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Alternative Approaches to Measuring Temporal Changes in Poverty with Application to India

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Abstract

This paper uses a new procedure suggested in Coondoo et. al. (2004) for setting and updating the poverty line to take account of inflation and changing tastes. The procedure, which is based on the estimation of nutrient prices, takes an "absolute" view of poverty that is rooted in the idea of age and gender specific minimum calorie requirements to be obtained from a "balanced" diet of nutrients. This study goes beyond recent investigations on the link between calorie and food expenditure by working in nutrient space and enforcing the idea of a "balanced diet" of the principal energy generating nutrients that would not be possible by focussing on calorie alone. Moreover, the proposed procedure of using estimated nutrient price indices to calculate cost of living indices provides a novel way of overcoming the problem of item comparability, definitions, missing items, etc. that affect the traditional cost of living indices based on food items.

Household level data from the individual states in India are used to calculate and compare alternative poverty rates over a time period that includes the period of recent economic reforms. The application to Indian data makes it particularly interesting given the regional heterogeneity in food expenditure patterns. Also, since the study covers the period of recent economic reforms in India, the results on the temporal movement in the state wise poverty rates are of considerable policy interest. The poverty rates obtained from the application of the nutrient price based new procedure are compared not only with the official poverty rates but also with those obtained from a constrained minimisation of food expenditure that yields the "shadow price" of nutrients. In several cases, the official poverty figures seem to understate poverty compared to those obtained from calorie/nutrient norms. Moreover, while the official poverty rates generally show declining poverty in India during the decade of the '90s., this is not true of the alternative poverty estimates.

A significant by product of this study is that we have proposed and implemented a new procedure for constructing spatial price indices, based on the application of the multi lateral EKS index to the estimated nutrient prices. The paper exploits the attractive property of circular consistency of the EKS index in calculating the spatial nutrient price index over the sixteen major States of the Indian Union. The estimated values are used to rank the States with respect to their nutrient prices. These are then compared with those obtained from the unit value of the Food items, both with respect to their individual magnitudes and their temporal movement, at the State level.

The results of this study on Indian data suggest that these procedures have considerable potential for future applications on international data sets.

Key Words: South Asia, India, Nutrient Prices, Poverty Rates

1. Introduction

The measurement of temporal changes in poverty raises the question: how should one update the poverty line to account for inflation and changing consumption patterns? The question gets more complicated in the context of large countries such as India with considerable regional heterogeneity in food prices and food preferences implying large spatial variation in prices and in their temporal movements. The chief motivation of this paper is to compare alternative methods of temporally updating the poverty line taking account of inflation and changing preferences in order to study changes in poverty over time. In doing so, we apply a new method proposed in Coondoo et. al. (2004), based on nutrient prices, for measuring spatial prices and their temporal movements for use in the construction of the regional poverty lines. These nutritionally determined spatial prices are compared with those that are obtained from the unit values of the various food items as implied by the quantity/expenditure data from the unit records of sample households.

The sensitivity of the poverty magnitude and its temporal movements to the alternative methods is studied in the context of India which, given its regional heterogeneity in food preferences and food prices, provides an interesting case study. Note, however, that the alternative methodologies that have been applied here are capable of wider implementation on other data sets. With the increasing availability in several countries of household level information on quantities, prices, household characteristics, nutritional intake, etc., the results of this exercise have considerable methodological and policy appeal.

Unidimensional measures of poverty such as the head count ratio, Sen (1976) index and the Foster, Greer and Thorbeck (1984) index are commonly used to estimate poverty. As is well known, central to these measures is the concept of *poverty line* - a threshold level of per capita income or consumer expenditure signifying an absolute level of living such that the population living with income or consumer expenditure below the poverty line are classified as poor[1]. Most official estimates of poverty for developing countries like India are based on the head count ratio, which is the proportion of the population living below the poverty line[2].

Poverty is thus defined as a state of living in which a household (or an individual) lives with an income or expenditure level (below the poverty line) such that if this state continues for long, the household (or the individual) may fail to survive[3]. Therefore, while setting the poverty line for a given community of people, two aspects of living, viz., basic need of food and nutrition for physical survival and minimum need of non-food (such as clothing, housing etc) required for social survival, become relevant. So far as the former (which is obviously the more important of the two aspects) is concerned, the basic need defined in terms of an appropriately specified nutritional (i.e., calorie) norm is specified[4]. As regards the latter, which is usually far less well defined, an allowance for non-food consumption, in principle, can be added to what is thought to be the minimum food expenditure required for meeting the nutritional norm to obtain the required poverty line.

In actual practice, in India and in other developing countries, the official poverty line for a *bench mark* year is worked out through *inverse* interpolation of the per capita total consumer expenditure corresponding to the specified norm of per capita calorie intake from the empirical/estimated engel curve of calorie intake that relates per capita calorie intake to per capita consumer expenditure[5]. Once the poverty line for the benchmark year is obtained this way, the poverty lines at current prices for other years (required for temporal analysis of poverty) are obtained by indexation done on the benchmark year poverty line to take care of

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[1] For measuring poverty in developed societies, however, the poverty level of income/consumer expenditure is defined relative to the corresponding mean level. In such cases, thus, the poverty line is designed to represent a relative rather than an absolute level of living.

[2] See, e.g., Kakwani and Krongkaew (1998).

[3] A destitute who manages just to keep himself/herself alive, may be regarded as socially non-alive if the poverty line is set keeping in view a socially acceptable minimum level of living.

[4] There has been considerable debate on this specific issue. For a comprehensive summary of this, see Sukhatme (1982).

[5] See, e.g., Government of India (1993) for a description of the methodology used by the Planning Commission, Government of India. Note that this way the problem of deciding the allowance to be given for meeting minimum non-food needs is avoided.

temporal changes in the price level, using a suitable consumer price index number. An alternative to this could be to follow the *basic needs* approach under which, given the set of commodity prices and the nutritional contents of the individual food items, the minimum food expenditure required to ensure some nutritional norm(s) is obtained solving basically a *Diet Problem*. If constraints relating to non-food consumption norms can be suitably added to this problem, this optimisation problem may, in principle, be extended to work out a poverty line[6]. However, this approach of finding the poverty line by solving the diet problem or an extended version of it may give rise to problems (see, e.g., Paul, 1989).

As far as the estimation of the food expenditure required to meet a given *basic need* nutritional norm is concerned, a possible approach may be as follows: Suppose the basic need nutritional norm is given in the form of a vector of nutrient quantities (corresponding to, say, a balance diet requirement) and an appropriate set of prices of these nutrients is available. One may then work out the cost of the basic need balanced diet menu. It may be mentioned here that a literature discussing the technique of estimation of nutrient prices based on the data on price and nutritional content of food items already exists (see, e.g., St-Pierre and Glamocic, 2000). Coondoo et. al. (2004) have proposed an alternative method of estimation of household-specific nutrient prices based on regression of household level data on food expenditure and corresponding nutrient intakes. In an illustrative application they have used the estimated household specific nutrient prices to construct household-specific poverty lines following the basic need approach.

This paper extends the earlier exercise of Coondoo et. al. (2004) by reporting temporal changes in the incidence of poverty in the rural and urban sector of the major Indian states over three time periods, viz., 1987-88, 1993-94 and 1999-2000. The present study is based on the household level data on food expenditure, nutrient intake and related variables

[6] See Paul (1989) for a comprehensive discussion on this line of approach.

provided by the three consecutive quinquennial surveys of the National Sample Survey Organization, Government of India conducted during the period mentioned (viz., NSS 43rd , 50th and 55th Round). This analysis uses the head count ratio as the measure of poverty and the required poverty lines have been constructed following essentially the basic needs approach mentioned above.

To be precise, we have used a *balanced diet nutrient vector* corresponding to the calorie levels of 2400 and 2100 calorie per capita per day for the rural and the urban sector respectively (that underlie the definition of official poverty lines used by the Planning Commission, Government of India[7]) and evaluated these nutrient vectors using estimated nutrient prices. In addition to using the regression analysis-based technique of estimation of implicit nutrient prices from household level data proposed in Coondoo et. al. (2004), we have derived shadow prices of individual nutrients as a dual solution of a diet problem that minimizes food expenditure, subject to a set of nutrient intake constraints (required to ensure a balanced diet at poverty level calorie norm), given the prices of food items. Using these, we have worked out the alternative poverty lines and compared these with the corresponding official poverty lines. However, in the temporal analysis of variation in nutrient prices, nutrient intakes and poverty incidence, we have used, not these shadow nutrient prices, but the ones based on the estimated household specific nutrient prices[8].

The organization of the paper is as follows: In Section 2, we explain the methodology used in the present analysis. This is done in three parts. Sub-section 2.1 summarizes briefly the regression-analysis based technique of nutrient price estimation of Coondoo et. al. (2004). Sub-section 2.2 explains the linear programming-based technique of estimation of shadow

[7] See Government of India (1979, 1993).

[8] As mentioned later, the uniqueness of the shadow prices of nutrients obtained by solving the diet problem requires that the solution of the primal problem is non-degenerate. In many cases, however, we have obtained a degenerate solution and hence non-unique shadow nutrient prices. In fact, our basic interest underlying the exercise on shadow nutrient prices was essentially to examine how close the poverty lines based on these prices would be to the corresponding official poverty lines.

prices of nutrients. Finally, Sub-section 2.3 discusses the construction of alternative poverty lines that have been used in the temporal analysis of poverty. Section 3 provides a brief description of the data set used for the empirical analysis. The results of the analysis are presented in Section 4. These are presented in four distinct parts keeping in view the separate components of the present analysis. In Sub-section 4.1, alternative poverty lines that have been derived are compared. In the next sub-section, 4.2, the temporal variations in the nutrient price and intake levels are examined. In Sub-section 4.3, temporal variations in the inter-state differentials of nutrient price and intake levels are discussed. This sub-section also contains a comparison of the spatial price and quantity indices of the nutrients and those of the Food items. Since the principal distinctive feature of this paper is its proposal to use the estimated nutrient prices, rather than food prices, to adjust the poverty line, a comparison of these alternative spatial price structures, as measured by the EKS index, is of special interest in the context of the present empirical exercise. Sub-section 4.4 presents the state and sector-specific results on temporal variations in the poverty incidence. Finally, the paper is concluded in Section 5.

2. Methodology

As already mentioned, the analysis presented in this paper involves three methodological or estimation issues – viz., regression analysis based estimation of nutrient prices from household level data, estimation of shadow prices of nutrients by solving appropriately specified diet problem and construction of poverty line following a basic need approach. In what follows, these are briefly discussed.

2.1 Estimation of Nutrient Prices based on Regression Analysis

Suppose we have household level data on total food expenditure (y_h^f), total quantity consumed of each of K nutrients (η_{ih} , $i = 1,2,...,K$), per capita income/total consumer expenditure or PCE (y_h) and an array of household attributes such as household size, age-sex composition etc. (z_h) for $h = 1,2,...,H$ sample households. The food expenditure function relating total food expenditure to total quantities of various nutrients is

$$y_h^f = \sum_{i=1}^{K} v_{ih}\eta_{ih}, \; h = 1,2,...,H \tag{1}$$

where v_{ih} denotes the implicit price/unit value of the *i-th* nutrient for the *h-th* household to be estimated. Let the nutrient price function for each major nutrient be specified as

$$v_{ih} = f_i(y_h, z_h, u_{ih}), i = 1,2,..., K \tag{2}$$

where $f_i(.)$ is a *positive valued* function and u_{ih} is a random disturbance term[9]. If (2) is of the following algebraic form with an additive random disturbance term:

$$v_{ih} = exp(\alpha_i + \beta_i \, ln\, y_h + \gamma_i' z_h + \delta_i' z_h^*) + u_{ih}, \; i = 1,2,...,K , \tag{3}$$

where z_h is the household characteristic vector of household h[10] and z_h^* is the vector of interaction terms $z_h \, ln\, y_h$. Substituting (3) in (1), the following estimating equation is obtained:

$$y_h^f = \exp(\alpha_i + \beta_i \ln y_h + \gamma_1' z_h + \delta_1'' z_h^*)\eta_{1h} + ... + \exp(\alpha_K + \beta_K \ln y_h + \gamma_K' z_h + \delta_K'' z_h^*)\eta_{Kh} + \varepsilon_h^*,$$

$$h = 1, 2, ..., H, \tag{4}$$

[9] This method has been proposed and discussed in Coondoo et. al. (2004). It may be noted that (2) is a generalized form of Prais and Houthakker’s (1955) quality equation that asserts that the price/unit value paid for a commodity is a function of a consumer’s real income level.

[10] In the empirical exercise, we have taken $z_h' = (ln(1+n_h^{am}), ln(1+n_h^{af}), ln(1+n_h^{cm}), ln(1+n_h^{cf}))$, where $n_h^{am}, n_h^{af}, n_h^{cm}, n_h^{cf}$ denote the number of adult males, adult females, male children and female children in the household *h,* respectively.

where $\varepsilon_h^* = \sum_{i=1}^{K} \eta_{ih} u_{ih}$ is the composite equation random disturbance term and α_i's denote the logarithm of *normalised* unit value or implicit price of the nutrients concerned, when $ln\, y_h$, z_h and z_h^* are all set to zero. The household-specific nutrient prices can be estimated as

$$\hat{v}_{ih} = exp(\hat{\alpha}_i + \hat{\beta}_i \, ln\, y_h + \hat{\gamma}_i' z_h + \hat{\delta}_i' z_h^*), i = 1,2,...,K; h = 1,2,....,H \, , \qquad (5)$$

where ^ denotes estimated value. Finally, averaging over sample households one would get the estimated mean price of a nutrient.

2.2 *Estimation of Shadow Prices of Nutrients*

Suppose the vector of *balanced diet* nutrient quantities corresponding to a recommended nutritional norm (corresponding to the calorie intake per capita per unit of time) at the poverty line is η - a *K*x*1* vector of nutrient quantities and *p* is the *n*x*1* vector of given prices of the *n* food items available for consumption. Let *A: K*x*n* be the matrix of nutrient composition of unit quantity of individual food items. The *basic need* per capita food expenditure can then be obtained by solving the following diet problem:

$$Minimize \quad p'q \quad subject\ to \quad Aq \geq \eta, \ q \geq 0$$

where *q* is a *n*x*1* vector of optimal food quantities to be consumed as a balanced diet to satisfy the recommended nutritional norm. The dual solution of this problem will give the set of shadow prices of nutrients[11].

The estimated shadow price of a nutrient measures the marginal increase in the minimized food expenditure if an extra unit of the nutrient is consumed. Further, as the linear programming results suggest, if the primal optimal solution is non-degenerate (i.e., the primal optimal solution q^*, say, is positive), only then will the corresponding shadow nutrient prices

[11] This is the standard balanced diet problem. See, for example, Dorfman, Samuelson, Solow (1964) and McFarlane and Tiffin (2003).

(i.e., dual solution) also be unique. In other words, in cases where all the three optimal food quantities are solved to be positive, one may take the corresponding unique shadow nutrient prices as virtual prices of these nutrients (since in these cases $\tilde{\pi}'\eta = p'q^*$ - i.e., the minimized food expenditure equals the cost of the given nutrient vector evaluated in terms of the shadow prices).

A comment on the qualitative comparison of the shadow prices with the corresponding regression analysis-based estimated prices of nutrients may not be out of place here. Given the observed values of explanatory variables of nutrient prices for a sample household, the implicit nutrient prices for the household can be obtained from the estimated nutrient price functions. On the other hand, given the vector of observed nutrient quantities of the household, the corresponding shadow prices of nutrients are obtained by solving the diet problem specified above. One would expect these two sets of nutrient prices to broadly agree for those households living on the poverty line for which the consumption of food items is more or less in line with the optimal solution of the diet problem (if it exists)[12]. This feature of the estimated shadow nutrient prices might delimit their usefulness, although from a normative viewpoint these may be thought relevant for setting the poverty line.

2.3 Setting up the Poverty Line

The alternative poverty lines can be explained as follows:

Poverty line based on Basic Need Food Expenditure: Given a set of nutrient prices and the vector of per capita per day balanced diet nutrient requirements corresponding to a poverty level calorie norm, the basic need food expenditure level will, in principle, be the sum total of

[12] The pattern of food consumption of a household, apart from the level of real income and the structure of relative prices of goods consumed, depends on a wide variety of non-economic factors, tastes, palatability, local food habits etc. Unless these are brought as explicit constraints in to a diet problem, the optimal solution of the problem may not turn out to be a realistic diet. However, so long as the nutrient constraints are binding in the optimal solution, the *scarcity* interpretation of the shadow nutrient prices may be of use. See Darmon, Ferguson and Briend (2002) for a detailed discussion.

the nutrient-specific values. However, when the shadow nutrient prices are used, the resulting basic need food expenditure is likely to be an underestimate, if many food items are left out when solving the diet problem[13]. In such a case, it may be required to revise the estimated basic need upward appropriately to make due allowance for the omitted food items. Once a realistic basic need food expenditure has been obtained, further allowances need to be made for *basic need non-food consumption* to arrive at the poverty line expenditure level. Alternatively, the poverty line per capita income/consumer expenditure may be obtained by *inverse interpolation* from the empirical/estimated engel curve for food.

As already mentioned, for the temporal analysis of poverty incidence of rural/urban sector of an individual state, we have used four different poverty lines based on alternative definitions, of which one is the official poverty line which is used by the Planning Commission, Government of India. In what follows, we define the three poverty lines that have been used here as alternative to the official one. It may be noted that all three of these poverty lines have been defined to be household-specific whereas the corresponding official one is defined in per capita terms.

Poverty line based on Calorie norm: The Indian official poverty lines for rural and urban population are based on calorie norms of 2400 and 2100 kcal per capita per day for rural and urban India, respectively. As per expert opinion, the age-sex specific daily normative calorie requirements corresponding to the overall calorie norm of per capita 2400 kcal/day for the

[13] Some food items have to be left out for one or more of the following reasons: for some commonly consumed food items (like prepared meals, say) accurate nutritional information may not be available, the unit of measurement of the quantity consumed of an item (especially those which are measured in numbers) may not correspond to that (e.g. per gram) in the nutrient conversion table, there may be many food items which do not contain the specific nutrients we are concerned with here, but expenditure is incurred on them (e.g. tea, salt).

average rural Indian are as follows[14,15]. The corresponding figures for the Indian urban population can be obtained by scaling down these numbers by a factor 0.875 (being the ratio of 2100 and 2400).

Gender	**Per capita Calorie Requirement Per Day (kcal) for the Age Group (in years)**							
	< 3	3 - 6	6 - 9	9 - 12	12 - 15	15 - 18	18 - 60	>60
Male	1200	1500	1800	2100	2500	3000	2800	1950
Female	1200	1500	1800	2100	2200	2200	2200	1800

Given the above, the aggregate calorie requirement of a sample household can be calculated using available information on the age-sex composition of the household concerned together with the norms given above. A household is then classified as (calorie) poor (non-poor), if its observed calorie intake turns out to be less (more) than the required amount.

Poverty line based on Food expenditure norm: As per the recommendation of the Indian Council for Medical Research (ICMR), a balanced diet of 2738.60 kcal energy should comprise 467.53 gms of carbohydrate, 66.6 gms of protein and 66.9 gms of fat (Gopalan *et. al.*, 1999). Given this *balanced diet* nutrient composition and the above-mentioned age-sex specific calorie requirement norms, the corresponding age-sex specific requirements of the three nutrients, viz., carbohydrate, protein and fat, can be calculated. Using these age-sex specific nutrient requirements, the aggregate requirement of each nutrient for a sample household of a given age-sex composition can be worked out. Based on these, a household-

[14] These have been obtained from the website www.MedIndia.net. It may be mentioned that these estimates are close to, though not exactly same as, the energy allowances recommended by an Expert Group of the Indian Council of Medical Research (see ICMR, 2002).

[15] Whether these stipulated calorie norms are relevant in present days has been an issue of debate. It is argued by some that with the improvement in transportation facility, spread of mechanization of agriculture and other technologies etc., the daily energy requirement of an average Indian is likely to be less today than what it used to be thirty years back. See Mehta and Venkatraman (2000).

specific *food* poverty line may be set as the total value of aggregate requirements of each of the three nutrients, using the estimated average nutrient prices for the state and the sector to which the household belongs. Given the poverty line thus obtained, a household can be classified as (food) poor (non-poor), if its food expenditure is observed to be less (more) than the corresponding food poverty line.

Poverty line based on Total expenditure norm: This poverty line is obtained by adding an allowance for non-food expenditure to the *poverty line based on food expenditure* defined above. Here we have assumed that the *engel ratio for food* for a poor household to be 0.7[16], so that if f_h is the food poverty line for the *h*th sample household, the poverty line in terms of total consumer expenditure is $t_h = 1.43 f_h$ approximately[17]. A household is thus classified as poor (non poor), if the observed household total consumer expenditure is less (more) than t_h.

3. Data Analysed

The temporal analysis of state and sector-specific poverty incidence reported here has been done for three time periods using the household level data of the three successive quinquennial consumer expenditure surveys of the NSSO, viz., the NSS 43, 50 and 55 rounds, covering the periods July 1987-June 1988, July 1993-June 1994 and July 1999-June 2000. In this study we have focussed on the intake of three major nutrients, viz., carbohydrate, protein and fat. Using the regression analysis-based procedure proposed in Coondoo et. al. (2004), household-specific estimates of prices of carbohydrate, protein and

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[16] This assumption is not unquestionable for at least two reasons. First, the engel ratio for food for households living close to the poverty line may be different for the rural and the urban sectors. Secondly and more importantly, what should be the appropriate allowance for non-food expenditures at the poverty level can be a debatable issue in itself. In the present exercise, we have tried alternative values of engel ratio for food ranging between 0.6 - 0.8 and reported the results corresponding to the value of engel ratio of food equal to 0.7 only.

[17] As already mentioned, an alternative procedure might have been to get the poverty level total consumer expenditure by inverse interpolation based on the empirical/estimated engel curve for food.

fat have been obtained for each of the three rounds for every rural and urban sample household of 16 major Indian States, viz., Andhra Pradesh (AP), Assam (AS), Bihar (BH), Gujarat (GU), Haryana (HA), Himachal Pradesh (HI), Karnataka (KR), Kerala (KE), Madhya Pradesh (MP), Maharashtra (MH), Orissa (OR), Punjab (PU), Rajasthan (RJ), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB)[18].

Tables A1 and A2 of the Appendix give the sample size and the value of R^2 of the fitted food expenditure equation for each of the three rounds separately for the individual states for the rural and the urban sector, respectively. Given the fact that the food expenditure functions have been fitted to the household level data, the goodness of fit of these fitted equations may be regarded as quite satisfactory.

Tables A3 and A4 of the Appendix give the estimated mean price for individual nutrients by state, sector and NSS round. Note that in most of the cases the temporal change of a mean nutrient price does not suggest a systematic rise over time (although the level of prices of food items may have risen over time due to inflation). However, systematic temporal variation of the *individual* nutrient prices is perhaps not expected either, even though food item prices, by and large, may have risen over time. This is because, given the nutrient compositions of individual food items and the quantities consumed of these items, individual nutrient prices are likely to be highly sensitive to changes in the composition of food items consumed in response to a change in their *relative price structure*.

Tables A5 and A6 of the Appendix complement the two tables of mean nutrient prices just mentioned above. These, calculated from the available data, give the mean quantity consumed of individual nutrients by state, sector and NSS round. Here also one may easily notice absence of systematic temporal variation in most of the cases. That is to be expected

[18] For consideration of space, the estimates of the food expenditure function on which the nutrient price estimation is crucially based are not presented here. Interested readers may get these from the corresponding author on request.

for basically the same reason put forward above in the case of nutrient prices. In this context, it may be mentioned that in order to get an idea about the temporal variation of nutrient price and quantity levels, one needs to examine the temporal variations in the price and quantity indices based on these mean nutrient prices and quantities. This has been examined in Section 4.3 below.

Finally, multilateral EKS price index numbers for Food prices and nutrient prices separately for each of the three NSS rounds for the rural and the urban sector, respectively, are presented in Tables A7 and A8 of the Appendix. These price indices indicate two things – viz., although the temporal variation of individual nutrient prices does not show any systematic pattern, the spatial index numbers based on these prices follow a far more stable pattern. More importantly, the pattern of spatial variation of nutrient price levels across states, on the whole, does not appear to be too dissimilar to that of food prices.

4. Results

Broadly, three sets of results are presented and compared in this Section – viz., those relating to the estimation of shadow prices of nutrients based on linear programming, those relating to the temporal variation in the levels of nutrient prices and nutrient intakes and those showing the change in the poverty incidence over the three NSS rounds. In each case, state and sector-specific results have been presented and discussed.

4.1 Poverty Lines based on Estimated Shadow Prices of Nutrients

As explained in Section 2.2 above, for a state and sector, the shadow prices of individual nutrients can be estimated by minimizing the total food expenditure, given the vector of balanced diet nutrient composition corresponding to the poverty line calorie norm and the mean prices of food items consumed. This exercise was done by state and sector for each of the three NSS rounds. Note that (1) only those food items, unit of quantity of which were in kilogram/litre or gram, were included in the exercise and (2) in a number of cases a non-degenerate optimal solution of the primal problem could not be obtained (i.e., the estimated shadow nutrient prices were non-unique).

Since the primary objective of the estimation of the shadow nutrient prices was to construct a poverty line along the basic need approach, we have tried to do so using these estimated shadow nutrient prices. This required two modifications of the estimated minimized food expenditure- viz., revising this upward to make due allowances for (1) the expenditure on the missed out food items and (2) non-food expenditure. These allowances were made in a realistic manner keeping in view the actual data. Thus, the allowance for omitted food items was made using the observed share in total food expenditure of the missed out food items and the allowance for non-food expenditure was made using the relevant observed engel ratio for food.

Table 1 presents the alternative state-specific poverty lines for the NSS 55th round period for the rural and the urban sectors. To be specific, three different sets of poverty lines are given in this Table, viz., the basic needs poverty lines based on estimated nutrient shadow prices, the official poverty lines and the mean of household level poverty lines[19] (based on total expenditure norm using the regression based household level estimated nutrient prices defined in Section 2.1 above). For the purpose of comparison, the minimized basic needs food expenditures underlying the basic needs poverty lines are also given in this Table. As the figures suggest, one cannot draw any definite conclusion about the agreement or otherwise of these alternative poverty lines. For example, whereas for the rural sector the margin of divergence between the official and the basic needs poverty lines is within 10% for

[19] As already mentioned, in the present exercise, we have used household-specific poverty lines to calculate the poverty incidence. The method of calculation of these household level poverty lines has been described in Section 2.3 above.

Haryana, Karnataka, Kerala, Tamil Nadu, Uttar Pradesh and Orissa, for the urban sector, all the states other than Assam, Bihar and Kerala have a divergence greater than 10%. Of course, one does not have any a priori basis to expect two poverty lines for a state and sector to be identical as the official poverty lines, as already explained, are not necessarily calibrated following the basic need approach.

4.2 Temporal Variations in levels of Nutrient Prices and Nutrient Intakes

Table 2 presents the state and sector-specific Elteto-Koves-Szulc (EKS) index numbers of nutrient prices and nutrient intakes for the 50 and 55th rounds with 43rd taken as the base period[20]. These have been computed on the basis of the mean nutrient prices and the corresponding mean nutrient intake data of Tables A3 – A6 of the Appendix. For the sake of comparison, we have also presented the corresponding indices of nutrient prices and intakes of cases in which unique shadow prices could be obtained for both the rounds compared. These shadow price-based indices have also been calculated using the mean nutrient intake data of Tables A3 – A6.

As Table 2 shows, compared to the 43rd round, the nutrient price level was 24-38% higher during the 50th round and 50-67% higher during the 55th round for the rural sector of the states. The corresponding figures for the urban sector are 26-44% and 38-77%, respectively. Temporal changes in nutrient intake levels turn out to be far more interesting. In case of the rural sector, the intake level in 50th round was lower by up to 6 % for half of the states and higher by up to 5% for the remaining half of the states (Assam and Uttar Pradesh recording the largest decline and largest increase in the level of nutrient intake, respectively). Further, for all the states except Rajasthan and Uttar Pradesh, the nutrient intake level in 55th round was lower than the corresponding 43rd round level. For the urban sector, on the other hand, the nutrient intake level of 50th round was lower than that of 43rd round for all the states except Bihar. However, in addition to Bihar, for Assam and Rajasthan the nutrient intake level of 55th round turned out to be marginally above that of 43rd round. Coming to the comparison of the two sets of nutrient price indices, it may be observed that *generally* the price indices based on shadow prices are larger in value. As to be expected, the quantity indices, being based on the same nutrient intake data, are similar in most cases.

It may be mentioned in this context that the decline in the nutrient intake level of Indian households in recent years has already been noticed and discussed. For example, in their study based on household level data, Meenakshi and Viswanathan (2003) documented the decline in calorie intake of Indian households between 43rd and 55th round[21]. They also tried to verify whether a significant change in the pattern of food consumption due to a shift of preference from *quantity* to *quality* of consumption had taken place, particularly among the poor. Their results show evidence of three major changes, viz., a decline in the level of nutrition at higher levels of living, an improvement in the distribution of nutrition at the lower end of the calorie distribution in most states and a significant substitution of cereals by items such as milk products, fats and oils, processed food etc.

4.3 Inter-State Differentials in Nutrient price and Intake Levels: Temporal Variations

Let us next examine the extent of temporal variation in the pattern of inter-state differential in the levels of nutrient prices and nutrient intakes. For this purpose, we have estimated EKS multilateral index numbers for nutrient prices and nutrient intakes for the states separately for the three NSS rounds. Tables 3 and 4 present the results for the rural and

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[20] Note that the EKS is a multilateral index number system that guarantees circularity consistency by construction. See Elteto and Koves (1964) and Szulc (1964), for details.

[21] The decline in the levels of cereal consumption and calorie intake brought out by the NSS consumer expenditure surveys in recent years is, as argued by many, a manifestation of the lower energy requirement of the Indian population due such factors as improvement in transporation facility, spread of mechanization in agriculture and other technological changes etc. See Mehta and Venkatraman (2000).

the urban sector, respectively. Note that the state-specific index numbers presented in these Tables have Andhra Pradesh taken as the base state (i.e., the value of the index number for Andhra Pradesh is 1.00 in every case).

Consider the results for the rural sector first. The differential in the levels of nutrient prices across states (as measured by the coefficient of variation (CV) of the set of multilateral nutrient price index numbers) declined from 43rd to 50th round and then increased sharply in the 55th round thus suggesting an upward time trend. The corresponding differential in the levels of nutrient intake levels, on the other hand, declined monotonically over the NSS rounds. Although the ordering of the states in respect of nutrient price level and the level of nutrient intake varied from one round to another, the states that experienced the highest and lowest levels remained more or less the same over the NSS rounds. Thus, while Kerala and Uttar Pradesh are observed to have the highest and lowest price levels, respectively, Haryana and Tamil Nadu are observed to have the highest and lowest levels of intake, respectively in all the rounds.

The pattern of the temporal variation of inter-state differentials in nutrient price and intake levels observed for the urban sector is, on the whole, a little different from what is observed for the rural sector. The temporal variations of CV of the index numbers for nutrient price nutrient intake suggest a trend rise in inter-state differential over the NSS rounds. Assam, West Bengal and Kerala are observed to be the states that have experienced higher price levels. Madhya Pradesh, Uttar Pradesh and Rajasthan, on the other hand, turn out to have experienced lower price levels. As regards the nutrient intake level, Punjab, Rajasthan and Uttar Pradesh may be seen to have higher levels and Tamil Nadu and Assam lower levels, among all the states.

Finally, in Table 5 below we present the summary results of a comparison of spatial variation in the levels of food prices with that of the corresponding nutrient prices. To be specific, we have examined the extent of agreement of the spatial variations in nutrient price levels and corresponding food price levels for the two sectors in each of the three rounds as measured by the EKS multilateral price index numbers[22]. While such an examination is useful on its own, this is relevant in the context of the present study for the following reason. Here we have calculated the state-specific poverty lines for individual NSS rounds by directly evaluating the cost of the *poverty line balanced diet requirement* using the nutrient prices estimated for that round, rather than deflating a base period poverty line for temporal changes in the price level. In the official procedure, the state-specific poverty lines for the base year are calculated by adjusting the all-India poverty by making allowance for spatial (i.e., inter-state) variation in the levels of prices and the state-specific poverty lines for subsequent years are obtained by deflating the corresponding base year poverty line by some state-specific consumer price index number, assuming that the pattern of spatial variation in price levels remain, by and large, unchanged over time. Needless to mention, this is a testable proposition and our results may be relevant in that context.

The results of Table 5 may be summarised as follows: For both the rural and the urban sector in every round the coefficient of variation (CV) of the state-specific EKS indices for nutrient prices is greater than that of the corresponding food price indices, implying thereby a greater spatial variation in nutrition price level, in general. Next, in all the cases the CV for the rural sector is larger than the corresponding urban sector value. Finally, as the estimated values of spearman rank correlation between the ranking of states in terms of food and nutrient price levels indicates, whereas for the 43rd round the degree of association between

[22] Since the set of EKS multilateral index numbers satisfy transitivity (i.e., the circularity test of consistency) by construction, here we have used the state-specific index numbers having Andhra Pradesh as the base state of comparison.

the two sets of price levels is non-significant, this is much stronger for the later two rounds and is indeed statistically significant.

4.4 Temporal Variations in Poverty Incidence

Indian poverty estimates have shown significant decline in the incidence of poverty across board over the period 1987-88 to 1999-2000. This has initiated considerable debate. While there is a tendency to present the *measured improvements* as a reflection of the improvement in absolute living conditions of the Indian population due to economic reforms etc., there is an equally strong voice of resentment arguing that the observed improvement is rather unreal and are mostly due to technical problems of the measurement procedure actually followed (see Bhalla, 2003; Sen and Himanshu, 2004). On the other hand, studies examining the phenomenon of level of living and poverty from the point of view of nutritional adequacy have unequivocally observed an overall decline in the level of calorie intake by the Indian households. Incidence of poverty measured in terms of the stipulated calorie norm(s) has naturally been observed to be much greater than what is estimated in terms of the official poverty line. This has led to the question as to whether the calorie norms underlying the official poverty lines of India are relevant any longer and need to be revised downward to make them realistic.

We present here our results of temporal variation in the incidence of poverty in India over the 1987-88 to 1999-2000 period based on the household level data pertaining to NSS 43rd, 50th and 55th rounds against the backdrop of the recent Indian debate mentioned above. Like some of the earlier studies, here we focus on poverty essentially from the nutritional adequacy angle of view and estimate the poverty incidence using the alternative poverty lines defined for the purpose of comparison. The results of temporal variation of state-specific rural and urban poverty are presented in Table 6 and 7, respectively.

As regards the magnitude of the poverty rates based on different definitions, it may be noted that for the rural sector the rates based on the official poverty line are mostly smaller in magnitude than those based on the other definitions. The corresponding differences for the urban sector are, however, somewhat smaller, by and large. Since the basic difference between the official poverty line and the other three lines that we have used lies in the stress on fulfilment of nutritional norm given in the latter, the smaller discrepancy in the observed poverty rates for the urban sector may be suggestive of a lower incidence of non-fulfilment of the nutritional norm of the urban population living above the official poverty line.

Let us next consider the time series movement in the poverty rates based on the official poverty lines. *For the rural sector, poverty may be seen to have declined over time in all the states except Uttar Pradesh.* For Assam, Haryana, Himachal Pradesh and Tamil Nadu, though the poverty incidence for the 50th round is larger than those of the other two rounds, there is an overall declining trend. The result for the urban sector is qualitatively somewhat different. In this case, for all the states except Assam, Orissa, Punjab and West Bengal, the poverty rate for the 50th round is larger than those of the other two rounds. Poverty rate for Assam, Punjab and West Bengal has increased monotonically over time, while for Orissa the rate has declined. For Bihar, Gujarat, Haryana, Himachal Pradesh, Kerala, Rajasthan and Tamil Nadu, although the 50th round poverty rate is larger, a broad declining trend over time is observed.

Temporal variation of poverty rate based on the *calorie norm* definition of poverty line offer a mixed pattern. For the rural sector, only in the case of Kerala the rate is found to decline monotonically over the time period. A monotonically rising rate, on the other hand, is observed for Bihar, Haryana, Karnataka, Madhya Pradesh, Punjab and Tamil Nadu. For a large number of states, viz., Andhra Pradesh, Gujarat, Himachal Pradesh, Maharashtra, Uttar Pradesh and West Bengal, the rate shows a broad tendency to rise over time. For the remaining states, a broadly declining tendency of the rate is observed. The corresponding result for the urban sector is somewhat different. For example, monotonically declining rates are observed for Haryana, Orissa, Punjab, Rajasthan and Tamil Nadu. Only in case of Assam the poverty incidence is seen to have increased over time. Of the remaining states, except Andhra Pradesh and Karnataka, a broad tendency for the rate to decline over time is observed.

The shift from the poverty line based on the calorie norm to that defined on the food expenditure norm resulted in some interesting changes in the estimated poverty rates. As it may be seen, for the rural and the urban sector alike, for almost all the states the rate for the 55th round (and for many states the rate for 43rd round) based on poverty line defined on food expenditure norm are lower than the corresponding rate based on the calorie norm poverty line, an opposite being true in case of the corresponding 50th round rates. Since the food expenditure norm based poverty line is defined in terms of a nominal expenditure, this perhaps suggests that, given the prices of food items and the corresponding estimated implicit nutrient prices of 43rd and 55th rounds, in these rounds, on an average, the chance that household having food expenditure above the poverty norm would not satisfy the calorie and hence nutritional norm was greater than in the 50th round.

Let us finally make a comparison of the temporal trends in poverty incidence as revealed by the rates based on the calorie, food expenditure and total expenditure norms. For the rural sector, whereas an increasing temporal trend is indicated for most of the states when the poverty line based on calorie norm is considered (Kerala being a major exception), for six out of the sixteen states a declining temporal trend is suggested when the poverty line based on food expenditure norm is used. Use of the poverty line based on the total expenditure norm, however, suggested declining temporal trend for the states. The corresponding results for the urban sector tend to show a lot more similarity across the poverty norms used. Thus, for a large number of states, rates based on all the three norms showed declining temporal trend (either monotonically or broadly) alike. These states are Bihar, Gujarat, Haryana, Himachal Pradesh, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. For the remaining states, the temporal trend indicated by rates based on different poverty norms showed some differences. However, except for Orissa, in all the other cases the poverty line based on total expenditure norm indicated a declining temporal trend.

How can one explain the result that the temporal trend of poverty based on the official poverty line is, by and large, a declining one, whereas those based on the poverty lines relating more directly to the calorie or nutritional norm are not necessarily so? One possibility is that the official poverty lines at current prices obtained through indexation (done to take care of the change in price level) do not any longer maintain the correspondence to the nutritional norm (of 2400 and 2100 calorie per day per capita for the rural and the urban population, respectively) that it was originally designed to. We have tried to verify this using the data for the NSS 55th round in the following manner.

If the mean of the conditional distribution of mpce, given the calorie intake level equal to the poverty line calorie norm (of 2400 and 2100 calorie per capita per day for the rural and the urban sector, respectively), is close to the official poverty line at current prices and *at the same time* the mean of the conditional distribution of calorie intake, given the level of mpce equal to the official poverty line, is close to the poverty level calorie norm, that will necessary mean that an inverse interpolation based on the *current data* would give *a poverty line at current prices* which is close to the *official poverty line* (that has been obtained by indexation of the base period poverty line).

We have tried to verify this using the 55th round data. In Table 8 we have reported the median value of the coefficient of variation (CV) of the ten conditional distributions of monthly per capita calorie intake (mpci) corresponding to the ten decile groups of mpce and also the median value of the CV of the ten conditional distributions of mpce corresponding to the ten decile groups of mpci by state and sector. As comparison of column (2) with column (4) and column (3) with column (5) will suggest, for a given mpci decile class, the variation of mpce is larger. In other words, the chance that the mpce will exceed the official poverty line, given the calorie norm, is greater than the chance that the mpci will exceed the calorie norm, given the official poverty line. These observations indicate that if the poverty lines for the 55th round period were calculated by inverse interpolation (i.e., by estimating the conditional mean of mpce corresponding to the poverty level nutritional norm, the resulting poverty line would be different from the corresponding official poverty line in most of the cases. Thus, it may be so that the official poverty line may have lost its correspondence with the nutritional norm with the passage of time.

5. Conclusions

This paper has both methodological and policy interest. It uses a new procedure proposed in Coondoo et. al. (2004) for setting and updating the poverty line to take account of inflation and changing tastes. The proposed procedure, which is based on the estimation of nutrient prices, takes an *absolute* view of poverty that is rooted in the idea of age and gender specific minimum calorie requirements to be obtained from a *balanced* diet of nutrients. This study goes beyond recent investigations on the link between calorie and food expenditure by working in nutrient space and enforcing the idea of a *balanced diet* of the principal energy generating nutrients that would not be possible by focussing on calorie alone. Moreover, the proposed procedure of using estimated nutrient price indices to calculate cost of living indices provides a novel way of overcoming the problem of item comparability, definitions, missing items, etc. that affect the traditional cost of living indices based on food items. In the

Indian context this study is particularly interesting given the regional heterogeneity in food expenditure patterns. Also, since the study covers the period of economic reforms in India, the results on the temporal movement in the state-specific poverty rates holds considerable policy interest.

The poverty rates obtained from the application of the nutrient price based proposed procedure are compared not only with the official poverty rates but also with those obtained from a constrained minimisation of food expenditure that yields the *shadow price* of nutrients. A significant empirical finding of this study is the sharp divergence between the magnitude and time series movement of the official poverty rates from those based on the alternative methods. In several cases, the official poverty figures seem to understate poverty compared to those based on calorie/nutrient norms. Moreover, while the official poverty rates generally show declining poverty in India during the decade of the '90s, this is not true of the alternative poverty estimates.

A significant by product of this study is that we have proposed and implemented a new procedure of constructing spatial price indices, based on the application of the multi lateral EKS index to the estimated nutrient prices. The paper exploits the attractive property of circular consistency of the EKS index in calculating the spatial nutrient price index over the sixteen major States of the Indian Union. The estimated values are used to rank the States with respect to their nutrient prices. These are then compared with those obtained from the unit value of the food items, both with respect to their individual magnitudes and their temporal movement, at the State level. While this comparison is useful and interesting in its own right, its relevance in the present context stems from its implications for the poverty comparisons and the sensitivity of the poverty magnitudes to the alternative methods.

The next step is to extend this exercise to multi-country data. As we stressed earlier, an important advantage of the proposed procedure is that it avoids the problem of non comparability of individual items that affects traditional item based price and quantity comparisons. We illustrated the workability of the proposed procedures by using State level data in the Indian context. The challenge is much greater in multilateral price and quantity comparisons between countries. With the increasing availability of cross country household data sets that contain the required information on food expenditures and their nutritional content, the alternative methodology of price comparisons that is proposed here seems capable of wider implementation. Such an exercise provides an interesting and policy driven research agenda for the future.

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Table 1: A comparison of Poverty Lines Based on Estimated Shadow Nutrient Prices and the Corresponding Official Poverty Line for NSS 55th Round

State	Rural				Urban			
	Minimized Food Expenditure (LP exercise)	**Basic Needs Poverty Line** (Prices of nutrients from LP exercise)	**Official Poverty Line**	**Mean Household Level Poverty Line** (Prices of nutrients from regression)	**Minimized Food Expenditure** (LP exercise)	**Basic Needs Poverty Line** (Prices of nutrients from LP exercise)	**Official Poverty Line**	**Mean Household Level Poverty Line** (Prices of nutrients from regression)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	123.83	217.97	262.90	394.2	150.59	330.95	457.40	414.8
Assam	159.96	253.90	365.40	401.7	180.33*	361.21	344.00	482.2
Bihar	131.40	204.36	333.10	298.4	191.97	351.94	379.80	384.9
Gujarat	134.67*	241.51	318.90	482.8	154.51*	336.69	474.40	520.9
Haryana	184.74*	344.63	362.80	478.8	207.84*	468.92	420.20	389.6
Himachal Pradesh	110.38	204.83	367.50	445.0	128.30*	369.78	420.20	474.0
Karnataka	172.10	327.09	309.60	396.3	159.35*	382.56	511.40	536.4
Kerala	159.07*	350.78	374.80	656.9	188.27*	472.81	477.10	581.6
Madhya Pradesh	125.77*	221.86	311.30	292.3	147.60*	317.60	481.70	350.3
Maharashtra	191.55	375.02	318.60	380.5	187.58*	450.29	539.70	453.8
Orissa	182.17*	292.05	323.90	312.3	189.00*	360..14	473.10	602.9
Punjab	111.66	225.84	362.70	468.2	10.05*	22.65	388.20	470.3
Rajasthan	237.98	420.57	344.00	361.1	121.12	247.37	465.90	374.1
Tamil Nadu	147.71*	284.28	307.60	541.8	180.32	421.44	475.60	531.8
Uttar Pradesh	174.95	311.37	336.90	288.5	223.74	460.45	416.30	326.6
West Bengal	121.13	191.87	350.20	446.1	119.01	240.97	409.20	470.7

Notes: 1. All entries in this Table are measured in Rs. per capita per 30 days.
2. Figures marked by * denote that the corresponding linear programming solution was degenerate and hence the relevant estimated shadow nutrient prices were non-unique.

Table 2: EKS Index Numbers of Nutrient Prices and Nutrient Intake Levels for NSS 50th and 55th Rounds with NSS 43rd Round Taken as the Base Round by State and by Sector

State	Rural				Urban			
	Nutrient Price Index		Nutrient Intake Index		Nutrient Price Index		Nutrient Intake Index	
	50th Round	55th Round	50th Round	55th Round	50th Round	55th Round	50th Round	55th Round
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	1.38 (1.19)	1.64 (1.74)	0.96 (0.96)	0.91 (0.91)	1.44 (1.50)	1.67 (1.85)	0.91 (0.93)	0.91 (0.94)
Assam	1.29	1.52 (1.78)	0.94	0.95 (0.94)	1.30	1.53	0.99	1.01
Bihar	1.24	1.50	0.99	0.99	1.26 (1.47)	1.53 (2.24)	1.00 (0.99)	1.01 (0.99)
Gujarat	1.30	1.57	1.02	0.98	1.29	1.54	0.98	0.97
Haryana	1.27	1.58	1.03	0.99	1.26	1.54	0.93	0.95
Himachal Pradesh	1.32	1.67	0.95	0.92	1.34	1.51	0.99	0.95
Karnataka	1.31	1.59	1.02	0.96	1.43	1.77	0.91	0.92
Kerala	1.35	1.65	0.96	0.96	1.33	1.62	0.94	0.95
Madhya Pradesh	1.28	1.50	1.00	0.96	1.29	1.38	0.94	0.97
Maharashtra	1.32	1.52	0.97	0.98	1.41	1.68	0.88	0.91
Orissa	1.26	1.52	1.01	0.96	1.32 (1.30)	1.54	0.95 (0.99)	0.96
Punjab	1.33 (1.39)	1.59 (1.91)	0.98 (0.96)	0.95 (0.92)	1.36	1.57	0.94	0.93
Rajasthan	1.26	1.55	1.02	1.03	1.29	1.39 (1.70)	0.93	1.0 (1.02)
Tamil Nadu	1.33	1.65	0.98	0.94	1.36	1.61	0.93	0.95
Uttar Pradesh	1.3 (1.32)	1.51 (2.20)	1.05 (1.03)	1.04 (1.01)	1.33	1.57 (2.43)	0.97	0.96 (1.00)
West Bengal	1.27	1.58	1.03	0.98	1.34	1.62	0.94	0.94

Note. Figures in brackets are the corresponding indices based on shadow nutrient prices.

Table 3: EKS Index Numbers Showing Inter-State Differentials in the Levels of Mean Nutrient Prices and Nutrient Intake Levels by NSS Round for the Rural Sector : NSS 43, 50 and 55 Round

State	EKS Price Index Number			EKS Intake Index Number		
	Round 43	Round 50	Round 55	Round 43	Round 50	Round 55
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	1.00	1.00	1.00	1.00	1.00	1.00
Assam	1.15	1.08	1.04	1.06	1.04	1.14
Bihar	1.00	0.92	0.92	1.09	1.09	1.18
Gujarat	0.98	0.99	1.10	1.20	1.19	1.11
Haryana	0.96	0.95	1.05	1.40	1.40	1.35
Himachal Pradesh	0.95	0.96	1.10	1.30	1.22	1.16
Karnataka	0.99	0.97	1.01	1.10	1.13	1.10
Kerala	1.15	1.15	1.23	1.07	1.04	1.05
Madhya Pradesh	0.95	0.91	0.90	1.14	1.14	1.16
Maharashtra	0.96	0.97	0.99	1.12	1.07	1.07
Orissa	1.04	0.98	0.91	0.98	1.00	1.09
Punjab	0.96	0.96	1.10	1.40	1.37	1.25
Rajasthan	0.92	0.90	0.97	1.32	1.32	1.33
Tamil Nadu	1.09	1.03	1.09	0.90	0.95	0.94
Uttar Pradesh	0.90	0.89	0.89	1.19	1.26	1.27
West Bengal	1.10	1.03	1.05	1.02	1.09	1.12
CV	7.73	6.93	9.03	13.02	11.96	9.81

Table 4: EKS Index Numbers Showing Inter-State Differentials in the Levels of Mean Nutrient Prices and Nutrient Intake Levels by NSS Round for the Urban Sector : NSS 43, 50 and 55 Round

State	EKS Price Index Number			EKS Intake Index Number		
	Round 43	Round 50	Round 55	Round 43	Round 50	Round 55
Andhra Pradesh	1	1	1	1	1	1
Assam	1.16	1.12	1.1	0.96	0.98	1.03
Bihar	1.01	0.94	0.97	1.08	1.1	1.13
Gujarat	1.02	1	1.11	1.16	1.13	1.04
Haryana	1.01	0.94	1.03	1.18	1.12	1.11
Himachal Pradesh	1.04	1.04	1.07	1.08	1.08	0.98
Karnataka	1.01	1.02	1.12	1.07	1.05	1.03
Kerala	1.1	1.07	1.17	1.06	1.03	1.01
Madhya Pradesh	0.99	0.93	0.89	1.14	1.13	1.12
Maharashtra	1.06	1.06	1.13	1.13	1.06	1.05
Orissa	1.08	1.02	1.05	1	1.01	0.99
Punjab	0.97	0.99	1.06	1.21	1.15	1.06
Rajasthan	0.97	0.95	0.92	1.24	1.16	1.19
Tamil Nadu	1.06	1.04	1.08	0.97	0.95	0.96
Uttar Pradesh	0.95	0.91	0.95	1.14	1.17	1.14
West Bengal	1.12	1.06	1.1	0.98	0.99	0.99
CV	5.66	5.90	7.70	8.14	6.60	6.39

Table 5: A Summary of the Results Showing the Extent of Agreement of the Patterns of Spatial Variation in the Food and Nutrient Price Levels by NSS Round for the Rural and the Urban Sector.

NSS Round	Sector	CV (%) of State-specific EKS indices of		Spearman rank correlation coefficient between Food and Nutrient Price Indices#
		Food Prices	Nutrient Prices	
(1)	(2)	(3)	(4)	(5)
43	Rural	2.883	7.731	0.200 (0.764)
	Urban	2.733	5.659	0.296 (1.158)
50	Rural	4.216	6.931	0.428 (1.772)
	Urban	3.447	5.899	0.593* (2.573)
55	Rural	4.167	9.027	0.893* (7.410)
	Urban	3.367	7.695	0.728* (3.972)

Figures in brackets are the t-values and * denotes that the null hypothesis of zero correlation of the two sets of ranks is rejected at 5 per cent level.

Table 6: State-Specific Incidence of Rural Poverty (in percentage) Based on Alternative Poverty Lines: NSS 43rd, 50th and 55th Rounds.

State	Official Poverty Line			Calorie Norm			Food Expenditure Norm			Total Expenditure Norm		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	30.3	25.2	8.4	55.3	65.4	64.3	43.7	86.3	61.6	56.5	79.1	47.19
Assam	42.7	52.6	35.2	64.4	74.5	75.5	89.4	90.1	53.3	93.8	94.5	49.57
Bihar	62.3	60.7	38.6	51.5	56.4	56.5	67.0	86.0	28.1	79.8	87.8	19.94
Gujarat	37.0	25.7	9.8	65.9	68.8	66.1	58.7	65.2	64.3	75.3	69.5	41.71
Haryana	19.2	25.3	6.8	31.9	38.7	42.2	38.7	44.1	40.4	42.8	40.9	19.92
Himachal Pradesh	18.8	27.6	5.7	28.6	42.1	35.3	13.0	56.6	26.3	24.5	54.1	10.66
Karnataka	37.9	32.3	13.8	58.7	62.1	66.5	68.7	81.9	50.4	77.5	79.2	31.47
Kerala	37.3	28.4	7.2	71.3	67.5	66.6	68.6	71.5	65.4	72.5	68.9	45.21
Madhya Pradesh	47.7	32.9	33.2	49.8	56.0	62.5	74.0	74.9	41.9	80.3	71.8	24.10
Maharashtra	47.3	46.1	19.5	63.9	73.7	65.4	76.8	83.1	54.6	79.9	77.7	27.30
Orissa	60.7	52.3	44.8	58.8	51.8	58.9	81.0	93.9	50.8	87.6	92.3	41.27
Punjab	19.2	13.6	4.7	41.3	41.8	43.5	25.7	32.0	41.5	36.0	26.8	12.65
Rajasthan	40.7	22.8	11.1	38.0	35.1	35.2	44.4	46.9	25.3	53.0	45.1	9.93
Tamil Nadu	24.1	37.8	16.8	69.1	73.7	75.9	58.4	79.3	72.9	82.3	78.3	59.98
Uttar Pradesh	22.4	37.5	26.9	40.7	42.9	41.8	61.7	68.3	26.3	81.3	64.7	9.79
West Bengal	54.7	48.3	27.5	56.8	54.1	60.4	87.0	89.6	58.1	91.3	87.9	50.91

Table 7: State-Specific Incidence of Urban Poverty (in percentage) Based on Alternative Poverty Lines: NSS 43rd, 50th and 55th Rounds

State	Official Poverty Line			Calorie Norm			Food Expenditure Norm			Total Expenditure Norm		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	13.5	30.9	23.2	42.5	49.5	44.4	18.5	60.0	27.3	27.1	47.5	9.55
Assam	11.2	7.6	4.8	42.6	44.0	44.3	51.2	72.7	20.2	62.5	62.4	7.97
Bihar	33.7	35.3	25.4	36.9	31.0	32.3	62.3	59.9	34.9	69.1	57.9	21.85
Gujarat	11.6	23.0	11.0	53.5	43.1	44.3	36.0	43.3	31.1	49.8	36.0	6.90
Haryana	9.5	9.6	8.0	39.1	39.1	38.6	38.4	38.9	12.1	45.5	26.6	0.61
Himachal Pradesh	2.5	3.1	2.1	16.8	18.7	13.6	11.6	28.7	6.8	17.2	22.9	0.45
Karnataka	14.6	27.3	18.8	44.1	47.2	45.8	21.6	55.7	44.1	32.8	43.1	17.39
Kerala	26.7	27.0	13.6	54.1	56.0	45.0	44.7	57.1	45.2	50.6	48.5	21.84
Madhya Pradesh	14.9	39.3	32.2	44.5	39.7	42.0	51.9	41.0	25.3	52.8	30.8	7.83
Maharashtra	14.8	26.8	19.7	49.5	50.5	44.9	26.6	47.8	22.6	29.8	34.5	4.51
Orissa	19.2	33.0	36.7	34.8	32.0	29.2	40.0	54.7	67.1	51.4	46.3	53.56
Punjab	8.5	5.4	3.5	45.9	36.9	36.2	10.9	32.9	34.5	13.8	19.6	4.25
Rajasthan	17.5	26.7	15.2	40.4	29.7	27.1	28.9	36.9	11.4	34.5	28.2	3.11
Tamil Nadu	20.2	37.3	19.1	55.6	54.9	50.9	37.6	64.0	32.5	40.3	55.4	16.12
Uttar Pradesh	21.4	30.9	23.7	41.4	34.7	39.0	31.4	31.3	15.0	37.5	24.8	2.55
West Bengal	22.5	15.4	10.7	46.3	40.0	45.7	34.9	57.5	24.9	47.1	48.0	10.04

Table 8: Median Value of CV of Conditional Distributions of mpce and PCCal: NSS 55th Round

State	Median value of CV of			
	PCCal by mpce class		mpce by PCCal class	
	rural	urban	rural	urban
(1)	(2)	(3)	(4)	(5)
Andhra Pradesh	0.308	0.329	0.368	0.537
Assam	0.210	0.260	0.269	0.428
Bihar	0.279	0.240	0.320	0.486
Gujarat	0.222	0.232	0.363	0.504
Haryana	0.213	0.274	0.324	0.414
Himachal Pradesh	0.347	0.506	0.393	0.563
Karnataka	0.355	0.269	0.382	0.595
Kerala	0.220	0.236	0.444	0.530
Madhya Pradesh	0.281	0.279	0.386	0.556
Maharashtra	0.346	0.323	0.464	0.658
Orissa	0.189	0.240	0.386	0.487
Punjab	0.256	0.284	0.363	0.417
Rajasthan	0.275	0.364	0.303	0.526
Tamil Nadu	0.264	0.403	0.499	0.552
Uttar Pradesh	0.303	0.468	0.382	0.588
West Bengal	0.218	0.382	0.347	0.567

Appendix

Table A1: Sample Sizes and Equation R^2 by State: NSS 43rd, 50th and 55th Rounds, Rural

State	Sample sizes			R^2 of the fitted food expenditure equation		
	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	6017	4907	5181	0.9625	0.9721	0.8272
Assam	3288	3199	3462	0.9765	0.9851	0.7649
Bihar	7745	6979	7311	0.9749	0.9833	0.8753
Gujarat	2799	2219	2479	0.9779	0.8838	0.8938
Haryana	1162	1040	1132	0.9734	0.9732	0.8761
Himachal Pradesh	1835	1875	1634	0.9696	0.9756	0.7539
Karnataka	3254	2617	2763	0.9635	0.9643	0.8253
Kerala	3359	2555	2604	0.9710	0.9785	0.8943
Madhya Pradesh	6293	5313	5144	0.9618	0.9052	0.8137
Maharashtra	5726	4440	4121	0.9528	0.8253	0.7951
Orissa	3499	3338	3477	0.9762	0.9843	0.9316
Punjab	2663	2046	2152	0.9761	0.9684	0.9547
Rajasthan	3605	3097	3229	0.9461	0.9771	0.8735
Tamil Nadu	4570	3901	4173	0.9482	0.8453	0.9349
Uttar Pradesh	10398	9010	9432	0.9560	0.9693	0.7460
West Bengal	4979	4480	4550	0.9776	0.9841	0.8865

Table A2: Sample Sizes and Equation R^2 by State: NSS 43rd, 50th and 55th Rounds, Urban

State	Sample sizes			R^2 of the fitted food expenditure equation		
	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	3422	3644	3806	0.9366	0.9510	0.7891
Assam	1172	880	852	0.9775	0.9704	0.8574
Bihar	2085	2155	2279	0.9742	0.9789	0.8710
Gujarat	2260	2372	2764	0.9696	0.9728	0.8284
Haryana	636	697	758	0.9653	0.9801	0.7852
Himachal Pradesh	459	400	947	0.977	0.8733	0.7410
Karnataka	2306	2469	2470	0.9523	0.9697	0.8405
Kerala	1432	1830	2015	0.9659	0.9717	0.8377
Madhya Pradesh	2887	3233	3145	0.9467	0.8617	0.7439
Maharashtra	5497	5528	5234	0.9326	0.9442	0.7269
Orissa	1151	1037	1050	0.9761	0.9734	0.8655
Punjab	1903	1947	1883	0.9648	0.9709	0.7555
Rajasthan	1733	1799	1985	0.9546	0.9687	0.7130
Tamil Nadu	4114	4042	4212	0.9344	0.9708	0.9708
Uttar Pradesh	4501	4451	4638	0.9409	0.9414	0.7628
West Bengal	3434	3338	3432	0.9617	0.9745	0.9959

Table A3: Summary Statistics for Different Nutrient Prices by State: NSS 43rd, 50th and 55th Rounds, Rural

State	Estimated Mean Price (Rs. per gm.)								
	Carbohydrate			Protein			Fat		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Andhra Pradesh	2.11	6.96	17.25	8.48	84.60	62.74	41.55	20.71	3.58
Assam	3.70	6.04	21.92	66.52	58.01	22.52	23.73	61.42	7.64
Bihar	4.19	8.49	17.45	33.66	73.04	14.59	15.07	0.01	4.65
Gujarat	3.92	10.91	21.83	49.36	72.27	67.39	8.24	0.01	0.64
Haryana	2.64	8.79	9.74	50.06	57.39	147.48	13.11	14.75	2.05
Himachal Pradesh	0.01	8.74	27.47	37.08	83.45	6.71	32.28	0.07	8.96
Karnataka	3.81	8.75	20.85	43.72	86.35	28.82	12.29	0.13	3.51
Kerala	4.56	6.16	24.62	46.82	74.40	115.83	26.70	64.66	0.73
Madhya Pradesh	4.68	8.98	11.86	46.46	61.76	13.62	2.39	0.23	40.01
Maharashtra	3.79	7.23	21.50	63.84	101.61	20.32	0.00	2.32	2.02
Orissa	3.19	3.91	15.82	35.63	82.84	31.73	25.54	42.02	2.30
Punjab	3.54	4.76	24.51	40.72	63.04	42.60	13.65	38.01	3.72
Rajasthan	0.75	7.64	7.82	44.87	70.78	58.65	21.43	1.30	53.30
Tamil Nadu	0.00	11.79	19.26	10.18	68.97	86.55	64.85	0.54	5.16
Uttar Pradesh	3.29	7.14	16.45	41.81	76.97	16.17	7.89	0.02	4.28
West Bengal	3.48	5.36	8.65	63.45	92.59	34.68	19.40	35.69	101.32

Table A4: Summary Statistics for Different Nutrient Prices by State: NSS 43rd, 50th and 55th Rounds, Urban

State	Estimated Mean Price (Rs. per gm.)								
	Carbohydrate			Protein			Fat		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	0.01	5.22	22.23	0.14	61.38	3.83	74.41	74.59	55.37
Assam	6.89	0.10	32.50	57.59	151.54	10.32	24.81	90.49	20.86
Bihar	4.36	10.30	18.91	59.58	98.99	62.87	15.93	1.09	21.17
Gujarat	7.54	15.08	26.70	54.70	70.69	38.09	2.97	9.37	56.83
Haryana	5.80	8.42	5.35	70.90	112.10	40.42	0.91	2.00	144.38
Himachal Pradesh	7.16	14.78	28.02	54.93	108.74	11.96	9.24	0.34	52.52
Karnataka	0.01	7.03	17.61	21.55	73.60	94.14	61.43	60.83	66.23
Kerala	5.59	7.75	27.89	49.87	90.24	115.17	28.16	60.23	5.62
Madhya Pradesh	6.58	0.29	3.58	57.76	74.46	95.81	3.15	74.47	61.35
Maharashtra	0.33	8.78	5.08	42.43	88.86	15.46	51.79	50.04	214.78
Orissa	3.60	2.86	3.73	37.37	60.99	171.65	41.59	97.60	92.61
Punjab	1.93	10.00	25.20	52.96	85.66	85.12	24.19	23.90	1.54
Rajasthan	2.16	12.37	18.05	58.88	81.88	24.29	19.59	0.12	41.12
Tamil Nadu	5.64	8.74	23.93	4.13	70.24	78.01	49.20	56.62	17.17
Uttar Pradesh	0.00	3.92	17.58	46.81	46.43	5.15	35.87	65.37	65.66
West Bengal	0.55	8.05	0.05	34.30	98.82	8.89	66.88	48.91	239.65

Table A5: Summary Statistics for Nutrient Intake by State: NSS 43rd, 50th and 55th Rounds, Rural

State	Mean per household intake per 30 days (kg.)								
	Carbohydrate			Protein			Fat		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	56.08	53.50	47.85	7.94	6.84	6.07	4.01	3.86	3.62
Assam	68.57	62.58	62.67	9.84	7.76	7.84	3.47	3.51	3.66
Bihar	69.91	66.62	65.45	10.82	9.65	9.33	3.39	3.95	4.20
Gujarat	52.53	54.38	47.86	11.15	9.10	8.07	7.44	7.95	8.02
Haryana	72.90	77.20	67.67	17.15	14.67	12.57	9.15	10.29	9.86
Himachal Pradesh	65.94	63.77	57927	14.12	11.10	10.11	7.51	7.10	7.55
Karnataka	62.79	66.55	54330	9.94	9.20	7.95	4.69	4.85	5.37
Kerala	53.20	48.70	48632	9.19	7.29	7.16	5.09	5.23	5.30
Madhya Pradesh	69.39	68.01	61919	11.98	10.44	9.32	4.59	4.85	5.01
Maharashtra	54.49	53.34	50724	10.79	8.27	8.03	5.34	4.91	5.63
Orissa	65.62	69.81	61604	8.31	7.94	6.94	2.22	2.34	2.27
Punjab	65.09	66.64	63950	16.62	12.81	11.71	10.22	10.46	9.59
Rajasthan	69.11	68.83	70154	15.08	13.15	13.20	7.36	8.87	9.18
Tamil Nadu	47.16	47.29	41752	6.67	6.08	5.44	3.19	3.42	3.57
Uttar Pradesh	71.11	75.34	73640	12.94	12.56	12.01	5.32	6.59	6.47
West Bengal	66.14	71.36	63903	9.02	8.75	7.90	3.25	3.81	3.70

Table A6: Summary Statistics for Nutrient Intake by State: NSS 43rd, 50th and 55th Rounds, Urban

State	Mean per household intake per 30 days (kg.)								
	Carbohydrate			Protein			Fat		
	43rd	50th	55th	43rd	50th	55th	43rd	50th	55th
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	50.85	48.20	46.58	8.11	6.53	6.41	5.36	4.68	5.24
Assam	48.16	51.47	49.09	7.97	6.86	6.93	3.87	4.10	4.75
Bihar	62.82	60.91	62.13	10.88	9.21	9.37	4.48	4.93	5.26
Gujarat	43.03	44.27	41.59	10.23	7.65	7.37	8.79	8.14	9.03
Haryana	56.57	47.90	49.37	12.29	8.64	8.73	7.31	6.73	7.85
Himachal Pradesh	43.70	45.01	39.61	10.11	7.88	6.95	6.49	6.34	6.63
Karnataka	52.16	50.71	47.63	9.45	7.36	7.15	5.98	5.21	6.02
Kerala	47.29	45.46	45.67	9.28	7.01	7.26	6.08	5.43	5.64
Madhya Pradesh	54.41	54.28	56.94	11.89	8.95	9.22	6.57	6.10	6.62
Maharashtra	44.34	42.68	45.75	10.32	7.25	7.63	7.35	6.31	7.18
Orissa	54.41	56.80	59.78	8.80	7.34	7.60	3.98	3.68	3.59
Punjab	44.32	46.38	45.31	12.42	8.64	8.29	8.43	7.63	7.41
Rajasthan	54.34	51.05	57.33	13.33	9.47	10.76	8.27	7.41	9.40
Tamil Nadu	44.54	42.80	41.80	7.48	5.92	6.02	4.88	4.24	5.03
Uttar Pradesh	53.25	58.01	56.17	11.82	9.90	9.46	6.15	6.43	6.94
West Bengal	47.63	47.74	47.50	8.16	6.83	6.81	4.53	4.27	4.92

Table A7: State-specific EKS Food and Nutrient Price Indices by NSS round for the Rural Sector

State	EKS Index Number (Andhra Pradesh = 100) for					
	43rd Round		50th Round		55th Round	
	Food Prices	Nutrient Prices	Food Prices	Nutrient Prices	Food Prices	Nutrient Prices
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	1.000	1.000	1.000	1.000	1.000	1.000
Assam	1.051	1.150	1.061	1.080	1.069	1.040
Bihar	1.049	1.000	1.002	0.920	1.005	0.920
Gujarat	1.086	0.980	1.092	0.990	1.080	1.100
Haryana	1.068	0.960	1.041	0.950	1.052	1.050
Himachal Pradesh	1.053	0.950	1.071	0.960	1.087	1.100
Karnataka	1.037	0.990	1.038	0.970	1.020	1.010
Kerala	1.072	1.150	1.142	1.150	1.139	1.230
Madhya Pradesh	1.014	0.950	1.006	0.910	0.987	0.900
Maharashtra	1.060	0.960	1.064	0.970	1.041	0.990
Orissa	1.014	1.040	0.976	0.980	1.002	0.910
Punjab	1.019	0.960	1.055	0.960	1.050	1.100
Rajasthan	1.064	0.920	1.043	0.90	1.037	0.970
Tamil Nadu	1.087	1.090	1.074	1.030	1.081	1.090
Uttar Pradesh	0.987	0.900	0.984	0.890	0.974	0.890
West Bengal	1.037	1.100	1.009	1.030	1.028	1.050

Table A8: State-specific EKS Food and Nutrient Price Indices by NSS round for the Urban Sector

State	EKS Index Number (Andhra Pradesh = 100) for					
	43rd Round		50th Round		55th Round	
	Food Prices	Nutrient Prices	Food Prices	Nutrient Prices	Food Prices	Nutrient Prices
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	1.000	1.000	1.000	1.000	1.000	1.000
Assam	1.076	1.160	1.075	1.120	1.067	1.100
Bihar	1.046	1.010	1.008	0.940	1.009	0.970
Gujarat	1.091	1.020	1.066	1.000	1.057	1.110
Haryana	1.068	1.010	1.044	0.940	1.058	1.030
Himachal Pradesh	1.050	1.040	1.064	1.040	1.048	1.070
Karnataka	1.028	1.010	1.030	1.020	1.038	1.120
Kerala	1.069	1.100	1.085	1.070	1.092	1.170
Madhya Pradesh	1.046	0.990	1.024	0.930	1.001	0.890
Maharashtra	1.103	1.060	1.114	1.060	1.087	1.130
Orissa	1.021	1.080	0.978	1.020	0.992	1.050
Punjab	1.043	0.970	1.059	0.990	1.019	1.060
Rajasthan	1.072	0.970	1.047	0.950	1.029	0.920
Tamil Nadu	1.093	1.060	1.069	1.040	1.077	1.080
Uttar Pradesh	1.024	0.950	1.004	0.910	0.981	0.950
West Bengal	1.043	1.120	1.023	1.060	1.025	1.100

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