decline in market production as suggestive evidence that larger households reap gains from heterogeneous abilities and specialization, allowing them to generate the same level of per capita expenditure with less physical effort. Off-setting the decline in market and domestic production is the increase in leisure, which may sometimes take the form of sports and exercise but usually involves less physically taxing activities. The biggest decline in minutes per capita is seen for free collection and travel activities, consistent with both large travel-related fixed costs and the lower shadow price of travel and time-saving durables for larger families.[31]

[30] As in Figure 3 the effects on caloric requirements are larger and our results are stronger when we do not allow BEE to vary with household size.

[31] We use logs to facilitate comparisons of magnitudes across larger and smaller households, which means we drop many households that report no travel or free collection for the last two columns. The results are qualitatively similar using levels and including zeros. Also note that our travel time results are all on the extensive/minutes margin. On a per minute basis motorcycles or bicycles may have similar or higher activity levels than walking, but by reducing time spent on travel relative to lower intensity activities like leisure they could still lower the caloric requirements that we calculate.

While our results provide the first confirmation of Deaton and Paxson (1998)'s conjecture that larger households have lower caloric requirements (holding per capita expenditures constant), the decline in caloric requirements we observe would not be large enough to account for the entire decline in measured caloric intake even with a (partial) elasticity of caloric intake to requirements of one. This suggests that other explanations may be equally important. At least for the Indian data, we view recall errors for food (relative to non-food) that are positively correlated with household size as the most promising.[32] In particular, we show in appendix Table 13 that the effect of household size on caloric intake and food expenditure is larger for (a) richer households, (b) urban households, and (c) households in more recent periods. In all three cases we observe greater consumption of processed food and more meals outside the home. Although our estimates of caloric intake account for these to the extent that they are observable, it is plausible that these types of food consumption are underestimated for larger households when consumption is based on the 30-day recall of a single individual.[33] We thus view our results as complementary to more systematic analysis of measurement error on the consumption side by Gibson (2002) and Gibson and Kim (2007). Just as their work shows that there is typically some "real" decline in food consumption in household size regardless of the measurement method, our findings suggest that economies of scale in caloric requirements are an important part – just not the only part – of the explanation for the Deaton and Paxson (1998) puzzle.

5. Trends in Food Consumption

Our previous results have been cross-sectional and control for village/urban block dummies, which means the households being compared face similar environments (including the disease environment, relative prices and availability of food and non-food goods, culture and preferences, etc.). We now turn to an exploration of changes in caloric requirements and food consumption over time. We begin by observing in Table 8 that there have been substantial changes over time in the primary indus-

[32]See Gibson (2002) and Gibson and Kim (2007) for more direct evidence of measurement error from other countries.

[33]In terms of caloric-requirement scale economies, we find slightly larger effects for urban households but substantially larger effects for poor households as well, which is inconsistent with caloric-requirement driving all of these patterns. These results are available from the authors by request.

try, education, home production and farm tasks, energy sources, relative prices and durable ownership of the average Indian household between 1983 and 2005 according to the NSS. The changes in occupation are actually modest compared to much larger changes in education, home production and especially electricity access. Another major change is the increase in the ratio of adults and seniors relative to children, from about 0.59 to 0.65 for rural households and 0.64 to 0.7 for urban households. Since Basal Requirements makes up well over half of caloric requirements, and adults are also more active than children in our data, this suggests a powerful force for rising caloric requirements over time. Data on durable ownership only exists from 1987 onwards, but indicates that car ownership is very low but bicycle and motorcycle ownership is quite prevalent and rising. We construct price indexes using state-level median unit values and Tornqvist weights, where rural Maharashtra in 1994 is the base. Relative prices for a NSS consumption group are calculated as the ratio of the group index to the overall price index.[34] Table 8 reports the large fall in relative grain prices between 1983 and 1994 and the large swings in energy prices, with a large increase between 1994 and 2005.

Many of these variables are common to the NSS and the Time-Use survey which allow us to impute caloric requirements over time even though we only directly observe detailed time use for the 1998 cross-section. An important caveat of this exercise is that extrapolating many years forward or backward in time may be less reliable. In particular, the time allocated to different tasks for an individual with the same industry, education, domestic chores, household expenditure, or other attributes may be quite different in 1983 or 2005 than in 1998 or the 1993-94 period we used for our earlier analysis. An additional caveat is that when extrapolating caloric requirements forward and backward in time, we hold heights and weights **constant** for a given age/gender cell, as we are less comfortable assuming that differences in height and weight in the cross-section due to education, occupation, or demographic features of the households would translate one to one into changes over time.[35]

[34]We use the same quality correction procedure described earlier. The full set of groups (not reported in the table) includes grains, pulses, milk, meat, oils, vegetables, fruit, beverages and processed food, intoxicants, clothing, fuel and light (energy).

[35]For example, in the cross-section height and weight may have a genetic component that will not vary over time for the Indian population. Given lags in the transmission of nutritional status to height and weight mediated by maternal nutrition, the cross-sectional differences we observe with respect to certain household characteristics may not translate into population level differences over time in the 22 year time period we examine.

With these caveats, Figure 4 provides a plot of caloric intake and caloric requirement "Engel curves" for 1983 and 2005 for rural and urban sectors using NSS data. We focus on the caloric requirements estimated using individual-level imputation (NSS schedule 10) which offers a better fit and uses the most detailed data on individual activities that exists over the entire sampled period. As in figure 1, caloric requirements tend to be much flatter in expenditures than caloric intake and to exhibit an inverted U-shape in log expenditure per capita. Holding real expenditure constant, there is a noticeable drop in caloric requirements between 1983 and 2005 for rural households at the bottom and top of the expenditure distribution of about 100 calories, with only a slight decline in the middle. For urban households there is a smaller drop at the top (about 80 calories) with no change or even a modest increase at the bottom. Table 7 provides the unweighted sample means of actual caloric intake and predicted caloric requirements at the household-level for the NSS survey rounds between 1983 and 2005. The average rural household experienced a -0.82% decrease in caloric requirements and the average urban household experienced a 1.35% increase in caloric requirements based on our measure.

We stress that this surprisingly modest change in caloric requirements is not due to a lack of change in predicted activity-levels. Figure 5 documents substantial declines in activity levels for adult men and women (particularly rural men) of about 10% at the top of the expenditure distribution. Activity-levels also declined for male and female children. Unlike household caloric requirements, individual activity-levels tend to decline monotonically in household expenditures so household expenditure growth contributed to the decline in average adult and child activity-levels. Table 7 documents declines in average activity levels as high as -5.89% for rural males or as low as -0.17% for urban males, with rural and urban females in-between. However, our data show that children have lower activity levels and lower basal requirements than adults. Thus the change in household composition between 1983 and 2005 due to lower child/adult ratios offsets most of the decline in activity levels in rural areas and all of the decline in urban areas. Smaller household sizes holding demographics constant also contributed to an increase in caloric requirements based on our analysis above, but the change in household size was fairly small over this period.

The main conclusion of our exercise is that while many features of our estimated household caloric requirements are qualitatively consistent with the broad patterns for caloric intake – higher initial levels and higher declines over time for rural households, larger declines for rich households than poor households over time – the magnitude of decline is insufficient to account for the large drop in measured caloric intake in the NSS. Although we acknowledge potential underestimation of the decline in activity-levels because we are unable to measure changes in activity levels that occurred for households with the same observed industry, education, domestic tasks and real expenditures, our findings strongly suggest that demographic forces have provided a substantial offset to any decline in activity levels.[36]

As an alternative to our imputation of caloric requirements over time, we also directly account for variables that may affect household caloric intake through the calorie channel using a Oaxaca-Blinder decomposition. A caveat to this exercise is that many variables might be expected to impact caloric intake through channels other than caloric requirements – for example, education may affect manual labor intensity but also preferences (e.g. spending on a child's education), farming may affect manual labor intensity but also the price paid for the food produced, and electricity usage uses financial resources and may make non-food consumption choices more viable in addition to lowering the physical effort required for domestic work. Nevertheless, this approach offers an alternative way to decompose the contribution of different factors to changes in caloric intake and does not require direct imputation of caloric requirements.

To implement this decomposition, we first estimate a model using pooled cross-sections from 1983, 1987-88 and 1993-94 (including year dummies) to predict log caloric intake per capita for rural and urban households.[37] The list of explanatory variables we use (many of which are reported in Table 8) can be classified as real expenditure per capita (deflated using state/sector-level quality-adjusted unit value price indexes, entering as a third-degree polynomial), demographics (size, age and gender composition, and household religion and caste/tribal status), occupation/education (industry codes, self-employment/casual labor, and adult education variables), domestic tasks (dummies for whether anyone in the household engaged in tasks recorded), farm activities (for rural households only), electricity/fuel (dummies for whether the household has electricity and whether it uses wood or dung as a fuel source), and

[36]As discussed earlier, we also somewhat underestimate this demographic offset since we hold height/weight constant for given age/gender combinations where the trend has been towards greater height and weight and hence higher basal requirements at any gender and age.

[37]We use the earlier survey rounds to estimate the model as these include the largest list of variables including both domestic/farm activities and measures of electricity access and cooking fuel source.

relative prices. We then use the coefficients estimated from these pooled "within-round" regressions together with the average changes in the explanatory variables in the sample to predict a total change in log caloric intake for the average household as well as the component of this change attributable to each factor. These estimates are equivalent to the "explained" part of a Oaxaca-Blinder decomposition using the pooled coefficients.[38]

Table 8 provides the results for caloric intake. These results generally reinforce the conclusions of our previous exercise. Predicted caloric intake due to changes in all explanatory variables lead to a similar decline in caloric intake for rural households (-0.8%) which is only about a quarter of the decline observed (-2.8%). Predicted caloric intake actually rises for urban households (4.2%) even though actual caloric intake fell. The effect of changes in occupation, education, domestic work and farm tasks on reducing caloric intake is substantial for rural households (-2.3%) and small for urban households (-0.4%), with demographic changes partly offsetting their effects in rural areas and completely offsetting them in urban areas. In both rural and urban areas the growth in real expenditure would have predicted large increase in per capita caloric intake of almost 10% for rural areas and over 6% for urban areas, consistent with elasticities of caloric intake to expenditure of about 30% and a roughly similar growth in real expenditures. The strongest force offsetting this increase are the effects of changes in electricity and fuel usage and changes in relative prices, particularly in rural areas. [39]

[38]In practice our results are very similar when using a single cross-sectional survey to estimate the coefficients.

[39]We caution that our relative price coefficients are estimated from state/sector-level cross-sectional variation in average unit values and therefore cannot be reasonably considered causal elasticity estimates. Given that the usual concern is that price elasticities are biased downwards (due to measurement error and positive demand shocks/preference-shifters interacting with upward sloping supply curves) we view this as suggestive evidence that relative price movements could play an even more important role. We have also used price coefficients estimated using only price variation within states over time, which typically leads to smaller effects that are still large relative to other factors. Like Deaton and Dreze (2009) we observe a decline in relative food prices over most of the period we consider, particularly for staples. As they observe, this is inconsistent with the notion that relative prices explain the decline in calories when the price elasticity is negative. However, Jensen and Miller (2008) provide evidence that these elasticities could be positive for poor households, at least for dietary staples that act like Giffen-Goods. Changes in relative prices within food – particularly for meals out and processed foods – are poorly measured in the NSS data and the changes in non-food prices are also quite heterogeneous. While there is some potential to explore the role of prices – particularly due to the PDS reforms in India in the early and late 1990s and the shift away from subsistence agriculture – we leave this for future work as a discussion of heterogeneous prices, heterogeneous price elasticities and the limitations of both survey-based unit values and official price indexes is not the focus of this

The results in tables 7 and 8 present the declines in mean caloric intake and requirements, but as figure 4 highlights the decline in intake and also requirements is larger among richer households. In the appendix we also consider a non-parametric Oaxaca-Blinder decomposition similar to DiNardo et al. (1996). This involves reweighting the observations from an earlier period (we use 1983) using their probability of appearing in the 2004-2005 sample given their observed characteristics.[40] Appendix figure 9 presents the results of this exercise where we condition either on expenditure and demographics only (two forces whose change between 1983-2005 would tend to increase caloric intake) or also including our occupation, education, and electricity/fuel variables.[41] The results are similar in that the distribution of calories per capita is shifted right due to expenditure and demographic effects (except at the very bottom of the calorie distribution) and this is only partly offset by changes in occupation, education, and electricity/fuel usage (concentrated at the top of the distribution and for the rural sector).

In the Appendix we also present similar exercises for the food share and grain share. Appendix Figure 8 presents the Engel curves for grain and food shares in 1983, 1993 and 2005. Appendix table 14 presents the mean decomposition and figures 10 and 11 present the non-parametric decompositions. In analyzing at these two margins that mediate the transmission of real expenditures to caloric intake, we highlight three points. First, the main difference from the previous exercises is that in both cases the rise in real expenditures per capita pushes in the "right" direction towards lower shares of expenditure on food and grains, which is then reinforced by the variables we consider as proxies for caloric requirements such as industry and domestic work variables. The demographic variables still push in the "wrong" direction towards higher food and grain expenditures. Second, the variables meant to capture caloric requirements do a better job at explaining the decrease in mean and leftward shift in the distribution of grain shares than food shares. This is consistent with our earlier result that the grain share of food is more closely tied to caloric requirements than the

paper.

[40] See their paper for a detailed description. In practice the exercise involves estimating a probit regression for whether an observation appears in the later round unconditionally or conditional on all observed characteristics, giving predicted probabilities P and $P*$. Each observation is then reweighted by $\frac{P*(1-P)}{P(1-P*)}$ which gives more weight to observations in the earlier round that would be more likely to appear in a later round (due to higher expenditures, education, etc.). One can then calculate the counter-factual density function.

[41] In this case we cannot use the change in schedule 10 domestic and farm variables since we do not observe those variables in later rounds for the *same* households for which we observe calories.

food share. Third, Appendix figure 8 and figure 14 also highlight that the contributions of these two margins to the decline in caloric intake varies over two sub-periods – the decline in the grain share of food is concentrated in the 1983-1993 period while the decline in the food share is concentrated in the 1993-2005 period. This is further evidence that there could be other factors at play, as declining caloric requirements alone would be unlikely to generate differential movement in these margins during the two periods.

Overall, the "predicted" change in caloric intake due to the changes in observed characteristics of households explain only a small (less than 25%) share of the decline in actual caloric intake for rural households between 1983-2005 and even less for urban households. On their own, changes attributable to work variables have modest effects that are not large enough to offset the effects of real expenditure growth, and are themselves largely offset by changes in demographics. Instead, it appears that other factors including changes in prices, access to new goods, preferences and the disease environment may be necessary to account for the decline in caloric intake. On the other hand, to the extent that the observed decline in caloric intake over time in the NSS is an artifact of measurement (Smith (2013)) or a result of real expenditure elasticities that are biased upwards (deemed plausible by Deaton and Dreze (2009)), one could plausibly attribute a larger share of the decline in (real) caloric intake to falling caloric requirements, particularly in rural areas.

6. Conclusion

Given the massive economics literature using food consumption to infer changes in welfare, poverty, price index bias, nutritional deficits and equivalence scales, it is surprising how little attention has been paid to measuring the purely "biological" demand for calories. Economists are rarely confronted with such an obviously quantifiable demand-shifter. While measuring this demand-shifter is a difficult task that involves combining different data sources with estimates from the health and nutrition literature that themselves are far from settled (despite better measurement), we find a substantial payoff.

We shed new light on numerous measurement issues and "puzzles" in the economics literature. While it is obvious that households with higher caloric requirements would consume more food, our finding that richer households in India are more sensitive to changes in caloric requirements than poor households (who are closer to subsistence and obviously hungrier to begin with) is less obvious. Similarly, our results indicate that the grain share of food proposed by Jensen and Miller (2010) is a useful indicator of hunger and caloric deficits with more attractive properties than the budget share of food proposed by Engel or even expenditures deflated by local price index.

While we provide evidence supportive of the conjectures in Deaton and Paxson (1998) and Deaton and Dreze (2009) that caloric requirements are lower for larger households and have declined over time at the individual-level, the magnitudes we measure appear to be too low to fully resolve these consumption "puzzles" on their own. Some of our conclusions require careful quantification informed by the nutrition literature. For example, we find that that the increase in the share of adults relative to children in Indian households, with associated increases in activity levels and metabolic requirements, is large relative to the decline in activity levels predicted by occupational variables. Another example is that we find that the higher metabolic energy requirements of larger households (due to greater height and weight) are not enough to offset their lower activity levels, such that their caloric requirements are lower overall.

While there are many interesting avenues for extending our findings, we are cautious in over-interpreting our results given the difficulties involved in measurement. As measurement errors could be equally large on the intake and requirement side, we believe that economists and nutritionists would benefit from closer collaboration in developing measurement tools suitable for smaller field experiments and larger national surveys, and by exploring the interplay of biological and economic factors that together shape food demand, activity levels and anthropometric outcomes. As technology for measuring intake and requirements improves and becomes cheaper, incorporating biological considerations into models of consumer behavior is likely to be a fruitful area of research, particularly in developing countries where food remains a large share of the budget and where under-nutrition remains a serious problem.

References

Abdulai, Awadu, "Economies of Scale and the Demand for Food in Switzerland: Parametric and Non-Parametric Analysis," *Journal of Agricultural Economics*, 2003, *54(2)*, 247–267.

Almas, Ingvild, "International Income Inequality: Measuring PPP bias by estimating Engel curves for food," *American Economic Review*, 2012.

Barr, Sadie B. and Jonathan C. Wright, "Postprandial energy expenditure in whole-food and processed-food meals: implications for daily energy expenditure," *Food Nutrition Research*, 2010, *54.*

Barten, Anton P., "Family Composition, Prices and Expenditure Patterns," in Gordon Mills Hart, Peter E. and John K. Whitaker, eds., *Econometric Analysis for National Economic Planning*, London: Butterworths, 1964.

Basu, Deepankar and Amit Basole, "The Calorie Consumption Puzzle in India: An Empirical Investigation," *Working Paper*, 2013.

Borgonha, S, P.S. Shetty, and A.V. Kurpad, "Total energy expenditure and physical activity in chronically undernourished Indian males measured by the doubly labeled water method," *Indian Journal of Medical Research*, 2000, *111*, 24–32.

Clark, Gregoy, Michale Hubermand, and Peter Lindert, "A British Food Puzzle," *The Economic History Review*, 1995, *48(2)*, 215–237.

Clegg, M.E., M. Golsorkhi, and C.J. Henry, "Combined medium-chain triglyceride and chilli feeding increases diet-induced thermogenesis in normal-weight humans," *European Journal of Nutrition*, 2013, *52(6)*, 1579–1585.

Costa, Dora L., "Estimating Real Income in the US from 1888 to 1994: Correcting CPI Bias Using Engel Curves," *Journal of Political Economy*, 2001, *109(6)*, 1288–1310.

Cutler, David M., Edward L. Glaeser, and Jesse M. Shapiro, "Why Have Americans Become More Obese?," *Journal of Economic Perspectives*, 2003, *17*, 93–118.

Dasgupta, Partha and Debraj Ray, "Adapting to Undernourishment: The Clinical Evidence and Its Implications," *WIDER Working Paper*, 1987.

Deaton, Angus and Christina Paxson, "Economies of Scale, Household Size, and the Demand for Food," *Journal of Political Economy*, 1998, *106(5)*, 897–930.

— and Jean Dreze, "Food and Nutrition in India: Facts and Interpretations," *Economic and Political Weekly*, 2009, *44(7)*, 42–65.

— and John Muellbauer, "On Measuring Child Costs: With Applications to Poor Countries," *Journal of Political Economy*, 1986, *94(4)*, 720–744.

— and S Subramanian, "The Demand for Food and Calories," *Journal of Political Economy*, 1996, *104(1)*, 133–162.

DiNardo, John, Nicole M. Fortin, and Thomas Lemieux, "Labor Market Institutions and the Distribution of Wages, 1972-1993: A Semi-Parametric Approach," *Econometrica*, 1996, *64(5)*, 1001–1044.

Du, S, B Lu, F Zhai, and B Popkin, "A New Stage of the Nutrition Transition in China," *Public Health Nutrition*, 2002, *5(1A)*, 169–174.

Duh, Josephine and Dean Spears, "Can Improving the Disease Environment Explain India's Calories Consumption Puzzle?," *Work in Progress*, 2013.

Engel, Ernst, "Die Lebenskosten Belgischer Arbeiter-Familien Fruher and jetzt," *International Statistical Institute Bulletin,*, 1895, *9*, 1–74.

et al., A. Raben, "Decreased postprandial thermogenesis and fat oxidation but increased fullness after a high-fiber meal compared with a low-fiber meal," *American Journal of Clinical Nutrition*, 1994.

et al., Barbara E. Ainsworth, "Compendium of Physical Activities: an update of activity codes and MET intensities," *Medicine and Science in Sports and Exercise*, 2000.

FAO/WHO/UNU Expert Consultation, "Energy and Protein Requirements," *World Health Organization Technical Report Series 724*, 1985.

— , "Human energy requirements," *Food and Nutrition Technical Report Series*, 2001.

Federation of Hotel and Restaurant Associations of India, "Restaurant Industry in India: Trends and Opportunities," *Research Study*, 2004.

Ferro-Luzzi, Anna, Cristina Petracchi, Rebecca Kuriyan, and Anura V. Kurpad, "Basal metabolism of weight-stable chronically undernourished men and women: lack of metabolic adaptation and ethnic differences," *American Journal of Clinical Nutrition*, 1997, *66*, 1086–1093.

Fogel, Robert and Stanley Engerman, *Time on the Cross: The Economics of American Negro Slavery*, Norton and Company, 1974.

Gardes, Francois and Christophe Starzec, "Economies of scale and food consumption: a reappraisal of the Deaton-Paxson paradox," *Working Paper*, 1999.

Gibson, John, "Why does the Engel method work? Food demand, economies of size and household survey methods," *Oxford Bulletin of Economics and Statistics*, 2002, *64(4)*, 341–359.

_ and Bonggeun Kim, "Measurement Error in Recall Surveys and the Relationship Between Household Size and Food Demand," *American Journal of Agricultural Economics*, 2007, *89(2)*, 473–489.

GK Krishnaveni et al., "Relationship between physical activity measured using accelerometers and energy expenditure measured using doubly labelled water in Indian Children," *European Journal of Clinical Nutrition*, 2009.

Gopalan, C, B V Rama Sastri, and S C Balasubramanian, *The Nutritive Value of Indian Foods*, Indian Council of Medical Research, Hyderabad: National Institute of Nutrition, 2004.

Gupta, Amlan Das, "Veblen Preferences and Falling Calorie Consumpton in India: Theory and Evidence," *Working Paper*, 2013.

Hamilton, Bruce W., "Using Engel's Law to Estimate CPI bias," *American Economic Review*, 2001, *91(3)*, 619–630.

Henry, C.J.K., "Basal metabolic rate studies in humans: measurement and development of new equation s," *Public Health Nutrition*, 2005.

Horowitz, Adam, "Household Size and Demand for Food," *Working Paper*, 2002.

Indian Council of Medical Research, "Nutrient Requirements and Recommended Dietary Allowances for Indians," *National Institute of Nutrition*, 1989.

_ , "Nutrient Requirements and Recommended Dietary Allowances for Indians," *National Institute of Nutrition*, 2009.

Jensen, Robert and Nolan Miller, "Giffen Behavior and Subsistence Consumption," *American Economic Review*, 2008, *98(4)*, 1553–1577.

_ and _ , "A Revealed Preference Approach to Measuring Hunger and Undernutrition," *Working Paper*, 2010.

Jeor, Sachiko T. St. and Phyllis J. Stumbo, "Energy Needs and Weight Maintenance in Controlled Feeding Studies," *Well-Controlled Diet Studies in Humans, A Practical Guide to Design and Management.*, 1999.

Karan, Anup and Ajay Mahal, "Health, nutrition and poverty: Linking nutrition to consumer expenditures," in "Financing and Delivery of Health Care Services in India," National Commission on Macroeconomics and Health, Ministry of Health and Family Welfare, Government of India, 2005.

Lee, Ronald and Karen Kramer, "Children's Economic Roles in the Maya Family Life Cycle: Cain, Caldwell, and Chayanov Revisited," *Population and Development Review*, 2004, *28(3)*, 475–499.

Logan, Trevon, "Economies of Scale in the Household: Puzzles and Patterns from the American Past," *NBER Working Paper 13869*, 2008.

_ , "The Transformation of Hunger: The Demand for Calories Past and Present," *The Journal of Economic History*, 2009, *69(2)*, 388–408.

Ng, Shu Wen and Barry Popkin, "Time Use and Physical Activity: A Shift Away from Movement across the Globe," *Obesity Review*, 2013, *13(8)*, 659–680.

Perali, Federico, "The Second Engel Law and Economies of Scale: an Empirical Puzzle to be Resolved," *Working Paper*, 2001.

Schofield, W.N., C. Schofield, and W.P.T. James, "Basal metabolic rate – review and prediction, together with an annotated bigliography of source material.," *Human nutrition and Clinical Nutrition*, 1985.

Shetty, P.S., M.J. Soares, and M.L. Sheela, "Basal metabolic rates of South Indian males," *Report of FAO*, 1986.

Smith, Lisa C., "The Great Indian Calorie Debate: Explaining Rising Undernourishment during Indias Rapid Economic Growth," *IDS Working Paper*, 2013, *430.*

Statistics Canada, “Low-Income Cutoffs,” *On-line: http://www.statcan.gc.ca/pub/75f0002m/2009002/s2- eng.htm*, 2009.

Westerterp, Klaas R, “Diet induced thermogenesis,” *Nutrition and Metabolism*, 2004, *1:5.*

Figures and Tables

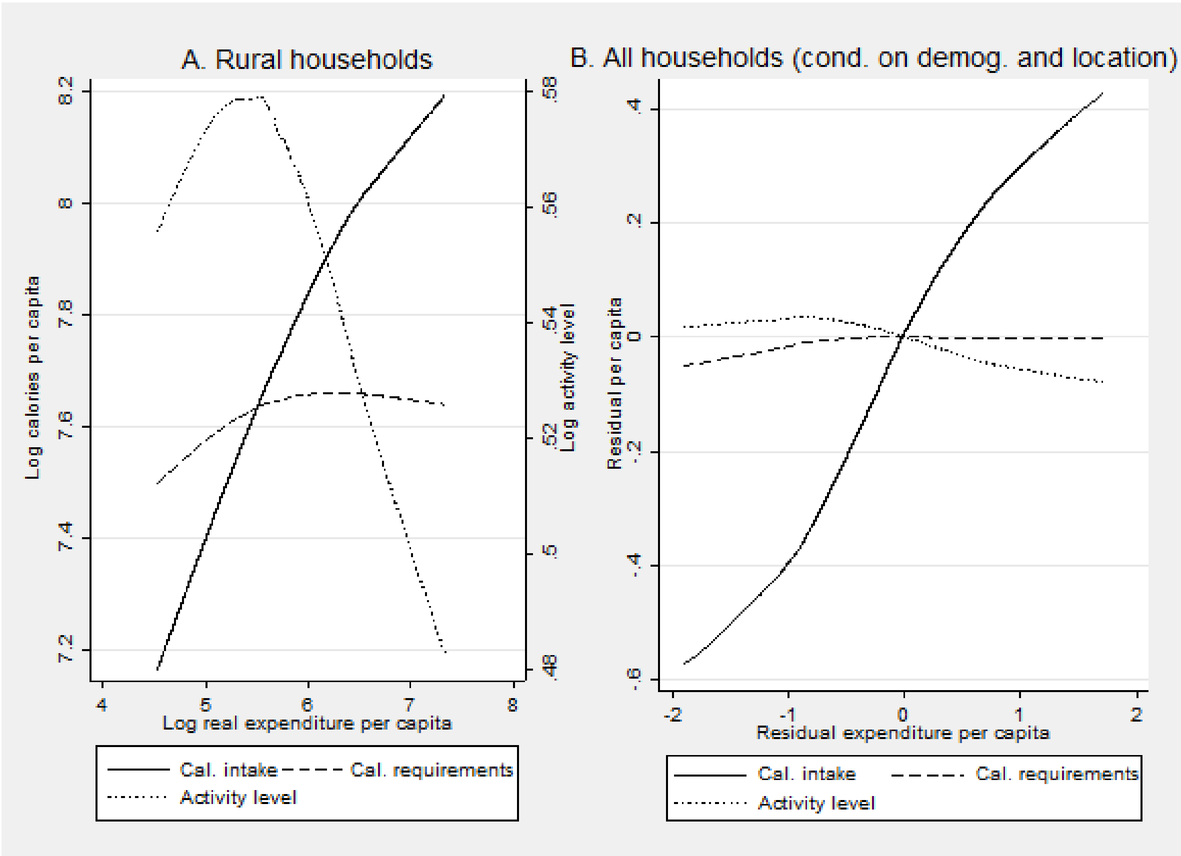

Figure 1: Household-level log caloric intake, log caloric requirements, and log activity levels vs. log expenditure (1993-1994). See text for details of sample selection. Panel A is for Rural households only, while Panel B uses all households but partials out demographic and location variables (village/urban block dummies).

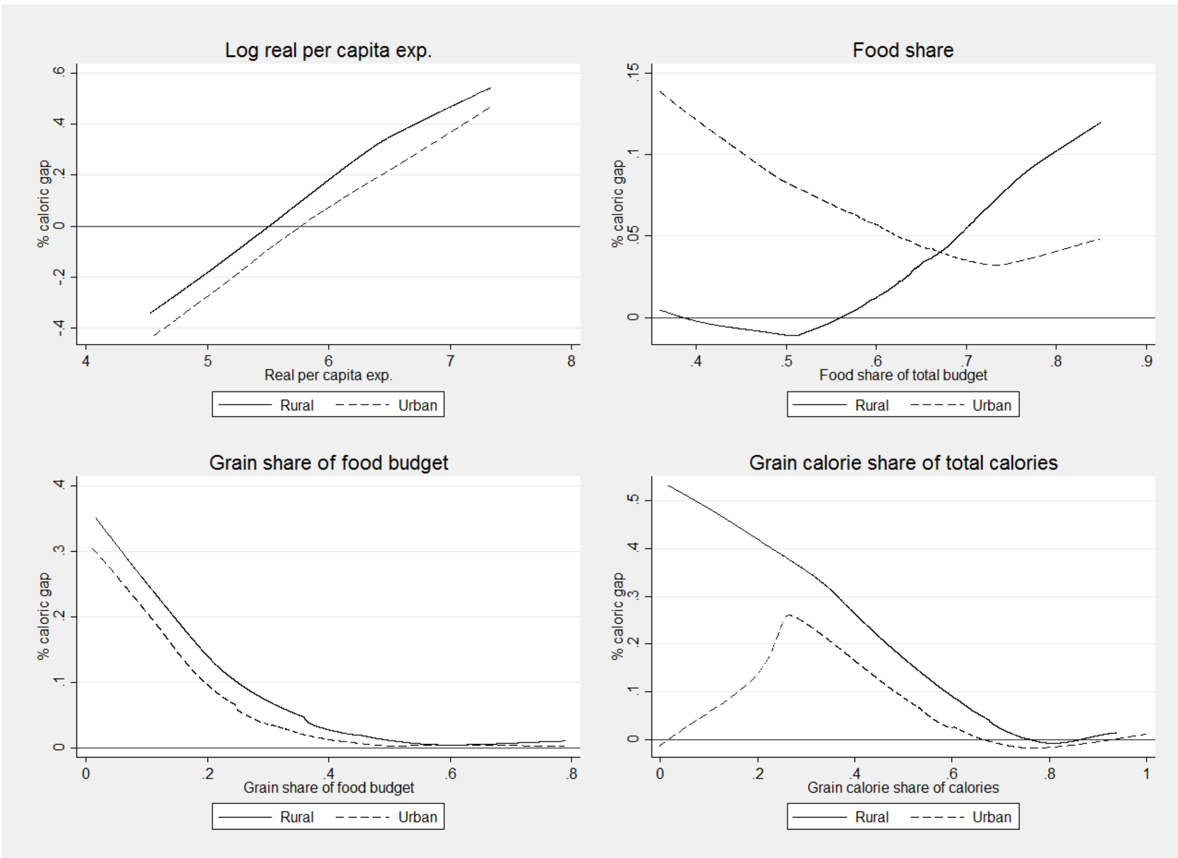

Figure 2: Predictors of net calories (1993-94). Net caloric intake (y-axis) is log household intake minus log household requirements (imputed to individuals using employment surveys and aggregated). See text for details of sample selection. Real expenditures use local unit-value price indexes as deflators.

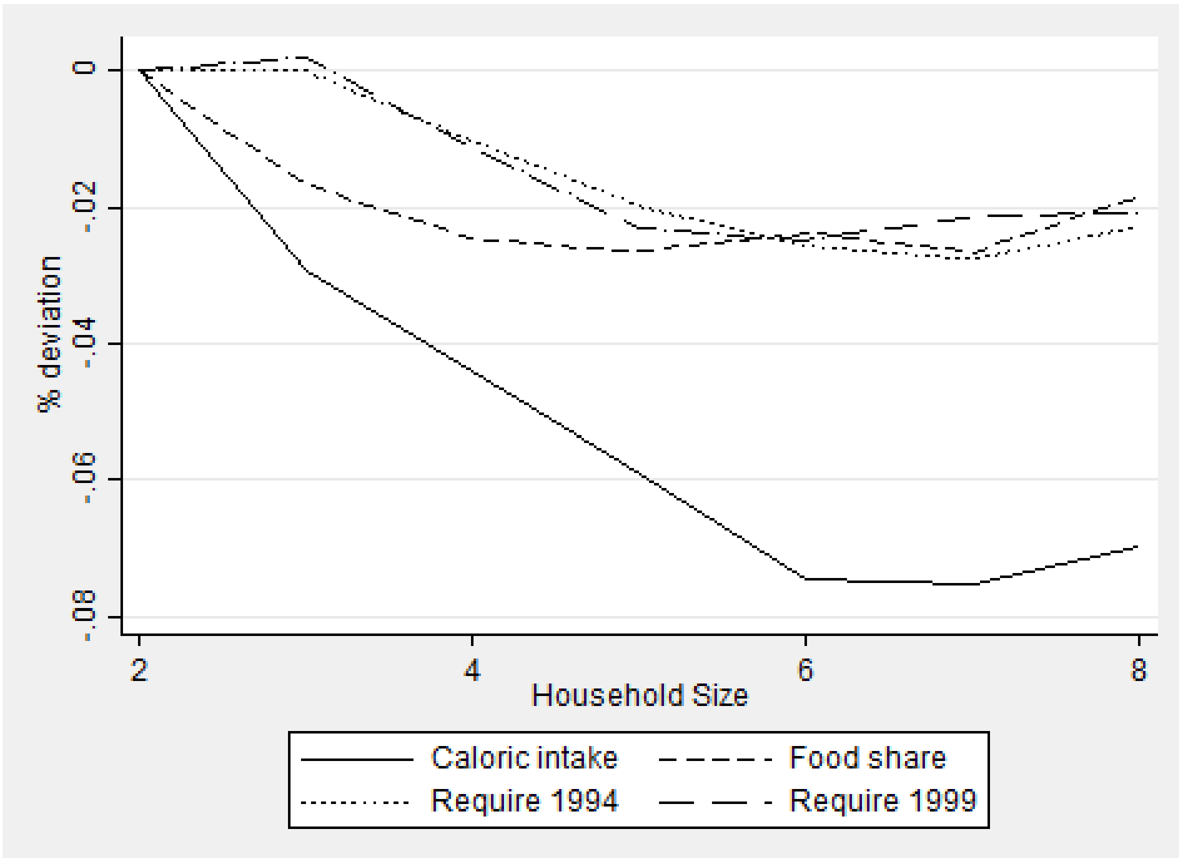

Figure 3: Variation in caloric intake and requirements with household size. Figure plots the coefficients on household size dummies from a regression controlling for per capita expenditure, demographic composition ratios, and other variables (see text). Omitted category is 2-person households, so Y-axis depicts % deviations for households with 3 to 8 members. Consumption data from 1993-1994 NSS. "Require 1994" based on caloric requirements imputed to 1993-1994 NSS (imputed to individuals using employment surveys and aggregated); "Require 1999" based on 1998-1999 Time-Use survey.

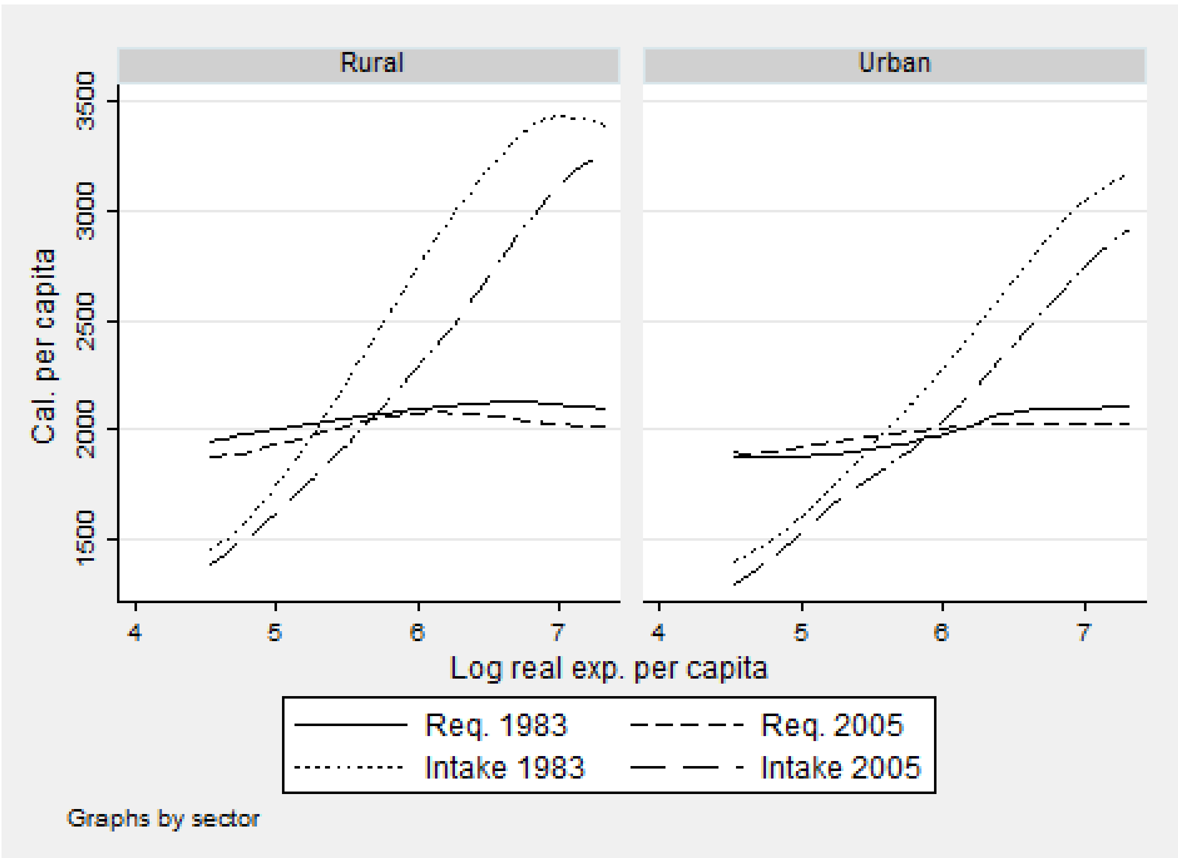

Figure 4: Household caloric intake and requirements over time. Requirements are imputed to individuals using employment surveys and aggregated. Real expenditures use national unit-value price indexes as deflators.

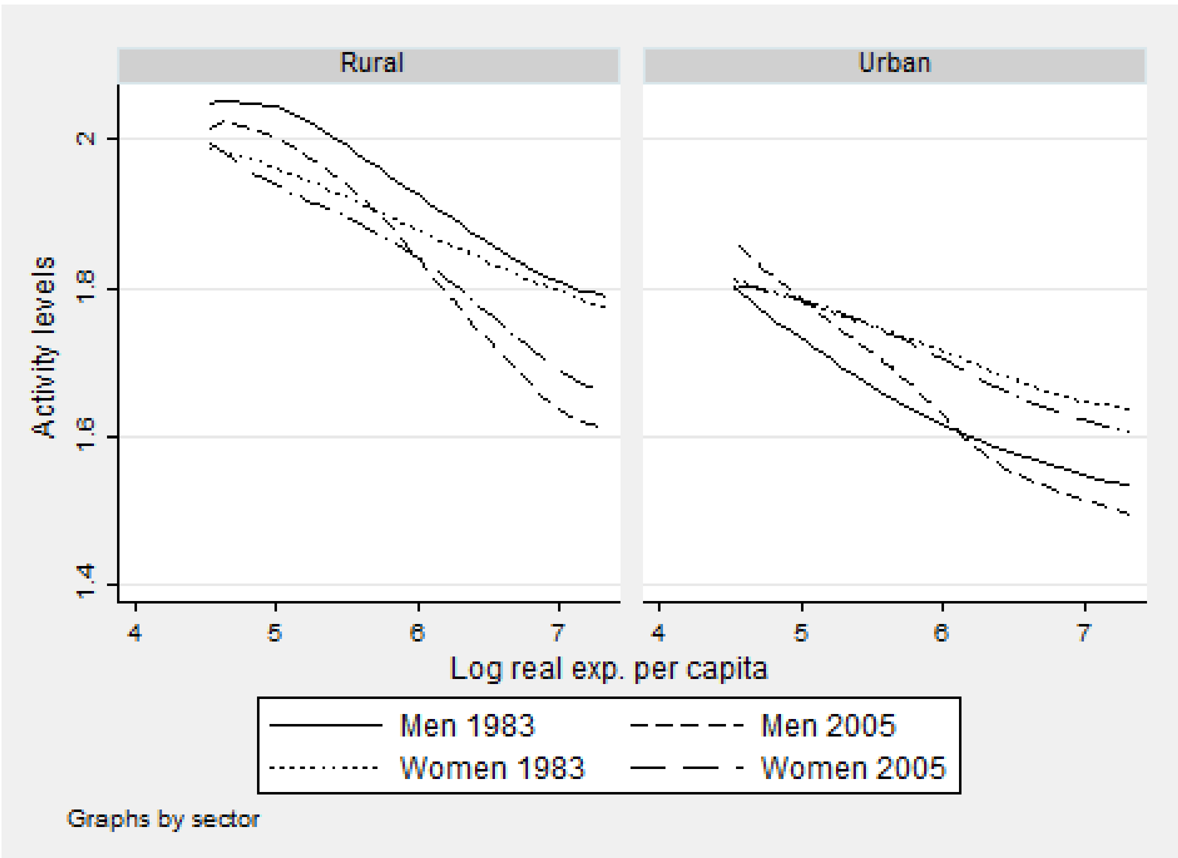

Figure 5: Adult male and female activity levels over time. Activity-levels are imputed using employment surveys. An activity level of one represents a state of total rest.

Table 1: Caloric requirements and intake: sample means and components

	Rural			Urban		
	Men	Women	Household	Men	Women	Household
Panel A: Caloric Requirements (1999 Time Use Survey, 2006 NFHS/2002 NNMB)						
Basal Requirement	1450	1126	1154	1566	1224	1271
	(102)	(52)	(152)	(111)	(76)	(178)
Activity Level	2.01	1.93	1.80	1.67	1.69	1.60
	(0.46)	(0.35)	(0.28)	(0.38)	(0.24)	(0.20)
Caloric Requirement	2916	2177	2140	2604	2072	2066
	(685)	(402)	(467)	(606)	(309)	(405)
Observations	16351	16090	12543	7761	7324	5735
Panel B: Caloric Intake (1993-1994 NSS, Time Use States)						
Caloric Intake	2923	2575	2211	2875	2592	2187
	(785)	(813)	(655)	(860)	(881)	(670)
Fraction of food expend.	0.83	0.95	0.97	0.54	0.75	0.93
directly converted	(0.31)	0(.14)	(0.07)	(0.40)	(0.37)	(0.16)
Caloric intake excluding	2359	2374	2130	1384	1979	2005
bev./processed/cooked meals	(1163)	(875)	(653)	(1345)	(1335)	(709)
Meal adjust. factor	1.05	1.07	1.02	1.09	1.04	1.02
	(0.14)	(0.21)	(0.09)	(0.21)	(0.17)	(0.11)
Observations	302	368	16126	575	228	10949
Alternative Estimates from Deaton and Dreze (2009)						
1993-1994 NSS			2153			2073
1999-2000 NSS			2148			2155

Notes: Standard deviations in parentheses. Rural males and females refer to adults aged 18 or over.
Time-Use states are Haryana, Gujarat, Madhya Pradesh, Meghalaya, Orissa and Tamil Nadu.
Individual caloric intake is based on one-person households only.
Meal adjustment factor is "(meals at home + free meals away)/(meals at home + meals to guests)"

Table 2: Rural household food consumption and caloric requirements: by industry, work type, education

	Cal. reqs	Basal req.	Act. level	Cal. intake	Food share	Grain share	Real exp.
Panel A: Primary industry (1-digit National Industrial Classification)							
Agriculture	2126.15	1123.65	1.81	2139.25	0.68	0.45	265.89
Mining	2038.35	1102.69	1.75	2122.23	0.66	0.47	285.89
Manufact. (natural)	1983.78	1162.96	1.68	2076.82	0.67	0.41	300.82
Manufact. (non-natur.)	1871.17	1113.40	1.64	1995.15	0.68	0.37	315.29
Utilities	1890.41	1116.59	1.65	2062.70	0.61	0.35	360.41
Construction	2109.08	1086.73	1.81	1988.93	0.66	0.39	278.70
Retail/wholesale/hotel/restaurant	1827.66	1170.02	1.58	2130.47	0.67	0.39	333.58
Transport/storage/communication	1857.90	1118.68	1.61	2074.33	0.66	0.34	315.77
Business services	1912.92	1198.40	1.61	2697.23	0.59	0.26	672.96
Personal/community/social services	1872.86	1177.53	1.60	2224.46	0.64	0.35	368.88
Other	1922.32	1144.64	1.63	2232.28	0.66	0.39	325.34
Panel B: Household work type							
Self-employed	2081.53	1140.40	1.77	2249.15	0.67	0.42	299.81
Casual labor	2123.17	1107.61	1.81	1962.67	0.68	0.46	240.80
Other	1836.65	1158.93	1.58	2239.45	0.65	0.38	366.53
Panel C: Household head education							
Illiterate	2142.39	1109.10	1.83	2063.84	0.68	0.46	246.23
Less than primary	2089.54	1122.39	1.78	2193.06	0.68	0.44	286.71
Primary	2073.47	1133.79	1.76	2133.76	0.67	0.39	302.48
Middle	2004.11	1146.88	1.71	2220.09	0.67	0.39	336.92
Secondary	1933.98	1176.71	1.65	2343.41	0.64	0.32	398.66
Post-secondary	1856.53	1217.74	1.58	2515.19	0.62	0.29	506.71

Notes: First three columns (Caloric Requirements, Basal Requirements and Activity Levels) are based on 1998-1999 Time-Use data. Next four columns (Caloric Intake, Food share of budget, Grain share of food budget, Real expenditure) are from 1993-1994 NSS.

Table 3: Household food consumption patterns as a function of total expenditures and caloric requirements (1993-1994 Time-Use States)

Dep. variable	Log caloric intake			Food share of budget			Grain share of food budget		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log caloric requirement	0.310***	0.197***	-0.178*	0.0121***	0.0575***	-0.0743*	0.0587***	0.124***	-0.0185
	(0.00756)	(0.0146)	(0.0972)	(0.00323)	(0.00650)	(0.0439)	(0.00356)	(0.00718)	(0.0428)
Log exp. per capita	0.402***	0.385***	-0.120	-0.0609***	-0.0616***	-0.239***	-0.138***	-0.127***	-0.319***
	(0.00361)	(0.00395)	(0.130)	(0.00153)	(0.00171)	(0.0588)	(0.00164)	(0.00172)	(0.0573)
Cal. req. X exp.			0.0663***			0.0233***			0.0253***
			(0.0172)			(0.00775)			(0.00755)
Constant	2.993***	3.587***	6.428***	0.909***	0.637***	1.637***	0.714***	0.000113	1.083***
	(0.0551)	(0.120)	(0.736)	(0.0236)	(0.0530)	(0.331)	(0.0264)	(0.0578)	(0.324)
Demographic controls	NO	YES	YES	NO	YES	YES	NO	YES	YES
R^2	0.689	0.702	0.702	0.478	0.488	0.488	0.796	0.807	0.807
Observations	26,981	26,981	26,981	27,069	27,069	27,069	27,069	27,069	27,069

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include village/urban block dummy variables. Demographic controls include: a cubic in log household size, gender/age composition ratios, household head gender and cubic in age.

Table 4: Household size effects on caloric requirements, caloric intake and food share.

	(1)	(2)	(3)	(4)
Dep. variable	Log cal. requ. 1998-99 TUS	Log cal. requ. 1993-94 NSS	Log cal. intake 1993-94 NSS	Food share 1993-94 NSS
Log household size	-0.0241***	-0.0243***	-0.0574***	-0.0145***
	(0.00374)	(0.00201)	(0.00420)	(0.00340)
R^2	0.686	0.827	0.717	0.474
Obs.	16,794	23,846	23,829	23,840

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

All regressions include basic demographic controls (see table 2), cubic in real per capita expenditures and rural/urban block dummies.

Column 1 uses TUS data on activities without regression-based imputation.

Column 2 uses individual-level regression-based imputation with NSS Schedule 10.

Table 5: Household size and caloric requirements: channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Minutes per person on:				
Dep. var. (in logs)	Basal no adj.	Basal adj.	Activity level	Market	Domestic	Leisure	Free col.	Travel
Log household size	0.0312***	0.0149***	-0.0566***	-0.166***	-0.250***	0.107***	-0.572***	-0.687***
	(0.00135)	(0.00010)	(0.00364)	(0.0173)	(0.0124)	(0.00493)	(0.0392)	(0.0411)
R^2	0.921	0.942	0.423	0.420	0.447	0.793	0.485	0.559
N	16,794	16,794	16,794	16,534	16,743	16,794	7,653	5,894

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

All regressions include basic demographic controls (see table 2), cubic in real per capita expenditures and rural/urban block dummies.

Basal no adj.: Basal Energy Expenditure (BEE) which varies either based on gender and age.

Basal adj.: BEE due to gender/age but also height/weight differences related to socioeconomic variables.

Domestic activities include free collection (Free col.).

Travel includes both market and domestic related.

Table 6: Household changes over time: sample means for 1983, 1994, 2005

	Rural 1983	Urban 1983	Rural 1994	Urban 1994	Rural 2005	Urban 2005
			NSS Schedule 1 variables			
Per capita real expenditure	297.79	410.32	308.94	444.41	354.72	552.26
Per capita caloric intake	2297.94	2192.97	2230.83	2208.00	2145.84	2133.41
Food share of budget	0.67	0.64	0.67	0.63	0.56	0.47
Grain share of food	0.53	0.36	0.41	0.29	0.35	0.26
Household size	5.24	4.94	4.91	4.60	4.93	4.51
Age of head	44.00	42.02	43.88	42.71	45.16	44.35
			Demographic composition ratios			
Male 18-59	0.25	0.33	0.27	0.33	0.27	0.34
Female 18-59	0.26	0.24	0.27	0.26	0.28	0.28
Male 60+	0.04	0.03	0.04	0.03	0.05	0.04
Female 60+	0.04	0.04	0.04	0.04	0.05	0.04
			Household primary industry (NIC 1-digit)			
Agriculture	0.74	0.09	0.70	0.08	0.64	0.06
Manuf. natural	0.05	0.15	0.05	0.11	0.05	0.12
Manuf. non-nat.	0.02	0.10	0.02	0.10	0.02	0.09
Construction	0.02	0.05	0.03	0.06	0.07	0.09
Retail	0.05	0.18	0.05	0.18	0.06	0.22
Transport	0.02	0.10	0.02	0.10	0.03	0.11
Business services	0.00	0.02	0.00	0.03	0.01	0.05
Social/personal services	0.06	0.24	0.07	0.24	0.06	0.18
			Household head education			
Illiterate	0.60	0.27	0.53	0.23	0.46	0.19
Some	0.15	0.13	0.16	0.13	0.11	0.08
Primary	0.13	0.17	0.12	0.13	0.15	0.14
Middle	0.08	0.15	0.10	0.15	0.15	0.18
Secondary	0.04	0.19	0.07	0.23	0.11	0.24
Post-secondary	0.01	0.09	0.02	0.13	0.03	0.17
			Other variables			
Electricity	0.14	0.57	0.36	0.82	0.54	0.92
Firewood	0.74	0.43	0.78	0.32	0.76	0.23
Dung	0.15	0.03	0.11	0.03	0.09	0.02
Rel. grain price	0.24	0.21	0.02	0.02	-0.03	-0.01
Rel. energy price	0.21	0.35	0.00	0.04	0.15	0.31
Bicycle	.	.	0.28	0.32	0.48	0.44
Motorcycle	.	.	0.02	0.09	0.08	0.25
Car	.	.	0.00	0.01	0.01	0.03
Observations	71374	38648	67046	41838	77140	42215
			NSS Schedule 10 variables			
Plowing	0.12	0.00	0.08	0.00	0.06	0.00
Planting	0.08	0.00	0.06	0.00	0.06	0.00
Weeding	0.09	0.00	0.10	0.00	0.11	0.00
Animal husbandry	0.10	0.00	0.11	0.00	0.13	0.00
Collect wood	0.31	0.07	0.30	0.06	0.28	0.05
Collect food	0.17	0.03	0.15	0.02	0.12	0.01
Husk paddy	0.18	0.02	0.11	0.02	0.09	0.02
Grind grain	0.26	0.11	0.12	0.07	0.10	0.06
Prepare dung cakes	0.32	0.07	0.36	0.07	0.30	0.04
Collect water	0.43	0.28	0.41	0.24	0.31	0.16
Home garden	0.10	0.04	0.12	0.04	0.10	0.02
Observations	71374	38648	67046	41838	78183	43001

All reported means use sample weights. For 1983 and 1994, the same households are sampled for Schedules 1 and 10.

Relative prices are the log ratio of group-level price indexes to an overall price index.

Price indexes are calculated relative to rural Maharashtra in 1994, using median unit values with quality correction and Tornqvist weights.

Table 7: Changes in caloric intake and requirements over time 1983-2005

	1983	1987-88	1993-94	1999-00	2004-05	% change 1983-2005
A. Requirements: Mean per capita						
Rural						
Male activity level	2.03	1.99	1.97	1.96	1.91	-5.89%
Female activity level	1.95	1.92	1.92	1.91	1.89	-3.26%
Household cal. req.	2056	2048	2070	2061	2040	-0.82%
Urban						
Male act. level	1.65	1.64	1.64	1.62	1.65	-0.17%
Female act. level	1.77	1.76	1.75	1.72	1.74	-1.94%
Household cal. req.	1972	1977	1988	1987	1999	1.35%
B. Household Caloric Intake: Mean per capita						
Rural						
Weighted	2230	2217	2160	2153	2079	-6.78%
Unweighted	2302	2351	2276	2286	2202	-4.34%
Deaton-Dreze (2009)	2240	2233	2153	2148	2047	-8.62%
Urban						
Weighted	2064	2076	2091	2135	2034	-1.46%
Unweighted	2204	2242	2244	2304	2138	-2.99%
Deaton-Dreze (2009)	2070	2095	2073	2155	2021	-2.37%

Caloric requirement and activity-level imputation using NSS schedule 10, see text for details. Male and female activity levels refer to adults aged 18-59.

Table 8: Percent change in caloric intake vs. 1983, actual and decomposition of predicted

	1987-88	1993-94	1999-00	2004-05
	Rural households			
Actual	0.025	-0.005	0.000	-0.028
Total Predicted	-0.003	-0.021	-0.068	-0.008
Real expenditure	0.018	0.038	0.052	0.098
Demographics	0.003	0.009	0.010	0.015
Occupation/educ.	-0.003	-0.006	-0.016	-0.018
Domestic tasks	-0.001	-0.001	-0.001	-0.001
Farm activities	0.002	0.000	-0.003	-0.004
Electric/fuel	-0.003	-0.007	-0.011	-0.014
Relative prices	-0.020	-0.054	-0.100	-0.084
	Urban households			
Actual	0.022	0.024	0.052	-0.017
Total Predicted	-0.002	0.027	0.019	0.042
Real expenditure	0.015	0.038	0.074	0.063
Demographics	0.005	0.013	0.019	0.021
Occupation/educ.	-0.002	-0.002	-0.008	-0.004
Domestic tasks	0.001	0.001	-0.001	0.000
Electric/fuel	-0.014	-0.009	-0.045	-0.020
Relative prices	-0.007	-0.013	-0.021	-0.018

Notes: “Actual” is measured as the difference in mean log household intake vs. 1983. “Total Predicted” is the sum of individual components; these are based on within-year coefficient estimates from pooled data for 1983, 1987-88, 1993-94, and changes in the mean sample household characteristics vs. 1983.

Relative prices are calculated as described in table .

A Appendix

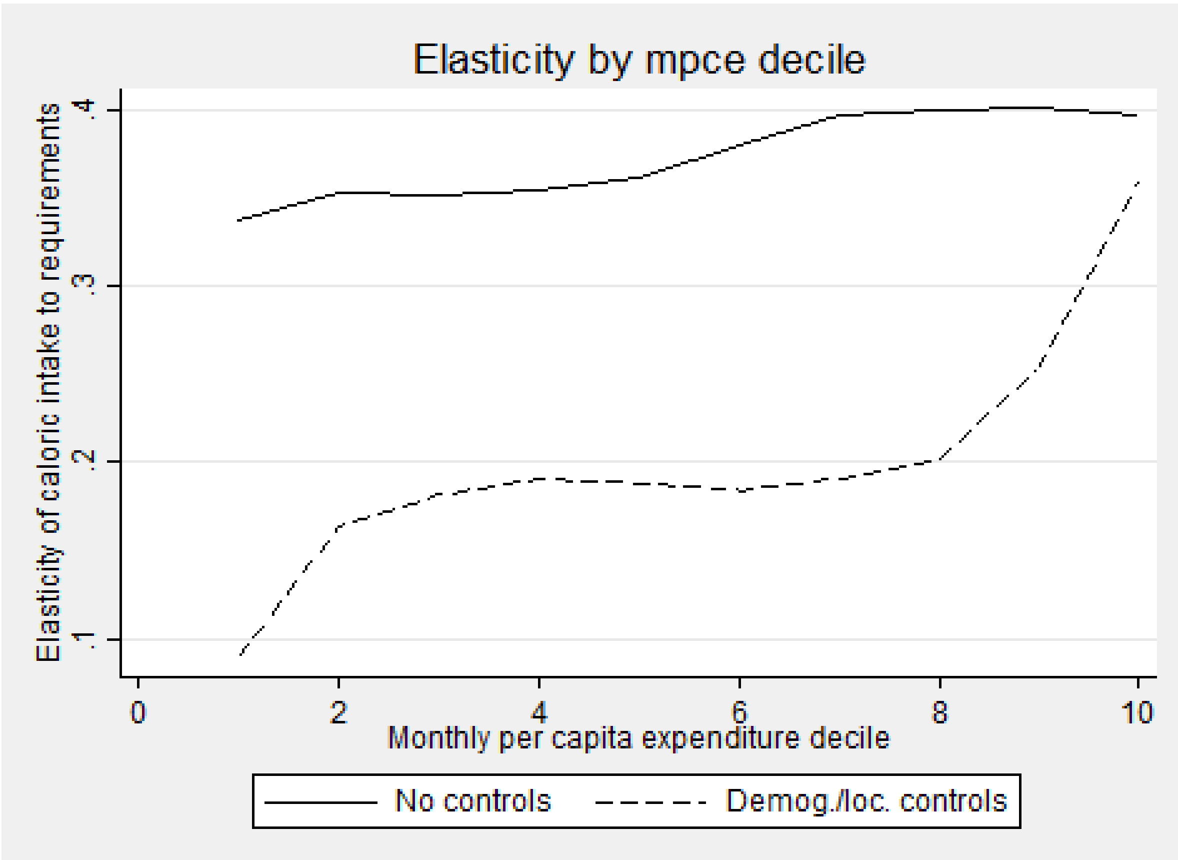

Figure 6: Intake-requirement elasticities by decile of per capita expenditure. We regress per capita caloric intake on per capita caloric requirements for each per capita expenditure decile in 1993-1994 (with or without controls for demographics and village/urban block dummies) and then plot the locally-weighted regression for the coefficients on caloric requirements.

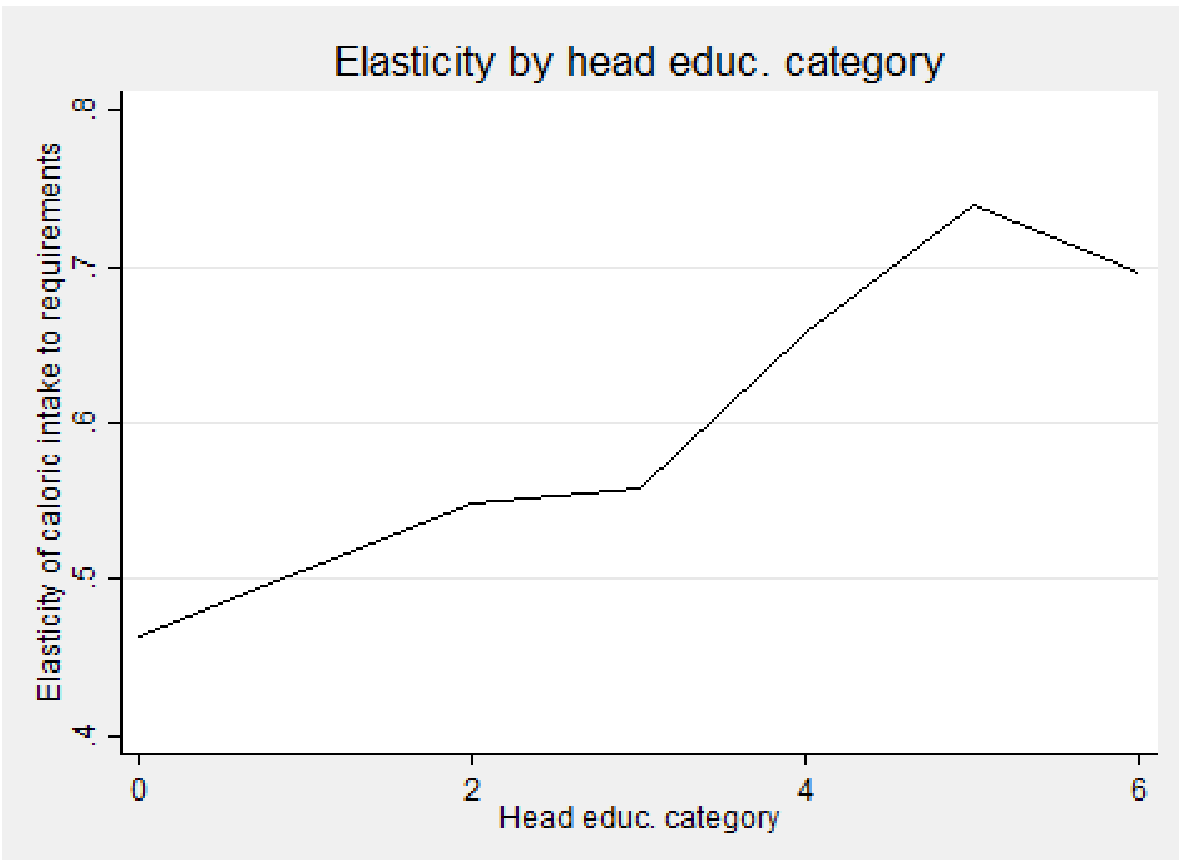

Figure 7: Intake-requirement elasticities by education category (no demog. controls). We regress per capita caloric intake on per capita caloric requirements for each head of household education class (0=illiterate and no school, 6=post-secondary) in 1993-1994 and report a line plot of the coefficients on caloric requirements.

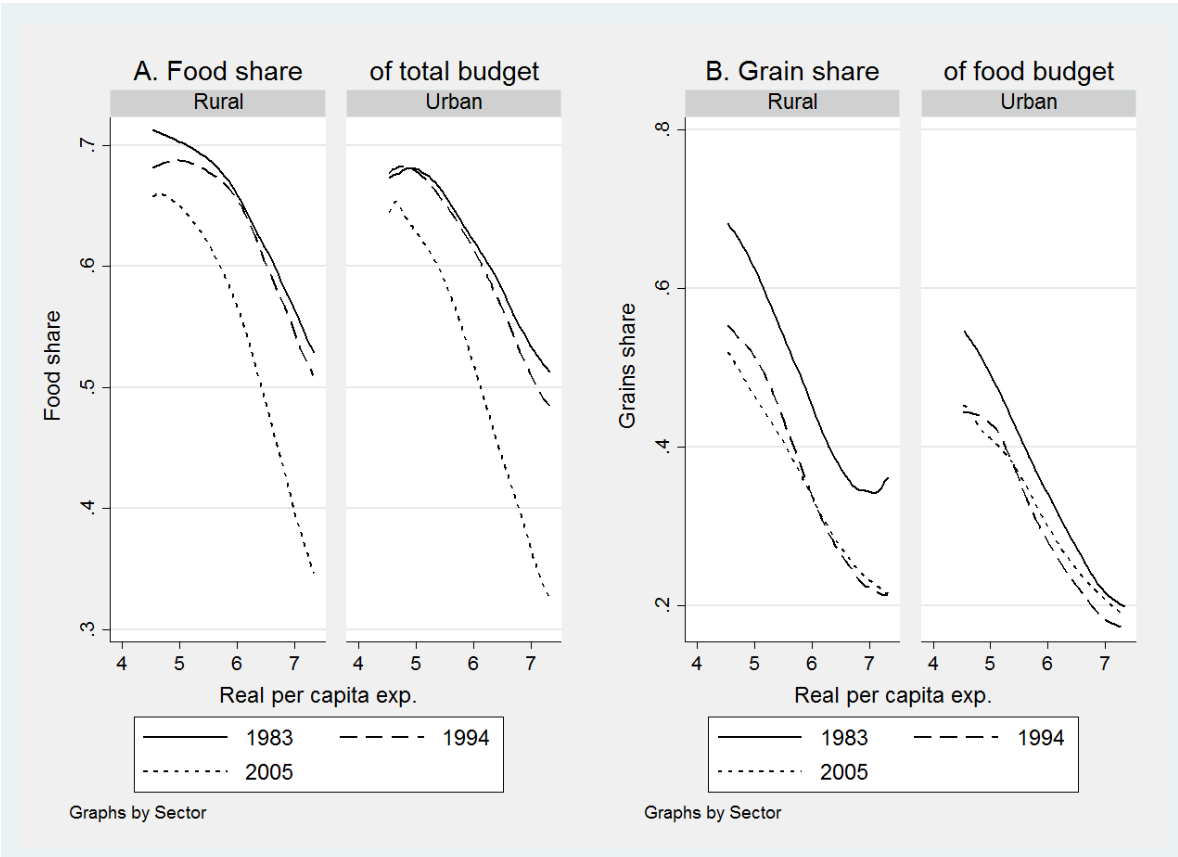

Figure 8: Food share and grain share of food over time as a function of real expenditures. Real expenditures use national unit-value price indexes as deflators.

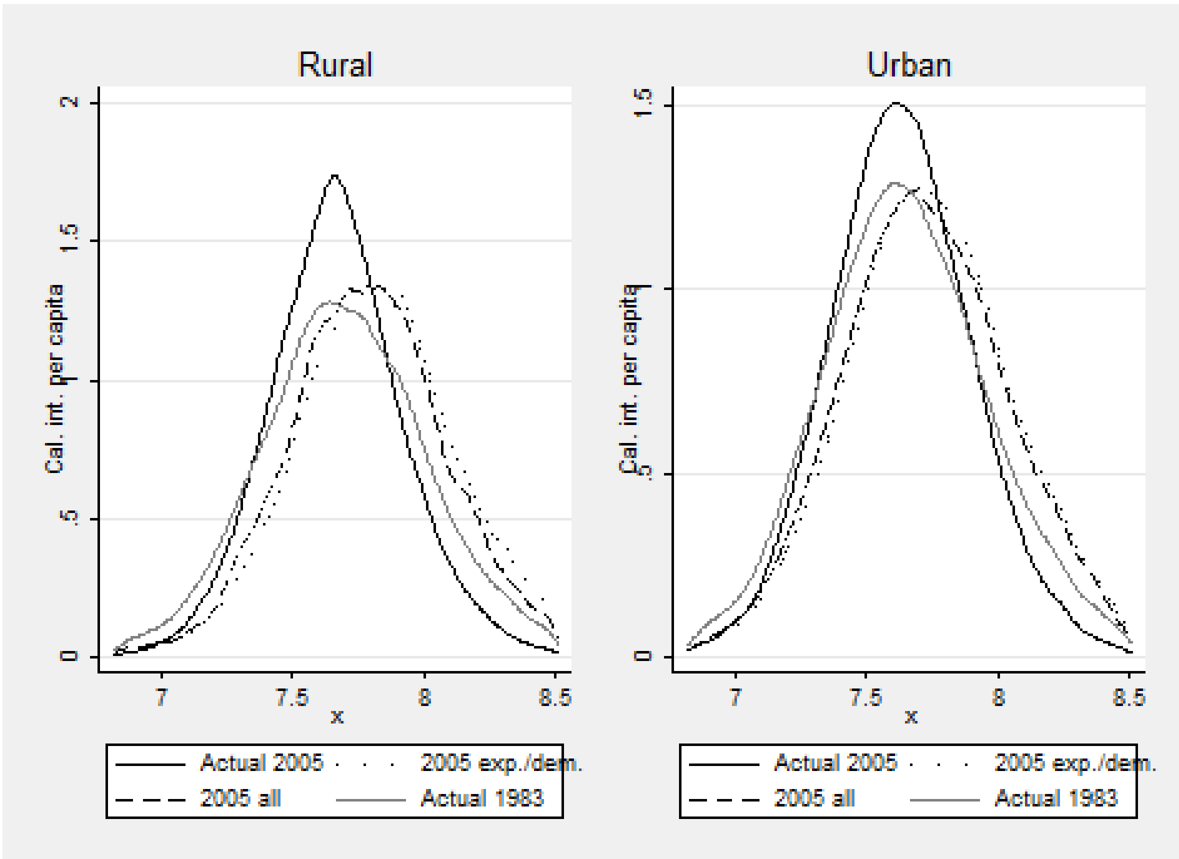

Figure 9: Caloric Intake: actual and counter-factual distributions for rural households. Figure depicts actual distribution of household caloric intake per capita for 1983 and 2005, along with counter-factual distributions based on re-weighting 1983 households based on the probability a household with similar characteristics is observed in 2005 (following DiNardo et al. (1996)). The characteristics used are either real expenditures and demographic variables (2005 exp./dem.) or all variables (which also includes occupation/education, energy/fuel usage, and prices as described in the text).

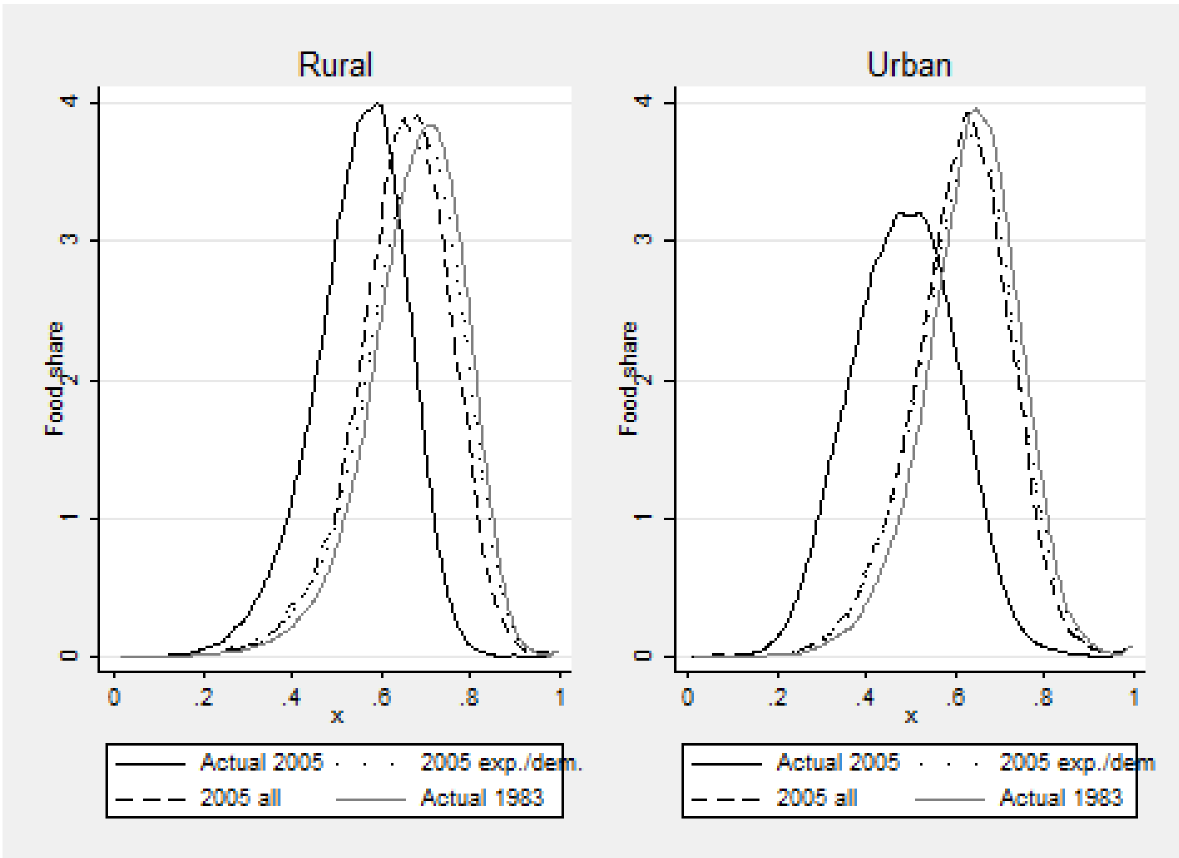

Figure 10: Food share: actual and counter-factual distributions for rural households. Figure depicts actual distribution of food share for 1983 and 2005, along with counter-factual distributions based on re-weighting 1983 households based on the probability a household with similar characteristics is observed in 2005 (following DiNardo et al. (1996)). The characteristics used are either real expenditures and demographic variables (2005 exp./dem.) or all variables (which also includes occupation/education, energy/fuel usage, and prices as described in the text).

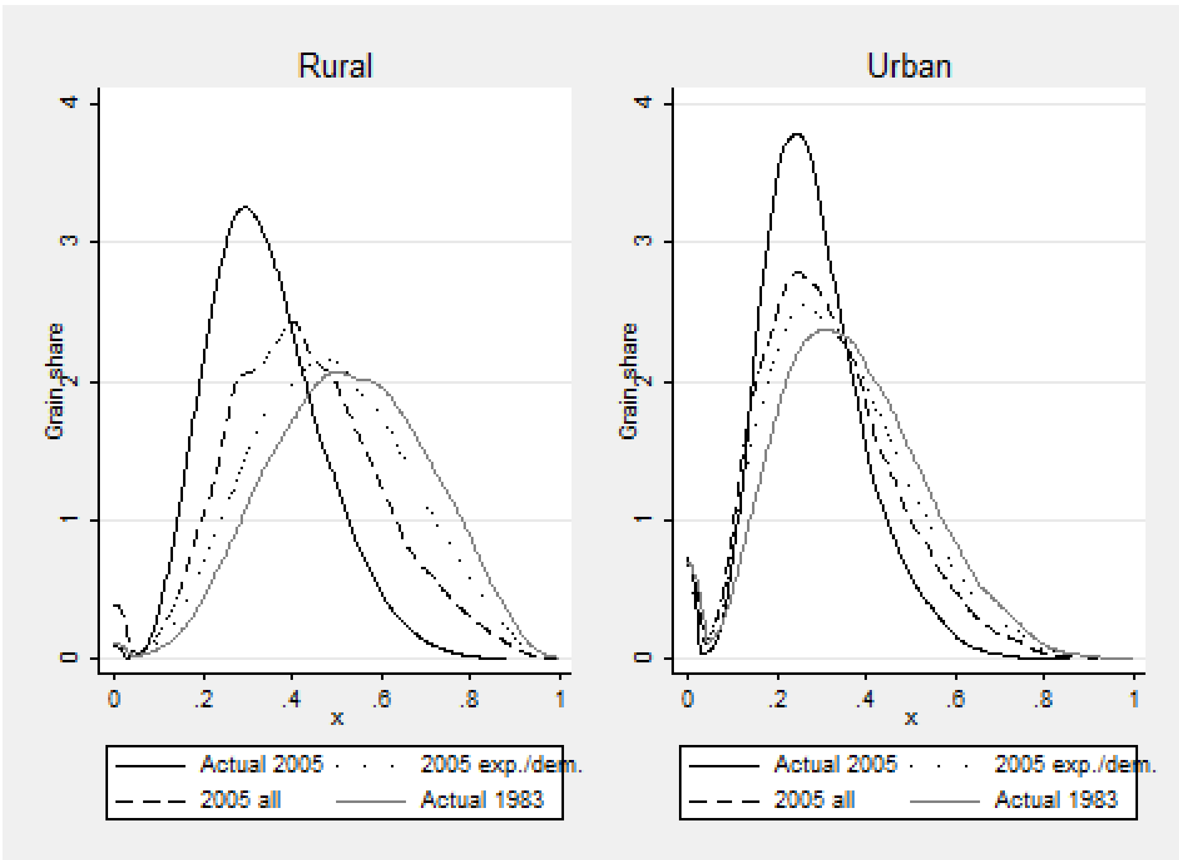

Figure 11: Grain share of food: actual and counter-factual distributions for rural households. Figure depicts actual distribution of grain share for 1983 and 2005, along with counter-factual distributions based on re-weighting 1983 households based on the probability a household with similar characteristics is observed in 2005 (following DiNardo et al. (1996)). The characteristics used are either real expenditures and demographic variables (2005 exp./dem.) or all variables (which also includes occupation/education, energy/fuel usage, and prices as described in the text).

Table 9: Minutes per day on various activities, by sector and gender (1998-1999 Time-Use Survey)

Activity	Household		Male adult		Female adult	
Sector	Rural	Urban	Rural	Urban	Rural	Urban
Primary	649.75	73.94	314.13	38.14	153.28	18.13
Free collection	73.33	17.13	12.22	2.39	38.10	10.25
Secondary	98.22	192.74	52.46	107.57	15.27	20.10
Tertiary	113.87	485.63	69.81	305.96	12.62	41.83
Total Market	935.16	769.44	448.62	454.06	219.27	90.32
Cook	229.04	233.30	5.40	5.99	161.51	171.63
Other hh maint.	230.15	241.47	23.06	19.56	137.30	157.02
Care for others	65.84	71.04	10.07	10.62	47.27	55.23
Total Domestic	525.02	545.81	38.54	36.18	346.09	383.88
Learning	248.41	317.16	7.83	18.46	2.31	12.12
Social	262.69	515.60	56.81	118.41	34.55	113.95
Sleep	1841.55	1817.84	528.54	503.76	515.28	511.11
Television	104.39	313.43	27.27	74.14	23.51	91.94
Other	1024.33	747.90	332.41	235.48	298.99	236.69
Total Leisure	3481.37	3711.93	952.86	950.24	874.64	965.80

Note: children under 6 are excluded from the household measure because their minutes are unrecorded. Primary, secondary, and tertiary refer to agriculture/fishing/forestry, manufacturing and services respectively. “Market” time is not restricted to wage/remunerated labor and includes self-employment and production for own consumption.

Table 10: Imputing caloric requirements and intake: sample means using 1998-99 Time Use Survey and 2006 NFHS/2002 NNMB

	Rural				Urban			
	Adult M	Adult F	Child M	Child F	Adult M	Adult F	Child M	Child F
Basal Energy Expenditures: Different imputation methods and formulas								
Impute BEE, Oxford eq.	1450.48	1125.89	953.52	787.78	1565.52	1223.87	1059.36	855.74
	101.55	52.35	270.16	200.24	110.70	75.69	309.84	218.86
Impute height/weight, Oxf.	1430.29	1127.70	885.02	840.77	1542.84	1228.38	990.74	910.82
	132.32	49.40	311.84	169.50	134.84	76.06	352.44	184.74
Impute height/weight, ICMR(2009)	1389.98	1134.01	986.53	904.77	1489.92	1236.04	1098.77	994.53
	95.13	60.80	284.49	243.62	98.89	80.33	309.65	254.09
Activity level (sleep=1): Different activity schedules								
FAO/WHO/UNU (2001)	2.01	1.93	1.45	1.46	1.67	1.69	1.42	1.41
	0.46	0.35	0.25	0.24	0.38	0.24	0.22	0.15
et al. (2000)	1.89	1.90	1.42	1.43	1.64	1.67	1.39	1.38
	0.44	0.34	0.24	0.24	0.44	0.28	0.22	0.16
"Calories per hr" web-site	2.29	2.12	1.62	1.61	1.93	1.80	1.56	1.54
	0.54	0.41	0.32	0.29	0.60	0.29	0.27	0.21
N	16351	16090	11097	9570	7761	7324	4364	3858

In the paper we use actual height/weight/age/gender and the Oxford equations from Henry (2005) to estimate BEE, and then imputes BEE based on common (NSS/TUS) characteristics. Alternately we can impute height and weight separately, and then construct BEE based on the heights and weights imputed based on common (NSS/TUS) characteristics.
The Indian Council of Medical Research (2009) measure uses the same height and weight but a different BEE formula.
Adult refers to individuals aged 18 and older.

Table 11: Urban household food consumption and caloric requirements: by industry, work type, education

	Cal. reqs	BEE	Act.factor	Cal. intake	Food share	Grain share	Exp.
Panel A: Primary Industry (1-digit National Industrial Classification)							
Agriculture	2131.83	1257.12	1.67	2177.70	0.67	0.37	298.88
Mining	1900.69	1137.58	1.62	2285.11	0.61	0.38	378.14
Manufacture (natural)	2012.79	1222.34	1.62	1995.38	0.65	0.32	360.24
Manufacture (non-natural)	2003.02	1232.74	1.59	2089.35	0.62	0.27	433.50
Utilities	1953.14	1274.88	1.52	2273.37	0.59	0.28	490.26
Construction	2365.02	1261.38	1.79	1948.66	0.65	0.35	316.99
Retail/wholesale/hotel/restaurant	1922.60	1239.09	1.53	1993.55	0.63	0.29	381.83
Transport/storage/communications	2001.44	1235.91	1.59	2002.42	0.64	0.32	345.05
Business Services	1958.76	1299.40	1.50	2368.47	0.58	0.23	623.35
Personal/community/social services	1959.33	1258.80	1.54	2112.23	0.62	0.28	430.35
Other	2012.37	1301.62	1.53	2244.61	0.63	0.28	460.77
Panel B: Household work type							
Self-employed	1990.61	1246.15	1.57	2053.99	0.63	0.30	382.23
Casual labor	2113.62	1193.96	1.70	1887.04	0.67	0.37	270.22
Other	1984.24	1275.28	1.54	2149.79	0.62	0.28	440.28
Panel C: Household head education							
Illiterate	2093.08	1196.99	1.70	1953.60	0.67	0.36	290.85
Some	2000.19	1212.43	1.61	1972.11	0.65	0.33	325.92
Primary	2010.38	1217.68	1.62	1972.80	0.65	0.31	343.98
Middle	2015.49	1227.00	1.60	2028.30	0.64	0.31	358.97
Secondary	1987.85	1274.22	1.54	2182.62	0.60	0.26	468.68
Post-secondary	2003.50	1309.28	1.52	2427.95	0.56	0.21	635.78

Notes: First three columns (Caloric Requirements, Basal Requirements and Activity Levels) are based on 1998-1999 Time-Use data. Next four columns (Caloric Intake, Food share of budget, Grain share of food budget, Real expenditure) are from 1993-1994 NSS.

Table 12: Selected coefficients on household variables in regressions using caloric intake or requirements as dependent variables

Data	1993-94 NSS (all)	1999-00 NSS*	1998-99 TUS*
Dep.var.	Log caloric intake per capita		Log caloric requirement per capita
	Demographic ratios (male 18-59 is omitted)		
F 18-59	-0.01	0.00	-0.25
M 60+	-0.02	-0.05	-0.17
F 60+	-0.03	-0.02	-0.48
M 0-2	-0.35	-0.29	-1.07
F 0-2	-0.32	-0.26	-1.53
M 3-4	-0.22	-0.23	-0.89
F 3-4	-0.23	-0.16	-1.17
M 5-9	-0.14	-0.09	-0.83
F 5-9	-0.16	-0.11	-1.02
M 10-14	-0.07	-0.04	-0.42
F 10-14	-0.10	-0.03	-0.68
M 15-17	-0.04	-0.02	-0.10
F 15-17	-0.07	-0.05	-0.38
	Adult education ratios (no schooling omitted)		
Some	-0.02	-0.04	0.01
Primary	-0.03	-0.02	0.00
Middle	-0.02	-0.05	-0.02
Secondary	-0.02	-0.11	-0.03
Post-sec	-0.03	-0.09	-0.06
	Principal NIC code (agriculture omitted)		
Mining	-0.04	-0.07	-0.04
Manufact. Oth.	-0.07	-0.04	-0.03
Manufact. Oth.	-0.08	-0.05	-0.05
Utilities	-0.08	-0.01	0.03
Construct.	-0.05	-0.02	-0.02
Trade/retail	-0.08	-0.07	-0.08
Transport	-0.06	-0.06	-0.07
FIRE	-0.07	-0.08	-0.03
Services	-0.06	-0.05	-0.05
Other	-0.07	-0.03	-0.04
	Household type (self-employed omitted)		
Casual labor	-0.04	-0.01	0.02
Other	-0.02	-0.05	-0.07

* Time-Use states only.

Regressions include cubic in household size and real expenditure

scheduled caste, tribe, religion, and head age and gender and state dummies.

Table 13: Regressions of log caloric intake per capita on household size for different household types (rich/poor, urban/rural)

Year	1993-1994				2009-2010			
	Rural		Urban		Rural		Urban	
	Rich	Poor	Rich	Poor	Rich	Poor	Rich	Poor
Log household size	-0.0559***	0.00210	-0.102***	-0.0170***	-0.104***	-0.0604***	-0.134***	-0.0717***
	(0.00484)	(0.00334)	(0.00481)	(0.00642)	(0.00375)	(0.00403)	(0.00420)	(0.00725)
R^2	0.657	0.711	0.657	0.691	0.703	0.764	0.710	0.791
Obs.	24,123	34,737	22,834	13,191	29,620	22,489	24,552	9,683

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Rich/poor defined as above/below 5.73 log real per capita monthly expenditure.

Sample only includes households with between 2 and 8 members.

Controls include cubic in log real expenditure, demographics, and rural village/urban block dummies.

Table 14: Percent change in food and grain shares, with decomposition

	Rural food share			Urban food share		
	1983-2005	1983-1993	1993-2005	1983-2005	1983-1993	1993-2005
Actual sched. 1	-0.126	-0.014	-0.112	-0.153	-0.014	-0.139
Actual sched. 10	-0.072		-0.057	-0.079		-0.065
Total Predicted	-0.064	-0.029	-0.035	-0.009	0.009	-0.018
Real expenditure	-0.010	-0.004	-0.006	-0.012	-0.007	-0.005
Demographics	-0.001	-0.001	0.000	-0.002	-0.001	-0.001
Occupation/educ.	-0.006	-0.002	-0.004	-0.005	-0.004	-0.001
Domestic tasks	0.000	0.000	0.000	0.000	0.000	0.000
Farm activities	-0.001	0.000	0.000			
Electric/fuel	-0.039	-0.018	-0.021	0.012	0.023	-0.011
Relative prices	-0.007	-0.004	-0.003	-0.002	-0.002	0.000
	Rural grain share of food			Urban grain share of food		
Actual sched. 1	-0.188	-0.123	-0.065	-0.081	-0.070	-0.012
Actual sched. 10	-0.149		-0.026	-0.056		0.014
Total Predicted	-0.244	-0.150	-0.094	-0.119	-0.076	-0.043
Real expenditure	-0.031	-0.012	-0.019	-0.018	-0.011	-0.007
Demographics	0.005	0.003	0.002	0.006	0.003	0.003
Occupation/educ.	-0.017	-0.007	-0.010	-0.007	-0.005	-0.003
Domestic tasks	-0.002	-0.002	0.000	-0.001	0.000	-0.001
Farm activities	0.000	-0.001	0.001			
Electric/fuel	-0.184	-0.123	-0.061	-0.083	-0.051	-0.032
Relative prices	-0.015	-0.007	-0.008	-0.016	-0.012	-0.004

Notes: Actual change is measured as difference in food or grain share vs. 1983
using either schedule 1 (detailed consumption) or schedule 10 (broader consumption groups).
Predicted change and components based on combination of coefficients from pooled
within-year regressions for 1983, 1987-88, 1993-94 and difference in mean household
characteristics in the sample vs. 1983 using schedule 1 and 10.
Relative prices calculated at state-level; see text for description of variables.

Table 15: Caloric requirement imputation: Time-Use classification and activity factors

TUS code	TUS desc.	% Rur. time	% Urb. time	FAO desc.	FAO factor	Comp. desc.	Comp. f
111	PLOUGHING, PREPARING LAND, CL	0.0153	0.0007	ploughing horse 4.8, buffalo 3	4	clearing land	5
112	SEWING, PLANTING, TRANSPLANTI	0.0066	0.0004	planting rice	3.7	planting seedlings, shrubs, tr	4.5
113	APPLICATION OF MANURE, FERTIL	0.0283	0.0022	fertilizing general	5.2	walking, applying fertilizer o	2.5
114	WEEDING	0.0103	0.0007	weeding general	4	weeding, cultivating garden	4.5
115	SUPERVISION OF WORK	0.0049	0.0006	standing	1.4	standing miscellaneous	2
116	KITCHEN GARDENING BACKYARD	0.0008	0.0002	weeding garden	3.3	general gardening	4
117	STOCKING, TRANSPORTING TO HOM	0.0021	0.0003	bundling rice	3.7	picking fruit off trees, picki	3
118	SALE AND PURCHASE RELATED ACT	0.0003	0.0000	standing	1.45	Sitting-light office work, etc	1.5
119	TRAVEL TO THE WORK	0.0112	0.0009	depends on type	.	depends on type	.
121	GRAZING ANIMALS OUTSIDE	0.0072	0.0003	walking around/strolling	2.1	farming, chasing cattle (non-s	3.5
122	TENDING ANIMALS CLEANING, W	0.0093	0.0009	tending animals	4.6	farming, feeding cattle, horse	4.5
123	CARING FOR ANIMALS : BREEDING	0.0009	0.0001	tending animals	4.6	farming, taking care of animal	6
124	MILKING AND PROCESSING OF MIL	0.0021	0.0003	milking by hand	3.6	milking by hand moderate effor	3
125	MAKING DUNG CAKES	0.0010	0.0001	making mud bricks (squatting)	3	FAO?WHO?UNU	3
126	POULTRY REARING FEEDING, CL	0.0002	0.0000	tending animals	4.6	farming, feeding small animals	4
127	OTHER RELATED ACTIVITIES	0.0010	0.0001		0		0
128	SALE AND PURCHASE RELATED ACT	0.0003	0.0001	standing	1.45	Sitting-light office work	1.5
129	TRAVEL TO THE WORK	0.0016	0.0001	depends on type	.	depends on type	.
131	NURSERY - SEEDLINGS	0.0001	0.0000	Forester-nursery work	3.6	planting seedlings, shrubs	4.5
132	PLANTING, TENDING, PROCESSING	0.0002	0.0000	planting trees	4.1	forestry, planting by hand	6
133	COLLECTING, STORING AND STOCK	0.0004	0.0000	picking by hand	3.4	picking fruit of trees,	3
134	WOOD CUTTING, CHOPPING AND	0.0012	0.0002	4.2 chopping wood (for fuel).	5	forestry ax chopping slow	5
135	FISH FARMING, CLEANING SEA-BE	0.0008	0.0004	line fishing 1.9, spear fishin	2.3	fishing general	3
136	CARE OF HOUSE PLANTS, INDOOR	0.0006	0.0002	weeding garden	3.3	general gardening	4
137	FLOWER GARDENING LANDSCAPIN	0.0001	0.0002	weeding garden	3.3	general gardening	4
138	SALE AND PURCHASE RELATED ACT	0.0002	0.0001	standing	1.45	Sitting-light office work	1.5
139	TRAVELLING TO THE WORK	0.0007	0.0001	depends on type	.	depends on type	.
140	FETCHING OF WATER	0.0022	0.0012	collecting water (from well)	4.5	farming, hauling water for ani	4.5
141	COLLECTION OF FRUITS, VEGETAB	0.0020	0.0010	picking fruit by hand	3.4	picking fruit of trees,	3
142	COLLECTION OF MINOR FOREST PR	0.0008	0.0002	collecting wood (for fuel)	3.3	picking fruit of trees,	3
143	COLLECTION OF FUEL/FUEL WOOD/	0.0013	0.0001	collecting wood (for fuel) is	3.8	carrying, loading or stacking	5
144	COLLECTION OF RAW MATERIAL FO	0.0022	0.0003	collecting wood (for fuel)	3.3	picking fruit of trees,	3
145	COLLECTION OF BUILDING MATERI	0.0000	0.0000	builder carrying wood	6.6	carrying, loading or stacking	5
146	COLLECTION OF FODDER	0.0013	0.0001	carrying straw	3.1	FAO?WHO?UNU	3.1
147	SALE AND PURCHASE RELATED ACT	0.0011	0.0001	standing	1.45	Sitting-light office work	1.5
148	COLLECTION OF OTHER ITEMS	0.0002	0.0001	collecting wood (for fuel)	3.3	picking fruit of trees,	3
149	TRAVEL TO WORK	0.0009	0.0001	depends on type	.	depends on type	.
152	MILLING, HUSKING, POUNDING	0.0007	0.0003	pounding grain	5.6	FAO?WHO?UNU	5.6
153	PARBOILING	0.0002	0.0000	standing	1.45	FAO?WHO?UNU	1.4
154	SORTING, GRADING	0.0004	0.0002	sorting ground nuts	1.9	FAO?WHO?UNU	1.9
155	GRINDING, CRUSHING	0.0003	0.0003	grinding grain using millstone	4.6	FAO?WHO?UNU	4.6
156	ANY OTHER RELATED ACTIVITY	0.0002	0.0002		0		0
157	SALES AND PURCHASE RELATED AC	0.0000	0.0001	standing	1.45	Sitting-light office work	1.5
159	TRAVEL FOR THE WORK	0.0001	0.0000	depends on type	.	depends on type	.
161	MINING/EXTRACTION OF SALT,	0.0000	0.0000	shovelling	4.6	coal mining/general	6
162	MINING/DIGGING/QUARRYING OF S	0.0009	0.0004	drilling with jackhammer	3.9	coal mining/general	6
163	DIGGING OUT CLAY, GRAVEL AND	0.0007	0.0003	shovelling	4.6	coal mining/general	6
164	DIGGING OUT MINERALS MAJOR	0.0000	0.0000	shovelling	4.6	coal mining/general	6
165	TRANSPORTING IN VEHICLES	0.0001	0.0001	driving a car/truck	2	driving	2
166	STORING, STOCKING	0.0001	0.0002	loading operations	3.2	shovelling coal	7
167	ANY OTHER RELATED ACTIVITY	0.0002	0.0002		0		0
168	SALE AND PURCHASE RELATED ACT	0.0000	0.0000	standing	1.45	Sitting-light office work	1.5
169	TRAVEL FOR THE WORK	0.0003	0.0002	depends on type	.	depends on type	.
211	BUILDING AND CONSTRUCTION OF DW	0.0032	0.0034	Chiselling=5, sawing/planing a	5	construction outside remodelli	5.5
212	CONSTRUCTION AND REPAIR OF AN	0.0001	0.0001		5	construction outside remodelli	5.5
213	CONSTRUCTION OF WALL, STORAGE	0.0004	0.0001		5	construction outside remodelli	5.5
214	CONSTRUCTION OF PUBLIC WORKS/	0.0006	0.0004		5	building road	6
217	ANY OTHER ACTIVITY RELATED	0.0005	0.0009		0		0
218	SALES AND PURCHASE RELATED AC	0.0001	0.0001	standing	1.45	Sitting-light office work	1.5
219	TRAVEL TO THE WORK	0.0006	0.0007	depends on type	.	depends on type	.
221	FOOD PROCESSING AND COOKING F	0.0010	0.0021	bakery work	2.5	bakery general moderate effort	4
222	BUTCHERING, CURING, PROCESSIN	0.0001	0.0001	bakery work	2.5	butchering	6
223	MANUFACTURING OF TEXTILES S	0.0031	0.0074	textile factory work	3.1	tailoring general	2.5
224	MAKING HANDICRAFTS, POTTERY,	0.0024	0.0023	shoemaker	2.6	shoe repair general	2.5
225	FITTING, INSTALLING, TOOL SET	0.0007	0.0018	textile factory work	3.1	machine tooling	3
226	ASSEMBLING MACHINES, EQUIPMEN	0.0002	0.0006	textile factory work	3.1	automobile repair	3
227	PRODUCTION RELATED WORK IN LA	0.0016	0.0030	textile factory work	3.1	automobile repair	3
228	SALE AND PURCHASE RELATED ACT	0.0003	0.0006	standing	1.45	Sitting-light office work	1.5
229	TRAVEL FOR THE WORK	0.0006	0.0014	depends on type	.	depends on type	.

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TUS code	TUS desc.	% Rural time	% Urban time	FAO desc.	Factor	Comp. desc.	Factor
311	BUYING AND SELLING GOODS SU	0.0043	0.0136	standing	1.45	Sitting-light office work	1.5
312	PETTY TRADING, STREET AND DOO	0.0018	0.0041	walking/strolling around	2.1	walking slowly and carrying li	3
313	TRANSPORTING GOODS IN TRUCKS,	0.0005	0.0015	driving a car/truck	2	automobile or light truck driv	2
314	TRANSPORTING IN HAND CARTS, A	0.0002	0.0017	pulling a hand cart unloaded	4.82	pushing a wheel chair	4
315	TRANSPORT OF PASSENGER BY MOT	0.0001	0.0011	driving a car/truck	2	automobile or light truck driv	2
317	ANY OTHER ACTIVITY	0.0005	0.0024		0		0
319	TRAVEL TO WORK	0.0005	0.0022	depends on type	.	depends on type	.
321	SERVICE IN GOVERNMENT AND SEM	0.0033	0.0155	writing	1.4	Sitting light office work	1.5
322	SERVICE IN PRIVATE ORGANISATI	0.0018	0.0106	writing	1.4	Sitting light office work	1.5
323	PETTY SERVICE : DOMESTIC SERV	0.0028	0.0058	housework (unspecified)	2.8	shoe repair general	2.5
324	PROFESSIONAL SERVICES : MEDIC	0.0016	0.0037	standing	1.45	standing light (bartending, st	1.8
325	PROFESSIONAL SERVICES : COMPU	0.0003	0.0008	standing	1.45	standing light (bartending, st	1.8
326	TECHNICAL SERVICES: PLUMBING,	0.0004	0.0019	writing	1.4	electrical work, plumbing	3.5
327	OTHERS	0.0018	0.0034		0		0
329	TRAVEL TO WORK	0.0015	0.0058	depends on type	.	depends on type	.
411	COOKING FOOD ITEMS, BEVERAGES	0.0411	0.0424	peeling vegetables(1.9), makin	2.4	cooking indian bread on an out	3
421	CLEANING AND UPKEEP OF DWELLI	0.0132	0.0122	Housework unspecified 2.8, Swe	2.8	cleaning house or cabin, gener	3
422	CLEANING OF UTENSILS	0.0090	0.0097	cleaning dishes	1.7	washing dishes	2.3
431	CARE OF TEXTILES: SORTING, ME	0.0076	0.0105	washing clothes	2.8	implied walking putting away c	2.3
441	SHOPPING FOR GOODS AND NON-PE	0.0063	0.0061	walking around/strolling	2.1	food shopping standing and wal	2.3
451	HOUSEHOLD MANAGEMENT: PLANNIN	0.0006	0.0008	writing	1.4	Sitting-light office work	1.5
461	DO-IT-YOURSELF HOME IMPROVEME	0.0039	0.0036	housework (unspecified)	2.8	home repair painting fence	4.5
471	PET CARE	0.0003	0.0001	child care(unspecified)	2.5	feeding animals	2.5
481	TRAVEL RELATED TO HOUSEHOLD M	0.0050	0.0034	depends on type	.	depends on type	.
491	HOUSEHOLD MAINTENANCE, MANAGE	0.0073	0.0050	housework (unspecified)	2.8	food shopping standing and wal	2.3
511	PHYSICAL CARE OF CHILDREN: WA	0.0093	0.0094	bathing child (standing)	3.5	child care standing	3
521	TEACHING, TRAINING AND INSTRU	0.0008	0.0021	standing	1.45	Sitting-light office work	1.5
531	ACCOMPANYING CHILDREN TO PLAC	0.0007	0.0007	depends on type	.	depends on type	.
541	PHYSICAL CARE OF THE SICK, DI	0.0007	0.0005	child care unspecified	2.5	elder care	4
551	ACCOMPANYING ADULTS TO RECEIV	0.0001	0.0001	depends on type	.	depends on type	.
561	SUPERVISING CHILDREN NEEDING	0.0037	0.0028	child care unspecified	2.5	standing light (bartending, st	1.8
562	SUPERVISING ADULTS NEEDING CA	0.0002	0.0002	child care unspecified	2.5	standing light (bartending, st	1.8
571	TRAVEL RELATED TO CARE OF CHI	0.0002	0.0002	depends on type	.	depends on type	.
572	TRAVEL RELATED TO CARE OF ADU	0.0001	0.0001	depends on type	.	depends on type	.
581	TAKING CARE OF GUESTS/VISITOR	0.0003	0.0007	child care unspecified	2.5	standing light (bartending, st	1.8
591	ANY OTHER ACTIVITY NOT MENTIO	0.0004	0.0005	.	0	.	0
611	COMMUNITY ORGANISED CONSTRUCT	0.0000	0.0000	sawing softwood (intermediate	5	building road	6
621	COMMUNITY ORGANISED WORK: COO	0.0000	0.0000	peeling vegetab;es	2.4	cooking indian bread on an out	3
631	VOLUNTEERING WITH FOR AN ORGA	0.0000	0.0000	standing	1.45	volunteering sitting, moderate	2.5
641	VOLUNTEER WORK THROUGH ORGANI	0.0000	0.0000	standing	1.45	volunteering sitting, moderate	2.5
651	PARTICIPATION IN MEETINGS OF	0.0001	0.0001	standing	1.45	Volunteer sitting meeting, g	1.5
661	INVOLVEMENT IN CIVIC AND RELA	0.0001	0.0000	standing	1.45	volunteer- standing, light wor	2.3
671	INFORMAL HELP TO OTHER HOUSEH	0.0004	0.0004	standing	1.45	volunteer- standing, light wor	2.3
681	COMMUNITY SERVICES NOT ELSEWH	0.0001	0.0001	standing	1.45	volunteer- standing, light wor	2.3
691	TRAVEL RELATED TO COMMUNITY S	0.0001	0.0001	depends on type	.	depends on type	.
711	GENERAL EDUCATION: SCHOOL/UNI	0.0239	0.0260	reading	1.4	Miscellaneous sitting, study	1.8
721	STUDIES, HOMEWORK AND COURSE	0.0181	0.0230	reading	1.4	Sitting-light office work	1.5
731	ADDITIONAL STUDY, NON-FORMAL	0.0002	0.0005	reading	1.4	Sitting-light office work	1.5
741	NON FORMAL EDUCATION BY CHILD	0.0000	0.0000	reading	1.4	Sitting-light office work	1.5
751	WORK-RELATED TRAINING	0.0001	0.0002	reading	1.4	Sitting-light office work	1.5
761	TRAINING UNDER GOVERNMENT PRO	0.0000	0.0000	reading	1.4	Sitting-light office work	1.5
771	OTHER TRAINING/EDUCATION	0.0002	0.0007	reading	1.4	Sitting-light office work	1.5
781	LEARNING NOT ELSEWHERE CLASSI	0.0003	0.0007	reading	1.4	Sitting-light office work	1.5
791	TRAVEL RELATED TO LEARNING	0.0036	0.0045	depends on type	.	depends on type	.
811	PARTICIPATING IN SOCIAL EVENT	0.0012	0.0010	standing	1.45	religious activities standin	1.5
812	PARTICIPATING IN RELIGIOUS AC	0.0032	0.0045	standing	1.45	religious activities standin	1.5
813	PARTICIPATING IN COMMUNITY FU	0.0001	0.0001	Dancing	5	religious activities dancing	5
814	SOCIALIZING AT HOME AND OUTSI	0.0008	0.0015	standing	1.45	standing, talking outside home	1.8
821	ARTS, MAKING MUSIC, HOBBIES A	0.0001	0.0005	playing cards/board games	1.6	miscellaneous sitting arts and	2
822	INDOOR AND OUTDOOR SPORTS PAR	0.0020	0.0025	Between running and batting/bo	5.5	cricket	5
831	GAMES AND OTHER PAST-TIME ACT	0.0225	0.0176	playing cards/board games	1.6	Miscellaneous sitting board	1.5
832	SPECTATOR TO SPORTS, EXHIBITI	0.0015	0.0022	watching tv	1.66	Miscelaneous sitting at spor	1.5
841	OTHER RELATED ACTIVITIES	0.0004	0.0008	watching tv	1.66	Miscelaneous sitting at spor	1.5
851	READING, OTHER THAN NEWSPAPER	0.0031	0.0051	reading	1.22	sitting reading	1.3
852	WATCHING TELEVISION AND VIDEO	0.0275	0.0764	watching tv	1.66	inactivity quiet watching tv	1
853	LISTENING TO MUSIC/RADIO	0.0040	0.0022	listenening to radio/music ave	1.5	inactivity quiet watching tv	1
861	ACCESSING INFORMATION BY COMP	0.0001	0.0001	watching tv	1.66	sitting reading	1.3
862	VISITING LIBRARY	0.0001	0.0003	reading	1.4	sitting reading	1.3
863	READING NEWSPAPER, MAGAZINES	0.0015	0.0061	reading	1.4	sitting reading	1.3
871	MASS MEDIA USE AND ENTERTAINM	0.0004	0.0015	reading	1.4	sitting reading	1.3

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TUS code	TUS desc.	% Rural time	% Urban time	FAO desc.	Factor	Comp. desc.	Factor
891	TRAVEL RELATED TO SOCIAL, CUL	0.0033	0.0042	depends on type	.	depends on type	.
892	TRAVEL RELATING TO SEARCH OF	0.0001	0.0004	depends on type	.	depends on type	.
911	SLEEP AND RELATED ACTIVITIES	0.3766	0.3738	sleeping	1	sleeping	0.9
921	EATING AND DRINKING	0.0563	0.0586	eating and drinking	1.5	eating sitting	1.5
922	SMOKING, DRINKING ALCOHOL AND	0.0011	0.0005	eating and drinking	1.5	eating sitting	1.5
931	PERSONAL HYGIENE AND HEALTH	0.0444	0.0425	Average of washing hands/face	2	grooming	2
932	WALKING, EXERCISE MINING, JOG	0.0028	0.0044	Between running and batting/bo	5.5		5
941	RECEIVING MEDICAL AND PERSONA	0.0002	0.0003	sitting quietly	1.2	sitting reading	1.3
942	RECEIVING MEDICAL AND PERSONA	0.0001	0.0001	sitting quietly	1.2	sitting reading	1.3
951	TALKING, GOSSIPING AND QUARRE	0.0486	0.0402	standing average for men and w	1.45	sitting talking on the phone	1.5
961	DOING NOTHING, REST AND RELAX	0.0651	0.0540	sitting quietly	1.2	lying quietly doing nothing	1
962	FORCED LEISURE	0.0012	0.0009	sitting quietly	1.2	lying quietly doing nothing	1
971	INDIVIDUAL RELIGIOUS PRACTICE	0.0037	0.0069	standing	1.2	inactivity light meditation	1
981	OTHER ACTIVITIES	0.0038	0.0043	standing	0		0
982	RESTING/CONVALESCING DUE TO P	0.0016	0.0015	lying	1.2	lying quietly doing nothing	1
991	TRAVEL RELATED TO PERSONAL CA	0.0037	0.0032	depends on type	.	depends on type	.

FAO factors expressed as PAL (physical activity level), from Annex 5 of FAO/WHO/UNU Expert Consultation (2001).
Compendium (Comp.) factors expressed as MET (metabolic equivalent task) from et al. (2000).