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By adopting the high-yielding crop variety programme, the additional income per hectare accounted for more than double of the expenses. As regards the pattern of income distribution, during 1968-69, on an average, 39.61 per cent was invested on crop production, 5.29 per cent on farm assets, making a total investment on farm production of the order of 44.90 per cent. The remaining 55.10 per cent was spent on either home consumption or saving.

The study suggests that the investment made for augmenting production on the farm was less than required. Therefore, for increasing the farm productivity and income, the farmer should make use of a major portion of his additional income for the utilization of more inputs.

EXPENDITURE ELASTICITIES FOR RURAL PUNJAB (CONCENTRATION CURVES APPROACH)

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The demand for food and other items of consumption in India, as in most developing economies, is increasing rapidly because of population growth, rising incomes and various changes in the structure of population. In order to measure the influence of income on consumption, consumption function on the basis of cross-section data is generally estimated in which the total expenditure per person is used as the principal explanatory variable and money expenditure on a given item is used as the dependent variable. It has been repeatedly shown that the calculated expenditure elasticities depend upon the type of the functions fitted. The choice of the mathematical form for the relationship between expenditure on an item and total expenditure, therefore, must be made carefully, especially when these elasticities are now frequently being used for projections of demand and supply.

Expenditure elasticities are generally computed by assuming certain forms such as semi-log, double log or probit relation for the Engel curves and then estimating them from family budget data by the conventional method of least squares. This procedure becomes complicated in view of the fact that the available cross-section data are generally grouped in size classes of per capita total expenditure of households. What one might get from published source of consumption materials, as are required for the present types of problems are some weighted arithmetic averages of consumption of different groups of consumer items and the averages of total expenditure per capita in each size class. The percen-

tage distribution of population in these classes is also provided. An attempt has been made in this paper to estimate the expenditure elasticities for some important groups of consumer items with the help of the concentration curves.[1] This method makes use of the following two curves.

(*a*) Lorenz curve which relates the proportion of total expenditure to the proportion of persons spending up to a given level of total expenditure per capita.

(*b*) The specific concentration curve which relates the proportion of total consumption of a specific commodity to the proportion of persons spending up to a given level of total expenditure per capita.

This method of concentration curves is based, however, on the assumptions of constant elasticity and log normality of the distribution of total expenditure per capita. The validity of the latter assumption and consistency of the technique has been examined in a number of places.[2]

Method and Material

For the purpose of estimating expenditure elasticities for various items of consumption in rural Punjab, the cross-section data provided by the 19th round of the National Sample Survey, State Sample (1964-65) were used. The material is available in the form of grouped data, the groups being fixed according to monthly per capita total expenditure of the households. Thirteen groups have been distinguished as: Rs. 0-8, 8-11, 11-13, 13-15, 15-18, 18-21, 21-24, 24-28, 28-34, 34-43, 43-55, 55-75, 75 and above.

X = per capita total expenditure.

Y = per capita expenditure on a specific item.

X and Y are assumed to follow Bivariate log normal distribution, *i.e.*, log x and log y follow normal distribution, marginal distribution of log x is normal (θ, λ) and conditional distribution of log y for a given value of log x is also normal ($\propto + \eta$ log x, σ_o) where η is the Engel elasticity of the specific item of consumption.

If p_c is the proportion of population having per capita total expenditure c or less,

$$p_c = \int_o^c g(x)\, dx = \int_o^c \frac{1}{\lambda x \sqrt{2\pi}}\, e^{-\frac{1}{2}\left[\frac{\log x - \theta}{\lambda}\right]^2} dx \qquad \text{if } x > 0$$

$$= 0 \qquad \text{if } x \leqslant 0$$

$$\therefore p_c = \phi\left(\frac{\log c - \theta}{\lambda}\right) \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (1)$$

$$\text{where } \phi(t) = \int_{-\infty}^{t} \frac{1}{\sqrt{2\pi}}\, e^{-\frac{1}{2}u^2} du$$

1. N. S. Iyengar, "On a Method of Computing Engel Elasticities from Concentration Curves," *Econometrica*, Vol. 28, No. 4, October, 1960.
2. N. S. Iyengar, "Estimation of Quality Elasticities for Certain Commodities from National Sample Survey Data," *Sankhya*, Series B, Vol. 25, November, 1963.

The proportion q_c of the total expenditure spent by these persons is given by

$$q_c = \frac{\int_0^c x\, g(x)\, dx}{\int_0^\infty x\, g(x) dx} = \phi\left(\frac{\log c - \theta}{\lambda} - \lambda\right) \quad .. \quad .. \quad .. \quad .. \quad (2)$$

Eliminating c from (1) and (2), we get the equation of the Lorenz curve:

$$t_q = t_p - \lambda \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (3)$$

where t is defined by the relation $k = \phi(t_k)$, $O \leqslant k \leqslant 1$. Similarly proportion Q_c of the total consumption of a specific commodity by persons whose total expenditure is c or less is given by

$$Q_c = \frac{\int_0^c E(y/x)\, g(x)\, dx}{\int_0^\infty E(y/x)\, g(x)\, dx} = \phi\left(\frac{\log c - \theta}{\lambda} - \eta\lambda\right) \quad .. \quad .. \quad (4)$$

Eliminating c from (1) and (4), we get the equation of the specific concentration curve as

$$t_Q = t_p - \lambda\eta \quad .. \quad .. \quad .. \quad .. \quad .. \quad (5)$$

$p_x = q_x = Q_x$ is the Egalitarian line.

The Lorenz curve and the specific concentration curves are drawn on the graph by plotting q_x and Q_x against p_x. Now for given $p = 1/2$, we see the expected values of q_x and Q_x from the graph and the corresponding values of t_q and t_Q are noted from the tables for normal probability integrals. These values of t_q and t_Q and $t_p = 1/2$ are substituted in equations (3) and (5) and these equations are then solved for λ and η. To examine the concentrations, Gini's ratios of concentration were also worked out as

Concentration ratio for total expenditure $= 2\phi\left(\frac{\lambda}{\sqrt{2}}\right) - 1$

Concentration ratio for i th specific item $= 2\phi\left(\frac{\lambda\eta_i}{\sqrt{2}}\right) - 1$

To analyse the comparative performance of the method of deriving expenditure elasticities from the concentration curves and the method of weighted least squares,[3]

3. Weights being the estimated proportion of persons in each expenditure class.

the latter technique was also applied under the assumption of constant elasticity. For this purpose a function of the form :

$$\log Y = a + b \log X$$

was also fitted to the given data. There the coefficient b represents the constant elasticity.

Results and Discussion

Per capita expenditure on a specific item and its percentage to the per capita total expenditure for each size class are presented in Table I. It is clear that a large

TABLE I—MONTHLY PER CAPITA EXPENDITURE ON DIFFERENT ITEMS OF CONSUMPTION AND ITS PERCENTAGE TO THE PER CAPITA TOTAL EXPENDITURE FOR RURAL PUNJAB: 1964-65

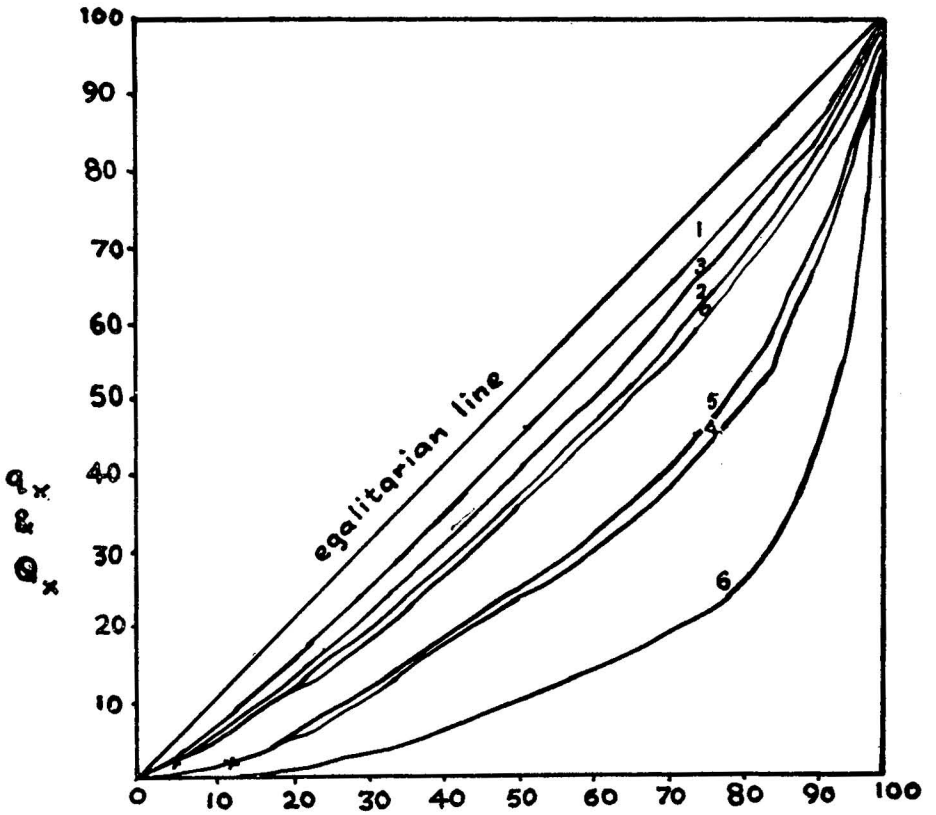
(in Rs.)

Expenditure classes (Rs.)	Food-grains	All food	Fuel and lighting	Clothing	Miscel-laneous goods and services	Durable goods	Total (all items)
0— 8	—	—	—	—	—	—	—
8—11	5·01	8·54	1·14	—	·48	—	10·16
	(49·31)	(84·06)	(11·22)		(4·72)	—	(100·00)
11—13	6·20	10·84	1·27	—	·60	—	12·71
	(48·78)	(85·29)	(9·99)		(4·72)	—	(100·00)
13—15	5·85	10·98	1·39	·88	·72	·020	13·99
	(41·82)	(78·48)	(9·94)	(6·29)	(5·15)	(·14)	(100·00)
15—18	7·37	13·93	1·33	·35	·85	·09	16·55
	(44·53)	(84·17)	(8·03)	(2·11)	(5·14)	(·54)	(100·00)
18—21	8·16	16·60	1·36	·84	·88	—	19·68
	(41·46)	(84·36)	(6.91)	(4·27)	(4·47)		(100·00)
21—24	9·12	17·86	1·27	1·65	1·45	·37	22·60
	(40·35)	(79·03)	(5·62)	(7·30)	(6·42)	(1·63)	(100·00)
24—28	9·73	20·93	1·70	1·66	1·39	·32	26·00
	(37·42)	(80·50)	(6·54)	(6·38)	(5·35)	(1·23)	(100·00)
28—34	9·75	24·74	1·84	1·76	2·36	·44	31·14
	(31·31)	(79·45)	(5·91)	(5·65)	(7·58)	(1·41)	(100·00)
34—43	10·71	28·61	2·10	3·02	2·68	·85	37·26
	(28·74)	(76·78)	(5·64)	(8·11)	(7·19)	(2·28)	(100·00)
43—55	10·92	32·63	2·32	6·20	4·23	2·24	47·62
	(22·93)	(68·52)	(4·87)	(13·02)	(8·88)	(4·70)	(100·00)
55—75	14·64	45·62	3·15	8·43	7·12	1·65	65·97
	(22·19)	(69·15)	(4·77)	(12·78)	(10·79)	(2·50)	(100·00)
75 and above ..	15·75	50·62	3·38	12·88	13·31	15·74	95·93
	(16·42)	(52·77)	(3·52)	(13·43)	(13·87)	(16·41)	(100·00)
All classes ..	9·74	23·72	1·80	2·57	2·41	·93	31·43
	(30·99)	(75·47)	(5·73)	(8·18)	(7·67)	(2·96)	(100·00)

* Figures in parentheses are percentages.
Source : Economic and Statistical Organization of Punjab.

proportion of the expenditure is due to food only. This proportion is above 80 per cent for expenditure classes up to Rs. 28 and then this proportion starts declining. On an average, per capita monthly expenditure on food is Rs. 23.72 and it forms 75.47 per cent of the total expenditure which is Rs. 31.43 per month. The average expenditure on clothing is Rs. 2.57 and the proportion of expenditure on clothing increases with the increase in total expenditure.

The concentration curves together with Lorenz curve are shown in Figure 1 and the values of p_x, q_x and Q_x are indicated in Table II. All these concentration curves display considerable symmetry about the diagonal opposite the Egalitarian line, this is a necessary condition for a log normal distribution.



p_x : Cumulative percentage of persons

0. Total expenditure
1. Foodgrains
2. All food
3. Fuel and lighting
4. Clothing
5. Miscellaneous goods and services
6. Durable goods

Figure 1—Lorenz Curve and Specific Concentration Curves, Rural Punjab: 1964-65

TABLE II—VALUES OF p_x q_x AND Q_x FOR DIFFERENT ITEMS OF CONSUMPTION

Expenditure classes (Rs.)	p_x	q_x	Q_x					
			Food-grains	All food	Fuel and lighting	Clothing	Miscella-neous goods and services	Durable goods
0—8 ..	—	—	—	—	—	—	—	—
8—11 ..	·44	·11	·23	0·16	·28	—	0·09	—
11—13 ..	1·86	·72	1·13	0·82	1·28	—	1·04	—
13—15 ..	4·65	1·96	2·80	1·30	3·43	·95	1·88	·06
15—18 ..	11·86	5·75	8·26	5·58	8·75	1·94	2·94	·76
18—21 ..	22·25	12·26	16·96	12·92	16·59	5·33	6·77	·76
21—24 ..	33·57	20·40	27·55	21·53	24·57	12·59	13·66	5·28
24—28 ..	51·37	35·73	45·35	37·24	41·36	24·07	24·03	11·43
28—34 ..	71·47	55·03	65·46	58·38	61·89	37·82	43·92	20·98
34—43 ..	84·71	70·72	80·01	74·54	77·32	53·36	58·79	33·13
43—55 ..	93·19	83·57	89·51	86·30	88·23	73·80	73·83	53·64
55—75 ..	97·75	93·13	96·36	95·16	96·20	88·74	87·44	61·76
75 and above	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

Elasticities derived by using both the techniques along with the Gini's concentration ratios are presented in Table III.

TABLE III—EXPENDITURE ELASTICITIES AND CONCENTRATION RATIOS, RURAL PUNJAB : 1964-65

Items	Expenditure elasticities		Gini's concentration ratio
	Weighted least squares method	Concentration curves method	
1. Foodgrains	·44	·40	·09
2. All food items	·83	·93	·21
3. Fuel and lighting	·59	·68	·15
4. Clothing	1·80	1·9	·41
5. Miscellaneous goods and services ..	1·51	1·8	·39
6. Durable goods	1·94	3·05	·61
7. All items		$\lambda = ·40$	·22

It is clear from Table III that the expenditure on foodgrains is most evenly distributed but food taken as a whole has a greater concentration than foodgrains taken alone. The concentration ratio for foodgrains is only .09 as against the concentration ratio of .21 for all food. This is to be expected since all food includes not only foodgrains but also relatively more luxurious items of consumer's food expenditure. Detailed analysis of other food items was also made and discussed elsewhere in this paper. The expenditure on durable goods possesses highest concentration of .61 and next to this is the expenditure on clothing with concentration ratio of .41.

The expenditure elasticity for durable goods is the highest indicating that one per cent increase in the total expenditure will increase the expenditure on this item by 3 per cent. Similar is the pattern for clothing and miscellaneous goods and services. For the other three items, *i.e.*, foodgrains, all food and fuel and lighting, the elasticities being less than one indicate that the proportion of expenditure on these items will decrease with the increase in the total expenditure.

Among different items of food, the items of (*a*) pan, tobacco and intoxicants and (*b*) milk and milk products show the highest concentration (Table IV). The distribution of edible oils is as even as that of the foodgrains. The expenditure

TABLE IV—EXPENDITURE ELASTICITIES FOR MAJOR FOOD ITEMS AND CONCENTRATION RATIOS, RURAL PUNJAB : 1964-65

Food items	Expenditure elasticity	Gini's concentration ratio
1. Milk and milk products	1·62	·35
2. Edible oils	·38	·09
3. Meat, eggs and fish	2·35	·20
4. Vegetables, fruits and nuts	·93	·21
5. Sugar	·78	·17
6. Salt and spices	·72	·17
7. Beverages and refreshments	1·08	·24
8. Pan, tobacco and intoxicants	1·80	·38
9. Foodgrains	·40	·09
10. All food items	·93	·21

elasticities for meat, eggs and fish, pan, tobacco and intoxicants, and milk and milk products are greater than unity, these being the luxurious items of food. The expenditure elasticity for beverages and refreshments is nearly one indicating that one per cent increase in the total expenditure will increase the expenditure on this item by one per cent. The other food items being the necessities, the expenditure elasticities are less than one.

Efficiency of the concentration curves can be seen easily by plotting the theoretical and observed specific concentration curves on the same graph and observing the closeness of these two curves. But when the efficiencies of two techniques are to be compared, the coefficients of correlations between the observed and expected expenditures are to be worked out. For this purpose, for different values of p_x, the expected values of t_q were worked out from the following equation:

$t_q = t_p - \lambda\eta_i$ (η_i is the expenditure elasticity for the i th specific item and $\lambda = 0.40$)

The value of Q_x for different values of t_Q were noted from the tables for normal probability integrals. And expected values of per capita expenditure on a specific item were worked out from Q_x. Coefficients of correlation between the observed and expected expenditures for the two methods are given in Table V.

TABLE V—COEFFICIENTS OF CORRELATION (R) BETWEEN THE OBSERVED AND EXPECTED PER CAPITA EXPENDITURES ON SPECIFIC ITEMS, RURAL PUNJAB : 1964-65

Items	Method of weighted least squares R^2	Method of concentration curves R^2
1. Foodgrains	0·91	0·93
2. All food items	0·98	0·99
3. Fuels and lighting	0·90	0·94
4. Clothing	0·86	0·91
5. Miscellaneous goods and services	0·93	0·94
6. Durable goods	0·55	0·80

In all the cases value of R^2 for the concentration curves method is higher than those for the method of weighted least squares.