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Dietary Shift and Diet Quality in India: An Analysis Based on 50th, 61st and 66th Rounds of NSS

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ACRONYMS

BIMARU: Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh

FDI: Food Diversity Index

IHDS: Indian Human Development Survey

MPCE: Monthly Per Capita Expenditure

NCD: Non Communicable Diseases

NSS: National Sample Survey

OBC: Other Backward Caste

SC: Scheduled Caste

ST: Scheduled Tribe

ABSTRACT

Our study examines changes in diets over the period 1993-2009. Diets have shifted away from cereals towards higher consumption of fruits, vegetables, oils and livestock products. Using household data, a food diversity index (FDI) is constructed, based on five food commodities. Significant price effects that vary over time are confirmed, as also income/expenditure effects. Over and above these effects, more sedentary life styles and less strenuous activity patterns played a significant role in shaping dietary patterns. An important finding is slowing down of dietary transition in the more recent sub-period 2004-09. Clues relate to weakening or strengthening of food price, expenditure and life-style effects over time. Using an instrumented measure of FDI in the second stage, and all other exogenous variables, its effects on nutrients' intakes are analysed. A common finding that food diversity is associated with better quality diet and higher intakes of nutrients is not corroborated. While there is a reduction in calorie intake, there are increases in protein and fat intakes. A case is made for provision of public goods, nutrition labelling, regulation of food standards, consumer awareness of healthy diets, food fortification and supplementation, and active involvement of the private sector in adhering to the regulatory standards and nutritional norms.

INTRODUCTION

India is currently undergoing a rapid economic and demographic transformation. Since 1980, average living standards have experienced a sustained and rapid rise. The gross domestic product per capita has risen by 230 per cent; a trend rate of 4 per cent annually. Life expectancy has risen from 54 years to 69 years while the (crude) birth rate has fallen from 34 to 22 per thousand between 1980 and 2008. Rapid economic growth has been accompanied by rising urbanisation. Between 1980 and 2000, the share of the urban population rose from 23 to 28 per cent. By 2030, it is likely to be as high as 41 per cent.

Rapid economic growth, urbanisation and globalisation have resulted in dietary shifts in Asia, away from staples and increasingly towards livestock and dairy products, fruits and vegetables, and fats and oil. Besides, current consumption patterns seem to be converging towards a Western diet (Pingali, 2004, 2006, and Popkin et al, 2012).[2]

These dietary changes reflect interaction of demand and supply factors.[3] The demand factors include: rapid income growth and urbanisation, bringing about new dietary needs; and, more generally, growing affluence and life style changes. Expansion of the middle class, higher female participation, the emergence of nuclear two-income families, a sharp age divide in food preferences (with younger age groups more susceptible to new foods advertised in the media) underlie the demand. As incomes rise, exposure to the global ‘urban’ eating patterns increases. Recent evidence also points to greater reliance of smaller and poorer households on street foods. Urban slums often mimic the branded products of fast food outlets (Pingali, 2004). On the supply side, the main factors associated with the availability of food are: closer integration of global economies, severing of the link between local production and availability of food; liberalisation of foreign direct investment, with a

[2] This is broadly defined by high intakes of refined carbohydrates, added sugars, fats, and animal-source food. In low and middle income countries, these changes are typical of urban areas but, more recently, increasingly visible in rural areas too. Diets rich in legumes, other vegetables, and coarse grains are declining in importance in all regions and countries (Popkin et al, 2012).

[3] As observed by Popkin et al. (2012), on the global level, new access to technologies (e.g. cheap edible oils, foods with excessive “empty calories”, modern supermarkets, and food distribution and marketing), and. the regulatory environments (the World Trade Organisation and freer flow of goods, services and technologies) are changing diets.

new role of multinational corporations — especially supermarkets and fast-food outlets,[4] and a sharp reduction in freight and transportation costs (Pingali, 2006).

Often diet diversity is taken to be synonymous with diet quality. In a recent contribution (Rashid et al. 2011), for example, one of the two measures of diet quality is diet diversity. The latter is defined as the number of different foods or food groups consumed over a given reference period. It is rationalised that increasing the variety of foods across and within groups ensures adequate intake of essential nutrients that promote good health. In fact, it is pointed out that there is a strong positive association between diet diversity and nutrient adequacy (Ruel, 2002).[5] A major limitation, however, of the studies reviewed by Ruel (2002) is that diet diversity is not adjusted for its endogeneity (in other words, it is the outcome of a choice). Hence the favourable effects of diet diversity on various nutrition indicators are suspect. But another study (SOFI, 2012) takes a broader view that dietary changes in the past two decades have had both positive and negative impacts on nutrition. On the positive side, the quality of diets at the aggregate global level has improved, and nutritional outcomes have improved in most parts of the world.[6] On the negative side, diets increasingly contain more energy-dense, semi-processed foods, saturated fats and sugars. These dietary shifts/changes are associated with an increase in overnutrition and obesity. The latter are causally linked to higher prevalence rates of non-communicable diseases (NCDs) such as diabetes, cardio-vascular and cancer. So whether the nutritional implications are positive or negative is essentially an *empirical* issue. This is what the present study aims to examine, overcoming a

[4] In a perceptive comment, Timmer (2010) addresses the following questions: impact of supermarkets on poor consumers, supply of staples, price stability, linkages with global markets, and health of consumers. While supermarkets offer greater consumer choice and lower prices, they consolidate the supply chain to only a few producers who are increasingly responsible for compliance with the cost, quality and safety standards. Although supermarkets are increasingly driving the food policy agenda, the state has to play a proactive role in laying down food safety standards, their compliance and in ensuring greater awareness of healthy food habits.

[5] Ruel (2002) observes that in spite of the variety in measurement approaches and in environmental conditions, the results are highly consistent in showing a positive association between dietary diversity and growth in young children. One of the main weaknesses of most studies, however, is the lack of appropriate control for socioeconomic factors. It may be that the association between diversity and growth is largely confounded by socioeconomic factors, since dietary diversity is also found to be strongly associated with household socioeconomic characteristics. Thus, it may be that dietary diversity is a good proxy for socioeconomic status and that children with higher dietary diversity are also children from wealthier households whose better growth is due to a combination of favourable conditions, including higher maternal education, household income, or greater availability of health and sanitation services, to name a few.

[6] These estimates cannot be accepted at face value as dietary shifts and nutritional outcomes are based on food/nutrient availability. For illustrative evidence pointing to not just greater prevalence of calorie deprivation but also reversal of a declining trend in proportion of undernourished in India over the period 1993-2009, see Gaiha and Kulkarni (2012).

major methodological weakness of extant studies (i.e. lack of adjustment for endogeneity of diet or food diversity).

The health implications of the dietary transition are unclear but the growing risk of NCDs ought not to be overlooked (Bloom and Cafeiro, 2012). Although India lags behind other developing countries in the epidemiological transition — decline in infectious disease mortality compensated for increasingly by higher mortality from chronic degenerative NCDs — there is some evidence of this transition taking place. Estimated deaths from NCDs are projected to rise from 3.78 million in 1990 (40.46 per cent of all deaths) to 7.63 million in 2020 (66.70 per cent of all deaths). Worse, about a quarter of the deaths occurred in the 35–64 age group in urban areas (Kulkarni and Gaiha, 2010).[7]

In a comprehensive study, Mahal et al. (2009) demonstrate that NCDs constitute a major economic burden in India. They report high levels of out-of-pocket spending by households with members suffering from NCDs, limited levels of insurance coverage (including subsidised public services) and the income losses that befall affected households. Associated with these costs are risks of catastrophic spending and impoverishment, and, of course, macro impacts.[8]

Although undernutrition still afflicts the world, dietary excess and related chronic diseases are increasing globally, aggravating the burdens on national budgets and institutions. Dealing with all forms of malnutrition (deficiencies as well as excess of calories and fats) poses a major challenge for governments and individuals (Kennedy et al. 2011).

The most recent round (66th round corresponding to the year 2009-10) of the National Sample Survey (NSS) provides new insights into the consumption and expenditure behaviour of households. Together with the 50th and 61st rounds of the NSS, the 66th round data allow analysis of changes in food consumption behaviour in the past two decades and their nutritional implications. Our analysis is based mostly on unit record data collected for these rounds of the NSS (corresponding to 1993–94, 2004–05, and 2009-10, respectively).[9]

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[7] For recent analyses, see Mahal et al. (2009) and Popkin et al. (2001, 2012).

[8] For a rigorous and innovative analysis of the overall effect of health on income, labour productivity, savings, and population effects, see Bloom et al. (2009).

[9] This analysis builds on Kaicker et al. (2011).

SCHEME

We first examine recent evidence on how prevalent eating out is and amounts spent, as these are closely linked to dietary diversification (Timmer, 2010). We then report our findings on changing dietary patterns of Indian households, based on three rounds of the NSS. Broadly, dietary transition is characterized by a substitution of traditional staples by primary food products that are more prevalent in western diets. To capture dietary transition, we construct an index of dietary or food diversification (FDI) and examine the changes in food diversity over the period 1993-2009.[10] This is followed by a demand theory based analysis of changes in the food consumption basket of Indian households and their nutritional implications. Finally, concluding observations are made from a broad policy perspective.

EATING OUT

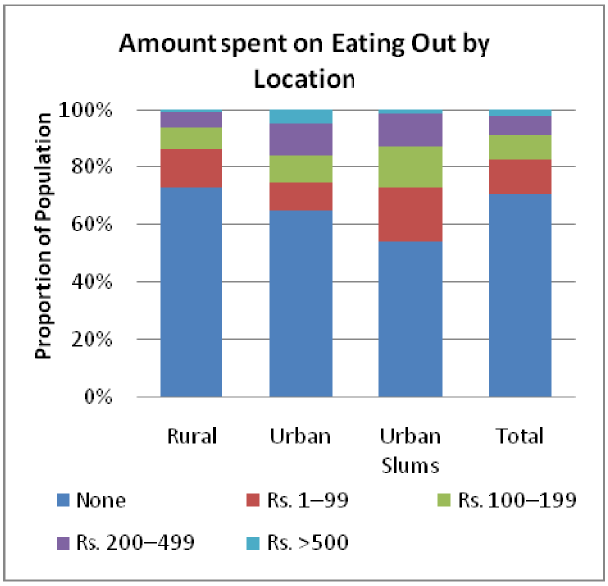
From the perspective of dietary transition as discussed above, we give below a distillation of our findings on eating out, based on an analysis of a nationwide household survey, *India Human Development Survey 2005* (IHDS), conducted jointly by the University of Maryland and the National Council of Applied Economic Research. Our focus is on the socio-economic status of households eating out, and their spatial distribution.[11] Eating out refers to meals or snacks served in restaurants, roadside eating places, tea and snack shops, and street vendors.

Eating out is pervasive going by the fact that about 30 per cent of the households did so. A large majority of those eating out (about 42 per cent) spent under Rs 99 per month, and about a quarter spent over Rs 200 per month (at 2004–05 prices) (Figure 1). Eating out is a feature not just of the metros or urban areas, but also of urban slums and rural areas, though it is less pervasive in the last two areas. In the six largest metros (Mumbai, Delhi, Kolkata, Chennai, Bangalore, and Hyderabad), about 34 per cent of the households ate out, as compared to about 27 per cent elsewhere. Over 47 per cent of the former spent Rs 200 or more per month on eating out, and less than one-quarter of the latter did so. Eating out is thus more pervasive among the metro residents, who also spend larger amounts.

[10] With three data points, a robust trend cannot be established. However, some useful insights are obtained into changing consumer behaviour over a period of two decades.

[11] For details, see Gaiha et al. (2010).

Figure 1: Amounts Spent on Eating Out in 2005



Source: Authors' calculations based on IHDS (2005)

About 25 per cent of the Scheduled Castes (SCs), about 27 per cent of the Scheduled Tribes (STs), and about 31 per cent each of the Other Backward Castes (OBCs), and Others ate out. Even some of the most deprived and socially excluded groups — especially the SCs and STs — have switched from traditional staples to fast foods and opted for greater variety in food consumption. This is further corroborated when the sample is split into the poor and non-poor households using the official poverty line. While a much larger proportion of the non-poor households (about 32 per cent) ate out, that of the poor (about 12.5 per cent) was far from negligible. A more disaggregated classification of the households into four MPCE classes (less than Rs 300, between Rs 300–500, between Rs 500–1000, and greater than Rs1000) further *dispels* any doubts that eating out as a manifestation of dietary transition is mostly *a middle-class phenomenon* (Fig. 2).

About 22 per cent of the households eating out had MPCE below Rs 500, with the majority (about 78 per cent) from the lower and upper-middle income classes (i.e., between Rs 500–1000, and greater than Rs 1000). Within the low income households too (less than Rs 500), the share of those eating out was 18 per cent, and 36 per cent among the lower and upper-middle income households. Also, there are differences in the distribution of expenditure on eating out disaggregated by family type (i.e. whether it is a nuclear or a joint family — Fig 3).

Fig 2: Distribution of Household Expenditure on Eating Out by monthly per capita expenditure (Rs)

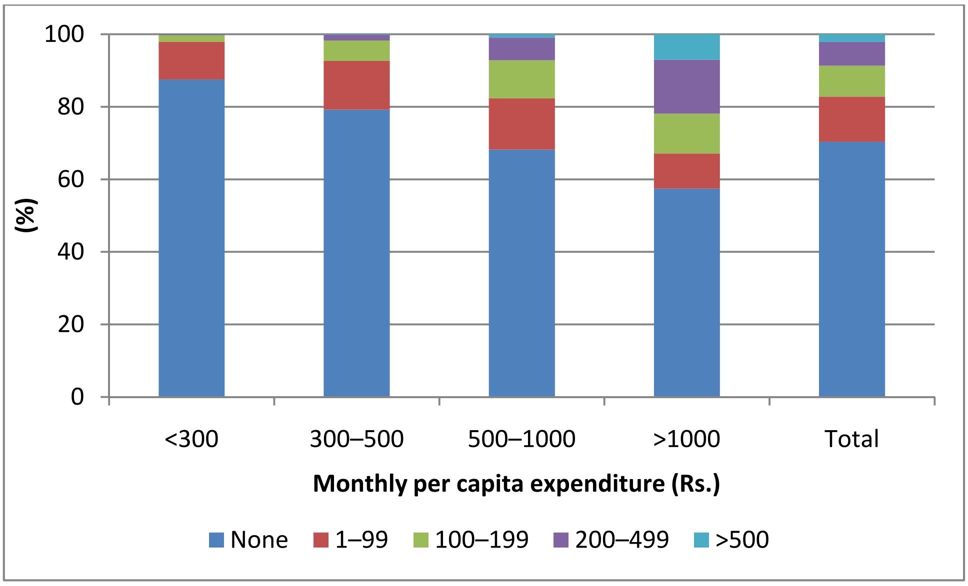
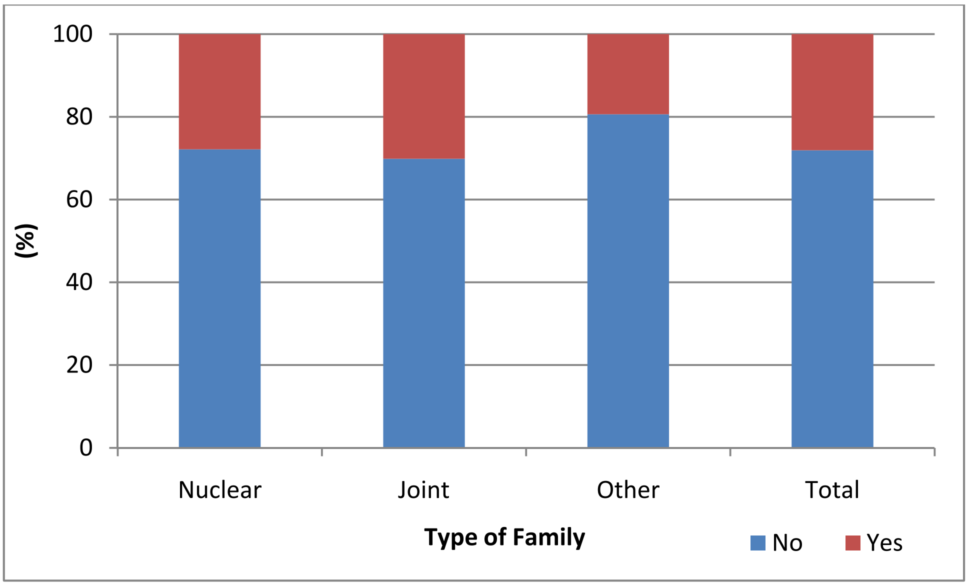


Fig 3: Distribution of Households Eating Out by Family Type



Source: Authors' calculations based on IHDS (2005)

Using an econometric model, we obtain additional insights into the *marginal* contribution of household traits and locational characteristics.[12] The results show that location of households, their demographic and caste characteristics and, above all, their relative affluence determine both the decision to eat out, and, conditional on it, the amounts spent.

[12] We use a Heckman model in which two steps are involved: first, the probability of eating out is determined and then, conditional on it, the amounts spent on eating out. For details, see Gaiha et al. (2010).

Metro and non-metro urban locations induce eating out, relative to the rural. SCs and STs have a lower propensity to eat out relative to Others, and OBCs are more likely to eat out. Over and above these effects, the higher the ratio of per capita expenditure to the poverty cut-off expenditure — as a measure of affluence — the higher is the probability of such households eating out.

Amounts spent on eating out vary with location. Households located in both metros and non-metro urban locations are likely to spend larger amounts on eating out, relative to rural areas. Between the metros and non-metros, households in the former are likely to spend much larger amounts. SCs, STs and OBCs are likely to spend lower amounts relative to Others. The higher the number of adult males in paid employment in the age-group 25 to 45 years, and of females in the older age-group, >45 years, the greater is the amount spent. The effect of higher per capita expenditure relative to the poverty line is large and significant, confirming that the more affluent are not just likely to eat out more often but also likely to spend larger amounts. Somewhat surprisingly, the higher the share of salary in household income, the lower is the amount spent. By contrast, the higher the share of business income, the larger is the amount spent.

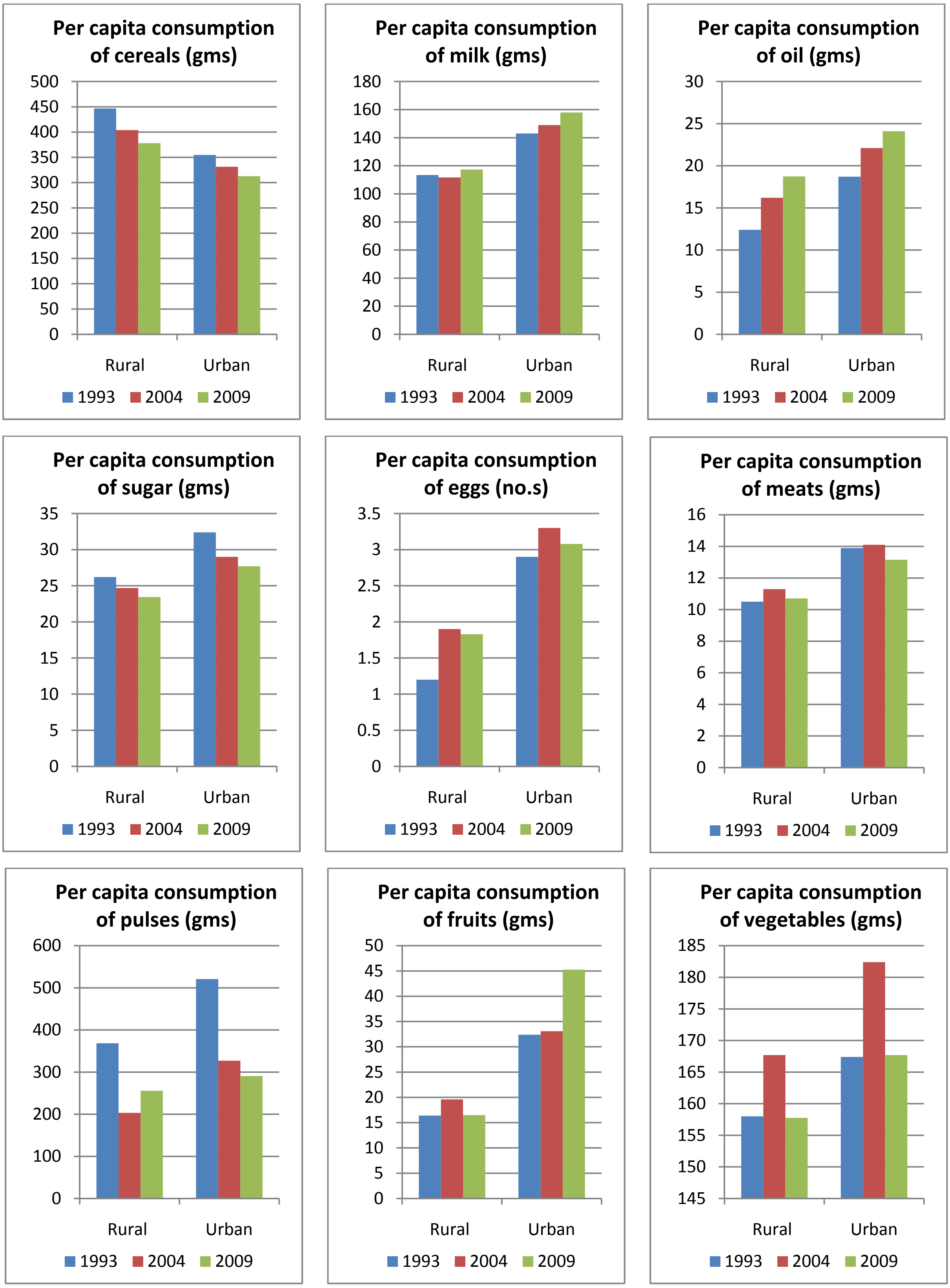
Thus, our analysis broadly confirms the important role of urbanisation, demographic changes, expansion of the middle class and its growing affluence in eating out, or, more generally, consumption of snacks, beverages and precooked meals. To the extent that even more deprived sections are not immune to these evolving dietary patterns, and, given their limited access to medical care and dietary awareness, the health outcomes may well be a lot grimmer than often acknowledged.

CHANGES IN DIETS

Let us first consider changes in consumption of various food items in rural and urban areas between 1993 and 2009. For details, refer to Figure 4 below and Table A.1.1 in Annex 1.

There was a sharp reduction in cereal consumption between 1993 and 2009 — 15 per cent in rural areas and 12 per cent in urban areas. While the reduction was more drastic in the first period (1993-94 to 2004-05) in rural areas, as compared to the second (2004-05 to 2009-10), in urban areas, the rate of reduction was almost equal in both the periods.

Figure 4: Changes in Diets (1993-2009)



Source: Authors' calculations based on NSS (various rounds)

In both rural and urban areas, pulses/nuts/dry fruits recorded a sharp drop between 1993 and 2004. While it continued to decline in urban areas (although at a lesser rate), it increased substantially in the rural areas. The consumption of sugar decreased too, in both the periods and in both the sectors — rural and urban.[13] By contrast, intakes of vanaspati-oil rose sharply in both rural and urban areas, especially in the first period. The consumption of milk and milk products increased, and, more substantially, for urban areas (by about 10 per cent between 1993 and 2009), especially in the second period. Intakes of meat/fish/poultry increased slightly in rural areas (by 2 per cent) and declined in urban areas (by 5 per cent) between 1993-2009. Vegetable intakes increased moderately in the first period in both rural and urban areas, but declined by an equal amount in the second, leaving the intakes largely unchanged between 1993 and 2009. Fruit consumption increased substantially in the urban areas, especially in the second period. There are marked differences in the intakes of various food commodities among various income classes too (refer to Table A.1.2 in Annex 1).[14]

Thus food composition/diet changed considerably in both rural and urban areas over the period 1993–2009.[15] The key features are a reduction in intakes of staples (cereal and pulses) and an increase in intakes of more energy dense foods, particularly fats (as seen in the increased intake of vanaspati oil). But dietary transition slowed down in the second period (2004-05 to 2009-10) compared to the first (1993-94 to 2004-05) — as seen in the reduction in the rate of decrease in staples consumption and rate of increase in oil consumption.

As these dietary shifts are linked to intakes of calories, proteins and fats with varying importance, an investigation of how food consumption patterns changed in response to changes in income and food prices, among other changes, is necessary.

DIET DIVERSIFICATION

To capture diversification in diets, i.e. a move from a cereal dominated diet to more variety in food consumption basket, we use a Food Diversity Index (FDI). The FDI is calculated as the sum of squares of the shares of the various food items in the food consumption basket.

Algebraically, $FDI_{it} = \sum_{j=1}^{5} S_{jit}^{2}$ (1)

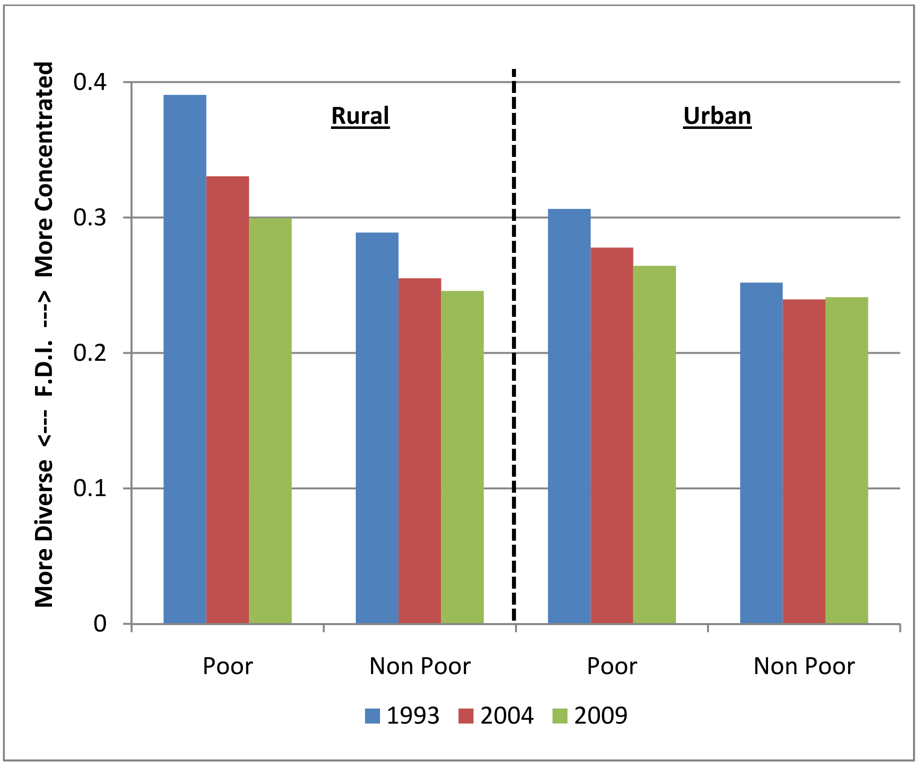
[13] It is well documented that sugar content of beverages is underestimated. See, for example, Popkin et al. (2012).

[14] For an earlier and influential analysis over the period 1983-2004, see Deaton and Dreze (2009).

[15] For a rich and insightful analysis of dietary changes in India — specifically, higher fat consumption by the bottom six per capita expenditure deciles over the period 1993–2004 — see Deolalikar (2010).

where FDI_{it} is the food diversity index for household i at time period t, S_{jit} is the share of jth commodity in the food consumption basket. This is similar to the Herfindahl index used to measure the competitiveness of an industry. High value of the index implies a monopolistic market (or, in our case, a more *concentrated* food basket) and low value implies a nearly perfectly competitive market (in our case, a more *diverse* food basket).[16] We use five food groups to construct the FDI: (i) cereals and pulses; (ii) milk, milk products, eggs, and meats; (iii) oil; (iv) sugar; and (v) fruits and vegetables. Figure 5 shows the variation in FDI for rural and urban areas between 1993 and 2009, and for the poor and the non-poor, separately.

Figure 5: Food Diversity Index (1993-2009)



Source: Authors' calculations based on various rounds of NSS.

[16] Single food or food group counts have been frequently used as measures of food/ dietary diversity in developing countries, probably because of their simplicity. The number of servings based on dietary guidelines was not considered in any of the developing country studies reviewed in Ruel (2002). In a refinement, Hoddinott and Yohannes (2002) used a weighting system, which scored foods and food groups according to their nutrient density, the bioavailability of the nutrients they contain, and typical portion sizes. For example, foods that were usually consumed in small amounts (e.g., condensed milk) were given a lower score than foods with similar nutrient content that were consumed in larger amounts (e.g., fluid milk). While this is a considerable improvement on food or food group counts, the precise weights seem arbitrary. This is of course an improvement over various indices of diet diversity or food variety used in the extant literature as it allows for differences in shares of food commodity groups consumed. Our index is justified on the grounds that the food group shares are *actual*.

The poor in both rural and urban areas had less diversified diets than the corresponding non-poor. For both the poor and non-poor, the food basket became more diversified (the Herfindahl index decreased) but with stark differences. In the rural areas, food diversity increased at a faster rate for the poor (15 per cent decline in the index as against 12 per cent among the non- poor) during 1993-2004. This diversification slowed down during 2004-09 among both the poor and non-poor (9 per cent and 4 per cent decline in the index, respectively). The change in urban areas was slower (increase in diversity by 9 per cent for the poor and 5 per cent for the non-poor between 1993-2004). Between 2004-09, the diets of the poor continued to diversify, albeit at a slower rate (5 per cent), and somewhat surprisingly became less diversified among the non-poor.

DEMAND THEORY BASED EXPLANATION OF CHANGES IN DIETS

METHODOLOGY

We report our findings on changing dietary patterns of Indian households, based on an analysis of the 1993, 2004 and 2009 household surveys conducted by the NSS. Estimation at the household level is preferred as there is greater variation in expenditure levels than found in grouped data. An instrumental variable regression estimation (IV) is used.[17] First, a *reduced* form demand relation is used in which the dependent variable is the Food Diversity Index (FDI), as defined earlier, and the right side/explanatory variables include prices of food commodities, income, household characteristics such as proportion of adults, educational level, caste, location, and the general environment (e.g. life-style changes, health environment).[18,19] The latter are sought to be captured through two dummy variables. D_t^1 is a dummy variable that takes the value 1 for 2004 and 0 otherwise, and another time dummy D_t^2 that takes the value 1 for 2009 and 0 otherwise (to allow for changes in factors other than food prices and expenditure over time), two regional dummies, RD^1 and RD^2, denoting BIMARU and coastal states, respectively, and whether a household belongs to the middle class or not denoted by CD_{it} based on whether it owns consumer durables (e.g. TV), and an error term.

[17] For an algebraic exposition, see Annex 2 at the end of this paper.

[18] For a rich and comprehensive exposition, see Behrman and Deolalikar (1988).

[19] For early important contributions to price induced food commodities' substitutions, and empirical verification of taste for food variety, see Timmer (1981) and Behrman and Deolalikar (1989). For an extension of the latter with India's data, see Jha et al. (2009).

As dietary transition is closely linked to the emergence of the middle class (Deolalikar, 2010, Pingali, 2004, 2006, and Popkin et al, 2012), the latter serves as an instrument for the diet/food diversity equation. It must be emphasised that our choice of the instrument is guided by the consideration that this variable directly influences diet composition (through, for example, more frequent eating out), and, through changes in diet composition, nutrient intakes. As shown later, validity of this instrument is corroborated.[20]

The regional dummies for BIMARU and coastal states are justified on the grounds that the first subset is among the poorest while the latter are among the more prosperous. An innovative feature of this specification is that both price and expenditure variables are interacted with time to allow for changes in their coefficients over time.[21]

In the second stage, calories consumed per capita per day, $calories_{it}$, and two other nutrients, protein and fats, are successively regressed on all exogenous variables in the reduced form except the instrument.[22]

We have pooled our sample over time (1993, 2004 and 2009) and do our analysis at all-India level. Some distinctive features of the demand functions estimated are: (i) use of food commodity prices whose effects vary over time; (ii) household characteristics such as size, proportion of adults, education level and caste affiliation; and (iii) time-related changes such as less strenuous activity levels and healthier environments, through two time dummies.

[20] For an elaboration and validation of the instrument variable designed to correct the endogeneity of FDI, see Annex 2.

[21] Hoddinott and Yohannes (2002), in their multi-country analysis of data from ten countries, tested whether household dietary diversity was associated with household per capita consumption (a proxy for household income) and energy availability (a proxy for food security). Dietary diversity was measured as the sum of individual foods consumed in the previous seven days. The authors also tested the findings with a food group diversity indicator, which included twelve food groups (using the food groups from the FAO food balance sheets). Household per capita consumption was measured by a consumption/expenditure instrument, which estimates the value of consumption of food and non-food goods during the previous seven days. Household energy consumption was calculated from the information on *food* consumption/expenditures in the same interval. Their results show that a 1 per cent increase in dietary diversity is associated with an average 1 per cent increase in per capita consumption/expenditure and a 0.7 per cent increase in total per capita energy availability. When separating energy from staples and non-staples, the authors show that a 1 per cent increase in household dietary diversity is associated with a 0.5 per cent increase in household energy availability from staples and a 1.4 per cent increase in energy availability from non-staples. There are, however, three problems: whether income is an appropriate instrument, omission of food prices, and endogeneity of energy availability. So whatever the plausibility of their findings, their unbiasedness and robustness are *suspect*.

[22] Recall that this is a methodological improvement on extant studies reviewed in Ruel (2002) which do not correct dietary diversity for its endogeneity.

RESULTS

The instrumental variable regression (IV) results for calories are discussed below (Tables A.2.1),[23] followed by those on protein (Tables A.2.2) and then on fats (Tables A.2.3).

Calories

Let us first examine the factors underlying the variation in FDI.[24] Our strategy here is to first summarise the regression results and then comment on their elasticities that are comparable across explanatory variables.

Going by the results in Table A.2.1, higher price of cereals and pulses increased food diversity.[25] This effect is magnified when interacted with the two time dummies, implying that the effect is larger. Higher prices of milk/meat/eggs reduced food diversity but this effect weakened over time (that is, in 2004 and 2009 relative to that in 1993). Higher prices of fruits and vegetables increased food diversity but this was diminished by the time effects. Higher oil prices increased food diversity despite a weakening of this effect over time. Higher sugar price also increased diet diversity but at a diminished rate over time.

Our measure of income/expenditure is relative to the poverty cut-off point. Greater (relative) affluence is associated with greater food diversity even though this effect weakened over time, especially between 2004-09.

Larger households displayed lower food diversity given the proportion of adults and dependency burden. This is a pure size effect as proportions of adults and dependency burden are held constant. Higher education of both adult males and females was associated with greater diet diversity. The caste variables include Scheduled Tribes (STs) and a residual group of Others, with the Scheduled Castes (SCs) as the omitted group. Both STs and Others displayed greater food diversity relative to the SCs.

Urban households displayed greater food diversity relative to the rural. Both BIMARU and Coastal states consumed more diversified diets relative to the omitted states.

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[23] To avoid confusion, comparison of elasticities is in *absolute* terms if the values are negative.

[24] Recall that FDI and food diversity are inversely related: higher value of FDI implies lower food diversity and *vice versa*.

[25] To make the results more intuitive, our comments focus on food diversity and not on FDI. So the signs are opposite of those in the regression results.

The middle class (instrument) variable was associated with greater food diversity relative to others (who did not own consumer durables).

As food prices and expenditure are interacted with time dummies, elasticities of food diversity (instead of FDI with a sign reversal) with respect to these variables, as also with respect to middle class affiliation, are computed. These are reported in Table A.2.4. They allow comparisons of magnitudes of their effects in an intuitive way, which is complicated by interaction effects with time dummies.

The elasticity of food diversity with respect to price of cereals (including pulses) is 0.06, implying that a 1 per cent higher price increases food diversity by 0.06 per cent, on average. On the other hand, the elasticity with respect to price of milk/meat and eggs is -0.03, implying that a 1 per cent higher price resulted in a lowering of food diversity by 0.03 per cent. If price of fruits and vegetables rose by 1 per cent, food diversity was higher by 0.065 per cent. But a 1 per cent higher price of vanaspati oil had a negligible effect on food diversity (as the elasticity was 0.0005 per cent). The elasticity with respect to price of sugar (0.05 per cent) was larger.

Why these food price elasticities differ in sign is difficult to explain as we do not know what the cross-price effects are –or, in other words, the extent of substitution between different food commodities as price of one changes. Despite this limitation, it is evident that food price changes resulted in diet diversity.

Somewhat surprising is the low elasticity with respect to expenditure (0.006). But it cannot be ruled out that part of the effect of (relative) affluence is subsumed in the middle class variable with an elasticity of 0.037.

Over and above the time effects in interactions with food price and expenditure variables, food diversity rose over the period 1993-2009, pointing to the effects of life-style changes, growth of supermarkets and popularity of convenience foods.

Let us examine the impact of these variables on calorie intake.

Using food diversity *instead* of FDI (with a sign reversal), calorie intake reduced with greater food diversity. Somewhat surprisingly, the price of cereals (including pulses) did not have a significant effect on calorie intake. Nor were interactions with time dummies significant. Higher the price of milk/meat/eggs, higher was calorie intake but with a weakening of this effect between 1993-2004. As it turns out, the overall effect was negative. Higher the price of fruits and vegetables, lower was the calorie intake, with a weakening in

1993-2004 and strengthening in 2004-09. The overall effect was positive. Price of vanaspati oil lowered calorie intake and more so over time. Higher price of sugar increased calorie intake with a weakening of this effect over time.

Higher expenditure resulted in larger calorie intake but this effect weakened over time. The effect, however, was positive.

Household size was inversely related to calorie consumption given proportion of adults and dependency burden. So size lowered calorie intake without change in household composition. Proportion of adults had a significant positive effect on calorie intake but dependency burden reduced it. Education of both adult males and females enhanced calorie intake.

While STs had lower calorie intake, Others had higher calorie intake, relative to the SCs (the omitted group).

Locational characteristics also influenced calorie intake. Urban areas (relative to the rural) consumed fewer calories. BIMARU states had lower calorie intakes and Coastal had higher intakes, relative to other states.

After accounting for interaction effects of time dummies with food prices and expenditure, residual time effects were positive in both time periods (1993-2004 and 2004-09).

In order to get a better sense of the magnitudes involved, elasticities of calorie intake with respect to food prices and expenditure were computed. These are given in Table A.2.4.

It is significant-especially in the context of evidence offered in support of improvement in nutritional outcomes consequent upon growing food diversity-that it is associated with a large reduction in calorie intake. As the elasticity is -0.322, it follows that a 1 per cent higher diversity results in 0.32 per cent reduction in calorie intake.

Subject to the caveat that cross-price effects on food commodity demands cannot be captured and thus their implications for calorie demand/intake are unclear, the food price elasticities reveal a contrast.[26]

As noted earlier, it is surprising that cereal price did not have a significant effect on calorie intake, as also its interactions with time dummies. Higher milk/meat/egg prices

[26] Note that, since calorie, protein and fat demands are obtained from intake data, we use the two interchangeably.

reduced calorie intake but the elasticity was small (-0.028). Higher price of fruits and vegetables increased calorie intake but by a small amount (the elasticity being 0.009). Higher vegetable oil price, however, had a moderate negative effect on calorie intake (the elasticity being -0.06). In sharp contrast, price of sugar had a large positive effect on calories (with an elasticity of 0.13). So food prices played a role in explaining changes in calorie intake.

Expenditure had a moderate positive effect on calories (the elasticity being 0.08).

Protein

Our comments are based on Table A.2.2. We will first comment on the marginal effects and then on selected elasticities.

As the results on FDI index (or food diversity) are identical to those in Table A.2.1, it is unnecessary to comment on them.

In contrast to the results on calories, food /diet diversity increases protein intake (given the sign reversal of a negative coefficient of instrumented FDI). This is consistent with extant evidence but with a methodological caveat (i.e. failure to correct for endogeneity of food diversity).

Price of cereals (including pulses) reduced protein intake, with positive effects of the two time dummies (for 2004 and 2009, respectively). However, the overall effect was positive. Price of milk/meat/ eggs was negative but with a positive coefficient of the 2004 dummy variable and a negative coefficient of the 2009 dummy. Altogether the effect was negative. Price of fruits/vegetables had a negative effect but with a large positive effect of the 2009 dummy variable. The overall effect on protein intake was positive. Higher price of vanaspati oil reduced protein intake with non-significant coefficients of the two dummy variables. Higher price of sugar reduced protein intake and the coefficients of the time dummies were non-significant.

Higher expenditure increased protein intake but with considerable weakening during the period 2004-09. The overall effect, however, was positive.

Household size reduced protein intake, as also dependency burden. Higher proportion of adults was, however, associated with larger protein intake. Higher education of adult males increased protein intake while that of adult females did not have a significant effect.

STs had lower protein intake while Others had larger protein intake, relative to the SCs.

Locational characteristics mattered too, with urban households recording lower protein intake. Somewhat surprising is the contrast with BIMARU states consuming more protein and Coastal ones consuming lower amounts than the rest.

Brief comments on selected elasticities (Table A.2.4) are given below.

Higher price of cereals (including pulses) induced higher protein intake but by a small amount (the elasticity being 0.02). Price of milk/meat/ eggs resulted in lower protein effect with a slightly higher (absolute) elasticity (-0.031). Higher price of fruits and vegetables is associated with slightly larger protein intake (the elasticity being 0.005). Higher sugar price induces higher protein intake (0.05). So food prices influenced protein intake with small or moderate effects.

Elasticity with respect to expenditure or (relative) affluence was moderate (0.09).

Fat

Our comments are based on the results in Table A.2.3. As in the case of protein, we will confine our comments to the determinants of fat intake.

As expected, food diversity results in a higher intake of fast (recall that food diversity and FDI are inversely related and there is a sign reversal).

Prices have significant effects too. Higher cereal price resulted in larger fat intake with a weakening of this effect over time. Price of milk/meat/ eggs lowered fat intake with the first time dummy weakening this effect and the second strengthening it. The overall effect, however, was negative. Higher price of fruits and vegetables lowered fat intake with the two time dummies weakening this effect-especially the second. The overall effect, however, was negative but small. Price of vanaspati oil lowered fat intake with a strengthening of this effect over the period 1993-2004. So the overall effect was negative. Price of sugar was inversely related to fat intake with positive coefficients of the time dummies. As a result, the overall effect of higher sugar prices was positive.

The effect of expenditure or (relative) affluence was positive with a weakening during 2004-09. The overall effect was positive.

Household size lowered fat intake but higher proportions of adults and dependency burden increased it. Higher education of adult males increased fat intake.

Only Others consumed more fat than the omitted SCs.

Among locational characteristics, only Coastal states possessed a significant but negative coefficient.

Let us now consider the elasticities in Table A.2.4.

Price of cereals (and pulses) had a moderate elasticity (about 0.12). Price of milk/meat /eggs had a negative but moderate elasticity of -0.074. Higher fruit/vegetable price lowered fat intake but by a small amount (the elasticity being -0.03). Higher vanaspati oil price substantially reduced fat intake with an elasticity of -0.36. Higher sugar price increased fat intake but moderately (the elasticity being 0.06). (Relative) affluence increased fat intake more than moderately as the elasticity was 0.14. The largest effect is associated with greater food diversity (the elasticity being 0.44).[27]

Slowing Down of Dietary Transition

To understand better the slowing down of the dietary shift over the period 2004-2009, let us first briefly consider an important argument of Behrman and Deolalikar (1989). They examine the conjecture that food variety *per se* is valued so that people value more variety in food consumption as their incomes rise while calorie intakes change slightly. They focus on two characteristics of consumer preferences over different foods: the degree of curvature and centrality (relative to the axes) of the location of food indifference curves which represent the consumer preference over two kinds of food e.g. staple foods, a cheaper source of calories, and non-staple foods, such as meat or vegetables, the expensive source of calories. If obtaining calories with low costs dominates in a household's food choices at very low incomes, the food indifference curves are likely to be relatively flat and located closer to the axis for the staple foods. As household income and food budgets increase, food indifference curves may be more sharply curved and centred far away from the staple foods' axis towards the non staple foods axis. In sum, Behrman and Deolalikar (1989) characterise "a taste for food variety" by greater curvature and locational centrality of food indifference curves.

Our results show that the dietary shift was associated with a more than moderate reduction in calorie intake. So the taste for food variety lowered calorie intake. Hence the Behrman-Deolalikar indifference curve analysis framework could be applied. The two building blocks of the taste for variety argument- centrality of indifference curves and their curvature- are relevant. Our analysis shows that a few food price effects weakened (e.g. fruits and vegetables, sugar in the food diversity equation) or strengthened (e.g. cereals and pulses) over time, implying lower or higher substitutions between different sources of calories (or, change in the curvature of indifference curves between cereals and other more expensive

[27] Recall that since food diversity and FDI are inversely related, the sign of the elasticity is reversed.

sources of calories). The effect of (relative) affluence also weakened over time.[28] With higher expenditure (as a ratio of the poverty cut-off point) and a shift of the food budget constraint-the latter also determined by changes in relative food prices-the food indifference curve moved away from the cheapest source of calories.

But a more definitive explanation requires a panel data analysis that is not feasible with the data used in the present analysis.

In sum, our analysis confirms first that the methodological refinement of adjustment of food/diet diversity for its endogeneity makes a difference. The nutritional outcomes are mixed with a lowering of calorie intake and higher intakes of protein and fats. Although average intakes of protein and fats are well below the desired levels, sizable segments of the rural and urban populations consume fat in excess of the recommended level. So the implications of dietary shifts for the rising burden of obesity and risk of NCDs ought not to be overlooked. A related contribution is the elaboration of the important roles of food prices and growing affluence in explaining both the dietary shift and nutritional outcomes. Finally, a conjecture is offered to explain the slowing down of the dietary shift-especially during 2004-09.

CONCLUDING OBSERVATIONS

The main findings are summarised from a broad policy perspective.

Dietary shifts –a switch away from traditional staples towards food products including milk/meat/eggs, oil, and fruits and vegetables with some variation- is confirmed over the period 1993-2009. Changes in consumption baskets of the poor and non-poor between rural and urban areas and sub-periods, 1993-2004 and 2004-2009, differed. Our analysis points to the important roles of food prices, expenditure, demographic characteristics and life-style changes in diet diversification and nutritional outcomes.

Two results are somewhat surprising: one is the slowing down of dietary transition in both rural and urban areas — especially in the former — over the period 2004-09. Another is that the slowing down was faster among the poor than among the non-poor — especially in rural areas. In urban areas, among the non-poor, diet diversification diminished slightly in

[28] For a useful exposition of the distinction between observed (or Cournot) food price elasticities and Slutsky elasticities and how the latter vary with income, see Timmer (1981). As computation of Slutsky elasticities is an exercise in itself, we have confined our comments to observed food price elasticities. This is a convenient but not necessarily a reliable approximation.

more recent years. Our econometric analysis offers a conjecture on the slowing down at all-India level. The clues relate to weaker or stronger food price, expenditure and life-style effects over time-especially during 2004-09. How these are linked to changes in food preferences and taste for variety calls for a more detailed analysis than attempted here.

Contrary to extant literature and dominant explanations of the calorie intake reduction over the last three decades, our analysis confirms that dietary shift has a mixed effect on nutritional outcomes. While calorie intake reduced, protein and fat intakes increased with diet diversification. Although opinions differ on calorie cut-offs, more than 35 per cent of the rural households had calorie intakes of below 1800 in 2009, pointing to pervasive calorie deprivation. Lowering of calorie intake in this context is thus not desirable. By contrast, both protein and fat intakes rose in association with diet diversification. As their averages are well below the desired intakes, increases in their intakes are desirable. However, given excess fat intakes among moderate to large segments of the population (21 per cent of the population consumed more than 50 gms of fat), dietary shift has the potential for aggravating the risk of NCDs.

While concerns for poverty and hunger must dominate the policy agenda, the options for dealing with obesity and the upsurge in non-communicable diseases can only be neglected at the peril of millions of lives that may suffer their worst consequences. Although shifts in diet and physical activities are desirable in many ways — arguably varied and pleasurable — it will be a mistake to overlook the onerous nutritional and health effects and the tragic but avoidable loss of well-being.

A challenge is to raise awareness of the health implications of the dietary transition *despite* its slowing down in more recent years. As growing affluence, life-style changes and urbanisation are *irreversible*, the focus must shift to provision of public goods (e.g. rural infrastructure) to facilitate participation of smallholders in high-value chains, regulation of food safety standards, nutrition labelling, food and nutrition supplementation, stringent restrictions on tobacco and alcohol consumption, nutritional education-especially of women-and active involvement of the private sector in adhering to regulatory standards and nutritional norms. The latter is largely a question of designing appropriate incentives for the private sector to collaborate better with the public sector. Whether these regulatory measures and norms alone will suffice is unclear as food preferences are shaped in complex ways by some irreversible changes taking place.

References

Behrman, J., and A. Deolalikar (1988), "Health and Nutrition", in *Handbook of Economic Development*, vol. 1 (eds), H.B. Chenery and T.N. Srinivasan, North Holland Publishing Company, Amsterdam.

Behrman, J., and A. Deolalikar (1989), "Is Variety the Spice of Life? Implications for Calorie Intake", *Review of Economics and Statistics*, vol. 71.

Bloom, D., D. Canning and G. Fink (2009), "Disease and Development Revisited", Cambridge: MA : NBER Working Paper 15137.

Bloom, D. and E.T. Cafiero (2012), "Not in the Pink of Health", *The Hindustan Times,* 8th November.

Deaton, A., and J. Dreze (2009), 'Food and Nutrition in India: Facts and Interpretations', *Economic and Political Weekly,* XLIV(7), 42–65.

Deolalikar, A. (2010), 'The Middle Class in Asia: Emerging Trends and Patterns and Their Implications', A paper presented at a Workshop on the Asian Middle Class, Asian Development Bank, May 27–8.

Gaiha, R., R. Jha and Vani S. Kulkarni (2010), 'How Pervasive is Eating Out in India?', Australia South Asia Research Centre, Australian National University, Working Paper (Revised and forthcoming in *Journal of Asian and African Studies*).

Hoddinott, J., and Y. Yohannes (2002), *Dietary Diversity as a Food Security Indicator,*Washington, D.C.: Food and Nutrition Technical Assistance, Academy for Educational Development.No.2010/16.

Jha, R., R. Gaiha and A. Sharma (2009), "Modelling Variety in Consumption Expenditure on Food in India", *International Review of Applied Economics*, online publication: 1 July, 2009.

Kaicker, N., Vani S. Kulkarni and R. Gaiha (2011), "Dietary Transition in India: An Analysis Based on NSS Data for 1993 and 2004", A paper given at the 13th IEA World Congress, Beijing, July.

Kennedy, E., P. Webb, P. Walker, E. Saltzman, D. Maxwell, M. Nelson, and S. Booth (2011), "The Evolving Food and Nutrition Agenda: Policy and Research Priorities for the Coming Decade", *Food and Nutrition Policy,* 32 (1).

Kulkarni, Vani. S. and R. Gaiha (2010), "Dietary Transition in India", Philadelphia: *India in Transition*, CASI, University of Pennsylvania, March.

Mahal, A., A. Karan and M. Engelan (2009), *The Economic Implications of Non-Communicable Diseases for India*, Washington DC: World Bank.

Pingali, P. (2004), “Westernisation of Asian Diets and the Transformation of Food Systems: Implications for Research and Policy”, Rome: ESA working Paper No. 04-17, FAO.

Pingali, P. (2006), “Westernisation of Asian Diets and the Transformation of Food Systems: Implications for Research and Policy”, *Food Policy , 32*, 281-298.

Popkin, B., S. Horton, S. Kim, A. Mahal, and J. Shuigao (2001), “Trends in Diet, Nutritional Status, and Diet-Related Non-Communicable Diseases in China and India: The Economic Costs of the Nutrition Transition”, *Nutrition Reviews*, 59(12), 379–90.

Popkin, B.M., L.S. Adair, and S.W. Ng (2012) “Global Nutrition and the Pandemic of Obesity in Developing Countries”, *Nutrition Review*, vol. 70, 3-21.

Rashid, D.A., L.C. Smith and T. Rahman (2011),“Determinants of Dietary Quality:Evidence from Bangladesh”, *World Development*, xx, (x).

Ruel, M. (2002), *Is Dietary Diversity an Indicator of Food Security or Dietary Quality? Do the Determinants of Diet Quantity and Quality Differ?* Washington DC: International Food Policy Research Institute, mimeo.

Food and Agriculture Organisation, (FAO, 2012) *The State of Food Insecurity in the World* (SOFI, 2012), Rome: Food and Agriculture Organisation.

Timmer, C.P. (1981) ,“Is There Curvature in the Slutsky Matrix?’, *The Review of Economics and Statistics*, 63 (3).

Timmer, C. P. (2010), ‘Reflections on Food Crises Past”, *Food Policy*, vol. 35.

ANNEX 1

Table A.1.1: Per Capita Consumption of Food Commodities (Gms), 1993, 2004 and 2010

Year	Cereals	Milk Products Ghee/Butter	Vanaspati-Oil	Sugar	Eggs	Meat/Fish /Poultry	Pulses/Nuts /Dry Fruits	Fruits	Vegetables
Rural India									
1993-94	446.8	113.4	12.4	26.2	1.2	10.5	368.6	16.4	158.0
2004-05	404.0	111.7	16.2	24.7	1.9	11.3	203.4	19.6	167.7
2009-10	378.2	117.3	18.7	23.5	1.8	10.7	255.7	16.5	157.8
Growth *(1993-94 to 2004-05)*	-10%	-1%	31%	-6%	58%	8%	-45%	20%	6%
(2004-05 to 2009-10)	-6%	5%	16%	-5%	-4%	-5%	26%	-16%	-6%
(1993-94 to 2009-10)	-15%	3%	51%	-10%	53%	2%	-31%	1%	0%
Urban India									
1993-94	354.7	143.0	18.7	32.4	2.9	13.9	520.8	32.4	167.4
2004-05	331.4	149.0	22.1	29.0	3.3	14.1	327.0	33.1	182.4
2009-10	312.9	157.9	24.1	27.7	3.1	13.2	290.6	45.3	167.7
Growth *(1993-94 to 2004-05)*	-7%	4%	18%	-10%	14%	1%	-37%	2%	9%
(2004-05 to 2009-10)	-6%	6%	9%	-4%	-7%	-7%	-11%	37%	-8%
(1993-94 to 2009-10)	-12%	10%	29%	-15%	6%	-5%	-44%	40%	0%

1. Authors' calculations based on various rounds of the NSS.

Table A.1.2: Per Capita Consumption of Food Commodities (Gms), 2009-10 by Deciles of Monthly Per Capita Expenditure

Deciles of MPCE	Cereals	Milk Products Ghee/Butter	Vanaspati-Oil	Sugar	Eggs	Meat/Fish /Poultry	Pulses/Nuts /Dry Fruits	Fruits	Vegetables
Rural India									
1	339.1	25.4	11.2	10.9	0.7	4.0	14.4	4.5	110.6
2	354.1	41.4	14.0	15.0	1.1	5.9	17.9	7.6	132.4
3	368.4	62.4	15.2	17.3	1.3	7.0	19.4	9.2	139.3
4	371.2	78.3	16.6	19.1	1.5	8.3	19.9	10.7	148.5
5	382.2	93.9	18.3	21.4	1.6	8.7	22.1	12.5	156.5
6	380.5	111.9	19.1	23.5	1.8	10.1	23.2	15.3	159.9
7	390.7	131.1	20.6	25.7	2.1	11.7	24.6	17.0	167.5
8	391.7	159.5	21.7	28.3	2.3	12.6	27.7	21.5	171.4
9	401.8	194.5	23.6	32.6	2.4	15.3	29.8	25.1	185.6
10	402.4	275.0	27.1	40.9	3.5	23.6	36.8	41.6	205.9
Urban India									
1	314.5	50.9	14.5	16.6	1.2	5.9	17.3	7.3	115.7
2	318.3	77.7	18.1	21.2	2.0	9.7	20.9	12.4	134.8
3	315.7	100.9	20.4	23.4	2.2	10.2	22.3	15.6	141.6
4	320.3	121.1	22.4	25.4	2.6	11.2	25.3	19.9	155.2
5	322.9	136.8	23.9	27.6	2.9	12.1	28.0	22.6	158.3
6	317.2	164.6	25.2	29.6	3.1	14.0	30.2	27.4	171.8
7	315.1	183.3	27.0	30.8	3.7	14.8	33.2	33.0	176.3
8	311.7	210.6	28.6	32.6	3.5	14.7	35.7	38.8	189.7
9	307.6	241.5	29.5	33.5	4.0	17.8	37.7	48.5	203.6
10	285.6	292.2	31.6	36.8	5.6	21.1	43.1	77.8	230.5

1. Authors’ calculations based on various rounds of the NSS.

ANNEX 2

IV Estimation

A demand theory based explanation is used to throw new light on the dietary shift and its nutritional outcomes. An instrumental variable regression estimation (IV) is employed. First, a reduced form demand relation is used in which the dependent variable is the Food Diversity Index (FDI), as defined earlier, and the right side/explanatory variables include prices of food commodities, income, household characteristics, location, and the general environment (e.g. life-style changes, health environment) captured through time dummies.[29]

$$\text{FDI}_{\text{ijt}} = \alpha + \boldsymbol{P_{jt}\beta} + \gamma E_{it} + \boldsymbol{X_{it}\delta} + \partial CD_{it} + \lambda_1 D_t^1 \quad + \lambda_2\, D_t^2 + \theta RD^1 + \vartheta RD^2 + \varepsilon_{ijt}$$

where the dependent variable is the food diversity index for ith household in time t, $\mathbf{P}_{\mathbf{jt}}$ is a vector of food prices (for selected commodity groups) computed from the NSS at the village level (j) and time t, E_{it} is household per capita expenditure as a ratio of the poverty cut-off point of ith household in time t, $\mathbf{X}_{it}$ is a vector of household characteristics (e.g. proportion of adults, household size, whether adult males and females possessed middle or higher level of education) and a few others specified as dummy variables (caste and education), D_t^1 is a dummy variable that takes the value 1 for 2004 and 0 otherwise, and another time dummy D_t^2 that takes the value 1 for 2009 and 0 otherwise (to allow for changes in factors other than food prices and expenditure over time), two regional dummies, RD^1 and RD^2, denoting BIMARU and coastal states, respectively, and whether a household belongs to the middle class or not, denoted by CD_{it}, based on whether it owns consumer durables (e.g. TV), and ε_{ijt} is the error term.

As dietary transition is closely linked to the emergence of the middle class (Deolalikar, 2010, Pingali, 2004, 2006, and Popkin et al., 2012), the latter serves as an instrument for the diet/food diversity equation. It must be emphasised here that our choice of the instrument is guided by the consideration that this variable directly influences diet composition (through, for example, more frequent eating out) and, through changes in diet composition, nutrient intakes. As shown later, validity of this instrument is corroborated.

[29] For a rich and comprehensive exposition, see Behrman and Deolalikar (1988).

In the second stage, calories consumed per capita per day, calories $_{it}$, and two other nutrients, protein and fat are successively regressed on all exogenous variables in the reduced form except the instrument, CD_{it}, as shown below:[30]

$$\text{Calories}_{\text{ijt}} = \alpha + \boldsymbol{P_{jt}\beta} + \gamma E_{it} + \boldsymbol{X_{it}\delta} + \pi\widehat{FDI}_{ijt} + \lambda_1 D_t^1 \quad + \lambda_2 D_t^2 + \theta RD^1 + \vartheta RD^1 + u_{ijt}$$

As may be noted, all right side variables are the same as in the previous equation, except that the instrument is omitted while an instrumented value of FDI is inserted, $\widehat{FDI}_{it}$. Standard errors are corrected for heteroscedasticity.[31]

The regression results are given in Tables A.2.1 — A.2.4. The definition of variables used is given in Table A.2.5.

As we have already commented on these results, we will confine our comments to tests of the validity of the instrument and identification.

As the dependent variable is FDI, the instrument (whether affiliated to the middle class) has a significant negative coefficient (with a t-value of -43.59). This is further corroborated by the F test of excluded instrument (F (1, 308891) =1899.87 which is significant at the 0 per cent level (0.0000). The null of underidentification is rejected by the Kleibergen –Paap rk LM statistic=1671.4, Chi-sq (1) P-value=0.0000. The null of weak identification is rejected by Kleibergen-Paap rk Wald F statistic =1899.87, given the critical value of 8.96 (for 15 per cent maximal IV size).

[30] Following Ruel (2002), dietary quality has traditionally been used to reflect nutrient adequacy. Thus, commonly used measures of dietary quality have been the nutrient adequacy ratio (NAR) and the mean nutrient adequacy ratio (MAR). The NAR is defined as the ratio of intake of a particular nutrient to its recommended dietary intake (RDA). The MAR is the average of the NARs, computed by summing the NARs and dividing by the number of nutrients. We prefer the first but with the difference that we use the quantity of a nutrient. The average is hard to interpret as each nutrient has its own role in determining the nutrition status.

[31] Recall that this is a methodological improvement on extant studies reviewed in Ruel (2002) which do not correct dietary diversity for its endogeneity.

Table A.2.1: Instrumental Variables Regression Estimates (Calorie)

	Number of observations = 308923					
	FIRST STAGE (Dependent Variable: Food Diversity Index)			SECOND STAGE (Dependent Variable: Calorie Intake)		
	F(31, 308891) = 1907.94 Prob > F = 0.0000			F(31, 308891) =885.41 Prob > F = 0.0000		
Predicted value of FDI from 1st Stage				2,092.6	(4.87)	***
Time Dummy 1 (2004=1)	-0.150	(-54.84)	***	245.659	(3.44)	***
Time Dummy 2 (2009 = 1)	-0.174	(-62.89)	***	216.523	(2.6)	***
Price of Cereals and Pulses	-0.001	(-14.07)	***	0.209	(0.13)	-
*Interaction (Price of Cereals and Pulses*Time Dummy1)*	-0.001	(-9.68)	***	3.582	(1.22)	-
*Interaction (Price of Cereals and Pulses*Time Dummy2)*	-0.000	(-4.37)	***	2.283	(1.11)	-
Price of Milk and Milk Products	0.000	(12.83)	***	-2.381	(-8.85)	***
*Interaction (Price of Milk and Milk Products*Time Dummy1)*	-0.000	(-3.49)	***	1.855	(5.61)	***
*Interaction (Price of Milk and Milk Products*Time Dummy2)*	0.000	(2.32)	**	0.026	(0.12)	-
Price of Fruits & Vegetables	-0.002	(-50.28)	***	2.614	(2.13)	**
*Interaction (Price of Fruits & Vegetables*Time Dummy1)*	0.000	(8.07)	***	-5.117	(-2.67)	***
*Interaction (Price of Fruits & Vegetables*Time Dummy2)*	0.002	(21.78)	***	3.359	(2.39)	**
Price of Vanaspati Oil	-0.001	(-20.83)	***	-1.010	(-2.36)	**
*Interaction (Price of Vanaspati Oil*Time Dummy1)*	0.001	(20.24)	***	-3.052	(-3.22)	***
*Interaction (Price of Vanaspati Oil*Time Dummy2)*	0.001	(22.31)	***	-1.221	(-1.88)	*
Price of Sugar	-0.003	(-37.56)	***	12.361	(8.19)	***
*Interaction (Sugar*Time Dummy1)*	0.004	(30.9)	***	-6.842	(-3.15)	***
*Interaction (Sugar*Time Dummy2)*	0.004	(42.2)	***	-14.854	(-7.86)	***
Ratio of MPCE to the Poverty Line	-0.002	(-4.48)	***	127.901	(4.44)	***
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy1)*	0.002	(3.16)	***	-30.033	(-0.89)	-
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy2)*	0.003	(4.89)	***	-70.919	(-2.42)	**
Household Size	0.003	(49.06)	***	-56.413	(-29.97)	***
Proportion of Adults in the household	-0.000	(-0.27)	-	616.295	(42.73)	***
Education Dummy Males (Above Middle education =1)	-0.009	(-28.94)	***	111.346	(15.39)	***
Education Dummy Females (Above Middle education =1)	-0.006	(-22.33)	***	21.543	(3.68)	***
Dependency Ratio (People aged below 15 and above 55 as a ratio of people in the age group 15 – 54)	0.000	(1.11)	-	-20.503	(-7.88)	***
Caste Dummy (ST =1 , Ref Category = SC)	-0.005	(-7.17)	***	-30.949	(-2.68)	***
Caste Dummy (Others =1 , Ref Category = SC)	-0.009	(-13.28)	***	70.933	(7.22)	***
Sector Dummy (Urban = 1)	-0.002	(-6.77)	***	-91.458	(-11.04)	***
State Dummy (Bimaru = 1)	-0.014	(-22.27)	***	92.248	(13.84)	***
State Dummy (Coastal States = 1)	-0.001	(-2.56)	**	-176.64	(-27.21)	***
Ownership of consumer durables (Instrument)	-0.029	(-43.59)	***			
Constant	0.518	(186.62)	***	1,031.1	(4.7)	***
***, ** and * refer to 1%, 5% and 10% significance levels, respectively.						

Table A.2.2: Instrumental Variables Regression Estimates (Protein)

	Number of observations = 308923					
	FIRST STAGE (Dependent Variable: Food Diversity Index)			SECOND STAGE (Dependent Variable: Protein Intake)		
	F(31, 308891) = 1907.94 Prob > F = 0.0000			F(31, 308891) = 1502.46 Prob > F = 0.0000		
Predicted value of FDI from 1st Stage				-15.687	(-1.38)	-
Time Dummy 1 (2004=1)	-0.150	(-54.84)	***	-7.056	(-3.78)	***
Time Dummy 2 (2009 = 1)	-0.174	(-62.89)	***	-11.404	(-5.05)	***
Price of Cereals and Pulses	-0.001	(-14.07)	***	-0.086	(-1.89)	*
*Interaction (Price of Cereals and Pulses*Time Dummy1)*	-0.001	(-9.68)	***	0.292	(3.67)	***
*Interaction (Price of Cereals and Pulses*Time Dummy2)*	-0.000	(-4.37)	***	0.207	(3.59)	***
Price of Milk and Milk Products	0.000	(12.83)	***	-0.062	(-8.55)	***
*Interaction (Price of Milk and Milk Products*Time Dummy1)*	-0.000	(-3.49)	***	0.042	(3.9)	***
*Interaction (Price of Milk and Milk Products*Time Dummy2)*	0.000	(2.32)	**	-0.012	(-1.95)	*
Price of Fruits & Vegetables	-0.002	(-50.28)	***	-0.064	(-1.67)	*
*Interaction (Price of Fruits & Vegetables*Time Dummy1)*	0.000	(8.07)	***	-0.052	(-0.98)	-
*Interaction (Price of Fruits & Vegetables*Time Dummy2)*	0.002	(21.78)	***	0.366	(8.02)	***
Price of Vanaspati Oil	-0.001	(-20.83)	***	-0.074	(-5.91)	***
*Interaction (Price of Vanaspati Oil*Time Dummy1)*	0.001	(20.24)	***	0.003	(0.15)	-
*Interaction (Price of Vanaspati Oil*Time Dummy2)*	0.001	(22.31)	***	-0.021	(-1.15)	-
Price of Sugar	-0.003	(-37.56)	***	0.193	(4.6)	***
*Interaction (Sugar*Time Dummy1)*	0.004	(30.9)	***	-0.080	(-1.3)	-
*Interaction (Sugar*Time Dummy2)*	0.004	(42.2)	***	-0.071	(-1.35)	-
Ratio of MPCE to the Poverty Line	-0.002	(-4.48)	***	3.442	(4.49)	***
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy1)*	0.002	(3.16)	***	-0.840	(-0.95)	-
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy2)*	0.003	(4.89)	***	-1.929	(-2.42)	**
Household Size	0.003	(49.06)	***	-1.251	(-24.46)	***
Proportion of Adults in the household	-0.000	(-0.27)	-	17.404	(43.5)	***
Education Dummy Males (Above Middle education =1)	-0.009	(-28.94)	***	2.222	(11.6)	***
Education Dummy Females (Above Middle education =1)	-0.006	(-22.33)	***	0.069	(0.36)	-
Dependency Ratio (People aged below 15 and above 55 as a ratio of people in the age group 15 – 54)	0.000	(1.11)	-	-0.361	(-4.97)	***
Caste Dummy (ST =1 , Ref Category = SC)	-0.005	(-7.17)	***	-0.616	(-2.19)	**
Caste Dummy (Others =1 , Ref Category = SC)	-0.009	(-13.28)	***	1.606	(6.59)	***
Sector Dummy (Urban = 1)	-0.002	(-6.77)	***	-3.252	(-14.14)	***
State Dummy (Bimaru = 1)	-0.014	(-22.27)	***	6.365	(32.62)	***
State Dummy (Coastal States = 1)	-0.001	(-2.56)	**	-8.457	(-48.32)	***
Ownership of consumer durables (Instrument)	-0.029	(-43.59)	***			
Constant	0.518	(186.62)	***	63.553	(11.09)	***
***, ** and * refer to 1%, 5% and 10% significance levels, respectively.						

Table A.2.3: Instrumental Variables Regression Estimates (Fats)

	Number of observations = 308923					
	FIRST STAGE (Dependent Variable: Food Diversity Index)			SECOND STAGE (Dependent Variable: Fat Intake)		
	F(31, 308891) = 1907.94 Prob > F = 0.0000			F(31, 308891) = 1365.87 Prob > F = 0.0000		
Predicted value of FDI from 1st Stage				-290.38	(-9.65)	***
Time Dummy 1 (2004=1)	-0.150	(-54.84)	***	-21.952	(-3.98)	***
Time Dummy 2 (2009 = 1)	-0.174	(-62.89)	***	-32.215	(-5.64)	***
Price of Cereals and Pulses	-0.001	(-14.07)	***	0.479	(7.62)	***
*Interaction (Price of Cereals and Pulses*Time Dummy1)*	-0.001	(-9.68)	***	-0.124	(-1.06)	-
*Interaction (Price of Cereals and Pulses*Time Dummy2)*	-0.000	(-4.37)	***	-0.175	(-2.56)	**
Price of Milk and Milk Products	0.000	(12.83)	***	-0.061	(-4.24)	***
*Interaction (Price of Milk and Milk Products*Time Dummy1)*	-0.000	(-3.49)	***	0.037	(2.3)	**
*Interaction (Price of Milk and Milk Products*Time Dummy2)*	0.000	(2.32)	**	-0.131	(-16.95)	***
Price of Fruits & Vegetables	-0.002	(-50.28)	***	-0.310	(-4.02)	***
*Interaction (Price of Fruits & Vegetables*Time Dummy1)*	0.000	(8.07)	***	0.065	(0.74)	-
*Interaction (Price of Fruits & Vegetables*Time Dummy2)*	0.002	(21.78)	***	0.587	(9.46)	***
Price of Vanaspati Oil	-0.001	(-20.83)	***	-0.227	(-8.89)	***
*Interaction (Price of Vanaspati Oil*Time Dummy1)*	0.001	(20.24)	***	-0.195	(-2.36)	**
*Interaction (Price of Vanaspati Oil*Time Dummy2)*	0.001	(22.31)	***	0.051	(1.15)	-
Price of Sugar	-0.003	(-37.56)	***	-0.646	(-6.37)	***
*Interaction (Sugar*Time Dummy1)*	0.004	(30.9)	***	1.273	(8.5)	***
*Interaction (Sugar*Time Dummy2)*	0.004	(42.2)	***	0.998	(7.89)	***
Ratio of MPCE to the Poverty Line	-0.002	(-4.48)	***	3.559	(4.42)	***
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy1)*	0.002	(3.16)	***	-0.092	(-0.09)	-
*Interaction (Ratio of MPCE to Poverty Line*Time Dummy2)*	0.003	(4.89)	***	-1.400	(-1.64)	-
Household Size	0.003	(49.06)	***	-0.992	(-6.86)	***
Proportion of Adults in the household	-0.000	(-0.27)	-	14.536	(18.17)	***
Education Dummy Males (Above Middle education =1)	-0.009	(-28.94)	***	2.268	(4.03)	***
Education Dummy Females (Above Middle education =1)	-0.006	(-22.33)	***	0.386	(1.06)	-
Dependency Ratio (People aged below 15 and above 55 as a ratio of people in the age group 15 – 54)	0.000	(1.11)	-	0.365	(2.26)	**
Caste Dummy (ST =1 , Ref Category = SC)	-0.005	(-7.17)	***	-0.975	(-1.17)	-
Caste Dummy (Others =1 , Ref Category = SC)	-0.009	(-13.28)	***	2.188	(3.26)	***
Sector Dummy (Urban = 1)	-0.002	(-6.77)	***	-0.323	(-0.63)	-
State Dummy (Bimaru = 1)	-0.014	(-22.27)	***	0.086	(0.2)	-
State Dummy (Coastal States = 1)	-0.001	(-2.56)	**	-6.376	(-14.07)	***
Ownership of consumer durables (Instrument)	-0.029	(-43.59)	***			
Constant	0.518	(186.62)	***	160.881	(10.64)	***
***, ** and * refer to 1%, 5% and 10% significance levels, respectively.						

Table A.2.4: Elasticities

	FIRST STAGE	SECOND STAGE		
DEPENDENT VARIABLE ---→>>>>	FDI	Calorie Intake	Protein Intake	Fat Intake
Price of Cereals and Pulses	-0.0673	-	0.0188	0.1185
Price of Milk and Milk Products	0.0336	-0.0284	-0.0312	-0.0738
Price of Fruits & Vegetables	-0.0644	0.0094	0.0053	-0.0302
Price of Vanaspati Oil	-0.0048	-0.0623	-0.0723	-0.3591
Price of Sugar	-0.0490	0.1288	0.0473	0.0555
Ratio of MPCE to the Poverty Line	-0.0058	0.0876	0.0860	0.1445
Ownership of consumer durables (Instrument)	-0.0373			
Predicted Value of FDI		0.3224	-0.0024	-0.0447

The elasticities referred to in the text are with respect to food diversity which is inversely related to FDI.

Table A.2.5: Variable Definition

Food Diversity Index (FDI)	Sum of squares of the shares of various food items in the consumption basket. The various categories of food are: (i) Cereals and Pulses (ii) Milk, Meat and Eggs (iii) Fruits and Vegetables (iv) Vanaspati-Oil and (v) Sugar. The FDI ranges between 0 and 1, a higher value implying a more concentrated food basket.
Calorie Intake	Calorie consumption per capita per day
Protein Intake	Protein consumption per capita per day
Fat Intake	Fat consumption per capita per day
Time Dummy 1	The time dummy gives a value 1 to the year 2004 (reference category: 1993)
Time Dummy 2	The time dummy gives a value 1 to the year 2009 (reference category: 1993)
Price of Cereals and Pulses	Price index of Cereals and Pulses (weighted by value) at the village level
Price of Milk and Milk Products	Price index of Milk and Milk Products, Meat and Eggs (weighted by value) at the village level
Price of Fruits & Vegetables	Price index of Fruits and Vegetables (weighted by value) at the village level
Price of Vanaspati Oil	Price index of Vanaspati Oil at the village level
Price of Sugar	Price index of Sugar at the village level
Ratio of MPCE to the Poverty Line	The Monthly per capita Expenditure (at 2004 prices) divided by the poverty line
Household Size	No. of people in a household
Proportion of Adults in the household	No. of adults in a household divided by the total no. of people in a household
Education Dummy Males	The highest level of education of male members in a household. Takes the value 0 if less than middle level of education, and 1 if more than middle level of education.
Education Dummy Females	The highest level of education of female members in a household. Takes the value 0 if less than middle level of education, and 1 if more than middle level of education.
Dependency Ratio	People aged below 15 and above 55 in a household as a ratio of people in the age group 15 – 54 in a household
Caste Dummy 1	The caste dummy takes the value 1 for the category Scheduled Tribes (Reference category: Scheduled Castes)
Caste Dummy 2	The caste dummy takes the value 1 for the category Others (Reference category: Scheduled Castes)
Sector Dummy	The sector dummy takes the value 0 for rural areas, and 1 for urban areas
State Dummy 1	The State dummy takes the value 1 for BIMARU states, i.e. Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh (Reference Category: Other States)
State Dummy 2	The State dummy takes the value 1 for all the states along the Coastline (Reference Category: Other States)
Ownership of consumer durables (Instrument)	This variable determines whether a household belongs to the middle class or not based on whether it owns consumer durables or not. It is measured as the proportion of households at the village level with at least one of the following (i) Air conditioner (ii) Television (iii) Refrigerator