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by

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Acronyms

BIMARU	Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh
FAO	Food and Agriculture Organization of the United Nations
FDI	food diversity index
IHDS	*India Human Development Survey*
MIT	Massachusetts Institute of Technology
MPCE	monthly per capita expenditure
NCD	non-communicable disease
NSS	National Sample Survey
OBC	other backward caste
SC	scheduled caste
ST	scheduled tribe

Foreword

Rapid income growth, urbanization and globalization are leading to major dietary shifts in Asia, with declining consumption of staples and increasing consumption of livestock and dairy products, fruits and vegetables, and fats and oils. Several demand and supply factors have led to these changes. On the demand side, major factors include growing affluence and lifestyle changes, expansion of the middle class, higher participation of women in the workforce, etc. On the supply side, main factors were closer integration of global economies, liberalization of foreign direct investment, a sharp reduction in freight and transportation costs, and growth of supermarkets and fast-food outlets.

The health implications of these changes are a matter of ongoing debate. Some argue that the quality of diets at the aggregate global level has been enhanced and nutritional outcomes have improved in most parts of the world. Others point to the fact that diets increasingly contain more energy-dense, semi-processed foods, saturated fats and sugars, which lead to obesity and a higher incidence of non-communicable diseases such as diabetes, cardiovascular diseases and cancer. Whether the nutritional implications of such dietary shifts are positive or negative is thus an empirical issue. Using data from three rounds of India's National Sample Survey, this study analyses the nutritional implications of the dietary shift empirically by addressing the major methodological weaknesses of past studies.

An important finding of this study is that a third of the rural households in India suffer from pervasive calorie deprivation, with intakes of less than 1 800 calories. In contrast, both protein and fat intakes of a fifth of the population increased with diet diversification, with the potential for aggravating the risk of non-communicable diseases. The study provides a number of recommendations relating to nutritional education, regulation of food safety standards and public awareness to deal with the potential negative implications of dietary shifts in India.

It is hoped that the findings of this study will be useful to policymakers, development practitioners, academics and civil society.

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Abstract

Our study examines changes in diet 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) was constructed based on five food commodities. Significant price effects that vary over time have been confirmed, as have income/expenditure effects. Over and above these, more sedentary lifestyles and less strenuous activity patterns have played a significant role in shaping dietary patterns. An important finding is the slowing of dietary transition in the more recent subperiod 2004-2009. Clues relate to the weakening or strengthening of food price, expenditure and lifestyle effects over time. Using an instrumented measure of FDI in the second stage and all other exogenous variables, FDI effects on nutrient intake are analysed. A common finding – that food diversity is associated with a better-quality diet and higher intake 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 the 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 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 to 68 years, while the (crude) birth rate fell from 34 to 21.2 per thousand from 1980 to 2010. Rapid economic growth has been accompanied by rising urbanization. In addition, from 1980 to 2010 the share of the urban population rose from 23 to 31.7 per cent. By 2030, it is likely to be as high as 41 per cent.

Rapid economic growth, urbanization and globalization have resulted in dietary shifts in Asia, away from staples and increasingly towards livestock and dairy products, fruits and vegetables, and fats and oils. Current consumption patterns seem to be converging towards a Western diet (Pingali 2004, 2006; Popkin, Adair and Ng 2012).[2]

These dietary changes reflect the interaction of demand and supply factors.[3] Demand factors include: rapid income growth and urbanization, bringing about new dietary needs; and, more generally, growing affluence and lifestyle changes. Expansion of the middle class, higher participation by women in the workforce, the emergence of nuclear two-income families, and 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 global 'urban' eating patterns increases. Recent evidence also points to greater reliance of smaller and poorer households on street food. Urban slums often mimic the branded products of fast-food outlets (Pingali 2004). On the supply side, the main factors associated with availability of food are: closer integration of global economies, severing the link between local production and availability of food; liberalization of foreign direct investment, with a new role for multinational corporations – especially supermarkets and fast-food outlets,[4] and a sharp reduction in freight and transportation costs (Pingali 2006).

Often diet diversity is assumed to be synonymous with diet quality. In a recent contribution (Rashid, Smith and Rahman 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 reasoned that increasing the

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

3 As observed by Popkin, Adair and Ng (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 regulatory environments (the World Trade Organization and a freer flow of goods, services and technologies) are changing diets.

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 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 and compliance with these and in ensuring greater awareness of healthy food habits.

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 by the Food and Agriculture Organization of the United Nations (FAO 2012) takes the 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, cardiovascular disease 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 major methodological weakness of extant studies (i.e. lack of adjustment for endogeneity of diet or food diversity).

The health implications of dietary transition or shift are unclear, but the growing risk of NCDs ought not to be overlooked (Bloom and Cafiero 2012). Although India lags behind other developing countries in the epidemiological transition – decline in infectious disease mortality compensated 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, Karan and Engelan (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 subsidized 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

5 Ruel (2002) observes that in spite of the variety in measurement approaches and environmental conditions, 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 socio-economic factors. It may be that the association between diversity and growth is largely confounded by these factors, since dietary diversity is also found to be strongly associated with household socio-economic characteristics. Thus it may be that dietary diversity is a good proxy for socio-economic 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 the proportion of undernourished people in India over the period 1993-2009, see Gaiha and Kulkarni (2012).

7 For recent analyses, see Mahal, Karan and Engelan (2009); Popkin et al. (2001); Popkin, Adair and Ng (2012).

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

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

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

I. Scheme

We first examine recent evidence on the prevalence of eating out and the 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 NSS rounds (50th, 61st and 66th). Broadly, dietary transition is characterized by a substitution of traditional staples with primary food products more prevalent in western diets. To capture dietary transition, we construct a dietary or food diversification index (FDI) and examine the changes in food diversity over the period 1993-2009.[10] This is followed by a demand-theory 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.

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.

II. Eating out

From the perspective of dietary transition as discussed above, we distil our findings on eating out below, based on an analysis of a nationwide household survey, the *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 or sold by street vendors.

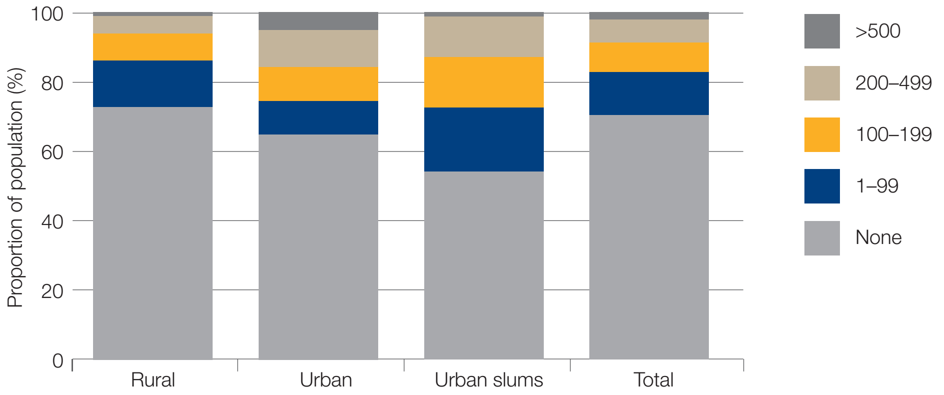
Eating out was pervasive, given the fact that about 30 per cent of households did so. A large majority of those eating out (about 42 per cent) spent under 99 Indian rupees (Rs) per month, and about a quarter spent over Rs 200 per month (at 2004/05 prices) (Figure 1). Eating out is a feature not just of metro or urban areas, but also of urban slums and rural areas, though it is less pervasive in the last two. In the six largest metro areas (Mumbai, Delhi, Kolkata, Chennai, Bangalore and Hyderabad), about 34 per cent of households ate out, as compared with 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 metro residents, who also spend larger amounts.

About 25 per cent of scheduled castes (SCs), 27 per cent of scheduled tribes (STs), and 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 SCs and STs – have switched from traditional staples to fast foods and have opted for greater variety in food consumption. This is further corroborated when the sample is split into poor and non-poor households, using the official poverty line. While a much larger proportion of non-poor households (about 32 per cent) ate out, that of poor households (about 12.5 per cent) was far from negligible. A more disaggregated classification of households into four monthly per capita expenditure (MPCE) classes (less than Rs 300, Rs 300-500, Rs 500-1,000 and greater than Rs 1,000) further dispels any doubt that eating out as a manifestation of dietary transition is mostly *a middle-class phenomenon* (Figure 2).

About 22 per cent of 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. Rs 500-1,000, and greater than Rs 1,000). Within low-income households (less than Rs 500), as well, the share of those eating out was 18 per cent, and 36 per cent among the lower- and upper-middle income households. There are also differences in the distribution of expenditure on eating out disaggregated by family type (i.e. whether it is a nuclear or an extended family – Figure 3).

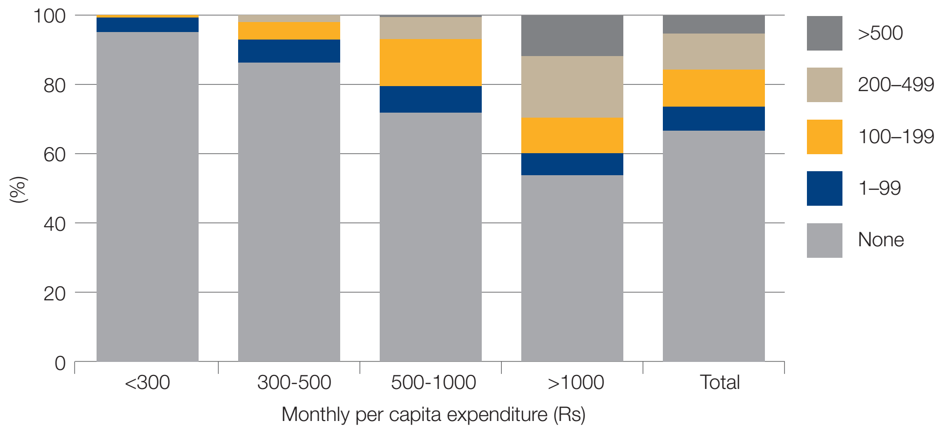
11 For details, see Gaiha, Jha and Kulkarni (2013).

Figure 1
Amount spent on eating out in 2005



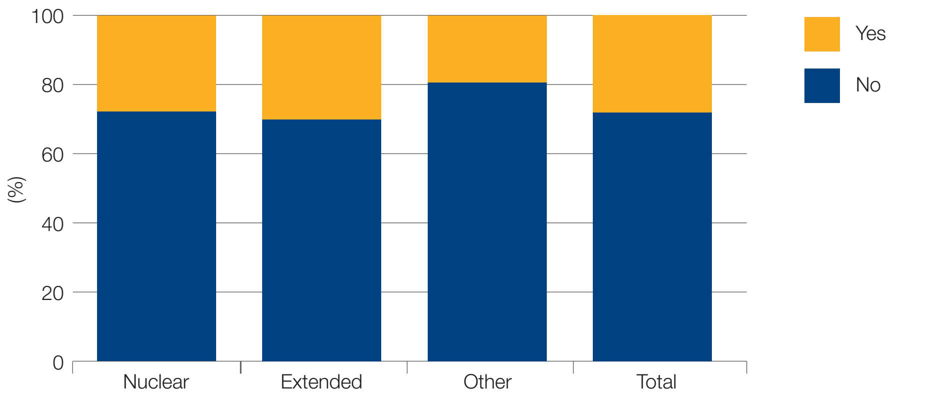
Source: Authors' calculations based on IHDS (2005).

Figure 2
Distribution of household expenditure on eating out by MPCE



Source: Authors' calculations based on IHDS (2005).

Figure 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 the 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. Metro and non-metro urban locations induce eating out, relative to rural areas. SCs and STs have a lower propensity to eat out relative to 'others', while 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 the probability of such households eating out.

Amounts spent on eating out vary with location. Households located in both metro and non-metro urban locations are likely to spend larger amounts on eating out, relative to rural areas. Between the metro and non-metro areas, 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 men in paid employment in the age group 25-45 years, and of women in the age group greater than 45 years, the greater 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 are also likely to spend larger amounts. Somewhat surprisingly, the higher the share of salary in household income, the lower the amount spent. By contrast, the higher the share of business income, the larger the amount spent.

Thus our analysis broadly confirms the important roles of urbanization, 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.

12 We use a Heckman model in which two steps are involved: first, the probability of eating out is determined, and then, conditional on the probability, the amounts spent on eating out. For details, see Gaiha, Jha and Kulkarni (2013).

III. Changes in diets

Let us first consider changes in consumption of various food items in rural and urban areas from 1993 to 2009. For details, refer to Figure 4 on page 16 and Table A.A.1 in annex A.

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

In both rural and urban areas, consumption of pulses/nuts/dry fruits recorded a sharp drop from 1993 to 2004. While it continued to decline in urban areas (although at a lesser rate), it increased substantially in rural ones. The consumption of sugar decreased, too, in both periods and in both sectors – rural and urban.[13] In contrast, intake of vanaspati oil [a hydrogenated vegetable 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 from 1993 to 2009), especially in the second period. Intake of meat/fish/poultry increased slightly in rural areas (by 2 per cent) and declined in urban ones (by 5 per cent) over both periods. Vegetable intake increased moderately in the first period in both rural and urban areas, but declined by an equal amount in the second, leaving intake largely unchanged from 1993 to 2009. Fruit consumption increased substantially in urban areas, especially in the second period. There are marked differences in the intake of various food commodities among income classes (refer to Table A.A.2 in annex A).[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 intake of staples (cereal and pulses) and an increase in intake of more energy-dense foods, particularly fats (as seen in the increased intake of vanaspati oil). But dietary transition slowed in the second period (from 2004/05 to 2009/10) compared with the first (from 1993/94 to 2004/05) – as seen in the reduction in the rate of decrease in staples consumption and the rate of increase in oil consumption.

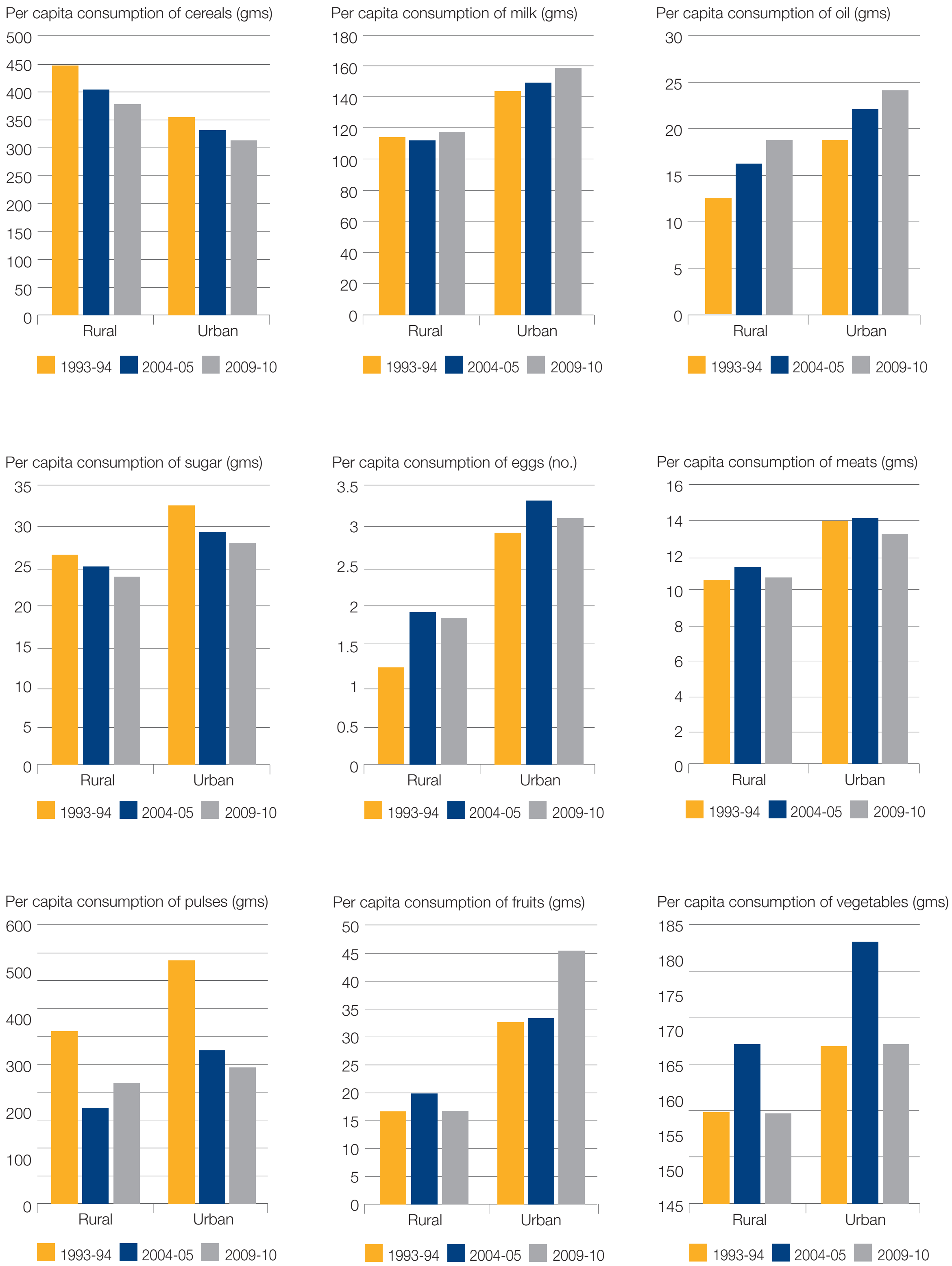
As these dietary shifts are linked to intakes of calories, proteins and fats with varying importance, an investigation of how food consumption patterns have changed in response to changes in income and food prices (among other changes) is necessary.

13 It is well documented that the sugar content of beverages is underestimated. See, for example, Popkin, Adair and Ng (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).

Figure 4
Changes in diets (1993-2009)



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

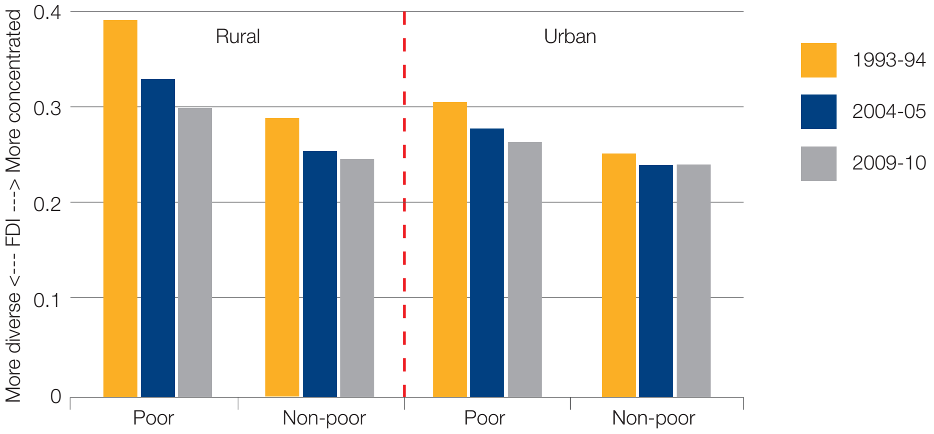
IV. Diet diversification

To capture diversification in diets, that is, a move from a cereal-dominated diet to a more varied food consumption basket, we use a food diversity index. The FDI is calculated as the sum of squares of the shares of the various food items in the consumption basket.

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

where FDI_{it} is the FDI 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. A high value of the index implies a monopolistic market (or, in our case, a more *concentrated* food basket) and a 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 meat; (iii) oil; (iv) sugar; and (v) fruits and vegetables. Figure 5 shows the variation in FDI for rural and urban areas from 1993 to 2009, and for poor and non-poor households, separately.

Figure 5
Food diversity index (1993-2009)



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

16 Single food or food group counts have frequently been 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 that 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 over food or food group counts, the precise weights seem arbitrary. It 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*.

Poor households in both rural and urban areas had less diversified diets than corresponding non-poor ones.[17] For both poor and non-poor households, the food basket became more diversified (the Herfindahl index decreased), but with stark differences. In rural areas, food diversity increased at a faster rate for poor households (a 15 per cent decline in the index as against a 12 per cent decline among non-poor ones) during 1993-2004. This diversification slowed during 2004-2009 among both poor and non-poor households (9 per cent and 4 per cent declines in the index, respectively). The change in urban areas was slower (an increase in diversity by 9 per cent for poor and 5 per cent for non-poor households during 1993-2004). During 2004-2009, the diets of poor households continued to diversify, albeit at a slower rate (5 per cent), and, somewhat surprisingly, became less diversified among non-poor households.

17 The poverty lines used were Rs 358.03 per capita per month in 2004/05 for rural areas, and Rs 540.40 for urban ones. These were adjusted for changes in prices over time, using the Consumer Price Index for Agricultural Labourers (CPIAL) for rural areas and the Consumer Price Index for Industrial Workers (CPI/IW) for urban ones.

V. Demand-theory 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 is found in grouped data. An instrumental variable regression estimation (IV) is used.[18] First, a *reduced* form demand relation is used, in which the dependent variable is the 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 and health environment).[19,20] We have sought to capture the latter through two time dummy variables – D_t^1 is a dummy variable that takes the value 1 for 2004 and 0 otherwise, and D_t^2 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, $RD1$ and $RD2$, denoting Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh (BIMARU) and the coastal states, respectively; whether a household belongs to the middle class or not, denoted by CDit, based on whether it owns consumer durables (e.g. a television); and an error term.

As dietary transition is closely linked to the emergence of the middle class (Deolalikar 2010; Pingali 2004, 2006; Popkin, Adair and Ng 2012), the latter serves as an instrument for the diet/food diversity equation. It must be emphasized 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 intake. As shown in annex B, the validity of this instrument has been corroborated.[21]

The regional dummies for BIMARU and the 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.[22]

18 For an algebraic exposition, see annex B.

19 For a rich and comprehensive exposition, see Behrman and Deolalikar (1988).

20 For early important contributions to price-induced food commodity substitution, 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, Gaiha and Sharma (2009).

21 For an elaboration and validation of the instrument variable designed to correct the endogeneity of FDI, see annex B.

22 Hoddinott and Yohannes (2002), in their analysis of data from 10 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 findings with a food group diversity indicator, which included 12 food groups (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.

In the second stage, calories consumed per capita per day, calories it, and two other nutrients, proteins and fats, are successively regressed on all exogenous variables in the reduced form except the instrument.[23]

We have pooled our sample over time (1993, 2004 and 2009) and our analysis has been done at the 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 the two time dummies.

Results

The instrumental variable regression (IV) results for calories are discussed below (refer to Table A.B.1 in annex B),[24] followed by those on protein and fats (Tables A.B.2 and A.B.3).

Calories

Let us first examine the factors underlying the variation in FDI.[25] Our strategy here is to first summarize the regression results and then comment on elasticities that are comparable across explanatory variables.

Given the results in Table A.B.1, higher prices of cereals and pulses increased food diversity.[26] 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 1993). Higher prices of fruits and vegetables increased food diversity, but the time effects diminished this. Higher oil prices increased food diversity, despite a weakening of this effect over time. A 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 from 2004 to 2009.

Larger households displayed lower food diversity given the proportion of adults and the dependency burden. This is purely a size effect, as the proportion of adults and the dependency burden are held constant. Higher education of both adult men and women was associated with greater diet diversity. The caste variables include STs and a residual group of 'others', with SCs as the omitted group. Both STs and 'others' displayed greater food diversity relative to SCs.

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

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

23 Recall that this is a methodological improvement over extant studies reviewed in Ruel (2002), which do not correct dietary diversity for endogeneity.

24 To avoid confusion, comparison of elasticities is in absolute terms if the values are negative.

25 FDI and food diversity are inversely related: a higher value of FDI implies lower food diversity and vice versa.

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

As food prices and expenditure were interacted with the time dummies, elasticities of food diversity (instead of FDI with a sign reversal) with respect to these variables were computed, as was also done with respect to middle class affiliation. These are reported in Table A.B.4. They allow intuitive comparisons of magnitudes of their effects, which are complicated by interaction effects with the time dummies.

The elasticity of food diversity with respect to the price of cereals (including pulses) is 0.06, implying that a 1-per-cent higher price increased food diversity by 0.06 per cent, on average. On the other hand, elasticity with respect to the price of milk and milk products is -0.03, implying that a 1-per-cent higher price resulted in a lowering of food diversity by 0.03 per cent. If the 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). Elasticity with respect to the 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 among different food commodities as the 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 declined 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. The higher the price of milk/meat/eggs, the higher was calorie intake, but with a weakening of this effect during 1993-2004. As it turns out, the overall effect was negative. The higher the price of fruits and vegetables, the lower was calorie intake, with a weakening in 1993-2004 and strengthening in 2004-2009. The overall effect was positive. The price of vanaspati oil lowered calorie intake, and more so over time. A 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 the proportion of adults and the dependency burden. So size lowered calorie intake without a change in household composition. The proportion of adults had a significant positive effect on calorie intake, but dependency burden reduced it. Education of both adult men and women enhanced calorie intake.

While STs had lower calorie intake, it was higher for 'others', relative to SCs (the omitted group).

Locational characteristics also influenced calorie intake. Urban areas consumed fewer calories relative to rural ones. BIMARU states had lower calorie intake and coastal states higher intake, relative to other states.

After accounting for the interaction effects of time dummies with food prices and expenditure, residual time effects were positive in both time periods (1993-2004 and 2004-2009).

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.B.4.

It is significant – especially in the context of evidence offered in support of improvement in nutritional outcomes as a result of growing food diversity – that diversity 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 a 0.32-per-cent reduction in calorie intake.

Subject to the caveat that cross-price effects on food commodity demand cannot be captured, and thus their implications for calorie demand/intake are unclear, food price elasticities reveal a contrast.[27]

As noted earlier, it is surprising that cereal price did not have a significant effect on calorie intake. Neither did its interactions with time dummies have a significant effect on this intake. Higher milk and milk product prices reduced calorie intake, but the elasticity was small (-0.028). A higher price of fruits and vegetables increased calorie intake, but by a small amount (the elasticity being 0.009). A higher vegetable oil price, however, had a moderate negative effect on calorie intake (the elasticity being -0.06). In sharp contrast, the 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.B.2. We will first comment on the marginal effects and then on selected elasticities. As the results for the FDI index (or food diversity) are identical to those in Table A.B.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).

The 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. The 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. The 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. A higher price of vanaspati oil reduced protein intake with non-significant coefficients of the two dummy variables. A 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 2004-2009. The overall effect, however, was positive.

Household size reduced protein intake, as did the dependency burden. A higher proportion of adults was, however, associated with larger protein intake.

27 As calorie, protein and fat demand are obtained from intake data, we use the two interchangeably.

Higher education of adult men increased protein intake, while that of adult women did not have a significant effect.

STs had lower protein intake, while 'others' had larger protein intake, relative to SCs.

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

Brief comments on selected elasticities (Table A.B.4) are given below.

A higher price of cereals (including pulses) induced higher protein intake, but by a small amount (the elasticity being 0.02). The price of milk/meat/eggs resulted in lower protein intake, with a slightly higher (absolute) elasticity (-0.031). A higher price of fruits and vegetables was associated with slightly larger protein intake (the elasticity being 0.005). A higher sugar price induced 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.B.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 fat (recall that food diversity and FDI are inversely related and there is a sign reversal).

Prices have significant effects, too. A higher cereal price resulted in larger fat intake, with a weakening of this effect over time. The price of milk and milk products lowered fat intake, with the first time dummy weakening this effect and the second strengthening it. The overall effect, however, was negative. A 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. The price of vanaspati oil lowered fat intake, with a strengthening of this effect over the period 1993-2004. So the overall effect was negative. The 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 2004-2009. The overall effect was positive.

Household size lowered fat intake, but higher proportions of adults and the dependency burden increased it. Higher education of adult men 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.B.4.

The price of cereals (and pulses) had a moderate elasticity (about 0.12). The price of milk/meat/eggs had a negative but moderate elasticity of -0.074. A higher fruit/vegetable price lowered fat intake, but by a small amount (the elasticity being -0.03). A higher vanaspati oil price substantially reduced fat intake, with an elasticity of -0.36. A 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).[28]

28 As food diversity and FDI are inversely related, the sign of the elasticity is reversed.

Slowing of dietary transition

To understand better the slowing 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 intake changes only slightly. They focus on two characteristics of consumer preferences for different foods: the degree of curvature and centrality (relative to the axes) of the location of food indifference curves, which represent consumer preference regarding two kinds of food: staple foods, a cheaper source of calories, and non-staple foods, such as meat or vegetables, a more-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 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) characterize "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 and sugar in the food diversity equation) or strengthened (e.g. cereals and pulses) over time, implying lower or higher substitutions among different sources of calories (or change in the curvature of indifference curves between cereals and other more-expensive sources of calories). The effect of (relative) affluence also weakened over time.[29] 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.

However, 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 fat. Although average intakes of protein and fat 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 of the dietary shift – especially during 2004-2009.

29 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 reliable approximation.

VI. Concluding observations

The main findings are summarized 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 – are confirmed over the period 1993-2009. Changes in the consumption baskets of poor and non-poor households differed between rural and urban areas and between the subperiods 1993-2004 and 2004-2009. 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 of dietary transition in both rural and urban areas – especially in the former – over the period 2004-2009. Another is that this process was faster among poor households than among non-poor ones – especially in rural areas. In urban areas, among non-poor households, diet diversification diminished slightly in more-recent years. Our econometric analysis offers a conjecture on the slowing at the all-India level. The clues relate to weaker or stronger food price, expenditure and life-style effects over time – especially during 2004-2009. How these are linked to changes in food preferences and taste for variety calls for a more-detailed analysis than attempted here.

Contrary to the extant literature and dominant explanations of calorie intake reduction over the last three decades, our analysis confirms that dietary shift has a mixed effect on nutritional outcomes. While calorie intake declined, protein and fat intakes increased with diet diversification. Although opinions differ on calorie cut-offs, more than 35 per cent of rural households had calorie intake 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 are desirable. However, given excess fat intake among moderate to large segments of the population (21 per cent of the population consumed more than 50 grams of fat), dietary shift has the potential to aggravate 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 NCDs 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 in more-recent years. As growing affluence, life-style changes and urbanization are *irreversible*, the focus must shift to provision of public goods (e.g. rural infrastructure) to facilitate the 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 for 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 to encourage 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.

Annex A

Table A.A.1.
Per capita consumption of food commodities, 1993/94, 2004/05 and 2009/10
(grams)

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%

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

Table A.A.2.
Per capita consumption of food commodities, 2009/10, by deciles of monthly per-capita expenditure (grams)

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

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

Annex B

IV estimation

A demand-theory 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 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 and health environment) captured through time dummies.[30]

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

where: the dependent variable is the FDI for i[th] household in time t, $\mathbf{P}_{jt}$ 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 i[th] household in time t, $\mathbf{X}_{it}$ is a vector of household characteristics (e.g. proportion of adults, household size, whether adult men and women 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. a television), and $\boldsymbol{\varepsilon}_{ijt}$ is the error term.

As dietary transition is closely linked to the emergence of the middle class (Deolalikar 2010; Pingali 2004, 2006; Popkin, Adair and Ng 2012), the latter serves as an instrument for the diet/food diversity equation. It must be emphasized 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 intake. As shown below, the validity of this instrument has been corroborated.

In the second stage, calories consumed per capita per day, caloriesit, 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:[31]

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

30 For a rich and comprehensive exposition, see Behrman and Deolalikar (1988).

31 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 MAR, 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 nutritional status.

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, $\widehat{FDI}_{ijt}$. Standard errors are corrected for heteroscedasticity.[32]

The regression results are given in Tables A.B.1-A.B.4. The definition of variables used is given in Table A.B.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 a household is affiliated with the middle class or not) 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-Paaprk LM statistic=1671.4, Chi- sq (1) P-value=0.0000. The null of weak identification is rejected by Kleibergen-Paaprk Wald F statistic =1899.87, given the critical value of 8.96 (for 15-per-cent maximal IV size).

32 This is a methodological improvement on extant studies reviewed in Ruel (2002), which do not correct dietary diversity for its endogeneity.

Table A.B.1.
Instrumental variables regression estimates (calories)

	Number of observations = 308923					
	FIRST STAGE (Dependent variable: food diversity index – FDI)			SECOND STAGE (Dependent variable: protein intake)		
	F (31, 308891) = 1907.94 Prob>			F (31, 308891) Prob>		
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 and vegetables	-0.002	(-50.28)	***	2.614	(2.13)	**
*Interaction (price of fruits and vegetables*time dummy1)*	0.000	(8.07)	***	-5.117	(-2.67)	***
*Interaction (price of fruits and 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 men (above middle education = 1)	-0.009	(-28.94)	***	111.346	(15.39)	***
Education dummy women (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.B.2.
Instrumental variables regression estimates (protein)

	Number of observations = 308923					
	FIRST STAGE (Dependent variable: food diversity index – FDI)			SECOND STAGE (Dependent variable: protein intake)		
	F (31, 308891) = 1907.94 Prob>			F (31, 308891) Prob>		
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 and vegetables	-0.002	(-50.28)	***	-0.064	(-1.67)	*
Interaction (price of fruits and vegetables*time dummy1)	0.000	(8.07)	***	-0.052	(-0.98)	-
Interaction (price of fruits and 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 men (above middle education = 1)	-0.009	(-28.94)	***	2.222	(11.6)	***
Education dummy women (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.B.3.
Instrumental variables regression estimates (fats)

	Number of observations = 308923					
	FIRST STAGE (Dependent variable: food diversity index – FDI)			SECOND STAGE (Dependent variable: protein intake)		
	F (31, 308891) = 1907.94 Prob>			F (31, 308891) Prob>		
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 and vegetables	-0.002	(-50.28)	***	-0.310	(-4.02)	***
*Interaction (price of fruits and vegetables*time dummy1)*	0.000	(8.07)	***	0.065	(0.74)	-
*Interaction (price of fruits and 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 men (above middle education = 1)	-0.009	(-28.94)	***	2.268	(4.03)	***
Education dummy women (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.B.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 and 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

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

Table A.B.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 and 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	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 men	The highest level of education of men members of a household. Takes the value 0 if less than middle level of education, and 1 if more than middle level.
Education dummy women	The highest level of education of women members of a household. Takes the value 0 if less than middle level of education, and 1 if more than middle level.
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. 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.

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