Executive Summary

of

Development of Methodology towards Measurement of Poverty

(Project sponsored by Ministry of Statistics and Programme Implementation)

by

Manoranjan Pal and Premananda Bharati
Indian Statistical Institute
Kolkata

1 Introduction:

Ministry of Statistics and Programme Implementation (MoS&PI) requested Indian Statistical Institute to take up a research project on development of a statistical methodology towards measurement of poverty (*vide letter no. D.O.NO.M-12012/38/2005-SSD, dated 19th October, 2005, from Dr. R.C. Panda, Additional Secretary, MoS&PI, Government of India, addressed to the Director, Indian Statistical Institute*). This is in view of the fact that the norm of 2400 Kcal for rural India and 2100 Kcal for urban India for calculation of poverty line was prescribed sometime in the beginning of seventies. **It is desirable to know whether these norms still hold good as of now as the consumption pattern as well as the quantum of daily energy requirements might have undergone changes during the last 35 years.** In doing so, we have developed some new techniques of measuring poverty. These techniques will be discussed here.

The attempts to measure absolute poverty in India were made by a **Working Group** (WG), a **Task Force** (TF) and an **Expert Group** (EG). All these were set up by the Planning Commission in 1962, 1977 and 1989 respectively. The Task Force in 1979 recommended poverty lines separately for rural and urban areas at national level. They have suggested Rs. 49.09 in rural areas and Rs. 56.64 in urban areas for the base year 1973-74 as official poverty lines. These correspond to the minimum daily calorie requirements of 2400 Kcal in rural areas and 2100 Kcal in urban areas.[1] For updating in subsequent years the consumption basket remained the same, and only the price changes were taken into consideration.

The National Institute of Nutrition (NIN) gives the "Recommended Dietary Allowances for Indians (Macronutrients and Minerals)" for different age-sex-occupation categories (NIN, 2003). "The guidelines promote the concept of nutritionally adequate diets and healthy lifestyles from the time of conception to old age". These are for maintenance of optimal health. We consider the optimum levels suggested by NIN as minimum requirements.

The indirect calculation of number of poor is through the poverty line method. There is a relation between the per capita food consumption and the per capita total consumption of the households which is known as the Engel relation for food. The Engel relation for food is found using these data for households who have expenditures near the poverty line expenditure. This relation is known to be very stable. We use this relation to find the per capita total consumption from the per capita food consumption. The per capita food consumption for this purpose is again calculated using the data on households with calorie consumption is around the optimal calorie requirements.

The **conventional Method** of finding the poverty lines is divided into few steps as follows.

[1] To be more precise the daily calorie requirements were worked out as 2435 Kcal for rural and 2095 Kcal for urban areas.

(i) Each member in a household is put in the respective group according to the pre-assigned age-sex groups and the activity status of adult members prepared for this purpose. In addition to it the status of pregnancy of female members may also be considered. For each age-sex-activity status group there is also a pre-assigned calorie requirement called calorie norm. **Calorie norm of a household** is determined by adding the calorie norm of each member of the household.

(ii) For a given region the proportion of population in each age-sex-activity status group is found. The average **calorie norm of the region** (may be termed as **Calorie Line**) is found by taking the weighted mean of the calorie norms of each category of members where weight is taken as proportional to the total population in that category. It is assumed that the poverty line of the region is a function of the calorie line. The poverty line of the region is thus based on this calorie line. The regions taken in India are the rural and urban sectors of each state. Overall calorie lines of rural and urban India are also found.

(iii) Actual Calorie consumption of the household is calculated by adding the calorie of each food item consumed by the household. This is done by using the calorie conversion factor of each item which is defined as the calorie content of one unit of the item. Naturally to find the **calorie intake** of the household one should have data on quantities of food items consumed by the household.

(iv) It is assumed that calorie intake or more precisely per capita calorie intake of a household is directly related with the per capita food expenditure and in turn with the per capita total expenditure of the household. In practice the two steps, i.e, finding relation between per capita calorie intake and the per capita food expenditure and then between per capita food expenditure and the per capita total expenditure are merged and only the relation between per capita calorie intake and the per capita total expenditure is found. The relation is established for different expenditure groups to make it as realistic as possible. The **Poverty line** is the per capita total expenditure which corresponds to the calorie norm of the concerned population. This may be done for each state separately for rural and urban regions. Since per capita Calorie intake is viewed as a function of the per capita total expenditure, the poverty line is found by inverse interpolation method.

It should be noted here that Official Poverty Line in India is not found by the conventional method. Rather it is found by projecting the poverty line from the base year poverty line to the current year poverty line using the relevant price indices. The base year poverty rates were found by a method which is similar to the conventional method.

2.1 The Proposed Calorie Norms

A detailed procedure of the calculation of Human Energy Requirements can be found in the important publication of the final report of the Joint FAO/WHO/UNU Expert Consultation on Human Energy Requirements, convened in October 2001 at FAO headquarters in Rome, Italy[2]. They estimated the human energy requirements from measures of energy expenditure plus the additional energy needed for growth, pregnancy and lactation.

Average energy requirements of infants from birth to 12 months, children and minors of each age in years, adults and elderly persons of each age group are given in the report. They also supply the daily energy requirements of mothers during pregnancy and lactation. Since NSSO consumption data usually do not cover information of mothers about pregnancy and lactation period, it is not possible for us to incorporate it in this paper. It is also necessary to have

[2] http://www.fao.org/docrep/007/y5686e/y5686e01.htm#TopOfPage. Henceforth this report will be referred to as 'FAO report' or 'report of FAO'.

information on the lifestyles of adults in relation to the intensity of habitual physical activity. All adults are put in one of the three categories (i) sedentary or light activity lifestyle, (ii) active or moderately active lifestyle and (iii) vigorous or vigorously active lifestyle. Total Energy Expenditure (TEE) will be different for different lifestyles.

Table 1 gives the summary of daily energy requirements for males and females at all age groups.

Table 1. Energy Requirements at Different Age Groups Separately for Males and Females: A Comparison between FAO and ICMR Estimates

	Males			Females			Females/Males		
Age groups	Body weight	Daily energy requirements		Body weight	Daily energy requirements		Body weight	FAO	ICMR
		FAO	ICMR		FAO	ICMR			
	Kg.	Kcal/d	Kcal/d	Kg.	Kcal/d	Kcal/d	-	-	-
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0-3y	10.5	865	1064	10.5	839	1064	1.00	0.97	1.00
4-6y	19.0	1425	1690	19.0	1368	1690	1.00	0.96	1.00
7-12y	31.1	2025	2070	29.2	1727	1960	0.95	0.86	0.95
13-18y	57.1	2912	2640	49.9	2160	2060	0.87	0.74	0.78
19 or more	60.0	2367	2425	50.0	1882	1875	0.83	0.89	0.77

2.2 Poverty Rates

From the energy requirements at different age-sex combination groups one can calculate the calorie lines. In addition to the calorie lines the proportion of persons below the calorie line can be calculated (may be termed as **Calorie Poverty Rate** or simply the **Calorie Poverty**) by conventional method and by direct comparison of households' total calorie intakes with the calorie line**.**

To get the poverty line one has to see the correspondence between the Daily Per Capita Calorie Intake (DPCI) and the (Monthly) Per Capita Consumption Expenditure (MPCE) of Households. For fixed Calorie Line method this process is rather simple. One can make different MPCE groups of households and find the relation between DPCI and MPCE and get the appropriate value of MPCE corresponding to the average calorie norm derived from the individual calorie norms and the weighing diagrams as set from time to time.

Table 2. Poverty Lines and Poverty Rates by Conventional and Direct Method Using Individual Multiplier: All India, NSSO 61st Round

Sector	Method Used	Calorie and Poverty Lines and Rates	FAO	ICMR
Rural	Conventional	Calorie Line	2231	2354
		Calorie Poverty Rate (Fixed Calorie Line)	0.71	0.78
	Direct	Calorie Poverty Rate	0.76	0.82
	Conventional*	Poverty Line	621.0	754.5
		Poverty Rate	**0.75**	**0.85**
Urban	Conventional	Calorie Line	2082	2149
		Calorie Poverty Rate (Fixed Calorie Line)	0.63	0.67
	Direct	Calorie Poverty Rate	0.71	0.76
	Conventional*	Poverty Line	980.9	1095.3
		Poverty Rate	**0.63**	**0.70**

Poverty Rates are too high to be accepted. **The Poverty Rates found by the Fixed Poverty Line Method are higher than the Calorie Poverty Rates found by Calorie Line Methods found earlier in this report for rural India. Almost the opposite is the case for urban India.**

3. New Methods of Finding Poverty Rate: Decomposition of Total Calorie Consumption over Members in the Households

Calorie consumption should be different for different compositions of members in the household. However, it is not apparently clear how one can estimate consumption pattern among the members of the households when the data on consumption are available only at household level.

Following the path of Mason, Montenegro and Khandker (1999) and Coondoo, Majumder and Ray (2003) decomposition of total calorie consumption among the members of the households is possible to some extent if we modify their model to suite the requirements in case of calorie consumption.

Suppose there are altogether K possible categories of members in a household h with number of members $x_{h1}, x_{h2}, \ldots, x_{hK}$, respectively. The total daily calorie consumption of the household is y_h. Since the total calorie consumption is the sum of individual calorie consumption we have the following identity.

$$y_h = c_{h1}\, x_{h1} + c_{h2}\, x_{h2} + \ldots + c_{hK}\, x_{hK}, \qquad \ldots (3.01)$$

where $c_{h1}, c_{h2}, \ldots, c_{hK}$ are the actual per head calorie consumptions of the respective categories. In general $c_{h1}, c_{h2}, \ldots, c_{hK}$ will vary from household to household. If the mean consumptions are $\beta_1, \beta_2, \ldots, \beta_K$, respectively, then we can write

$$c_{hk} = \beta_k + u_{hk}, \text{ for } k = 1, 2, 3, \ldots, K, \qquad \ldots (3.02)$$

where $u_{h1}, u_{h2}, \ldots, u_{hK}$ are the deviations of the actual calorie consumption from the respective mean values. The deviations $u_{h1}, u_{h2}, \ldots, u_{hK}$, have zero means. We also assume that this deviation for a single person in that category have same variance for all the households and is denoted by ν_k^2, k = 1, 2, …, K. We can thus rewrite the above identity as

$$\begin{aligned} y &= (\beta_1 + u_{h1})\, x_{h1} + (\beta_2 + u_{h2})\, x_{h2} + \ldots + (\beta_k + u_{hk})\, x_{hK} \\ &= \beta_1\, x_{h1} + \beta_2\, x_{h2} + \ldots + \beta_k\, x_{hK} + \varepsilon_h, \qquad \ldots (3.03) \end{aligned}$$

where $\varepsilon_h = \sum_k u_{hk}\, x_{hk}$. Because of this variable parameter model heteroscedasticity in the error term is introduced.

In real life the total food expenditure on food includes expenditure on food offered to guests, servants and other visitors of the house. Total calorie consumption of the household implied by the food consumption will then be greater than the sum of calorie consumption of the individual members. Also some members of the household may avail food outside the house. Thus the inequality may be other way round also. It is necessary to introduce a variable intercept in the equation to accommodate it, which ultimately reduce to

$$y = X'\beta + \varepsilon, \qquad \ldots (3.04)$$

where $y = (y_1, y_2, \ldots, y_H)'$, $\varepsilon = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_H)'$, and

$$X = \begin{bmatrix} 1 & x_{11} \ldots & x_{1K} \\ 1 & x_{21} \ldots & x_{2K} \\ \ldots & \ldots \ldots & \ldots \\ 1 & x_{H1} \ldots & x_{HK} \end{bmatrix} = (x_{.0}, x_{.1}, x_{.K}) = \begin{bmatrix} x_{1.} \\ x_{2.} \\ \ldots \\ x_{H.} \end{bmatrix}, \qquad \ldots (3.05)$$

where H is the total number of units (households) taken for regression.

The subsequent tables present the results of the analysis applied to our proposed model using NSS 61st round data. The NSS data provides multiplier to each household. The multiplier is calculated from the sampling scheme adopted by NSSO. This can be used as weights to get more accurate estimates.

3.1 The Results

The coefficients of the regression model, where the regressors are the numbers of members in each of the age-sex groups belonging to the households, along with the intercepts terms are presented in Table 3. In most of the cases coefficients associated with the male members have higher values than those of the female members.

Table 3. All India Average Calorie Intake of Members of Households by Age Group and Sex: Results of the Regression Method Using NSS 61st Round Data

		Rural		Urban		Rural + Urban	
Coefficients		Coefficients	F/M	Coefficients	F/M	Coefficients	F/M
Intercept		435.4	-	699.3	-	520.2	-
0-3 yrs.	Males	1006.5	.93	831.6	1.02	978.8	.95
	Females	937.0		847.9		925.2	
4-6 yrs.	Males	1483.4	.91	1299.0	.85	1452.3	.91
	Females	1349.2		1108.9		1318.8	
7-12 yrs.	Males	1748.7	.95	1571.5	.96	1728.9	.94
	Females	1656.2		1514.3		1624.7	
13-18 yrs.	Males	2115.6	.93	1915.8	.87	2067.9	.91
	Females	1965.7		1660.8		1886.9	
19 or more yrs.	Males	2328.7	.90	2093.6	1.01	2269.2	.91
	Females	2097.0		2118.0		2074.2	

It is felt that the treatment on the members would be different for different income/expenditure levels. We grouped the households into 12 expenditure groups. Group 1 has the lowest and the Group 12 has the highest per capita expenditures. The groups are same as the ones taken by NSSO. The results of the regression analysis are much different now (Tables 4-5). Except for higher income groups, there are no differences in the calorie consumptions of female members relative to that of male members between rural and urban sectors in India.

Table 4. Average Calorie Intake of Members of Households by Age Group, Sex and Expenditure Group in Rural India

Age Groups →		0 – 3 years			4 – 6 years			7 – 12 years			13 – 18 years			19 years or more		
Exp. Group	Intercept	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M
Gr1	-657.1	1072.1	1089.8	1.02	1357.1	1306.5	0.96	1556.4	1528.6	0.98	1546.0	1533.5	0.99	1553.6	1746.9	1.12
Gr2	273.6	1404.7	1227.6	.87	1301.7	1382.4	1.06	1656.1	1425.3	.86	1697.6	1767.4	1.04	1699.1	1461.9	.86
Gr3	10.1	1199.0	1175.2	.98	1633.1	1562.4	.96	1700.7	1732.9	1.02	1947.3	1739.0	.89	1783.7	1724.9	.97
Gr4	156.9	1328.7	1482.9	1.12	1617.7	1617.1	1.00	1865.5	1772.8	.95	1936.9	1767.4	.91	1854.8	1786.5	.96
Gr5	30.3	1609.0	1328.7	.83	1677.8	1717.5	1.02	1970.0	1854.7	.94	2139.7	1888.5	.88	2037.2	1838.2	.90
Gr6	131.4	1411.4	1582.8	1.12	1830.5	1788.6	.98	2034.9	1899.2	.93	2148.6	2121.4	.99	2001.7	1927.8	.96
Gr7	198.5	1593.3	1577.1	.99	2034.0	1744.3	.86	1985.5	1926.9	.97	2129.2	2087.8	.98	2104.6	2000.2	.95
Gr8	15.42	1477.6	1479.4	1.00	2075.1	1795.1	.87	2085.8	1929.0	.92	2418.1	2165.1	.90	2267.2	2199.9	.97
Gr9	145.5	1456.7	1635.3	1.12	1940.0	1655.3	.85	2117.0	2036.1	.96	2343.8	2381.4	1.02	2331.4	2316.6	.99
Gr10	266.3	1614.7	1347.8	.83	1975.1	1867.2	.95	2238.1	2184.3	.98	2458.5	2349.9	.96	2423.0	2395.0	.99
Gr11	257.8	1433.9	1392.6	.97	2446.0	1955.2	.80	2276.3	2102.9	.92	2640.7	2315.7	.88	2693.1	2634.4	.98
Gr12	306.3	1267.9	1055.3	.83	1767.7	1584.1	.90	2250.9	2747.5	1.22	2947.1	2677.5	.91	2975.9	3287.6	1.10

Table 5. Average Calorie Intake of Members of Households by Age Group, Sex and Expenditure Group in Urban India

Age Groups →		0 – 3 years			4 – 6 years			7 – 12 years			13 – 18 years			19 years or more		
Exp. Group	Intercept	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M	Males	Females	F/M
Gr1	-346.2	852.0	934.5	1.10	1303.6	1366.4	1.05	1503.8	1533.7	1.02	1638.2	1454.0	.89	1571.4	1687.4	1.07
Gr2	-77.8	1300.4	1204.3	.93	1569.0	1276.5	.81	1513.2	1562.1	1.03	1778.3	1930.6	1.09	1858.1	1552.5	.84
Gr3	-39.1	1129.3	1144.2	1.01	1601.5	1565.7	.98	1654.1	1555.5	.94	1949.7	1732.1	.89	1818.2	1771.5	.97
Gr4	17.9	1142.1	1154.6	1.01	1482.1	1677.6	1.13	2145.5	1667.3	.78	1908.8	1879.9	.98	2019.2	1797.4	.89
Gr5	200.7	1458.6	1372.2	.94	1436.5	1226.0	.85	1834.3	1770.5	.97	1970.8	1932.4	.98	1902.0	1872.8	.98
Gr6	402.8	1314.0	1263.4	.96	1676.2	1630.4	.97	1581.8	1660.8	1.05	2087.1	2060.4	.99	1995.7	1879.9	.94
Gr7	344.8	1298.5	1401.2	1.08	1829.2	1605.8	.88	1921.5	1727.3	.90	2139.9	1871.9	.87	2058.1	2000.5	.97
Gr8	280.5	1380.6	1475.8	1.07	1796.6	1408.1	.78	1836.1	1997.5	1.09	2057.5	1862.4	.91	2205.9	2134.1	.97
Gr9	448.2	1318.0	1283.9	.97	1498.1	1455.0	.97	1882.0	2015.8	1.07	2111.5	2003.8	.95	2180.7	2236.2	1.03
Gr10	581.4	1274.4	1502.3	1.18	1887.2	1439.6	.76	2042.9	1875.5	.92	2434.3	2048.0	.84	2250.1	2228.9	.99
Gr11	786.6	1164.7	1391.5	1.19	1869.8	1269.4	.68	2174.9	1877.7	.86	2514.9	2096.8	.83	2269.8	2408.4	1.06
Gr12	948.1	1082.7	1300.0	1.20	960.1	993.0	1.03	2281.3	1862.7	.82	2425.4	2236.1	.92	2423.5	2653.1	1.09

3.2 The Poverty Rates by Calorie Decomposition Method

The results of the previous section are not only useful in determining the gender bias in calorie, but also have other uses. In this section we use the member wise expected calorie consumption of the households to arrive at the poverty rates.

For a given household, the sum of the expected amount of calories consumed by the members is then found. The intercept term of the expenditure group should be added to the sum to get the estimated calorie consumption of the household. The sum of calorie norms of members in the household is found in a straightforward manner. Here the question of intercept term does not arise. The calorie norm of the household is compared with the estimated calorie consumption to determine whether the household is poor. If a household is poor then it is given a dummy value '1', otherwise it is given the value '0'. Weighted means of these dummy values give us the poverty ratios (Table 6).

Table 6. Estimates of Poverty Rates Assuming that Activity Status of All Adults are in the Sedentary Level: NSS 61st Round Data.

Method of Calculation		Norm	Rural		Urban		All India	
			W/o Weight	With Weight	W/o Weight	With Weight	W/o Weight	With Weight
Our	7 Exp Groups	ICMR	0.331	0.479	0.517	**0.556**	0.399	0.498
	9 Exp Groups		0.363	**0.508**	0.676	0.737	0.477	0.566
	7 Exp Groups	FAO	0.274	0.399	0.460	**0.488**	0.342	0.421
	9 Exp Groups		0.313	**0.434**	0.586	0.633	0.412	0.484
Direct		ICMR	-	0.560	-	0.616	-	0.574
		FAO	-	0.508	-	0.578	-	0.526

In any case these estimates are not plausible. The urban poverty ratios are found to be higher than the corresponding rural poverty ratios. What has gone wrong? Clearly the activity status! And if we take activity status then it will further inflate the poverty rates.

4. A New Method of Finding Poverty Rate: Error Distribution Method

In this section we assume that the variables like calorie consumption, expenditure and the calorie norm follow certain distribution.

Let us first try to visualize the direct method in the distribution set up. Each household has a fixed age-sex-activity status configuration and thus Daily Per Capita Calorie Norm (DPCN) for the household is fixed. Consider all the households with this same configuration. The monthly per capita expenditure (MPCE) of the households will vary even for a fixed DPCN. Let us denote this random variable (MPCE) by X. Y is similarly a random variable representing the Daily Per Capita Calorie Intake (DPCI) of the household. This also varies from one household to anther household. Let us assume that Z represents DPCN. We then take multiple linear regression model as given below.

$$y_h = a + bx_h + cz_h + \varepsilon_h, \text{ for all h such that } x_h \in (A,B),$$

We can find the weighted least squares estimates $\hat{a}, \hat{b}, \hat{c}$, of a, b and c and then Prob(y<z|x & z) or Prob(y-z<0|x & z), or Prob(a+bx+cz+ε-z<0|x & z), or Prob(ε<-(a+bx+cz-z) |x & z), or

$$\Phi[-\{a+bx+(c-1)z\}/\hat{\sigma}_\varepsilon],$$

assuming that ε follows a normal distribution with mean '0'. We face the problem of fixing x and z in practice. We can use the lower and upper boundary values of x and see if the two values differ much for a fixed value of z. We can take the mid value of the two. To fix the z value we can take the weighted mean value of z values in the given interval. All these are however approximations.

Table 7 gives the poverty rates assuming MPCE values same as the (i) lower boundary, (ii) upper boundary and (iii) mean value and the calorie norm as the actual mean per capita norm of all households in the given interval taking FAO norms (DPCN). The rural and urban poverty rates are found as 0.77 and 0.68 taking mean MPCE and DPCN values of each interval. These values are at the higher ends of the values found earlier (0.71-0.76 for rural and 0.63-0.71 for urban India).

Table 7: Poverty Rates Found by Trivariate Regression of DPCI on MPCE and DPCN (PCNFAO) Separately for Rural and Urban Sectors using Household Truncated Data with 100 Kcal < DPCI < 10000 Kcal and Individual Multiplier: Rural and Urban India, NSSO 61st Round.

Rural						Urban					
Lower Boundary	Upper Boundary	Weight	Pov Rate1*	Pov Rate2**	Pov Rate	Lower Boundary	Upper Boundary	Weight	Pov Rate1*	Pov Rate2**	Pov Rate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0	235	0.048	1.00	0.97	0.99	0	335	0.050	1.00	0.96	0.98
235	270	0.051	0.99	0.98	0.99	335	395	0.051	0.95	0.95	0.95
270	320	0.099	0.98	0.96	0.97	395	485	0.097	0.91	0.89	0.90
320	365	0.105	0.95	0.92	0.94	485	580	0.104	0.87	0.81	0.84
365	410	0.102	0.92	0.87	0.90	580	675	0.097	0.85	0.80	0.83
410	455	0.093	0.89	0.86	0.87	675	790	0.100	0.77	0.72	0.75
455	510	0.099	0.85	0.79	0.82	790	930	0.103	0.75	0.68	0.72
510	580	0.102	0.79	0.73	0.76	930	1100	0.097	0.63	0.57	0.60
580	690	0.103	0.71	0.64	0.68	1100	1380	0.102	0.63	0.46	0.55
690	890	0.098	0.62	0.51	0.57	1380	1880	0.099	0.53	0.41	0.48
890	1155	0.050	0.51	0.35	0.44	1880	2540	0.051	0.45	0.30	0.39
1155	∞	0.050	0.36	0.00	0.33	2540	∞	0.049	0.32	0.00	0.31
	Total	**1.000**	**0.81**	**0.74**	**0.79**		**Total**	**1.000**	**0.73**	**0.64**	**0.70**

*. Assuming Lower Bound of Exp. Group and Mean DPCN, **. Assuming Upper Bound of Exp. Group and Mean DPCN.

If there is a calorie norm below which all households are assumed to be poor then gradual decrease of proportions of poor persons does not make any sense. But where do we put the cut-off point. The best point should be the point where we have 50% below and also 50% above the point. This can be found by quadratic interpolation method. All the households above this cut of point should be taken as non-poor. The logic behind this is the following. Suppose more than 50 percent of population with a given per capita income can consume food having calorie intake more than the calorie norm then the rest of the households with the same per capita income should be able to consume food as the same level as this group. This will be clear if we take the following figure.

In the Figure 4.1 horizontal axis represents Per Capita Expenditure and the vertical axis represents the degree of poverty. Area under the curve ACD is the poverty rate. From ACD we take the mirror image of AC as EC. So we also remove the portion under the curve EC. The actual poverty region is the yellow shaded portion AEC. The area of AEC is found to be 0.54 for rural India. There are methods which are independent of any assumption of distribution. This is found by subtracting 1 from twice the poverty rates of each interval.

Figure 4-1: A Diagrammatic Representation of Poverty Regions

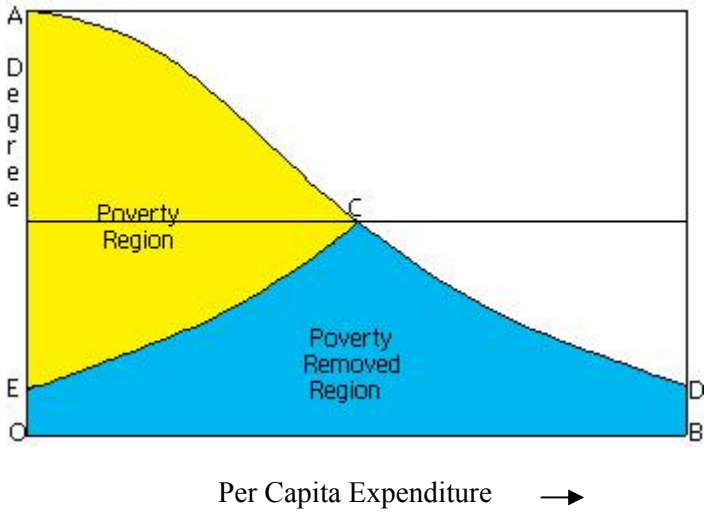

Table 8: Improvements of Poverty Rates Found by Trivariate Regression of DPCI on MPCE and PCNFAO for Rural Sector using Household Truncated Data With 100 Kcal < DPCI < 10000 Kcal and Individual Multiplier: Rural India, NSSO 61st Round.

Rural				Urban			
Lower Boundary x	P(Y<Z|X=x)	P(Y<Z|X=x) – (1-P(Y<Z|X=x)) (Z=897)	Wt	Lower Boundary x	P(Y<Z|X=x)	P(Y<Z|X=x)-(1-P(Y<Z|X=x)) (Z=897)	Wt
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	1.00	1.00	0.048	0	1.00	1.00	0.050
235	0.99	0.98	0.051	335	0.95	0.90	0.051
270	0.98	0.96	0.099	395	0.91	0.82	0.097
320	0.95	0.90	0.105	485	0.87	0.74	0.104
365	0.92	0.84	0.102	580	0.85	0.70	0.097
410	0.89	0.78	0.093	675	0.77	0.54	0.100
455	0.85	0.70	0.099	790	0.75	0.50	0.103
510	0.79	0.58	0.102	930	0.63	0.26	0.097
580	0.71	0.42	0.103	1100	0.63	0.26	0.102
690	0.62	0.24	0.098	1380	0.53	0.06	0.099
890	0.51	0.02	0.050	1880	0.45	0.00	0.051
1155	0.36	0.00	0.050	2540	0.32	0.00	0.049
Pov. Rate	**0.81**	**0.64**	**1.000**	**Pov. Rate**	**0.73**	**0.48**	**1.000**

It was already noted that the calculations of poverty rates in each interval needs fixing up values of x and z. While no satisfactory solution exists on how we should fix the x values other than taking the weighted mean value of x in the given interval or taking the boundary points, there exists an alternative satisfactory solution for fixing z value. **This is done by transforming calorie norms of all members in the given household into adult equivalent scale. In this case all households will have the same calorie norm which is the calorie norm of an adult member.** Adult equivalent calorie intake of a household is found from the following relation.

$$AECI = CNA \times TotCal/SumCalNorm,$$

where, AECI stands for Adult Equivalent Calorie Intake of a Household, CNA is the calorie norm of a sedentarily active adult member in the household, TotCal is the total calorie intake of all the members in the household and SumCalNorm is the sum of calorie norms of all the members in the Household. Taking the norms specified by FAO with modifications on the average weight of the members in each category, we get the CNA value as 2367 Kcal per day for both rural and urban sectors.

In this case we should take the following linear regression model.

$$y_h = a + bx_h + \varepsilon_h, \text{ for all h such that } x_h \in (A,B),$$

The weighted least squares estimates of a and b are used to find Prob(y-z<0|x & z), or Prob($\hat{a}+\hat{b}$x+ε-z<0|x & z), or Prob(ε<-($\hat{a}+\hat{b}$x-z)|x & z), or $\Phi[-\{\hat{a}+\hat{b}x-z\}/\hat{\sigma}_\varepsilon]$, assuming that ε follows a normal distribution with mean '0'. We can use the lower and upper boundary values of x. We can take the mid value of the two boundary points. The best way to fix it is at the weighted mean values of x's in the given interval. The z value is already fixed at 2367 Kcal per day. The poverty rates thus found along with the improvements suggested for the tri-variate case is given in Table 9.

The poverty rates are now less than the corresponding poverty rates found from tri-variate regression method. The most interesting part of this method is that we get almost same poverty rates for both rural and urban sectors.

Table 9: Poverty Rates Found by Trivariate Regression of DPCI on MPCE and PCNFAO Separately for Rural and Urban Sectors using Adult Equivalent Scale of Household Consumption Data Truncated at 500 Kcal < DPCI < 5000 Kcal and Using Individual Multiplier: Rural and Urban India, NSSO 61st Round.

Rural					Urban				
Lower Boundary (x)	Mean MPCE	Wt	P(Y<Z| X=x)	P(Y<Z|X=x)-(1-P(Y<Z|X=x))	Lower Boundary (x)	Mean MPCE	Wt	P(Y<Z|X=x)	P(Y<Z|X=x)-(1-P(Y<Z|X=x))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0	199.5	0.048	0.992	0.98	0	279.7	0.050	0.981	0.96
235	253.8	0.051	0.963	0.92	335	368.2	0.051	0.922	0.84
270	296.6	0.099	0.928	0.86	395	441.3	0.097	0.877	0.75
320	342.4	0.105	0.882	0.76	485	533.2	0.104	0.820	0.64
365	387.7	0.102	0.841	0.68	580	625.8	0.097	0.795	0.59
410	432.1	0.093	0.787	0.57	675	730.2	0.100	0.725	0.45
455	481.6	0.099	0.746	0.49	790	858.0	0.103	0.702	0.40
510	543.3	0.102	0.703	0.40	930	1014.3	0.097	0.623	0.34
580	630.4	0.103	0.643	0.28	1100	1226.4	0.102	0.533	0.07
690	775.0	0.098	0.545	0.09	1380	1594.4	0.099	0.473	0.00
890	999.9	0.050	0.430	0.00	1880	2157.2	0.051	0.367	0.00
1155	1956.6	0.050	0.318	0.00	2540	4235.6	0.049	0.280	0.00
Pov.Rate		**-**	**0.74**	**0.51**	**Pov.Rate**		**-**	**0.68**	**0.41**

5. Findings of the Study and Discussions

The entire study is based only on NSS data as supplied by the Ministry.

The calorie poverty rates by direct method are always higher than the fixed calorie line method. The calorie line of the household may be very much different from the fixed calorie line because the age-sex-activity status of the household may be much different from the average age-sex-activity pattern of all the households. The direct method thus seems to be superior to the fixed calorie line method in this respect.

Calorie poverty rates show an increasing trend whichever method is used except for urban sector during 50th and 55th rounds of NSS. One of the reasons is possibly due to the change in the activity status over time. The correspondence between National Classification of Occupation made in 1968 (NCO-1968) and the activity status has undergone a sea change. The life styles have changed very much due to the introduction of many work and time saving devices. Many new commodities have come into the market. The tests and preferences on the commodities by the people have changed. The workers who were designated as hard workers have possibly ceased to be so. So are the moderate workers. And this is reflected in the trend of Calorie Poverty Rates. We also apprehend that many of the members, who were designated as sedentary workers by NCO-1968, are now leading a sub-sedentary life. Also the health status of the members is not considered at all.

We have found the Poverty Rates using both linear and quadratic methods of regression of DPCI on MPCE for each class interval. The linear and quadratic methods give almost same result.

Two entirely new methods have been proposed in this report – Calorie Decomposition Method and the Error Distribution Method. Poverty Rates found by both the methods are higher than expected. Calorie Decomposition Method also enables us to prepare Adult Equivalent Scales. Some modifications of the error decomposition method have also been proposed.

5.1 Reviews and Discussions

It has long been observed that official poverty lines and the poverty lines based on calorie consumption are very much different, the poverty lines based on calorie norms being much higher than those obtained by official poverty lines. Consequently, the head count ratios based on calorie

norms have been found to be much higher than those based on official poverty lines (Meenakshi and Viswanathan, 2003).

The problem of the persistent discrepancy between the two methods has also been pointed out by many authors including Saith (2005), Sen (2005), Bhalla (2003), Palmer-Jones and Sen (2001), and it has unequivocally been agreed that the poverty in India has declined (See for instance Sundaram and Tendulkar, 2003)

Sen (2005) has made some important and crucial observations.

1. He has found the intake of proteins to be higher than what would be necessary for a balanced diet.
2. The southern states exhibit lower average calorie intake especially among the poor than the rest of the country. But they are in a better position when health indicators are considered.
3. The observed reduction in the per capita consumption of calories has arisen mainly from lower consumption of cereals, which has decreased in absolute terms, especially in rural areas, in recent years.

The above three observations, made by Sen, lead to the question whether we should take all the three main nutrients, namely, calorie, protein and fat into the considerations. In that a case one should find a device by which one can combine the three indicators. Sen himself raised the same question by saying "… Indian dietary habits are steadily moving away from an excessively calorie focused diet to a more balanced one. Does this then imply that it should now be possible to evolve a more multi-dimensional measure of nutritional adequacy which could form the basis of a new poverty line?"

In short, the following points emerge from the above mentioned findings and discussions:

1. Consumption pattern/food habit must have changed a lot.
2. The grouping of activity status through NCO-1968 does not seem to be valid still now. NSS consumption schedule does not through any light towards the activity status other than NCO code. In the same occupation status the employees do not do so much physical work that they used to do. We have work saving devices at work place as well as in the house and other places. Also, there may be an under-reporting of consumptions, especially the food consumption?

6. Recommendations:

(A) The NSS consumption schedule should have a separate block consisting of items necessary for finding calorie requirements of each member in the household.

More specifically the following data are needed for each member:

(1) *Age, sex, weight, height and occupation status of each member in the household.*
(2) *Average number of hours spent on each activity in a day along with detailed description of the activities:* These data are to be collected for each member and not only for adult members. It is apprehended that the physical work exerted by non-adult members are also decreasing over time. Weight is an important factor necessary for measuring calorie requirements. Along with this the status of pregnancy and lactation of mothers are also required.
(3) *Information on any chronic or acute illness of each member:* It should be taken along with data on decrease in the amount of food (calorie/fat/protein) intake of the concerned member due to this illness.

(B) There should be a system of verification of the data collected for at least a portion of the sampled households by a different agent altogether.

(C) It is also possible to find the poverty rates using protein or fat intake of members. Should we get a poverty rate combining all the three factors namely, Calorie, Protein and Fat? If so, how should we combine these factors? There are different measures of poverty discussed in the report. Which one should we take as an official index? A committee should be set up to look into all these matters. The committee may also look into other dimensions of poverty, such as property, possession of selected items like mobiles, cars, cattle etc.

Minimum energy requirements of calorie, protein and fat as recommended by ICMR or FAO are based on scientific experiments and thus cannot be questioned. What we can question is whether these experiments are done in an environment suitable for Indian situation. One can question whether ICMR has taken representative people from most of the states in India. It should be noted that FAO recommendations not only take age, sex and activity status into considerations while calculating the average norms but also give functional relations so that one can calculate the norms if the exact values of age, sex, activities throughout the day and weight are known. NCO codes are not sufficient to capture the activity status.

References:

1. Bhalla, S. (2003): Recounting the Poor: Poverty in India, 1983-99, *Economic and Political Weekly*, January 25, 2003, pp. 338-349.
2. Coondoo, D., Majumder, A. and R. Ray (2003): "Estimation of a set of Multi Lateral Consumer Price Indices for Nutrients", Working Paper No. ERU/2003-12, Indian Statistical Institute, Kolkata, India.
3. Coondoo, D., Majumder, A. and R. Ray (2004), "A Method of Calculating Regional Consumer Price Differentials with Illustrative Evidence from India", *Review of Income and Wealth*, 50(1), 51-68.
4. Deaton, A. (1989): "Looking for Boy-Girl Discrimination in Household Expenditure Data", *World Bank Economic Review*, **3**(1), 1 - 15.
5. Deaton, A. (1997): *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*, The World Bank, Washington DC.
6. Deaton, A. and C. Paxson, 2000, "Growth and saving among individuals and households," *Review of Economics and Statistics*, **82**(2), 212–25.
7. Deaton, A. and J. Dreze (2002): 'Poverty and Inequality in India: A Re-examination', *Economic and Political Weekly*, Vol 37, No 36.
8. Deaton, A. (2003): Adjusted Indian Poverty Estimates for 1999-2000, *Economic and Political Weekly*, January 25, 2003, pp. 322-326.
9. Deaton, A (2003): "Prices and Poverty in India, 1987-2000", EPW, Jan. 25.
10. Dreze, J. and A. Sen (1989): *Hunger and public action*, Oxford, Oxford University Press.
11. Gangopadhyay, S., L.R. Jain and A. Dubey (1997): "Poverty Measurement and Socio-economic Characteristics: 1987-88 and 1993-94," Report submitted to the Dept. of Stat., Govt. of India.
12. Government of India (1979): "Report of the Task Force on Projections of Minimum Needs and Effective Consumption Demand", Perspective Planning Division, Government of India, Planning Commission.
13. Government of India (1993): "Report of the Expert Group on Estimation of Proportion and Number of Poor", Planning Commission, Perspective Planning Division.
14. ICMR (2002): Nutrient Requirements and Recommended Dietary Allowances for Indians: A Report of the Expert Group of the Indian Council of Medical Research, New Delhi.
15. Lancaster, G., Maitra, P. and Ray, R (2007): Household Expenditure Patterns and Gender Bias: Evidence from Selected Indian States, Paper presented at the Indian Statistical Institute Platinum Jubilee Conference on "Gender Issues and Empowerment of Women", held at Kolkata during 1-2 February 2007.
16. Manna, G. C. (2007): On Calibrating the Poverty Line for Poverty Estimation in India, *Economic and Political Weekly*, July 28, 2007, pp. 3108-3115.
17. Mason, Andrew D., Claudia E. Montenegro, and Shahidur R. Khandker (1999): "Can we say anything more about gender and poverty using household consumption data," Poverty Reduction and Economic Management Network, The World Bank.
18. Meenakshi, J V and B Viswanathan (2003): 'Calorie Deprivation in Rural India', *Economic and Political Weekly*, Vol 38, No 4.
19. National Institute of Nutrition (2003): "Dietary Guidelines for Indians – A Manual" by National Institute of Nutrition, Indian Council of Medical Research, Hyderabad – 500 007, India, 2003.
20. Palmer-Jones, R., and K. Sen (2001): On India's Poverty Puzzles and Statistics of Poverty, *Economic and Political Weekly*, January 20, 2001, pp. 211-217.
21. Ray, R and G Lancaster (2005): 'On Setting the Poverty Line Based on Estimated Nutrient Prices: Condition of Socially Disadvantaged Groups during the Reform Period', *Economic and Political Weekly*, January 1, Vol XL, No 1.
22. Saith, A (2005): Poverty Lines versus the Poor: Method versus Meaning, *Economic and Political Weekly*, October 22, 2005, pp. 4601-4610.
23. Sen, P. (2005): Of Calories and Things Reflections on Nutritional Norms, Poverty Lines and Consumption Behaviour in India, *Economic and Political Weekly*, October 22, 2005, pp. 4611-4618.

24. – (2003): Poverty Has Declined in the 1990s: A Resolution of Comparability Problems in NSS Consumer Expenditure Data, *Economic and Political Weekly*, January 25, 2003, pp. 327-337.