

# The Calorie Consumption Puzzle in India: An Empirical Investigation\*

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## Abstract

Over the past four decades, India has witnessed a paradoxical trend: average per capita calorie intake has declined even as real per capita monthly expenditure has increased over time. Since cross sectional evidence suggests a robust positive relationship between the two variables, the trend emerges as a major puzzle. The main explanations that have been offered in the literature to address the puzzle are: rural impoverishment, relative price changes, decline in calorie needs, diversification of diets, a squeeze on the food budget due to rising expenditures on non-food essentials, and decline in subsistence consumption (due to commercialization). In this paper we construct a novel panel dataset from household-level National Sample Survey data to test the “food budget squeeze.” Our panel consists of 74 NSS “state-regions” over six time periods (1983–84, 1987–88, 1993–94, 1999–00, 2004–05 and 2009–10). We demonstrate a strong effect of rising expenditures on non-food essentials like health, education, transportation and services, on calorie intake. We also construct a food price index directly from household-level expenditure data and show that the real food budget has been stagnant in India since the late 1980s.

**JEL Classification:** O1; I130.

**Keywords:** calorie consumption puzzle, India, panel data.

## 1 Introduction

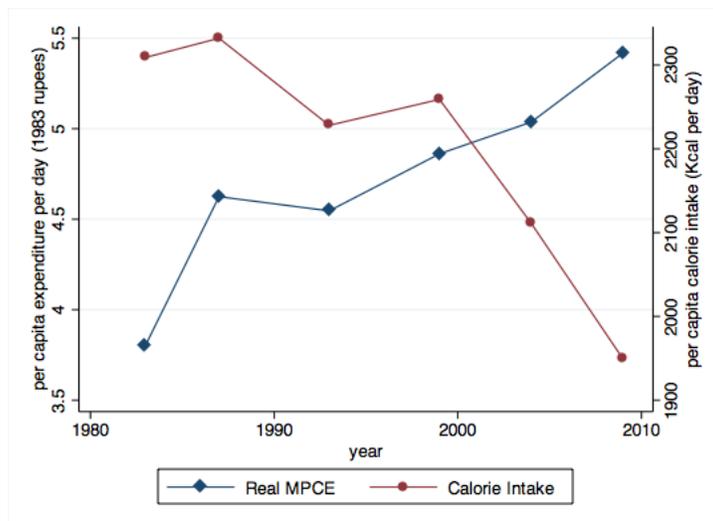
One of the most enduring puzzles related to economic development in India over the past few decades is what Chandrasekhar and Ghosh (2003) have called the calorie consumption puzzle. Average calorie intake has declined over time in India even as real consumption expenditures (and by most measures real per capita incomes) have increased. Since cross sectional evidence shows a robust positive relationship between per capita income and calorie intake, the time series pattern

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**Figure 1:** Real monthly per capita expenditure (in 1983 rupees) and estimated average calorie intake (Kcal per day) in rural India. Source: Authors calculations based on various NSS rounds.

in India clearly presents a puzzle. Moreover, the puzzle has been around for a long time. Data collected from the large scale, nationally representative consumption expenditure surveys (CES) conducted roughly every five years by the National Sample Survey Organization (NSSO), the so-called thick rounds, show that this trend starts in 1972–73 (NSSO, 1996).

Deaton and Dreze (2009) provide a comprehensive analysis of the facts pertaining to and possible interpretations of this puzzle with data running from 1983 (the 38th round of the NSS) to 2004–05 (the 61st round of the NSS). They find that estimated average calorie intake in rural areas declined by about 10 percent over the two decade period between 1983 and 2004, the decline being higher at the upper end of the expenditure distribution. Urban areas witnessed a milder decline in estimated average calorie intake. Real average monthly per capita expenditure (MPCE) increased substantially (about 22 percent in rural areas in India) over the same period. When we extend the analysis to 2009–10 (the 66th round of the NSS), we see that the same trend continues. For instance, in the period between 1983 and 2009, estimated average calorie intake in rural India declined by about 15 percent. During this period, on the other hand, real average MPCE increased by 42 percent in rural areas. Thus, this opposite trend movement in calorie intake and real MPCE highlighted in Figure 1 indicates that the calorie consumption puzzle endures: as people become richer, they consume less calories.

There is disagreement in the literature on whether this should be a matter of concern, as far as nutritional status of the Indian population is concerned. One approach, taken by Utsa Patnaik, has been to argue that falling calorie intake indicates a real and substantial welfare loss, and that total expenditures (and incomes) have in fact not risen in real terms. Hence there is no puzzle to explain. There has been a vigorous debate in the pages of the Economic and Political Weekly over whether real expenditures have been rising or falling (Patnaik, 2004, 2007, 2010a,b; Deaton and Dreze, 2009, 2010). Using our own food price index constructed from unit-level NSS data from the six thick consumption-expenditure (CES) rounds since 1983, we also find that total household expenditures have risen in real terms, in rural India over this period. Hence we do not pursue the falling real expenditures explanation.

Deaton and Dreze (2009) have favored the explanation that people consume fewer calories because their calorie needs have declined over time due to improvement in the epidemiological environment, changes in occupational structures, and mechanization of agricultural work (Rao, 2000; Mittal, 2007; Deaton and Dreze, 2009; Li and Eli, 2010)<sup>1</sup>. While they do not offer any direct evidence in support of the hypothesis, they do indicate that anthropometric measures such as height-for-age, weight-for-height, and weight-for-age among children and adult BMI have shown improvement over time in India. Thus, if these outcome variables are improving it is not clear why the decline in calorie intake should be a matter of concern.

Two comments may be made against this view. First, as Deaton and Dreze (2009) also argue, even though anthropometric measurements have improved in India, they are still among the worst in the world, for both adults and children, and improvements are slow relative to what might be expected given recent rates of economic growth. The authors note that,

Undernutrition levels in India remain higher than for most countries of sub-Saharan Africa, even though those countries are currently much poorer than India, have grown much more slowly, and have much higher levels of infant and child mortality. (p. 42)

Second, a voluntary or non-coercive explanation of calorie intake decline has to contend with

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<sup>1</sup>Some researchers like Gaiha et al. (2010) emphasize the importance of price changes in driving the puzzle, which is a coercive explanation, but also find evidence in support of the declining calorie needs thesis, which is a non-coercive explanation.

the fact that for the majority of rural Indians, per capita calorie intake is still well below both the 1972 poverty line norm of 2400 kcal per capita per day for rural areas and the more recent standards developed by the Indian Council for Medical Research<sup>2</sup>. The question remains, would people voluntarily reduce calorie intake while falling well short of basic nutritional requirements?

Taken together, the continued poor performance of India in improving child and adult nutrition and the relatively low levels of calorie intake in a significant proportion of the population suggest that a coercive mechanism (as opposed to purely a voluntary reduction in intake) may indeed be at work. In this paper, we offer evidence for one such mechanism: a squeeze on the food budget (Mehta and Venkatraman, 2000; Sen, 2005; Deaton and Dreze, 2009). A food budget squeeze can arise if rapidly rising expenses on non-food essentials like health care, education, transportation and other essential services absorb all the increases in total expenditures and keep real expenditures on food from rising. This can have an important coercive component driven by a decline in the supply of social services by the State.

We construct a panel dataset from household level National Sample Survey data, to empirically investigate the relationship between share of expenditure spent on non-food essentials (a proxy for the operation of food budget squeeze) and calorie intake over time taking advantage of regional variation in these (and other relevant) variables. The NSSO divides each Indian state into regions based on geographical and agro-ecological criteria. Samples from each such “state-region” are representative of that region. Our complete panel consists of rural areas of 74 state-regions from the six thick rounds of the NSS: 1983-1984 (38th round), 1987-1988 (43rd round), 1993-1994 (50th round), 1999-2000 (55th round), 2004-2005 (61st round), and 2009-2010 (66th round) (see methods for details). The regression results presented in Section Five, utilize only four time periods, due to data-matching constraints.

The choice of rural India is motivated by several facts. First, according to the provisional population data from the 2011 Census, about 69 percent of Indians lived in rural areas in 2011.

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<sup>2</sup>Over the years, the Indian Council for Medical Research (ICMR) has recomputed the Indian calorie norms informed by improved methodologies and using more complete information. The most recent figures for Indian calorie norms were released by the ICMR in 2009. For men, the calorie norms (measured in Kcal per day) were as follows: 2320 (sedentary work), 2730 (moderate work), 3490 (heavy work). The corresponding norms for women were: 1900 (sedentary work), 2230 (moderate work), 2850 (heavy work) (ICMR, 2009, Table 4.14).

Thus, the majority of the Indian population lives in rural areas even today. Second, there is widespread consensus that poverty and deprivation is more acute in rural areas. Lastly, a key non-coercive explanation for the puzzle is the reduction in share of rural population engaged in hard agricultural labour. Hence, focusing on rural India for investigating the calorie consumption puzzle seems natural.

Using fixed effects estimation, we find a robust significant negative effect of the share of non-food essential expenditures on calorie intake; we interpret this as evidence in favour of the food budget squeeze hypothesis. In quantitative terms, we find that a 1% increase in the share of monthly expenditure on non-food essentials is associated with a 1% decline in calorie intake after controlling for changes in real expenditures, calorie needs, home-grown cereal consumption, and diversification of diets.

The rest of the paper is organized as follows. Section 2 presents a brief summary of the explanations that have so far been offered in the literature about the calorie consumption puzzle. Section 3 investigates the possible determinants of calorie consumption; this leads to the empirical model of the paper. The empirical model and data are discussed in section 4. Section 5 contains the main results of the paper. In section 6 we discuss the results and section 7 concludes.

## **2 Declining calorie needs or a squeeze on the food budget?**

The recent study by Deaton and Dreze (2009) provides a comprehensive account of different explanations advanced for the Indian calorie consumption puzzle. After an analysis of the empirical evidence related to all the major factors that have been offered, the authors tentatively accept declines in required calories as the most plausible explanation. They note that decline in the need for calories can arise due to changes in occupational structure (the main factor being reduction in proportion of the workforce engaged in agricultural work), mechanization of agricultural work, improvement in the epidemiological environment (e.g., access to better drinking water and health care), decline in fertility, and labour saving technical change within the households (e.g., increasing use of consumer durables).

While their hypothesis is plausible, they present no direct evidence in support of it. Further, it

is well-known that calorie intake has been falling across all deciles of the expenditure distribution (with the exception of the bottommost decile, where it is stagnant, see Figure 4). It is not clear that a decline in calorie needs, even if it has occurred, can completely explain the decline in average calorie intakes, especially for the lower expenditure deciles where calorie intakes are still very low. In 2009, all MPCE deciles except the top three fell below the 1972 poverty line norm of 2400 Kcal per capita per day and even below the updated 2009 norms published by the Indian Council of Medical Research (author's calculations and ICMR (2009, Table 4.14)). The lower five MPCE deciles lie far below the line having average calorie consumption of less than 2100 Kcal per capita per day. The needs explanation requires us to believe that a significant proportion of rural Indians is voluntarily foregoing food consumption even while falling far short of the basic minimum nutritional requirement.

An alternative explanation considered briefly by Deaton and Dreze, but more substantially emphasized by Sen (2005) and Mehta and Venkatraman (2000), we believe, is likely to be at least as important as declining needs, if not more so. Sen argues,

[It is likely] that the cost of meeting the minimum non-food requirements has increased to such an extent that the earlier proportion of expenditures no longer suffices and a larger proportion has to be applied to meet the requirements, thereby leading to a decrease in the income left available for food. There are at least two items of non-food expenditure- rent and health care- which may take precedence over food as claims on income, and it has been observed that these are the fastest growing components of household expenditure in urban and rural areas respectively.

Similarly, in a recent study that sets out to explain India's missing calories in terms of declining calorie needs also concludes that while the rural-urban difference in calorie intake can be explained by reduced needs, declining needs are not enough to explain the downward shift in calorie Engel curves over time in India (Eli and Li, 2012). Interestingly, the authors favor a food budget squeeze explanation as well

... analyzing the composition of household budgets directly if food budget shares have fallen holding real expenditure constant, which categories have been rising?...certain

categories particularly use of fuel and light, and education have increased substantially, others have increased slightly (transportation, services, durables, and non-durables) and others are mixed (clothing, medical care). The 10 percentage point decline in budget share for food can be almost entirely explained by the upward shift in energy use and education expenditure, which suggests that relative price effects, complementarity with new goods, and investment related expenditures can explain a substantial part of the downward shift in calorie Engel curves over time. (p. 26)

Both these account suggest that increases in essential non-food expenditures like fuel, education, healthcare, services, and transportation have not allowed the food budget to increase over time. In the next section we present direct evidence from the NSS thick rounds, that this is indeed the case.

Independent of declining needs or food expenditures, there are two other factors that have a direct bearing on calorie intake. The first is decreasing proportion of food consumed out of home production. This is an important issue because home-grown cereals have traditionally been an important source of calories and the reduced home-produced calories may or may not be substituted by market-purchased calories depending on changing tastes and the overall growth in the food budget. While Deaton and Dreze (2009) mention the possibility of declines in consumption out of home production they fear that lack of data makes this issue difficult to address.

Lastly, a relatively non-controversial phenomenon that has a bearing on the decline in calorie intake is the diversification of diets. A slow but steady substitution of cheaper with more expensive sources of calories, e.g., rice and wheat with vegetables and fruits, in both rural and urban India has been noted by several scholars (Rao, 2000; Mittal, 2007). A substitution of more expensive calories for cheaper ones, given a constant food budget, is expected to reduce calorie intake.

Drawing on this discussion, in the next section, we investigate the determinants of calorie intake for the average rural household. In the subsequent section, we use our investigation of the determinants of calorie intake to construct an empirical model and use a panel data set to estimate its key parameters. The estimated parameters, both their magnitudes and signs, offer us some clues about a possible solution to the calorie consumption puzzle.

### 3 Determinants of Calorie Consumption

In a developing country like India, there are two sources of calorie intake: (a) food purchased in the market, and (b) non-market access to food (home grown, accessed from common property resources, etc.). The calorie intake from purchased food depends on the total real expenditure on food and how it is divided between various items. In the context of a poor country facing calorie deficits, it is useful to distinguish between two types of food items, cereals and non-cereals, because the former are a cheaper source of calories and have traditionally been the largest part of the food basket of poor households. Thus, denoting by  $C$  the total calorie consumption, we have

$$C = f\left(\frac{E_f}{p_f}, w_c, NM_f\right) \quad (1)$$

where  $E_f$  refers to the total expenditure on food,  $p_f$  refers to an index of food prices,  $w_c$  denotes the share of food expenditure devoted to cereals, and  $NM_f$  refers to non-market food that is available to the household.

The total expenditure on food depends on the share of expenditure devoted to non-food items and the total expenditure of the household. The share of expenditure devoted to non-food items, in turn, depends crucially on what we might term expenditure on non-food essentials and calorie needs of the household. Non-food essentials include education of children as well as health care, transportation and other essential services that are necessary to sustain a decent modern life. Calorie needs of a household, on the other hand, depends on the occupational pattern, i.e., whether the family is involved in agricultural work, the epidemiological environment, induction of labour-saving technologies within the household, and other such factors. Thus

$$E_f = h(w_{nfe}, E, CN) \quad (2)$$

where  $w_{nfe}$  refers to the share of total expenditure devoted to non-food essentials,  $E$  refers to the total expenditure of the household, and  $CN$  refers to the calorie needs of the household.

Incorporating (2) into (1), we get

$$C = f(w_{nfe}, \frac{E}{p_f}, CN, w_c, NM_f) \quad (3)$$

implying that five sets of factors are the proximate determinants of calorie consumption by households in rural India: the share of total expenditure devoted to non-food essentials ( $w_{nfe}$ ), the level of calorie needs ( $CN$ ), the total expenditure deflated by the food price index ( $E/p_f$ ), the share of food expenditure devoted to cereals ( $w_c$ ), and the access to non-market sources of food ( $NM_f$ ).

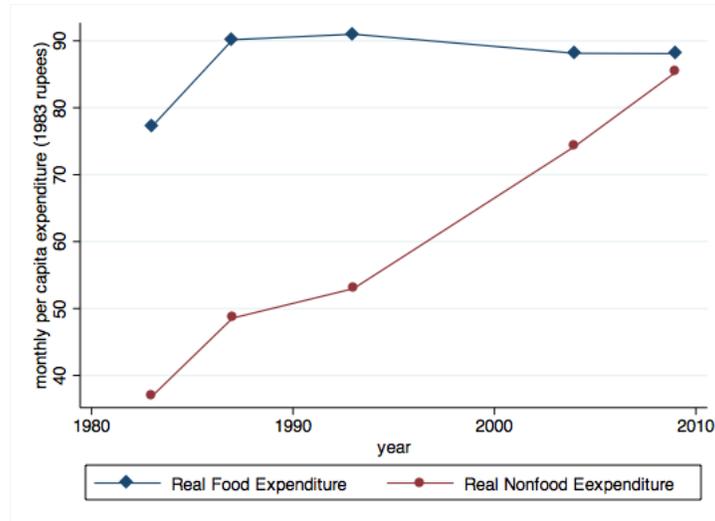
### 3.1 Expenditures on non-food essentials

The first factor on the RHS of (3), the share of expenditure devoted to non-food essentials (NFE) relates to the phenomenon of “food budget squeeze.” We feel that this is an especially important variable that has so far not received much attention in analyses of the calorie consumption puzzle. As we have already indicated, expenditures incurred on education, health care and transportation can be categorized as non-food essential expenses in the sense that they are necessary for a decent modern life. Thus, when the share of total expenditure devoted to such non-food essentials increases, it leaves less purchasing power for food consumption. Indeed, the trends in the food and non-food (all non-food items, not only essentials) expenditures are very revealing in this regard. Figure 2 shows that over the past three decades, non-food expenditures have increased steadily in real terms, while food expenditures have stagnated after the mid 1980s.<sup>3</sup>

It seems that all the income increases have been absorbed by expenditure on non-food items, so that food expenditures have not increased in real terms. This food budget squeeze is likely to be a function of several factors such as relative price movements, changes in real incomes, changes in tastes and preferences, and public provisioning of social services. Pressures squeezing the food budget from the demand side would include the increasing importance given to education by the poor who know full well that this is the most important route for upward social mobility.

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<sup>3</sup>Nominal household-level food expenditure data has been deflated using a Laspeyres-type chained food price index constructed directly from household-level data. See the Methods section for details.



**Figure 2:** *Real monthly per capita expenditure on food and non-food items (1983 rupees). Source: Authors calculations based on various NSS rounds.*

Additionally, demand for better and/or more formal- institutional health care like childbirth in hospitals or allopathic medicines would also increase the pressure on household budgets. Moreover, with the inability of the agricultural sector to generate stable incomes, peasants are forced to join the huge circuit of internal migration of labour in India. This increases transportation expenditures and creates additional demands on already strained household budgets.

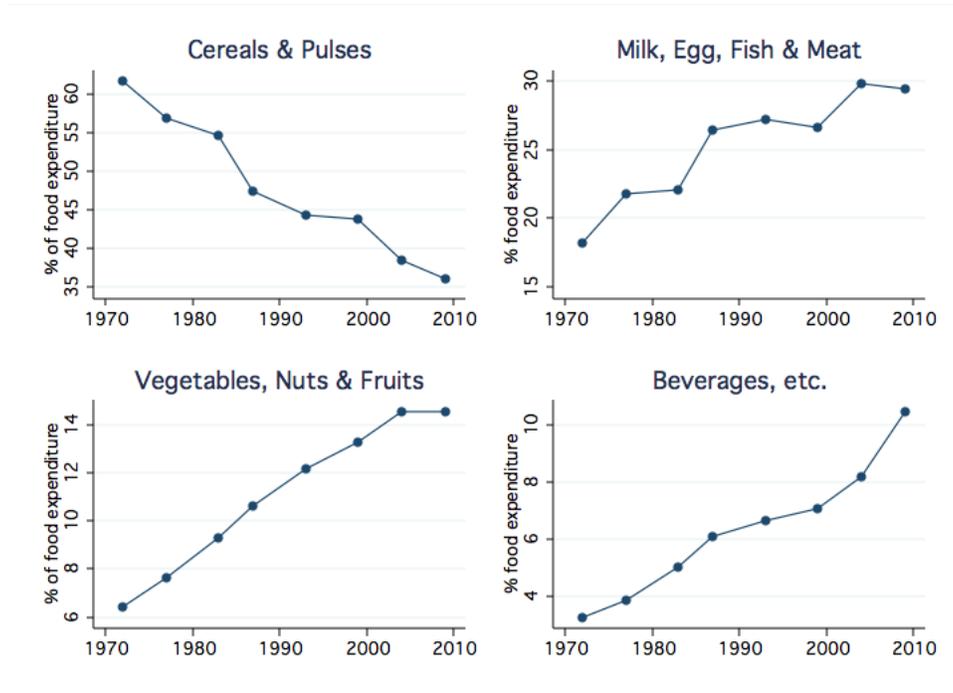
On the supply side, an important factor is stagnant or even declining public expenditure on social services in the post-reform period (Mooij and Dev, 2004; Joshi, 2006; Tilak, 2004). For example, throughout the 1990s, social sector expenditure, as a percentage of GDP, was lower than that in the late 1980s. Further, the quality of government-run schools has long been a matter of concern with high-rates of teacher absenteeism and lack of resources. For example, a recent nationwide survey finds that only 53.4% of children in Grade V can read a Grade II level text. Not surprisingly, it is seen that private schools are disproportionately located in villages with high rates of teacher absence in government schools and private school enrollment at the national level has increased steadily from 16.3% in 2005 to 24.3% in 2010 (Pratham, 2011; Chaudhury et al., 2005). With the State provisioning of these non-food essentials declining at the same time as the demand for these same services increases, an increasingly larger share of the household budget may be claimed by them. If this effect is big enough, it might lead to a food budget squeeze and lower

calorie intake by households.

### 3.2 Other determinants

The next variable on the RHS of (3) is CN, the calorie needs of the population. This is potentially an important variable, as argued by Deaton and Dreze (2009), and could be driven by several factors. First, it is a well known fact that, on average, agricultural work is far more physically demanding than non-agricultural work. Thus, as a larger share of the Indian workforce moves from agriculture to industry and services, the average calorie needs of the population might decline. Second, as the epidemiological environment of the country improves, the calorie absorption capacity of the population would increase. This might reduce the average calorie consumption needs of the population because a larger share of whatever is consumed can now be retained. Third, mechanization of key parts of agricultural work (like threshing), adoption of labour-saving durables within households, mechanization of transportation (i.e., switch from walking to using bicycles, from bicycles to motorcycles, and so on), and decline in the total fertility rates might also reduce the average calorie intake needs of the population. In our empirical analysis, we will use two variables to capture the calorie needs of the population at the state level: the share of the workforce that is in the agricultural sector, and the percentage of households that have access to safe drinking water, i.e., water coming from a tap, a tube well or a hand pump.

The next variable on the RHS of (3) is the food price-deflated total nominal expenditure ( $E/p_f$ ). In using the food price index to deflate nominal expenditure, we are departing from much of the existing literature that instead uses the consumer price index for agricultural labourers (CPIAL). Our reason for using the food price index is to control for changes in the price of food items over time because the dependent variable in our regression is calorie intake (which is derived from consumption of food items). Since the CPIAL contains both food and nonfood components, using it will be an accurate way to capture food price changes only when the two components of the CPIAL move together. To take account of possible divergences in the evolution of food and nonfood items, it is better to use an index of food prices. Since household level data on value and quantity of consumption of over 150 food items allow us to construct a price index based on actual prices faced



**Figure 3:** *Expenditure on Various Categories of Food Items, Rural India. Source: NSSO (2011).*

by households, we opt for this method.

The penultimate variable on the RHS of (3) is the share of the food budget that is devoted to cereals,  $w_c$ . We use this as a measure of the diversification of food consumption of households. It depends on both price and non-price factors, the former being the relative price of cereals to non-cereals, and the latter the preferences of households for a diversified diet at all relative price levels. For the purposes of the analysis in this paper, we do not need to distinguish between the different determinants of diversification; we will treat it as a variable in itself. Figure 3 presents a picture of diversification seen in the food budget of the average rural household in India over the past four decades. Even though the analysis in this paper is restricted to the period since 1993–94, Figure 3 drives home the point that rural India has indeed witnessed substantial diversification of the food budget over the last few decades. Thus it is important to control for this trend towards increasing consumption of more expensive calories in the forms of milk products, fruits, vegetables, and meat.

The last variable on the RHS of (3) is the total amount of food that a household can access

outside the market, most of which would come from home production. This variable is an extremely important one for a developing country like India where even today a large portion of the consumption of poor households, especially in rural areas, is met from non-market sources. More than 60 percent of milk, about 40 percent of wheat, 30 percent of rice, 11 to 18 percent of seven common pulses, and 14 percent of eggs, and a large portion of common vegetables consumed in rural India in 2004-05 came from home produce (NSSO, 2007). If structural transformation of the economy and commercialization forces households to seek a larger share of their consumption needs through market transactions, perverse price and income dynamics might kick in to reduce food/calorie intake. As we saw earlier, Deaton and Dreze (2009) note the importance of decline in non-market sources of food but feel that it is difficult to get an empirical handle on the effect. In fact the NSSO does collect data on quantity of food consumed out of home production. Hence the latter part of their assertion is only partly true. Here we construct a measure of home-grown consumption which is the share of cereals consumed out of home-grown stock (in kilograms) in total cereal consumption. We use this measure in the regressions to capture the effect of changes in access to non-market sources of food on calorie intake.

## 4 Data and Regression Model

The empirical analysis in this paper uses a novel panel data set that we have constructed from 6 thick rounds (1983-84, 1987-88, 1993-94, 1999-00, 2004-05, and 2009-10) of the quinquennial Consumption Expenditure Survey (CES) conducted by the National Sample Survey Organization (NSSO). The “thick” rounds of the CES are large scale, nationally representative surveys of households, conducted approximately every 5 years, which collects detailed data about the level and pattern of consumption expenditure.

While any round of the CES provides a wealth of information that can be useful in understanding cross sectional variations in calorie intake, a key component of the calorie consumption puzzle involves changes over time. Therefore, to analyze the time dimension of changes that underlie the calorie consumption puzzle, we need a data set that offers cross sectional and time variations. Unfortunately, the CES is not a panel data set, i.e., the same set of households are not interviewed

every time; rather, a stratified random sample is selected anew in every round. So, we construct a panel data set by aggregating household level information to what the NSSO refers to as “state-regions” for the six “thick round” years.

State-regions lie between states (which are bigger) and districts (which are smaller) and represent the lowest levels of aggregation at which the representative nature of the CES data is retained. Using detailed information on the creation of new states and districts, and reorganization of districts within states over time, we have constructed 74 unique state-regions that can be consistently compared for all the 6 thick rounds of the CES. Thus, our panel data set records observations for 74 state-regions for 6 time periods, giving us a sample of potential size 444 (some variables might not have observations for all the state-regions and all the time periods). However, due to some data constraints we are compelled to leave the 38th and 55th rounds out of the regression analysis presented in the next section.

The discussion in the previous section gives us the empirical model of this paper:

$$\begin{aligned} \log(CALINT_{it}) = & \beta_1 \times SNFE_{it} + \beta_2 \times \log(RMPCE_{it}) + \beta_3 \times ACT1_{it} + \beta_4 \times ACT2_{it} \\ & + \beta_5 \times SW_{it} + \beta_6 \times CRLSHR_{it} + \beta_7 \times NM_{it} + \alpha_i + \gamma_t + u_{it} \end{aligned} \quad (4)$$

where  $i = 1, 2, 3, \dots, n$  indexes the states of India,  $t = 1, 2, \dots, T$  indexes time periods,  $CALINT$  denotes estimated average calorie consumption,  $SNFE$  refers to the share of total expenditure devoted to non-food essentials,  $ACT1$  and  $ACT2$  are dummies corresponding to occupation codes (NCO-1968) for “heavy” and “medium” categories respectively (“light” is the omitted category) and hence measure the proportion of households in a given state-region belonging to these categories,  $SW$  stands for the proportion of households with access to safe drinking water,  $CRLSHR$  denotes the diversification of the average diet,  $RMPCE$  refers to real (total) expenditure,  $NM$  measures the access to non-market sources of food, and  $\alpha_i$  stands for a state-level time-invariant (or slowly changing) unobserved heterogeneity, and  $\gamma_t$  is a time-period fixed effect.

There is significant variation in average calorie consumption and its possible determinants across states and over time, as we highlight in the next subsection. Therefore, our empirical strategy exploits this variation by using a panel data set to test for the statistical significance of the co-

variation of average calorie intake with the proximate determinants discussed above. Our main interest lies in testing whether there is support for the food budget squeeze effect even after we have controlled for the effects of other possible determinants like changing calorie needs, changing dietary preferences, and changes in real expenditure.

The regression model has per capita calorie intake as the dependent variable and the following independent variables: real monthly per capita expenditure, share of monthly expenditure devoted to nonfood essentials, activity level, access to safe drinking water, degree of diversification of diet, and a measure of access to non-market sources of food. Each of these variables is computed at the household level and then aggregated to the state-region level using population weights (provided with data files for each CES).

The dependent variable in our regression is per capita per day calorie intake. Using details of consumption of over 150 food items, and the calorie conversion for each food item, we compute monthly calorie intake at the household level. Dividing monthly calorie intake by the household size and 30 gives us the estimate of per capita per day calorie intake.

The first independent variable in our regressions is the share of monthly expenditure devoted to nonfood essentials (SNFE), which is defined as the share of total monthly expenses devoted to the following four items: education, healthcare, transportation, and consumer services. Key items of nonfood consumption that are left out of NFE are the following: tobacco and intoxicants, fuel and lighting, clothing and footwear, and durable goods. The rationale for including the four items mentioned is that expenditure on these increased quite rapidly in the period in question and previous studies have also singled these items out as possible candidates for a food budget squeeze. The rationale for leaving out some non-food items is that our empirical methodology, to test for the food budget squeeze, relies on analyzing the sign and significance of the coefficient on SNFE in the regression model once we have controlled for total monthly real expenditure. SNFE is defined as the share of nonfood essential expenditures in total monthly expenditure, i.e.,

$$SNFE = NFE_i / (FE + NFE_i + NFE_e) \tag{5}$$

where  $FE$  denotes real expenditure on food,  $NFE_i$  (i for included) denotes real expenditure on education, healthcare, transportation and consumer services, and  $NFE_e$  (e for excluded) denotes real expenditure on excluded nonfood items. Note that total real MPCE is the sum of  $FE$ ,  $NFE_i$  and  $NFE_e$ . Thus, when we control for real MPCE, we restrict the denominator of SNFE to be constant.

If  $NFE_i$  increases, this increases  $SNFE$  (because the denominator is restricted to be constant). What will be the impact of this increase on calorie intake? Since the sum of  $FE$ ,  $NFE_i$  and  $NFE_e$  must remain unchanged, the increase in  $NFE_i$  must be balanced by a decline in the sum of  $FE$  and  $NFE_e$ . There are three distinct possibilities.

1.  $FE$  remains unchanged and  $NFE_e$  declines by exactly the amount of the increase in  $NFE_i$  (to keep the denominator constant): in this case, there will be no impact on calorie intake (since we have controlled for diversification and access to non-market sources of food).
2.  $FE$  increases and  $NFE_e$  declines by an amount that is larger than the increase in  $NFE_i$ : in this case, calorie intake will rise (since we have controlled for diversification and access to non-market sources of food).
3.  $FE$  falls and  $NFE_e$  declines by an amount that is smaller than the increase in  $NFE_i$ : in this case, calorie intake will decline (since we have controlled for diversification and access to non-market sources of food).

We will call case 3 as the food budget squeeze. This is the case where the increase in  $NFE_i$  is accompanied by a decline in  $FE$ , which translates into a fall in calorie intake. Thus, if the coefficient on  $SNFE$  is negative and statistically significant, that can be interpreted as evidence in favor of the food budget squeeze explanation of the calorie consumption puzzle.

It is worth noting that our empirical specification does not rule out any particular sign on the coefficient of  $SNFE$ . Since any of the three possibilities listed above can occur, it is possible for the sign to be positive, or negative. In fact, for most advanced capitalist countries in the world, we would expect a positive sign on SNFE because real expenditures have increased by enough to accommodate for increases in both  $FE$  and  $NFE$ . Thus, a negative sign on  $SNFE$  indicates a

food budget squeeze.

The next independent variable is real monthly per capita expenditure, which is defined as nominal monthly per capita expenditure deflated by a food price index. We compute the nominal monthly expenditure for a household by summing up the expenditures on all items reported in the CES. The food price index is constructed from household level price data as a chained Laspeyres-type index using the method outlined in Deaton (2008). Food price inflation as measured by our index matches results reported in the literature using the Consumer Price Index for Agricultural Laborers (CPI-AL).

Our regression model includes two variables that capture the effects of calorie needs, activity level and safe drinking water dummy. Using the National Classification of Occupations (NCO) codes, we create three dummy variables to capture activity levels (after making adjustment for supervisors and non-manual workers): heavy, moderate and light. Two of these dummy variables are included in the regression to control for the effects of activity levels on calorie intake<sup>4</sup>. The second variable that is meant to capture the effect of calorie needs is access to safe drinking water. We construct a dummy variable for this purpose which takes the value of unity if a household has access to water coming from a tap, tube well or hand pump, and zero otherwise. For CES rounds that do not report data on safe drinking water, we use the closest alternative household survey of the NSSO that has information on this variable.

In developing countries like India, a substantial proportion of calorie consumption comes from non-market sources; hence, it is important to take account of this. We use consumption of home grown cereals (rice, wheat and coarse cereals) as a share of the total consumption of cereals to capture the effect of changes in access to non-market sources of food on calorie intake trends over time.

The last independent variable in our regression, apart from state-region and year fixed effects, is the degree of diversification of diets of household. We measure the degree of diversification as the share of the food budget devoted to consumption of cereals.

Table 1 presents summary statistics for these seven variables. Estimated average per capita

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<sup>4</sup>We thank Prof. Richard Palmer-Jones for kindly sharing his code that classifies NCO codes into activity categories.

**Table 1: Summary Statistics for the Main Variables: Rural India<sup>a</sup>**

Year	CAL	RMPCE	NFE	ACT1	SW	CRLSHR	HMGRN
<b>1987–88</b>							
Mean	2333.41	152.18	0.08	0.77	0.51	0.41	0.33
Median	2280.81	141.81	0.08	0.81	0.50	0.40	0.32
SD	278.15	40.82	0.02	0.11	0.24	0.12	0.17
<b>1993–94</b>							
Mean	2247.75	154.91	0.10	0.74	0.63	0.39	0.31
Median	2199.05	146.23	0.10	0.78	0.69	0.40	0.31
SD	260.28	40.40	0.03	0.12	0.23	0.11	0.17
<b>2004–05</b>							
Mean	2110.41	176.68	0.15	0.71	0.77	0.32	0.29
Median	2081.12	160.72	0.15	0.76	0.83	0.31	0.26
SD	204.07	54.92	0.04	0.15	0.22	0.09	0.18
<b>2009–10</b>							
Mean	1963.39	182.07	0.17	0.45	0.80	0.29	0.24
Median	1941.21	165.31	0.16	0.46	0.87	0.27	0.23
SD	197.32	66.11	0.04	0.13	0.21	0.08	0.16

<sup>a</sup> The variables in this table are as follows. CALINT: estimated average calorie intake (Kcal per capita per day); RMPCE: real monthly per capita expenditure (1983–84 rupees); NFE: share of non-food essential expenditure; ACT1: share of households reporting “heavy activity” NCO codes; SW: share of households reporting access to safe drinking water; CRLSHR: share of food budget devoted to cereals; HMGRN: share of cereals consumed from home production.

calorie intake declines from 2333 Kcal in 198788 to 1963 Kcal in 200910, a decline of about 16 percent. Over the same period, real MPCE (in 198384 prices) increases by about 19 percent. The share of total expenditure claimed by non-food essentials increases secularly from 8 percent in 198788 to 17 percent in 200910.

The share of the workforce engaged in heavy occupations (mostly agricultural work) has declined from about 77 percent to 45 percent. The proportion of households with access to safe drinking water has increased from 51 percent to 80 percent. Thus, both variables meant to capture the calorie needs of the population indicate a movement in the direction of lower calorie requirements. The measure of diversification, the share of the food budget devoted to cereals, shows a steady decrease over this period from 41 percent to 29 percent. The measure of access to non-market food (home grown consumption of cereals) decreases steadily as expected, as well. This decline could be the result of both loss of land for cultivation and shifting preference for cereals purchased in the

market. Without further investigation, we will not be able to distinguish between these two effects.

## 5 Results

### 5.1 Regression Results

We now present results from estimating the model in (4) with a panel data set for 74 NSS state-regions and 4 time periods, 1987-88, 1993-94, 2004-05 and 2009-10. Table 2 reports the results of the fixed effect model<sup>5</sup>, showing that across all specifications, the sign on the SNFE coefficient is negative. A magnitude of 0.1 gives us the following interpretation: a 1 percentage point increase in the share of total expenditures devoted to non-food essentials is associated with a 1 percent decline in average calorie intake. Moreover, this coefficient is statistically significant at the 1 percent level across all specifications. In the full model with region and year fixed effects and a full set of controls, the coefficient on NFE is still significant and negative, though reduced in magnitude. In our opinion, this provides strong evidence in favor of the food budget squeeze thesis.

As we discussed earlier, there is no a priori reason for the coefficient on the share of expenditure devoted to non-food essentials to be negative in a regression like (4). In fact, for most countries in the world, it can be expected to be positive. This is because, even if controlling for real per capita expenditures, there is an increase in the share devoted to essential services like education, health care, etc., this need for necessarily be accompanied by a decline in food expenditures (and hence calorie intake). In a healthy growth scenario, income/expenditure growth and a fall in the real price of food ensures that even a lower share of household expenditure devoted to food is enough to secure an increasing (or at least constant) calorie intake. Therefore, when an increase in the share of non-food essential expenditure leads to a decline in calorie intake, it is a perverse outcome, one that we wish to denote as a “food budget squeeze.”

Our results also show that it is not necessary to assume a decline in total expenditures to explain the calorie intake decline (Patnaik 2007, 2010 a,b). Even though rural expenditures have

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<sup>5</sup>Specification tests suggest that the fixed effect estimation strategy is superior to the pooled regression (the F-test of the null hypothesis that all the state fixed effects are zero is strongly rejected). This implies that controlling for the unobserved state-level heterogeneity is important.

**Table 2:** *Basic Regression Results: Fixed Effects*

	(1)	(2)	(3)	(4)
	Log Cal	Log Cal	Log Cal	Log Cal
lrmpce	0.368*** (3.84)	0.333*** (3.37)	0.352*** (3.10)	0.309*** (2.77)
Share of non-food essentials	-0.0223*** (-9.40)	-0.0153*** (-4.63)	-0.0141*** (-4.00)	-0.00698* (-1.98)
Heavy activity		0.155*** (3.86)	0.106** (2.47)	-0.0441 (-0.65)
Moderate activity		-0.00771 (-0.05)	-0.0397 (-0.29)	-0.0373 (-0.32)
Safe Drinking Water		-0.0936* (-1.73)	-0.0591 (-1.00)	-0.0116 (-0.18)
Share of Cereals			0.261 (1.40)	0.0961 (0.50)
Share of Homegrown Cereals			0.0526 (0.76)	0.0339 (0.43)
Observations	265	265	265	265
Region Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	N	N	N	Y

*t* statistics in parentheses

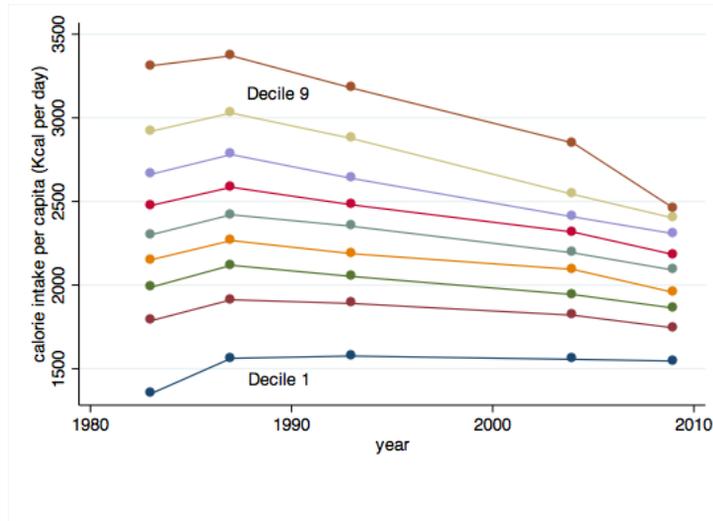
\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

increased during this period, they have not increased enough to accommodate both, the increased need for spending on non-food essentials, as well as sustained nutritional intake. Since our results consistently show a negative and statistically significant coefficient on non-food essentials, we can conclude that this effect is indeed strong and remains in operation even after we have controlled for real expenditure growth, diversification and possible changes in calorie needs.

The other significant coefficients are those on real monthly per capita expenditure and the activity dummy. The coefficient on log real MPCE, which is the expenditure elasticity of calorie consumption varies from 0.31 to 0.37. This value is in accord with existing results on this subject (Deaton and Dreze, 2009; Gaiha et al., 2010). The dummy on activity level 1 (heavy agricultural and other work) is positive as expected and significant at the 0.01 percent level in all but the last specification. This suggests an important contribution of calorie needs to calorie intake, as expected. It is well known that agricultural work is, on average, far more physically demanding than industrial or service sector work. The argument in Deaton and Dreze (2009) suggests that as people moved out of agriculture, calorie needs would go down, driving down average calorie intake

While the other coefficients on safe drinking water, diversification and home grown cereals have the expected signs, none of them reach significance in any specification. Diversification, measured by the share of food expenditure devoted to cereals, is expected to have a positive effect on average calorie intake when other relevant factors (including total expenditure) are controlled for: if the total expenditure on food is more or less constant, then a switch towards less expensive sources of calorie (cereals) would lead to an increase in calorie intake. Access to safe drinking water dramatically reduces the prevalence of gastrointestinal diseases. The argument in Deaton and Dreze (2009) suggested that as the epidemiological environment improves and the capacity of people to retain calories increase, this would reduce the calorie intake.

Lastly, the coefficient on home-grown consumption is also of the expected sign (greater access to home-grown cereals should increase calorie intake) but is also statistically insignificant at the 10 percent level.



**Figure 4:** *Estimated average calorie intake (Kcal per day) across MPCE decile classes in rural India. Source: Authors calculations from various NSS rounds.*

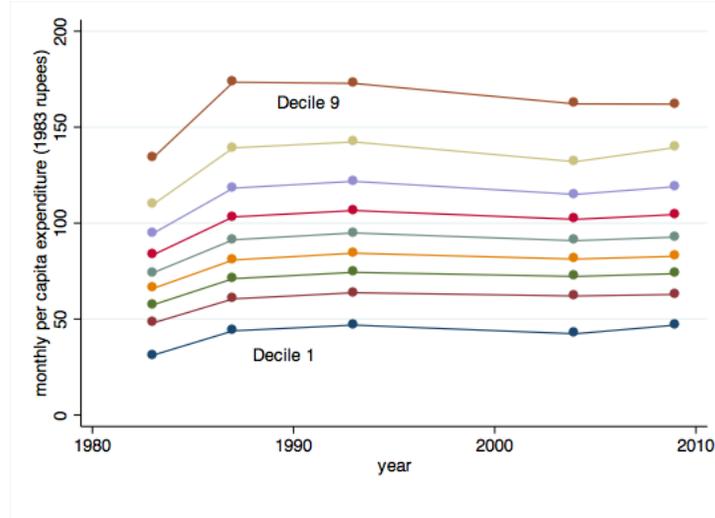
## 5.2 Variation across MPCE classes

We have thus far looked at the effect of rising non-food expenditures on average calorie intake across all rural expenditure classes. It seems plausible to argue that that this relationship might vary across MPCE classes. While investigating this issue in detail is beyond the scope of this paper, we make a few initial observations in this regard. Across class analysis of the food budget squeeze is part of ongoing work.

As mentioned earlier, calorie intake has declined in India for all expenditure deciles (Figure 4). The decrease is larger for richer households.<sup>6</sup> However, it is important to note that a decline in calorie intake for the upper expenditure classes, even if larger in absolute (or even percentage) terms, would not have the same implications for nutritional status as even a much smaller decline for the lower expenditure classes. This is because they have very different starting points (say 3000 Kcal versus 2000 Kcal).

Further, a given change in NFE does not have the same implication for the food budget for all expenditure classes. Figures 5 and 6 show the change in real food and non-food budgets for the bottom nine MPCE deciles over entire period between 1983 and 2009. Strikingly, non-food

<sup>6</sup>The uppermost MPCE decile has been omitted in this and the following two figures to better illustrate the trends in the lower deciles.



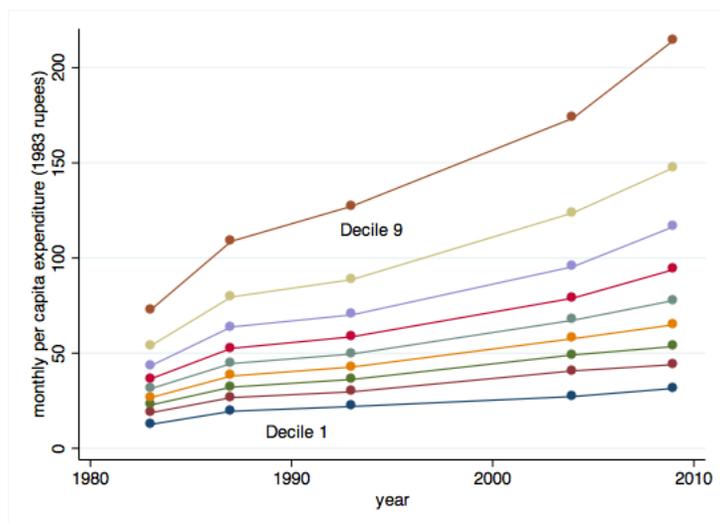
**Figure 5:** *Real expenditures on food across MPCE decile classes in rural India. Source: Authors calculations from various NSS rounds.*

expenditures have increased across all deciles and correspondingly, the food budget has stagnated across all deciles. Stagnation in the real food budget, coupled with diet diversification (substitution of more expensive calories for cheaper ones) and declining access to non-market sources of calories can together explain the downward trend in calorie intake.

How are we to understand the stagnation in the food budget across all expenditure classes? Has it stopped increasing because of declining calorie needs, which free up more resources for non-food expenditures (which make available household appliances, energy sources and transport equipment that further reduces energy needs)? While this interpretation may be reasonable for the upper deciles, because they already consume calories well in excess of the nutritional norms, we believe it cannot suffice for the lower expenditure classes.

As is clear from Figure 4 calorie intake for the bottom six deciles in 2009 was lower than the poverty line norm as well as the ICMR nutritional norm. Failure to spend more on food under these circumstances is likely to be as much compulsion as choice. While our analysis here does not allow us to distinguish between the two cases, we offer some points for discussion in the next section.

Lastly, note that the poorest of the poor seem to be unaffected or relatively less affected by the food budget squeeze: for the lowest MPCE class we see a small increase in calorie intake (50



**Figure 6:** *Real expenditures on all non-food items across MPCE decile classes in rural India. Source: Authors calculations from various NSS rounds.*

Kcal/day) as well as the largest increase in real food expenditures in the period between 1983 and 2009. One possibility is that the bottom expenditure class households are so desperately poor that they cannot afford to send their children to private schools or access private healthcare in the first place. Hence, the increasing cost of education or healthcare does not have a large impact on their household budgets. So, they are able to devote the increases in their real incomes to food consumption, allowing them to increase their calorie intakes.

## 6 Discussion

### 6.1 Coercive versus Non-coercive Mechanisms

While we have interpreted the negative impact of the share of nonfood expenditure on calorie intake as evidence for a squeeze on the food budget which prevents people from consuming the desired number of calories, it could also be argued that stagnant spending on food and increased spending on nonfood items is voluntary. On the basis of our analysis we cannot rule out such an explanation. The variables that we have controlled for in our empirical analysis account for structural factors such occupational structure (as a proxy for prevalence of hard labor) or access to safe drinking water (as a proxy for the epidemiological environment) and not for a change in preferences for

nonfood essential services like education and health care. However, given the low absolute level of real expenditure on food as well as number of calories consumed by the majority of the rural Indian population, we do not think the non-coercive or voluntary explanation can be the whole story.

One way to operationalize the difference between voluntary and involuntary declines might be to take a calorie norm as the dividing line. That is, declines in nutritional intake among MPCE classes that already consume less than the basic minimum maybe taken as coercive or involuntary declines. As noted earlier, the absolute level of calorie intake for the bottom eight deciles in 2009-2010 was below the minimum ICMR norm of 2320 Kcal per capita per day. By this reasoning, a large section of the rural population in India is consuming lower calories because they are being coerced to do so due to the combination of a food budget squeeze and declining access to non-market sources of food.

That said we would also like to point out that disentangling coercive from non-coercive factors is not straightforward. For example, consider the following scenarios. It is reasonable to suppose that people are voluntarily spending more on education because they believe this is the way to ensure economic security for their children and social respect for their families. But the increasing unviability of agriculture as a source of income and the precariousness of informal employment, which are structural factors, also play a role in increasing the allure of formal sector jobs for which school education is a must. Second, people may spend more on health care not only because preference for allopathic care is on the rise but also because the public health-care system is in decline. This is again a mixture of involuntary (structural) and voluntary changes. Third, people could be spending more on transportation because of a decline in rural livelihood options (a structural factor) and increased pull of urban jobs and lifestyles (a taste based factor). Thus in most realistic situations a combination of the two would be in operation.

The aspirational component of the food budget squeeze is underlined by that fact that the lowest expenditure decile has seen the largest increase in the food budget along with a small increase in calorie intake. Thus the squeeze operates only for those among the rural poor who are rich enough to want to emulate the consumption patterns of the upper deciles (sending children to private schools, for example), but not rich enough to maintain a constant or growing food budget

alongside. In future research we plan to explore the relationship between non-food expenditures and calorie intake across MPCE classes. This may also shed light on relative strengths of coercive versus non-coercive factors discussed above.

## 7 Conclusion

A puzzling feature of Indian economic development over the past few decades has been the trend movement of per capita real income (measured by real MPCE or per capita real GDP) and average per capita calorie intake in opposite directions. While per capita real incomes have increased, average per capita calorie intake has declined over time. Several explanations have been offered for this puzzling phenomenon, including movements in relative prices, impoverishment of a large section of rural India, diversification of food consumption, decline in calorie needs and a squeeze of the food budget.

The present study makes several novel contributions to this ongoing debate. Using household-level data from the six recent “thick” rounds of the NSS Consumption Expenditure Survey (1983-84, 1987-88, 1993-94, 1999-2000, 2004-05 and 2009-10) we construct a food-price index and show that real food expenditures have stagnated in India while non-food expenditures have climbed sharply. Using a novel panel data set for 74 NSS state-regions and four time periods we test the hypothesis that a rise in non-food essential expenditures has squeezed the food budget and find strong support for such a squeeze.

The food budget squeeze could be driven by both demand and supply side factors. Increased demand for formal schooling, consumer services, transportation, and institutional health care on the demand side, and a retreat of State from provisioning these services on the supply side, could interact to effect a squeeze on the food budget. Investigating the various components of non-food expenditure as well as conducting an analysis of the relationship between NFE and calorie intake across expenditure classes are future research questions that arise from this paper.

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