An Empirical Investigation of the Calorie Consumption Puzzle in India

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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. In this paper we construct a novel panel dataset from household-level National Sample Survey data on consumption expenditure to test the "food budget squeeze" hypothesis. Our panel consists of 74 NSS "state-regions" over six time periods (1983, 1987–88, 1993–94, 1999–00, 2004–05 and 2009–10). We demonstrate a statistically significant negative effect of a rising share of expenditures on non-food essentials (health, education, transportation and consumer services), on calorie intake. We also construct a food price index directly from household-level expenditure data and show that real food expenditure 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

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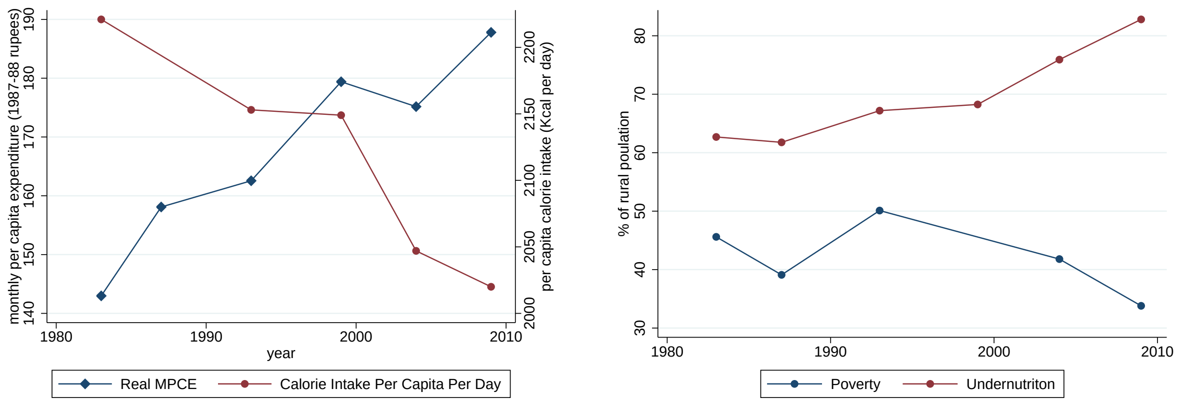
by most measures real per capita incomes) have increased. Since cross sectional evidence shows a robust positive relationship between per capita income and calorie intake, the time series pattern in India clearly presents a puzzle. Moreover, the puzzle has been around for a long time. Data collected 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 to 2004–05. They find that estimated average calorie intake in rural areas declined by about 10 percent over the two decade period between 1983 and 2004–05, 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.

In this paper, we have extended the analysis to 2009–10, and 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 16 percent. During this period, on the other hand, real average MPCE increased by 40 percent in rural areas. Thus, this opposite trend movement in calorie intake and real MPCE, highlighted in the left panel of Figure 1, indicates that the calorie consumption puzzle endures: as people become richer, they consume less calories.

Another way to highlight the calorie intake puzzle is to compare the evolution of poverty (POV) and the prevalence of undernutrition (POU). In the right panel of Figure 1, we plot POV as measured by the proportion of the rural population below the poverty line (the head count ratio) and POU as measured by the proportion of rural population that consumed less that 2400 Kcal per capita per day.[1] The right panel of Figure 1 shows that even as poverty measured by the head count ratio has declined – some of the fluctuation in the head count ratio is probably driven by the periodical changes in the definition of the poverty line – the prevalence of undernutrition has

[1] Figures for the rural head count ratio is from the website of the Planning Commision of India; for details see `http://planningcommission.nic.in/data/datatable/2504/databook_68.pdf` (accessed June 30, 2013). The prevalence of undernutrition is computed by us from various NSS "thick" rounds of the CES.



(a) Real MPCE and Calorie Intake

(b) Poverty and Undernutrition

Figure 1: *The calorie consumption puzzle. For left panel, real monthly per capita expenditure (in 1987 rupees) and estimated average calorie intake (Kcal per day) in rural India are from (NSSO, 2011, 2012). For the right panel, poverty is measured as the proportion of households below the poverty line (source: website of the Planning Commission of India), and undernutrition is measured as the proportion of rural households which had calorie intake of less than* 2400 *Kcal per capita per day (source: author's calculations from NSS data).*

increased. The stark divergence between POV and POU, especially since the early 1990s, is another way to highlight the fact that as people become richer (hence the head count ratio falls) they are consuming less calories (hence the prevalence of undernutrition rises).[2]

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 in rural India have risen in real terms over this period. Hence we do not pursue the line of explanation that relies on falling real expenditures.

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

[2]This divergence was highlighted, and its implications for food security noted, by Ray (2007).

environment, changes in occupational structures, and mechanization of agricultural work (Rao, 2000; Mittal, 2007; Deaton and Dreze, 2009; Li and Eli, 2010)[3]. 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 body mass index (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.

There are at least two reasons to be concerned. 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 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[4]. 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

[3]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.

[4]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).

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.[5]

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 Data Appendix for details). The regression results presented in Section 5, utilize only about 54 state-regions, 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. 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 percentage point increase in the

[5] Some researchers have suggested that failure of the NSSO to capture expenditures on food items outside the home (such as in restaurants) can explain the (apparent) decline in calorie intake (NSSO, 2011). We do not believe this can account for the decline for three reasons. First, the aggregate data on food availability from the production side is in close agreement with the NSS consumption figures, at least for the thick rounds (Deaton and Dreze, 2009, pp. 48). Thus, food items consumed outside the home, and possibly not recorded in the NSS surveys, is not quantitatively very significant. Second, NSSO does attempt to capture this type of spending under an omnibus category (beverages etc.) which we incorporate in our analysis. Third, such spending is likely to be of less importance in the rural areas, where our analysis is focused.

share of monthly expenditure on non-food essentials (education, health care, transportation and consumer services) is associated with a 1% decline in calorie intake after controlling for changes in real expenditures, the relative price of food, 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. Details of data sources and construction of variables are collected together in a data appendix.

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. 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 norm, having average calorie consumption of less than 2100 Kcal per capita per day. The "calorie 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, a recent study that sets out to explain India's missing calories in terms of declining 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 (Eli and Li, 2012). The authors say that while food budget shares have fallen holding real expenditures constant, fuel, education, transportation, services, and durables have risen. They further argue that 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, health care, 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, controlling for relative price effects.

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

$$C = f(\frac{E_f}{p_f}, s_c, NM_f) \tag{1}$$

where E_f refers to the total expenditure on food, p_f refers to an index of food prices, s_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 food items and the total expenditure of the household. The share of expenditure devoted to food items, in turn, depends on the relative price of food items, calorie needs of household members and on the expenditure share on what we might term non-food essentials (health care, education, transportation and other essential services that are necessary to sustain a decent modern life).

Ordinarily, one expects household budget allocation between food and non-food items to be a function of relative prices, preferences, and basic physiological needs (calorie needs). But if calorie needs and relative prices do not completely account for falling calorie intakes, we may be forced to consider a third possibility: that preferences have changed in such a way that non-food essential expenditures have increased to the detriment of food expenditures.[6] It is to test for this third possibility that we allow the share of food expenditure to be independently impacted by the share of non-food essentials.

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

$$\frac{E_f}{p_f} = s_f \times \frac{E}{p_f}$$

where s_f denotes the share of monthly expenditure falling on food, and

$$s_f = h(\frac{p_f}{p}, s_{nfe}, CN) \tag{2}$$

[6] Of course this would only be the case if overall incomes have not increased adequately to accommodate rising food and non-food expenditures.

where p stands for a general price index, $\frac{p_f}{p}$ denotes the relative price of food (p_f), s_{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.

It is possible that changing preferences autonomously increase expenditure on certain non-food items like education, health, transportiation and consumer services to the extent that they squeeze the food budget. As already indicated above, it is this possiiblity that we wish to capture by including the share variable, s_{nfe}, in the model.[7]

Incorporating (2) into (1), we get

$$C = f(s_{nfe}, \frac{p_f}{p}, \frac{E}{p_f}, CN, s_c, NM_f) \tag{3}$$

implying that six sets of factors are the proximate determinants of calorie consumption by households in rural India: relative price of food ($\frac{p_f}{p}$), the share of total expenditure devoted to non-food essentials (s_{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 (s_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, transportation and consumer services (which includes telephone charges, and services like tailoring, washing, repair charges for non-durables, etc.) 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. We

[7]Note that $s_f + s_{nfe} \neq 1$. Many nonfood items of consumption, like fuel & lighting, clothing & bedding, durables, are not part of what we call "nonfood essentials". The importance of leaving out certain nonfood items from the definition of "nonfood essentials" is discussed in detail in section 4.2.2.

highlight this fact in two sets of charts.

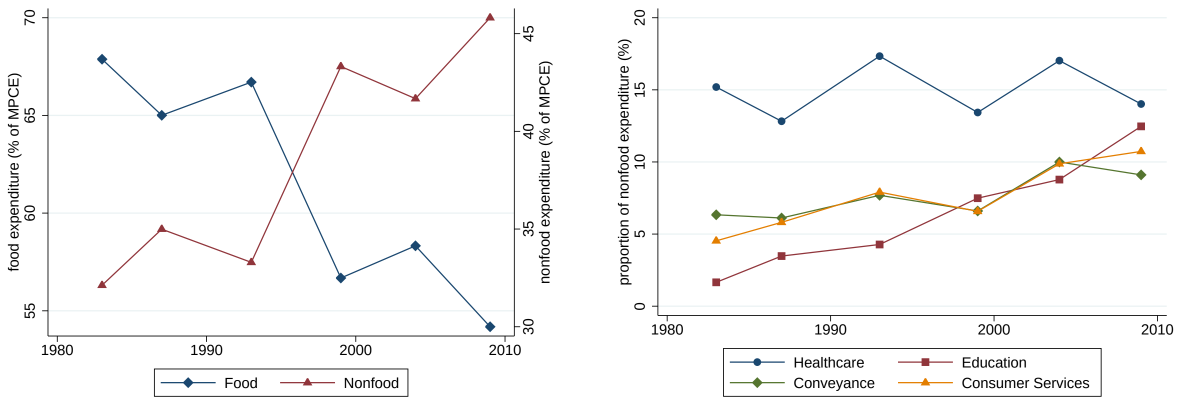
Figure 2 plots the time series of shares of expenditures between 1983 and 2009–10. The left panel plots the shares of total monthly per capita expenditure devoted to food and nonfood. Over this 3 decade period, the share of expenditure falling on food items has declined from 68% to 54%, with the share of nonfood increasing accordingly. The right panel of Figure 2 plots the share of total nonfood expenditure that is devoted to education, health care, transportation and consumer services. While the share devoted to health care is largest among these four categories, it has hovered around 15% of total nonfood expenditure. On the other hand, the share of nonfood expenditure claimed by education, transportation and consumer services have all increased substantially over the last 3 decades. Among the four nonfood "essential" categories, the largest increase has been registered by education, with it's share in total nonfood expenditure increasing from 1.66% in 1983 to 12.47% in 2009–10.

Figure 2 presents a picture that one would see in most countries of the world: as incomes rise, the share of food in total expenditure falls. In most countries of the world declining share of food expenditures goes hand in hand with an increase in real food expenditure. This is because incomes rise fast enough to accomodate both increases on food and nonfood items in real terms.[8]

In contrast to this well known pattern, Figure 3 shows that this is not the case in India. The left panel shows that over the past three decades, non-food expenditures have increased steadily in real terms, while food expenditures have virtually *stagnated* after the mid 1980s.[9] The right panel of Figure 3 plots the time series of real expenditure on education, health care, transportation and consumer services. In stark contrast to the real expenditure on food, each of these items have recorded significant increases in real terms. For instance, education has registered a 14-fold increase in real terms over these 3 decades; during the same period real expenditure on food has increased by a meager 1.14 times.

[8]Other than Sub-Saharan Africa, where calorie intake has been stagnant, and transition economies, where calorie intake has declined, most other countries and regions in the world have experienced an increased calorie intake (i.e., increased food consumption). For details, see `http://www.who.int/nutrition/topics/3_foodconsumption/en/` (accessed June 26, 2013).

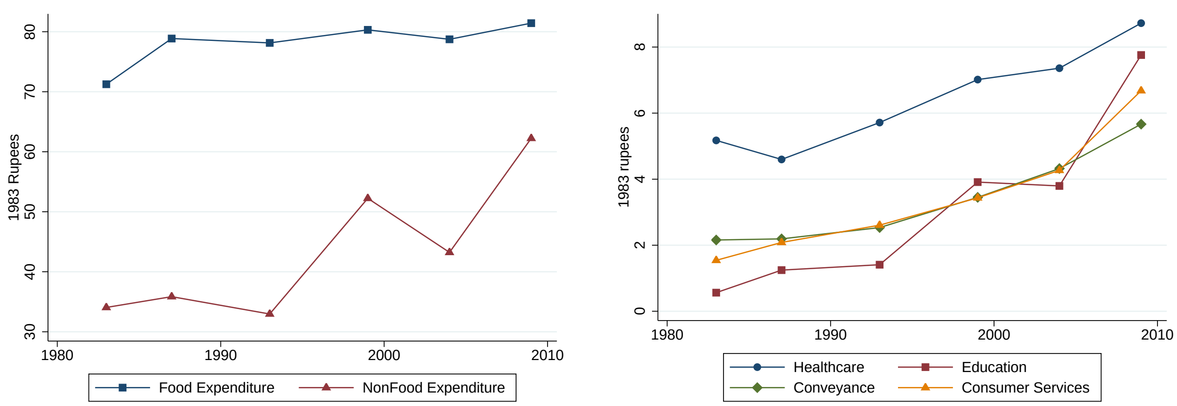
[9]Nominal food expenditure data has been deflated by the food component of the CPIAL; nominal nonfood expenditure and components of nonfood essentials have been deflated by the "miscellaneous" component of the CPIAL. Data on CPIAL and its components is from the EPWRF. For details, see the data appendix.



(a) Share of Food and Nonfood in Total

(b) Share of Essentials in Nonfood

Figure 2: *Share of Expenditure on Food and Nonfood in Total Monthly Expenditure, and Share of Essentials in Nonfood Expenditure. Source: authors' calculation from various NSS rounds.*



(a) Real Expenditure on Food & Nonfood Items

(b) Real Expenditure on Nonfood Essentials

Figure 3: *Real monthly per capita expenditure on food and non-food items (1983 rupees). Real food expenditure has been calculated by deflating nominal food expenditure by the food component of the CPIAL; real nonfood expenditure has been calculated by deflating nominal nonfood expenditure by the miscellaneous component of the CPIAL. Source: authors' calculations based on various NSS rounds, using CPIAL data from the Economic and Political Weekly Research Foundation India Time Series Data Set.*

Thus, 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. 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 Relative Price of Food

A potentially important factor underlying the decline in food consumption (that shows up in falling calorie intake) could be the movement of the relative price of food items. Is it the case that over time nonfood items have become relatively cheaper, so that households have shifted away from food to nonfood items of consumption? To address this question, we plot various components of the national consumer price index for agricultural labourers (CPIAL) in Figure 4.[10]

The left panel of Figure 4 plots four important components of the national CPIAL between January 1983 and December 2010: (1) all food items, (2) fuel and lighting, (3) clothing, footwear and bedding, and (4) education, health care, transportation and consumer services (the "miscellaneous" component). Indexes for each of the component has been normalized to a value of 100 in January, 1983, the beginning point of our period of analysis. Among these four components, the price of fuel & lighting has increased the least (about 400% over 3 decades), and the price of education, health care, transportation and consumer services has increased the most (about a 782% increase over the same 3 decade period). While the index for food items has increased by 724%, the index for clothing, footwear & bedding has increased by 679% over the corresponding period. Thus, food has not become relatively expensive over this period.

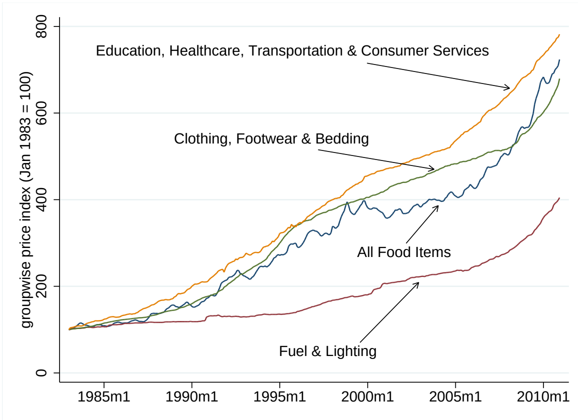
To highlight the evolution of the relative price of food, the right panel of Figure 4 plots the time series of the ratio of the food component to the "miscellaneous" component of the CPIAL. It is immediately seen from this chart that there is no upward trend in the relative price of food. If anything, food has become relatively cheaper over the last three decades.

While there is no overall trend in the movement of the relative price of food, we do observe interesting medium-run swings. There are two periods during which food became relatively cheaper: between the early 1980s and the early 1990s; and again, between the early to the mid 2000s. Similarly, there are two periods of relative increase in the price of food items: the decade of the 1990s; and the period since the mid-2000s. But, to reiterate the important point, over the whole 3 decades period there is no trend of increase in the relative price of food.

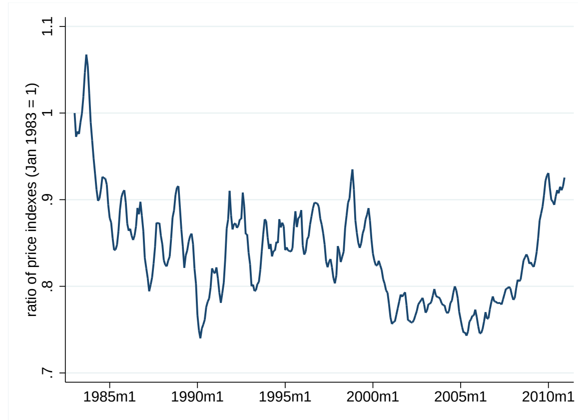
3.3 Other determinants

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.

[10] For details of data sources, see data appendix.



(a) Group wise CPIAL



(b) Ratio of Food to Misc in CPIAL

Figure 4: *Components of the CPIAL (January 1983==100). Source: authors' calculations based on CPIAL data from the Economic and Political Weekly Research Foundation India Time Series Data Set.*

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). The food price index has been constructed by aggregating household level unit prices of over 150 food items. This is an independent contribution of this paper, and extends the work in Deaton (2008).[11]

[11] For details of the construction of the NSS data-based food price index, see the data appendix.

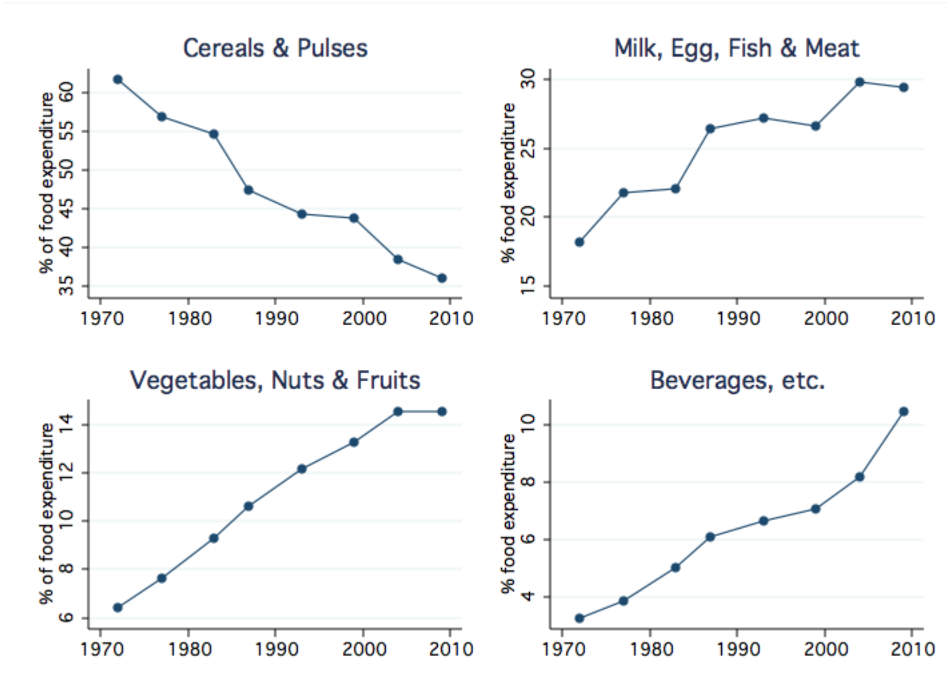


Figure 5: *Expenditure on Various Categories of Food Items, Rural India. Source: NSSO (2011).*

The penultimate variable on the RHS of (3) is the share of the food budget that is devoted to cereals, s_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 5 presents a picture of diversification seen in the food budget of the average rural household in India over the past four decades. Figure 5 drives home the point that rural India has indeed witnessed substantial diversification of the food budget over the last few decades. For instance, the share of cereals has secularly declined; the share of fruits & vegetables has increased; the share of beverages have increased; the share of egg, meat & fish has not changed much relative to the mid-1980s. 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 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

4.1 Data

The empirical analysis in this paper uses a novel panel data set that we have constructed from 6 "thick" rounds of the quinquennial Consumption Expenditure Survey (CES) conducted by the National Sample Survey Organization (NSSO) in the following years over the last three decades: 1983–84 (38th Round), 1987–88 (43rd Round), 1993–94 (50th Round), 1999–00 (55th Round), 2004–05 (61st Round), and 2009–10 (66th Round). The "thick" rounds of the CES are large scale, nationally representative surveys of households, conducted approximately every 5 years, which collect 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 both 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 terms a "state-region" for the six thick round years.

State-regions lie between states (which are bigger) and districts (which are smaller) and are 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 potential sample size of 444 (some variables might not have observations for all the state-regions and all the time periods).

While the "thick rounds" of the CES are the main source of our data, we have also had to access other data sources for two variables that are important for our analysis but not covered by the CES. The first is an index of the nonfood - especially education, health care, transportation and consumer services - component of the CPIAL. We take data on this variable from the Economic and Political Weekly Research Foundation (EPWRF) India Time Series data set. The second is information on the percentage of household with access to safe drinking water, i.e., households which use tap, hand pump or tube well as their source of drinking water. We extract this information from relevant NSS surveys that are closest to the "thick round" years. Details about data sources and construction of variables, are collected together in the data appendix.

4.2 Regression Model

The discussion in the previous sections has given us the empirical model of this paper:

$$\begin{aligned} \log(CALINT_{it}) = {} & \beta_1 \times SNFE_{it} + \beta_2 \times \log(RMPCE_{it}) + \beta_3 \times PR_{it} + \beta_4 \times ACT1_{it} \\ & + \beta_5 \times ACT2_{it} + \beta_6 \times SW_{it} + \beta_7 \times CRLSHR_{it} + \beta_8 \times NM_{it} + \alpha_i + \gamma_t + u_{it} \end{aligned} \tag{4}$$

where $i = 1, 2, 3, \ldots, n$ indexes the state-regions, $t = 1, 2, \ldots, T$ indexes time periods, $CALINT$ denotes estimated average calorie consumption, $SNFE$ refers to the share of total expenditure devoted to non-food essentials, PR is the relative price of food, $ACT1$ 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 α_i stands for a state-level time-invariant (or slowly changing) unobserved heterogeneity, and γ_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 is 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).

4.2.1 The Dependent Variable

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.

4.2.2 Key Independent Variable: Share of Nonfood Essentials

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, health care, 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, health care, 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.

4.2.3 Other Independent Variables

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.[12] 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.

4.3 Summary Statistics

Table 1 presents summary statistics for these seven variables. Estimated average per capita calorie intake declines from 2337 Kcal in 1983 to 1963 Kcal in 2009–10, a decline of about 16 percent. Over the same period, real MPCE (i.e., nominal MPCE deflated by the NSS data-based food price index with 1983 as base period) increased by about 45 percent. The share of total expenditure claimed by non-food essentials (i.e., education, health care, transportation and consumer services) increased secularly from 8 percent in 1983 to 17 percent in 2009–10.

[12]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*[a]

	CAL	**MPC**	**ESS**	**PRI**	**AC1**	**AC2**	**SWR**	**CSR**	**HMG**
1983									
Mean	2336.85	123.96	7.68	20.03	0.88	0.00	0.26	0.49	0.24
Median	2324.48	118.71	7.16	19.57	0.92	0.00	0.25	0.50	0.22
Std Dev	291.70	32.67	4.29	1.82	0.10	0.01	0.04	0.12	0.15
1987									
Mean	2333.41	150.66	7.69	18.53	0.77	0.07	0.51	0.41	0.33
Median	2280.81	141.20	7.89	18.52	0.81	0.07	0.50	0.40	0.32
Std Dev	278.15	39.20	2.45	2.30	0.11	0.04	0.24	0.12	0.17
1993									
Mean	2247.75	145.69	9.90	17.40	0.74	0.07	0.63	0.39	0.31
Median	2199.05	137.03	10.15	17.51	0.78	0.06	0.69	0.40	0.31
Std Dev	260.28	37.52	2.70	3.36	0.12	0.05	0.23	0.11	0.17
1999									
Mean	2571.54	179.08	13.05	17.94	0.76	0.07	0.63	0.37	.
Median	2218.01	167.34	12.81	17.81	0.78	0.07	0.68	0.35	.
Std Dev	1396.24	54.67	3.38	2.21	0.13	0.04	0.24	0.11	.
2004									
Mean	2110.41	165.49	15.16	17.97	0.71	0.10	0.77	0.32	0.29
Median	2081.12	150.40	15.11	17.97	0.76	0.08	0.83	0.31	0.26
Std Dev	204.07	48.67	3.87	2.37	0.15	0.07	0.22	0.09	0.18
2009									
Mean	1963.39	180.31	16.79	19.16	0.45	0.12	0.80	0.29	0.24
Median	1941.21	155.41	16.43	19.34	0.46	0.11	0.87	0.27	0.23
Std Dev	197.32	74.94	3.80	2.58	0.13	0.08	0.21	0.08	0.16

[a] The variables in this table are as follows. CAL: estimated average calorie intake (Kcal per capita per day); MPC: real monthly per capita expenditure (1983–84 rupees); ESS: share of non-food essential (education, healthcare, transportation and cosumer services) expenditure (%); AC1: share of households reporting "heavy activity" NCO codes (fraction); AC2: share of households reporting "medium activity" NCO codes (fraction); SWR: share of households reporting access to safe drinking water, i.e., the households for which the sources of water is tap, tubewell or handpump (fraction); CSR: share of food budget devoted to cereals (fraction); HMG: share of cereals consumed from home production (fraction).

The share of the workforce engaged in "heavy" occupations (mostly agricultural work) has declined from about 88 percent to 45 percent. The share of workforce working in "medium" occupation has increased secularly from close to zero to about 12 percent. The proportion of households with access to safe drinking water has increased from 26 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. Our measure of diversification, the share of the food budget devoted to cereals, shows a steady decrease over this 3 decade period from 49 percent to 29 percent. Our measure of access to non-market food (home grown consumption of cereals as a share of total cereal consumption) decreases steadily after 1987–88 as expected, even though there is an increase in the initial years, i.e., between 1983 and 1987–88. 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 Regression Results

We now present results from estimating the model in (4) with a panel data set for 54 NSS state-regions and 6 time periods, 1983, 1987–88, 1993–94, 1999–00, 2004–05 and 2009–10. Table 2 reports the results of estimating the model with the fixed effect estimator.[13] The results show that across all specifications, the sign on the SNFE coefficient is negative and statistically significant. The magnitude of the coefficient on SNFE is 0.01, which gives us the following interpretation (because the dependent variable is the logarithm of calorie intake): *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.* 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. Since we have controlled for all relevant factors, including the relative price of food, real expenditures, calorie needs and diversification, in our opinion, this result provides strong evidence in favor of the food budget squeeze hypothesis.

[13]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.

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 not 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, 2010a,b). Even though rural expenditures have 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, the relative price of food, diversification of diets 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 0.27 to 0.21. This value is close to but a little lower than existing results on this subject (Deaton and Dreze, 2009; Gaiha et al., 2010). The last column in Table 2 shows the estimate of coefficient on log real MPCE to be 0.214 and a standard error of 0.131. A one-tailed test shows that this is significant at the 5 percent level.[14] The elasticity is even more strongly significant for the other specifications.

The coefficient on the relative price of food is negative and small. Moreover it is statistically

[14] Suppose the coefficient on log real MPCE is β. Then, the null and alternative hypotheses for a one-tailed tests are the following: $H_0 : \beta = 0$, and $H_1 : \beta > 0$. A one-sided alternative is meaningful in this case because we do not expect the expenditure elasticity of calorie intake to be negative in a predominantly poor country like India. The t-statistic is 1.6336, so that the p-value for the one-sided test is 0.051.

Table 2: *Basic Regression Results: Fixed Effects*

	(1) Log Cal	(2) Log Cal	(3) Log Cal	(4) Log Cal	(5) Log Cal
Real MPCE	0.271***	0.285***	0.291***	0.221*	0.214
	(0.0668)	(0.0757)	(0.0858)	(0.119)	(0.131)
Share of Essentials	-0.0219***	-0.0153***	-0.0150***	-0.00739***	-0.00579*
	(0.00161)	(0.00144)	(0.00142)	(0.00251)	(0.00304)
Price Ratio	-0.000412	-0.0000471	-0.000121	0.00261	0.00221
	(0.00294)	(0.00314)	(0.00313)	(0.00304)	(0.00314)
Heavy Activity		0.125***	0.112***	-0.0636	-0.0902
		(0.0307)	(0.0322)	(0.0692)	(0.0788)
Medium Activity		-0.0996	-0.0964	-0.0731	-0.0454
		(0.0916)	(0.0907)	(0.114)	(0.115)
Safe Drinking Water		-0.0772***	-0.0670**	-0.0557*	-0.0266
		(0.0269)	(0.0270)	(0.0322)	(0.0318)
Diversification			0.0774	-0.00997	-0.00497
			(0.147)	(0.149)	(0.167)
Home Grown Cereals					0.0626
					(0.0659)
Constant	6.606***	6.409***	6.352***	6.767***	6.800***
	(0.358)	(0.420)	(0.516)	(0.695)	(0.751)
Region Fixed Effects	Y	Y	Y	Y	Y
Time Fixed Effects	N	N	N	Y	Y
Observations	326	326	326	326	272

Robust standard errors in parentheses

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

insignificant in all specifications. Given our discussion of relative price trends in section 3.2, this result is not surprising: the relative price of food does not display any trend movement over the last 3 decades, and cannot really explain a declining calorie intake (or food consumption). While the negative sign is expected - as food becomes relatively more expensive, people shift to nonfood items - the effect is statistically significant.

The dummy for activity level 1 (heavy agricultural and other work) is positive, as expected, and significant at the 1 percent level (p-value is less than 0.01) in the first three specifications. When we include time dummies the coefficient on this variable changes sign and loses significance. The sign on the dummy for activity level 2 (medium level of activity in terms of physical demands) is consistently negative but statistically insignificant. 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. Taken together, our results suggest that this effect, even when present, is not very strong or consistent.

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. Our results support this hypothesis. The coefficient on safe drinking water is consistently negative and is statistically significant in all but the last specification. The negative sign suggests that as the epidemiological environment improves, households have a tendency to reduce calorie intake.

The coefficients on diversification changes signs and is never statistically significant. 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. In specification (3) in Table 2, the sign is positive. But once we include time dummies, in specification (4) and (5), the sign changes. Moreover, the coefficient is never statistically significant.

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

6 Discussion: 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 as 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 contributions to this ongoing debate. First, using household-level unit price data from the six recent "thick" rounds of the NSS Consumption Expenditure Survey (1983, 1987–88, 1993–94, 1999–00, 2004–05 and 2009–10) we construct a food-price index and show that real food expenditures have stagnated in rural India while non-food expenditures have climbed sharply. Second, using a novel panel data set for 54 NSS state-regions and 6 time periods we test the hypothesis that a rise in non-food essential expenditures (education, health care, transportation, and consumer services) has squeezed the food budget and find strong support for such a squeeze. Our results show that a 1 percentage point increase in the share of monthly expenditure devoted to nonfood essentials reduces average calorie intake by 1 percent even after controlling for real expenditure, the relative price of food, calorie needs, diversification of diets and non-market access to food.

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.

Data Appendix

In this Appendix, we provide details of data sources and describe the construction of the variables used in our analysis.

Calorie Intake and Expenditure Categories

Each "thick round" of the Consumption Expenditure Survey (CES) of the NSSO collects consumption information - value and quantity - on more than 150 food items and an equally large number of nonfood items. Using this information for the following years, 1983, 1987–88, 1993–94, 1999–00, 2004–05 and 2009–10, we construct the following variables.

- Calorie Intake Per Capita Per Day: Using information on quantity of consumption and calorie conversion factors (i.e., how many calorie is a unit of a food item equivalent to) provided in various years of the NSSO report "Nutrition in India", we calculate the calorie intake of each household by summing up the calorie intake from each food item. Dividing this by the household size (and by 30) gives us the calorie intake per capita per day.

- Total Monthly Per Capita Expenditure: The CES also provides information on value of consumption of all food and nonfood items. By summing them up, we get total monthly expenditure. Dividing that by the household size (and by 30) gives us the total nominal monthly expenditure per capita.

- Share of Expenditure devoted to Nonfood Essentials: Dividing expenditure on education, health care, conveyance and consumer services, by total expenditure gives the share of expenditure devoted to what we have called “nonfood essential”.

- Diversification Index: Dividing expenditure on cereals by total expenditure on food gives us the “diversification index”.

We aggregate all these variables to the state-region level for our regression analysis.

Price Indices

NSS Data-based Price Index at the State-region level

For the main empirical analysis, we construct a food price index for each state-region from household level unit prices, for all households within a give state-region, using the method outlined in (Deaton, 2008). In brief, the price index for any state-region is a weighted average of the ratio of median unit values for consecutive time periods, where mean shares of each item in the food budget are used as weights.

Let $t = 0, 1, 2, 3, 4, 5$ index the 6 time periods that we deal with; let $i = 1, 2, \ldots, n$ index the food items. For any state-region, let p_{it} denote the median unit price for food item i in period t, where the median is calculated over all households in the state-region under consideration. For period t, let s_{it} denote the mean share of food item i in the food budgets of household in the given state-region.

For each state-region, the median unit prices are aggregated with a Laspeyres formula to arrive at the food price index for consecutive prods. Thus, the food price index for period 1 (with period 0 as the reference period) for any state-region is given by

$$P_{10} = \sum_{i=1}^{n} s_{i0} \times \left(\frac{p_{i1}}{p_{i0}} \right).$$

It is worth pointing out that because we are comparing consecutive rounds, which are relatively close together in time, the problem of new items of food appearing, or old items dropping out, is minimized. When the problem crops up, we deal with it in the manner described in Deaton (2008).

In a similar manner, food price indexes are constructed for each state-region for consecutive time period, and then linked together to give us a single price index (with reference period 1983) for the all state-regions in the country. This state-region level food price index is used to compute real food expenditure at the state-region level, and to calculate the ratio of food prices to general prices.

State-level Price Index

In our regression analysis, one of the key variables is the price ratio, i.e., the ratio of an index of food prices and a general price index. While we construct an index of food prices at the "state-region" level by aggregating prices observed at the household level (as described above), there is no consumer price index for agricultural labourers (CPIAL) series available at the state-region level. The most disaggregated level at which CPIAL figures are available is at the level of states. Hence, we use the state-level CPIAL (for all the state-regions within a state) to calculate the ratio of food prices and the general price level.

State level CPIAL data was taken from the Economic and Political Weekly Research Foundation (EPWRF) India Time Series Data set, which provides two state level CPIAL series at a monthly frequency.[15] The first series runs from January 1970 to October 1995, uses 1960–61 as the base year and provides data for 15 major states. The second series runs from November 1995 to December 2010, uses 1986–87 as the base year and provides data for 20 major states.

Since we have two separate CPIAL series with base years 1960–61 and 1986–87 and no overlapping periods, we need to link the two to generate a single consistent time series of CPIAL. We adopt the following method to accomplish this.[16]

[15] The original data comes from the Labour Bureau of the Government of India. The EPWRF has compiled this data and made available to the public at a nominal subscription. For details see `http://www.epwrfits.in/index.aspx`

[16] An alternative method would be to use "linking factors" provided with the CPIAL data to link the two series. We do not use this method because linking factors are not available for all states and for all components of the CPIAL. For instance, a key focus of this paper is the "miscellaneous" component of the CPIAL, which includes education, health care, transportation and consumer services. But there is no linking factor available for this component.

Recall that the transition between the two CPIAL series occurs between October and November 1995. To "link" the two series, we assume that the the inflation rate between these two months is equal to the average inflation over a 12 month period centered on the transition month. Thus, the inflation rate between October and November 1995 is equated to the average inflation rate for a 6 month period before October 1995 and a 6 month period after November 1995. This generates a CPIAL number for November 1995 that uses 1960–61 as the base year and is linked to October 1995 by this average growth rate (i.e., inflation rate). Once we generate this CPIAL number for November 1995, we update the CPIAL series every month ahead of November 1995 using the monthly inflation rate from the CPIAL series with base year 1986–87.

Since the period of study in our analysis begins in 1983, we recalibrate with January 1983 as the base period (the series takes a value of 100 in January 1983). Thus, we get a consistent state-level CPIAL series with January 1983 as the base time period. Since state-level CPIAL data with base year 1960–61 is available only for 15 our final series can also cover only these 15 states: Andhra Pradesh, Assam, Bihar, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

Thus, the unit of observation for our regression analysis will comprise of all the state-regions that fall within these 15 states (we have roughly 55 such state-regions). For our empirical analysis we generate average state level CPIAL for the periods corresponding to the "thick" rounds of the Consumption Expenditure Survey of the NSSO by averaging over the relevant months as indicated below:

- 38th Round: January 1983 to December 1983
- 43rd Round: July 1987 to June 1988
- 50th Round: July 1993 to June 1994
- 55th Round: July 1999 to June 2000
- 61st Round: July 2004 to June 2005
- 66th Round: July 2009 to June 2010

National-level Price Index

We have used national level CPIAL for graphical analysis. This data also comes from the EPWRF India Time Series Data set, which offers two national level monthly CPIAL series. The first runs from July 1970 to October 1995, and has 1960–61 as the base year. The second runs from November 1995 to December 2010, and uses 1986–87 as the base. From this data set, we take the CPIAL and also indexes for two components of the CPIAL: (1) food items, and (2) what is referred to as "miscellaneous items". Education, health care, transportation, and consumer services comprise the main sub-components of "miscellaneous items". Using the same procedure that we adopted for the state-level CPIAL, we linked the two series to generate a single consistent state level CPIAL series, and its components, running from January 1970 to December 2010.

Calorie Need Variables

Safe Drinking Water

To capture the effect of the epidemiological environment on calorie intake, we construct a dummy variable for "safe drinking water". For any household, the dummy takes the value of 1 if it accessed drinking water from a tap, tube well, or a hand pump (this is the definition of safe drinking water that is used in the Census of India publications).

Rounds 38 (1983) and 50 (1993–94) of the consumption expenditure survey (CES) have a question on source of drinking water within their schedules. Hence, we could use this data for these two rounds. The other rounds of the CES do not have this question. For these other rounds, we go to the nearest NSS survey round that contains information on sources of drinking water.

- For Round 43 (1987–88), we use Round 42 (Schedule 25.1: Maternity, Child Care, Family Planning and Utilization of Public Distributions System)
- For Round 55 (1999-00) we use Round 54 (Schedule 3.1: Common Property Resources, Sanitation and Hygiene Services)
- For Round 61 (2004–05) we use Round 60 (Schedule 25: Morbidity and Health care)

- For Round 66 (2009-10) we use Round 65 (Schedule 1.2: Housing Conditions)

For each of these rounds, we compute the dummy variable at the household level, aggregate it to the state-region level and then merge that information into our main data set.

Activity Level

Using the National Classification of Occupations (NCO) codes available in the CES, we create three dummy variables to capture the effect of physical activity levels on calorie intake. After making adjustment for supervisors and non-manual workers, we generate three categories of "activity level": 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. We calculate the dummies for each household and then aggregate them up to the state-region for our regression analysis.

Non-Market Access to Food

The "thick rounds" of CES, other than the 55$^{\text{th}}$ Round, provides information on the quantity of consumption (for certain food items) that comes out of "home grown stock". Since cereals continue to remain the largest source of calorie of poor households, we use the ratio of cereals that is consumed from home grown stock and total cereal consumption as a measure of the access of households to nonmarket sources of food. We calculate this ratio for each household and aggregate it up to the state-region level for our regression analysis.

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