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AN EMPIRICAL ANALYSIS OF REDISTRIBUTIVE IMPACT OF THE PERSONAL INCOME TAX: A CASE STUDY OF INDIA

PAWAN K. AGGARWAL

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Pawan K. Aggarwal

ABSTRACT

This paper develops a model to isolate empirically the effect of income inequality from the effect of tax parameters (tax progressivity and tax level) on the redistributive impact of personal income tax. Inequality in the distribution of income is found to significantly influence redistributive impact of the tax. For a given tax structure, a rise (fall) in inequality in the distribution of income increases (decreases) redistributive impact of the tax. The study also suggests that a comparison of redistributive impact of different tax rate structures has to be associated with a measure of the redistributive impact.

During the period 1961-62 to 1983-84, but for the rise in the level of tax rates, redistributive impact of the Indian personal income tax would have marked a sharp declining trend.

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1. Introduction

Recent literature in applied public finance shows revived interest in measuring redistributive impact of personal income tax[1]. Redistributive impact has been shown to be an exact function of average tax rate and tax graduation/progressivity[2]. Such a formulation detracts explicit identification of the impact of inequality in pre-tax income on the redistributive impact. Inequality in pre-tax income can be expected to play a significant role in redistribution of income under a progressive income tax. The purpose of this paper is to suggest a methodology for isolating empirically the impact of income inequality from the impact of the rate structure on the redistributive impact of the tax.

Plan of the study is as follows. Section 2 gives a review of earlier studies. A model of redistributive impact is discussed in Section 3. The model is estimated with data on the personal income taxpayers in India. The data limitations, estimates of various variables involved and the model estimates are discussed in Sections 4, 5, and 6 respectively. Finally, Section 7 gives conclusions.

2. Review of Earlier Studies

Measures of redistributive impact have been defined as corresponding to specific measures of tax progressivity[3]. Earlier studies by Kakwani [1977], and Pfahler [1983] have shown, for specific measures of redistributive impact and tax progressivity, that the former is an exact function of the latter and the average tax rate (defined as the ratio of tax liability to pre-tax income). The measures of redistribution and progressivity used in these studies have been defined with reference to concentration indices/curves of pre-tax and post-tax incomes and that of tax. Kakwani [1977] defines tax progressivity as the difference between concentration indices of tax and pre-tax income, and redistributive impact as the difference between concentration indices of pre-tax and post-tax incomes[4].

Pfahler [1983] has shown the said relationship with respect to two measures of the redistributive impact. In one case, his measure of redistributive impact can be characterised as the maximum distance between concentration curves of pre-tax and post-tax incomes, that expresses the percentage of total post-tax income redistributed from the top to the bottom of the income scale, and the measure of tax progressivity is taken to be the relative mean deviation of actual taxes from (revenue-equivalent) proportional taxes. In the other case, his measure of redistributive impact can be expressed as twice the area between 45^{o} - proportional line and the relative concentration curve of post-tax income with reference to pre-tax income (say Ly = f(Lx), where Lx and Ly denote cumulative proportions of pre-tax and post-tax incomes respectively) as shown by the shaded area in Figure 1, and for progressivity, Suit's [1977] measure of tax progressivity is used.

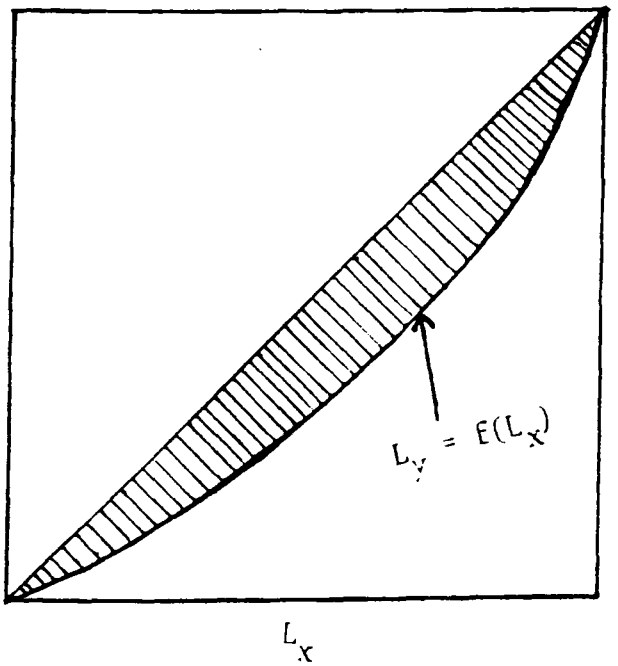

Figure 1

Recently Pfahler [1987] has described a general class of income redistributive measures as based on a general class of measures of tax progressivity. His class of redistributive measures is an exact function of average tax rate and his class of measures of tax progressivity. The above discussed measures of tax progressivity and the corresponding measures of redistributive impact have been shown to be special cases of his general formulation of the redistributive impact.

These developments seem to contribute significantly to the analysis of income redistributive impact of personal income tax. These allow to identify the effects of tax level and of tax progressivity on income redistribution, for various measures of tax progressivity and of income redistribution/redistributive

impact. However, these formulations do not allow identification of the effect of inequality in pre-tax income because this variable is not explicitly included. Though the variables such as average tax rate and tax progressivity, used in these formulations, implicitly incorporate inequality in pre-tax income, identification of its effect on redistributive impact requires its explicit inclusion and also, perhaps redefining tax level and tax progressivity variables basically in terms of statutory tax rates[5]. A simple, though not comprehensive, model that allows identification of the effect of income inequality along with the effects of tax level and tax progressivity, on the redistributive impact, is described in the next section.

3. A Model of Income Redistributive Impact

Redistributive impact of personal income tax can be expressed as function of tax progressivity (P) and the average tax rate (t) as follows:

$$RI = f_1(P,t) \qquad (1)$$

As discussed earlier, relationship (1) has been shown to be an exact function ($RI \equiv P.t$) for measures of redistribution and progressivity defined with reference to concentration indices/curves of pre-tax and post-tax incomes and that of tax. This, however, is not an exact function for other measures of redistribution and progressivity such as those defined with reference to the notion of equally distributed equivalent level of income developed by Kolm (1969), Atkinson (1970) and Sen (1973). In any case, in our further development of relationship (1), it

will be seen shortly that it does not matter whether or not relationship (1) is an exact function. It may, however, be noteworthy that relationship of P and t with RI is multiplicative.

In the formulation of the redistributive impact as given by relationship (1), a measure of tax progressivity (P) incorporates, invariably, the combined effect of inequality in the distribution of pre-tax income and graduation in the statutory tax rates. An attempt at isolating the effect of income inequality (II) on the redistributive impact of the tax requires expressing tax progressivity (P) as a function of income inequality (II) and tax progressivity defined in terms of statutory tax rates (TP) with no reference to the distribution of income. Tax progressivity (P) can be expressed as a function, which is not exact, of income inequality (II) and tax progressivity (TP) as:

$$P = f_2(II, TP) \qquad (2)$$

The average tax rate (t), like tax progressivity (P), incorporates, invariably, the combined effect of inequality in the distribution of pre-tax income, graduation in the statutory tax rates and the tax scale or the level of statutory tax rates. An attempt at isolating the effect of income inequality (II) on the redistributive impact of the tax also requires expressing the average tax rate (t) as a function of the former, tax progressivity (TP) and tax level (TL) defined in terms of statutory tax rates with no reference to the distribution of income. The average tax rate (t) can be expressed as a function, which is not exact, of income inequality (II), tax progressivity (TP), and tax level (TL) as:

$$t = f_3(II, TP, TL) \qquad (3)$$

From (1), (2) and (3) we get

$$RI = f_1(f_2(II, TP), f_3(II, TP, TL)) \quad (4)$$

or

$$RI = f(II, TP, TL) \quad (5)$$

where $f=f_1(f_2,f_3)$ is a function which is not exact because functions f_2 and f_3 are not exact functions. Function f_1 is multiplicative in functions f_2 and f_3 as it is multiplicative in P and t. This suggests that function f would be multiplicative in II, TP and TL.

It may be noted that all the relations (1) to (5) developed here are technical, like the production functions, and not behavioural. Thereby, behavioural variables such as levels and composition of income, and tax evasion are beyond the scope of our formulation of the redistributive impact of the tax.

Representing the tax structure by the summary measures - tax progressivity (TP) and tax level (TL) and inequality in the distribution of income by a summary measure (II) results in omission of some information which could be captured in principle, by a variable. Inexactness of the functions f_2 and f_3 and hence of the function f is attributable to omission of such a variable. Such an omitted variable is unlikely to be correlated with the included variables. The following specification of the functional relationship (5) seems defendable:

$$RI = \alpha TL^{\beta} \cdot TP^{\gamma} \cdot II^{\delta} \quad (6)$$

where α, β, γ and δ are parameters to be estimated. Expected signs of α, β and γ are positive. In other words, a rise in tax level or tax progressivity or income inequality is expected to enhance redistributive impact of the tax. δ can take any sign as the effect of a rise or fall in income inequality on the redistributive impact is not unambiguous.

The specification, for no tax (TL=o) or for a proportional tax (TP=o) shows the redistributive impact to be nil for all values of income inequality (II). Similarly for equal distribution of income (II=o) it shows nil redistributive impact irrespective of tax level and tax progressivity.

Specification (6) can be rewritten in the double log linear form as:

$$LRI = \alpha_o + \beta LTL + \gamma LTP + \delta LII \qquad (7)$$

where LRI = Log (RI), LTL = Log (TL) LTP=Log (TP)
LII = Log (II) and αo = Log (α).

The parameters β, γ and δ in equation (7) are interpretable as constant elasticities of RI with respect to TL, TP and II respectively. Equation (7) can be modified as follows to allow for variable elasticities with respect to level of the variables TL, TP and II:

$$LRI = \alpha_o + \beta_1 LTL + \beta_2 (1/LTL) + \gamma_1 LTP + \gamma_2 (1/LTP) + \delta_1 LII + \delta_2 (1/LII) \qquad (8)$$

where α_0 β_1 ,β_2 ,γ_1 ,γ_2,δ_1 and δ_2 are parameters to be estimated. Equation (8) allows elasticity of RI with respect to TL to vary with level of TL, that with respect to TP to vary with level of TP, and that with respect to II to vary with level of II.

Redistributive impact of the tax can be represented by a measure belonging to Pfahler's [1977] class of income redistribution measures or by the difference between inequalities in the distributions of pre-tax and post-tax incomes measured in terms of Atkinson's [1970] concept of equally distributed equivalent level of income[7] for a given level of inequality aversion.

Tax level can be represented by a simple or weighted average of the statutory marginal tax rates. In case of weighted average, proportion of taxpayers subjected to different marginal tax rates, may be taken as the weights[8]. Thus, the tax level, as weighted average, can be expressed as

$$TL = \sum_{i=1}^{k} w_i m_i \qquad (9)$$

where w_i is the weight attached to the ith marginal tax rate m_i (i=1,2,3.....,k). For simple average of the marginal rates $w_i=1/k$, and for weighted average with proportion of taxpayers as weights $w_i=p_i$ (i=1,2,3....,k), where p_i is the proportion of taxpayers subjected to ith marginal tax rate m_i. This formulation of tax level does implicitly incorporate an element of income inequality to the extent inequality is represented by number of persons subjected to different marginal tax rates. An alternative measure of tax level can be thought of as a weighted average of the average tax rates of different taxpayers. This can be obtained

by replacing marginal tax rate by average tax rate in equation (9). Such a formulation, however would implicitly incorporate income inequality to a greater extent as compared to formulation (9). In the absence of a suitable measure of tax level, completely independent of income inequality, the formulation (9) has been used.

Tax progressivity, can be represented by a measure dependent on variation in marginal tax rates such as relative mean deviation, coefficient of variation, standard deviation, range of marginal tax rates, and the ratio of maximum to minimum marginal tax rate etc. The latter two measures would be sensitive to changes in minimum and maximum marginal tax rates.

4. The Data

The data relating to the personal income taxpayers in India have been obtained from All India Income Tax Statistics (AIITS) - the only source of data on income classwise distribution of the taxpayers in India. The data have been compiled for each of the years from 1961-62 to 1983-84 excepting for the years 1970-71 and 1973-74 for which these data were not published. 1983-84 is the latest year for which data comparable with those in the previous years are available[9]. The limitations of these data have been widely discussed in the literature (see, for example, Gupta and Aggarwal [1982, Chapter II]; and Bagchi and Aggarwal [1983]). These data are based on the assessments completed in a year which correspond to the incomes earned in the previous years with declining weight of the successive preceding years. The fraction of total number of assessments completed in a year, covered in

AIITS has varied from year to year. Nevertheless, these data can be taken to reasonably reflect the changes in the distribution of income among the taxpayers.

During the reference period, 1961-62 to 1983-84, number of income classes by which the data in AIITS are presented has varied from 14 to 20. In order to avoid any distortion, due to variation in the level of diaggregation[10] in the estimates of relevant variables, the data have been regrouped into a set of 14 income classes in each of the years in the reference period.

The data on statutory marginal tax rates for each of the years under consideration are taken from the annual budgets of the Union Government of India.

5. Computation of Redistribution, Progressivity and Tax Level

Redistributive impact of Indian personal income tax is measured by a commonly used measure defined as the difference between concentration indices of pre-tax and post-tax incomes[11]. The concentration indices are computed as Gini index based on Lorenz curve and Atkinson's measure of inequality based on the concept of equally distributed equivalent income level. The Atkinson's measure is computed for different values of inequality aversion ranging from 0.50 to 4.00 with an interval of 0.25[12]. The results, however, are reported for only two values, 0.50 and 3.75, of inequality aversion. The former is generally considered the minimum value and the latter is that value for which the estimates of inequality are found in the vicinity of corresponding Gini indices. Inequalities in pre-tax incomes for values of inequality aversion as 0.50 and 3.75 are denoted by A2 and A3 respectively,

and the corresponding inequalities in post-tax income are denoted by $A2^*$ and $A3^*$ respectively. The estimates of these inequalities/ concentration indices are given in Table 1 (columns 4 to 7).

Gini indices of pre-tax and post-tax incomes are estimated, following Kakwani [1980, Chapter 6] on the assumption of linear density functions within the income classes[13]. Lower and upper values of the estimates were obtained to test for goodness of fit of the linear density functions within the income classes. The estimated values of Gini indices of pre-tax as well as of post-tax incomes were found to lie between their lower and upper values implying that the assumption of linear density functions within the income classes is not unrealistic. The estimates of Gini indices of pre-tax and post-tax incomes are denoted by G and G* respectively, and reported in Table 1 (Columns 2 and 3).

Based on the above discussed estimates of income inequality/concentration index, three measures of the redistributive impact of the tax are obtained as follows:

$$RI1 = G-G^* \tag{10}$$

$$RI2 = A2-A2^* \tag{11}$$

$$RI3 = A3-A3^* \tag{12}$$

where RI1, RI2 and RI3 are estimates of income redistribution/redistributive impact. The estimates of the redistributive impact are presented in Table 1 (columns 8 to 10).

The progressivity in terms of statutory tax rates has been computed as a ratio of maximum to minimum marginal tax rate and denoted by TP1. Tax progressivity has also been computed by using Kakwani's measure of tax progressivity defined as TP2=((1-t)/t)

(G-G*) where t is average tax rate. TP2 is used as a test of robustness. The values of TP1 and TP2 are reported in Table 1 (columns 11 and 12).

Computation of tax level (TL) as a weighted average of marginal tax rates (equation 9) involved complexities. Some of the marginal tax rate brackets overlapped with some of the income classes used for grouping the taxpayers. In such cases, the number of taxpayers in different marginal tax rate brackets have been obtained by fitting pareto distribution[14] to the distribution of taxpayers for each of the years in the reference period. Column 13 in Table 1 gives the values of tax level.

It is worthwhile making a few observations on the estimated variables which may be useful in the next section in analysing the redistributive impact of the tax. It may be noted from Table 1 (columns 2 to 7) that post-tax income is more evenly distributed than pre-tax income implying that Indian personal income tax does result in redistribution of income. This is also evident from the values of the redistributive impact (columns 8 to 10). Further it may be noted that inequality in pre-tax income as well as in post-tax income has markedly declined during 1961-62 to 1983-84. Gini index of pre-tax income (G) has declined from 0.4755 to 0.3218 (column 2) and that of post-tax income (G*) has declined from 0.4118 to 0.2381 (column 3). Similarly Atkinson's measure of inequality (say) for inequality aversion of 3.75 has declined from 0.3740 to 0.3348 for pre-tax income (column 5) and from 2.2983 to 0.2481 for post-tax income (column 7).

6. Estimation of the Model and Results

Equation (8) of redistributive impact is estimated by ordinary least squares method with different measures of the variables involved. With the dependent variables, namely, RI1, RI2 and RI3, the sets of measures of exogenous variables taken are (TL, TP1,G), (TL,TP1,A2) and (TL,TP1,A3) respectively. These sets differ only with respect to measure of income inequality. An additional set of exogenous variables (TL, TP2,G) has also been tried with RI1 as a test of robustness. Existence of first order serial correlation has been identified by Durbin-Watson Statistic. An equation with serial correlation has been reestimated by Cochrane and Orcutt (1949) iterative method that incorporates necessary adjustments for first order serial correlation[16]. The parameter estimates of the meaningful estimated equations are given in Table 2.

The equations (1) and (4) in Table 2 differ with respect to measures of tax progressivity. Accordingly, the relationship between redistributive impact and tax progressivity depicted by these equations also differs. While equation (1) suggests that redistributive impact rises (falls) with rise (fall) in tax progressivity at all levels of tax progressivity, equation (4) implies that redistributive impact falls (rises) with rise (fall) in tax progressivity in a range of values of tax progressivity[17]. The relationship depicted in equation (4) however does not corroborate theoretically expected relations[18]. This suggests that use of Kakwani's measure of tax progressivity (which implicitly accounts for distribution of income) along with the tax level variable (which does not depend basically on the distribution of income) is not adequate. The equation (4), therefore is not used in subsequent discussion.

It may be noted from Table 2 that explanatory power (column 9) of the estimated equation (1) using Gini index is higher than those of (equations (2) and (3) employing Atkinson's measure of inequality. The signs of all the parameter estimates corroborate a priori expectations. In these equations, absence of inverse terms of tax level and income inequality suggest constant elasticities of the redistributive impact with respect to these variables. The elasticity with respect to tax progressivity is found to vary with its level. All the three equations depict similar structural relationship between redistributive impact and the exogenous variables: tax level, tax progressivity and income inequality.

Positive values of coefficient of income inequality (Table 2, column 8) suggest that redistributive impact of the tax rises (falls) with rise (fall) in income inequality among the taxpayers. Similarly, negative values of coefficient of inverse of tax progressivity (Table 2, column 7) suggest that redistributive impact of the tax rises (falls) with rise (fall) in tax progressivity. Therefore, the decline in both the income inequality (Table 1, columns 2,4, and 5) and tax progressivity (Table 1, column 11) during 1961-62 to 1983-84 would have tended to substantially decrease, over time, the redistributive impact of the tax.

Positive values of coefficient of tax level(Table 2, column 5) also suggest that redistributive impact of the tax rises (falls) with rise (fall) in tax level. Therefore, the rise in tax level[19] (Table 1, column 13) during 1961-62 to 1983-84 would have tended to substantially increase, over time, the redistributive impact of the tax. The rise in redistributive impact measured as RI1 and RI3 (Table 1, columns 8 and 10) imply that the negative

impact of decline in tax progressivity and income inequality on the redistributive impact has been more than compensated by positive impact of rise in tax level. However, the fall in redistributive impact measured as RI2 implies that in this case even the rise in tax level has failed to compensate the negative impact of the decline in tax progressivity and income inequality. This perhaps is attributable to higher elasticity of redistributive impact with respect to income inequality measured by Atkinson's measure with low value of inequality aversion than with inequality measured by Atkinson's measure with high value of inequality aversion or by Gini index (Table 2, column 8).

From the above discussion it seems to follow that (i) income inequality plays significant role in determining redistributive impact of the tax, and (ii) the redistributive impact of the Indian personal income tax would have declined had substantial increases in the tax level not taken place during 1961-62 to 1983-84.

It is interesting to note variation in the redistributive impact over time. It may be noted from Table 1 (columns 8 to 10) that the redistributive impact measured as RI1 and RI2 (the measure based on Gini indices and that based on Atkinson's measures of inequality with inequality aversion of 3.75) seem to show a rise while that measured as RI3 (the measure based on Atkinson's measure of inequality with inequality aversion of 0.50) seems to show a fall over time. This contrast in the trends of redistributive impact needs explanation. Also this suggests that a comparison of redistributive impact over time or across tax-rate structures, like that of tax progressivity has to be associated with a measure of redistributive impact or of inequality and welfare function associated with such a measure.

A society with lower inequality aversion would assign lower weight to lower income. Consequently, improvements in the relative position of low income persons would not be adequately reflected in a measure of social welfare such as income inequality. Vice Versa is true for higher degree of inequality aversion. Further, lower the inequality, still lower would be the weight assigned to improvements in the relative position of low income persons. Thus, with the observed declining trend in inequality in pre-tax income and with low degree of inequality aversion, improvements in the relative position of the low income taxpayers would have been assigned a declining weight over time. It may have resulted in declining trend of the redistributive impact with low degree of inequality aversion in contrast to what is obtained with high degree of inequality aversion or that with a measure based on the Gini indices.

7. Conclusions

The study presents a model to isolate empirically the effect of income inequality from the effect of tax parameters, on the redistributive impact of personal income tax. Inequality in the distribution of income is found to significantly influence redistributive impact of the tax. For a given tax structure, a rise (fall) in inequality in the distribution of income increases (decreases) redistributive impact of the tax. Similarly, for given distribution of income a rise (fall) in tax level or tax progressivity increases (decreases) redistributive impact of the tax. The trend of the redistributive impact, however, is not found independent of the form of social welfare function and/or degree of inequality aversion associated with the measure of redistributive impact. Comparison of redistributive impact of different tax-rate structures or of a tax structure over time has

to be associated with a measure of the redistributive impact or the form of welfare function and/or the degree of inequality aversion associated with such a measure.

During 1961-62 to 1983-84, while the decline in tax progressivity and income inequality among the taxpayers have tended to decrease, the rise in tax level has tended to increase the redistributive impact of the Indian personal income tax. But for the rise in the level of tax rates the redistributive impact of the tax would have declined considerably.

TABLE 1

Estimates of Income Inequality, Tax Level, Tax Progression and Redistributive Impact of the Tax

Year	G	G*	A2	A3	A2*	A3*	RI1 (2-3)	RI2 (4-6)	RI3 (5-7)	TP1	TP2	TL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1. 1961-62	.47546	.41180	.14991	.37395	.09726	.29826	.06960	.05265	.07569	26.66667	0.43655	10.88894
2. 1962-63	.46004	.39483	.14181	.36314	.08987	.28634	.07025	.05194	.07680	27.61900	0.44342	12.13639
3. 1963-64	.44954	.38636	.13384	.34086	.08439	.26722	.06756	.04945	.07364	27.61900	0.45996	11.56331
4. 1964-65	.44570	.38016	.12912	.32661	.08242	.25781	.06313	.04670	.06880	15.52080	0.49347	13.48471
5. 1965-66	.43710	.37802	.12536	.31117	.08070	.24582	.06016	.04466	.06535	16.25000	0.46576	11.52000
6. 1966-67	.44396	.37717	.13781	.34529	.08762	.27122	.06749	.05019	.07407	16.25000	0.43801	13.08352
7. 1967-68	.44502	.37455	.14319	.35824	.08972	.27955	.07139	.05347	.07869	16.25000	0.42899	13.71522
8. 1968-69	.42570	.35692	.13305	.35895	.08535	.28252	.06759	.04770	.07643	16.25000	0.43205	15.58945
9. 1969-70	.42126	.35202	.13141	.36055	.08400	.28358	.06777	.04741	.07697	15.00000	0.42827	15.34607
10. 1971-72	.41102	.34063	.13144	.37395	.07987	.29053	.07340	.05157	.08342	8.50000	0.38522	16.98929
11. 1972-73	.39636	.32101	.12343	.32701	.06612	.23747	.07960	.05731	.08954	8.88636	0.41700	15.63989
12. 1974-75	.37320	.30208	.10964	.32088	.05956	.23742	.07405	.05008	.08346	8.88636	0.40707	17.15978
13. 1975-76	.35411	.28234	.10092	.31493	.05639	.23133	.07211	.04453	.08360	5.83333	0.43105	18.05006
14. 1976-77	.36065	.29057	.11027	.34659	.06524	.26145	.07108	.04503	.08514	4.11760	0.38756	18.97227
15. 1977-78	.33123	.25939	.09898	.31703	.05400	.23143	.07167	.04498	.08560	4.00000	0.42003	18.33898
16. 1978-79	.31610	.24460	.09145	.30541	.05022	.22256	.06914	.04123	.08285	4.00000	0.37286	19.80264
17. 1979-80	.30840	.23469	.09072	.28869	.04865	.20515	.07117	.04207	.08354	4.00000	0.38549	21.21974
18. 1980-81	.32260	.24420	.09552	.31059	.05208	.22671	.07576	.04344	.08388	4.00000	0.35258	21.92540
19. 1981-82	.31246	.23214	.09415	.30095	.04870	.21203	.07895	.04545	.08892	4.00000	0.37600	22.35205
20. 1982-83	.29120	.22436	.07533	.28587	.04162	.21336	.06607	.03371	.07251	2.00000	0.31142	21.55913
21. 1983-84	.32181	.23809	.09382	.33477	.04975	.24808	.08126	.04407	.08669	2.00000	0.34180	28.09130

Notes: G(G*) = Gini index of pretax (posttax) income.
A2 and A3 = Atkinson's measures of inequality in pretax income with inequality aversiveness of 0.50 and 3.75 respectively. Corresponding measures for posttax income are marked by *.
RI1,RI2 & RI3 = Redistributive impact of the tax based on G, A2 and A3 respectively.
TL = Tax level
TP = Degree of tax progression.

TABLE 2

Estimates of Equation of Redistributive Impact of the Tax

Equation	Dependent variable	Measure of		Constant term	Coefficient of					DW-Statistic
		TP	II		LTL	LTP	(1/LTP)	LII	R^{-2}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1*	LRI1	TP1	G	-3.8170 (27.21)	0.5258 (6.11)		-0.1182 (2.95)	0.2614 (2.01)	0.79	1.16
2*	LRI2	TP1	A2	-2.3673 (7.18)	0.5719 (3.65)		-0.1950 (1.83)	0.9997 (4.63)	0.63	2.02
3	LRI3	TP1	A3	-3.3312 (12.82)	0.4376 (4.79)		-0.1812 (2.47)	0.2939 (1.94)	0.55	1.60
4	LRI1	TP2	G	-0.9380 (1.07)	0.4989 (5.63)	1.6562 (3.47)	1.1889 (3.06)	0.3035 (2.31)	0.82	2.12

Notes: 1* Equation is estimated by Cochrane and Orcutt Iterative method that adjusts for first order serial correlation.
LTRI1 = Log (RI1), LRI2 = Log (RI2), LRI3 = Log (RI3)
LTL = Log (TL), LTP = Log (TP), LII = Log (II)

2. All the coefficients reported here are significant at 90 per cent level of confidence.

3. Figures in brackets give t-statistics.

NOTES

1. See, for example, Kakwani (1977, 1986, 1987), Alchin (1981) and Pfahler (1983, 1987).

2. See, for example, Kakwani (1977, 1986 & 1987) and Pfahler (1983, 1987).

3. See, for example, Kakwani (1977) and Pfahler (1983).

4. This concept of income redistribution first used by Musgrave and Thin (1948) in defining a measure of tax progressivity has also been used by other researchers [see Reynolds and Smolensky (1985)]. Some of the researchers have used a normalised version of this measure of redistributive impact, with respect to concentration index of pre-tax income, perhaps with no theoretical justification (see, for example, Pechman and Okner (1974), Alchin (1981), and Kakwani (1987)).

5. That is statutory marginal tax rates.

6. Let e_1, e_2 and e_3 denote elasticities of RI with respect to TL, TP and II respectively. From equation (4), we get:

$$e_1 = \beta_1 - \beta_2 \quad (1/LTL^2)$$
$$e_2 = \gamma_1 - \gamma_2 \quad (1/LTP^2)$$
$$e_3 = \delta_1 - \delta_2 \quad (1/LII^2)$$

For $\beta_1 > o$, $\beta_2 > o$ ($<o$) would mean that e_1 rises (falls) with rise in LTL. Similarly for $\gamma_1 > o$, $\gamma_2 > o$ ($< o$) would mean that e_2 rises(falls) with rise in LTP, and for $\delta_1 > o$, $\delta_2 > o$ ($< o$) would mean that e_3 rises (falls) with rise in LII.

7. For a review of limitations of a measure of inequality based on the concept of Lorenz curves and for merits of that based on Atkinson's (1970) concept of equally distributed equivalent level of income, see Kiefer (1985).

8. This formulation of the tax level takes into account density of the taxpayers with respect to different marginal tax rates.

9. From the year 1984-85, the data are published on the basis of income as reported by the taxpayers instead of income as assessed by the income tax officers.

10. Variation in the level of disaggregation over time can cause distortion in the measures of skewness (see, for example, Atkinson (1980)).

11. See, for example, Kakwani (1977), Lambert (1985), and Gupta and Aggarwal (1982).

12. The formula adopted for computing Atkinson's measure of inequality (A), based on a homogeneous and symmetric social welfare function, is:

where $$A=1-\{\sum_{i=1}^{n}(\mu_i/\mu)^{1-\varepsilon}f_i\}^{1/(1-\varepsilon)}$$

μ_i = mean income of the ith income class(i=1,2...n)

μ = mean income of all the tax payers

f_i = proportion of taxpayers in the ith income class

ε = inequality aversion parameter.

There is no hard and fast rule for assigning a value to. It is assigned on the basis of value judgement about a society's aversion towards income inequality.

13. Suppose there are n taxpayers that are grouped into k income classes, $(x_0$ to $x_1)$,$(x_1$ to $x_2)$,....., (x_{k-1}, x_k). Let n_i and y_i denote number and income of taxpayers in the ith income class. Further, let f_i and p_i denote proportions of number of taxpayers in and upto the ith income class respectively. The formula used for computation of Gini index, based on the assumption of a separate linear density function within each income class which exactly fits the data points, is:

$$G = GL + \frac{1}{\mu} \sum_{i=1}^{k} f_i^2 \mu_i G_i$$

where

$$GL = 1 - \sum_{i=1}^{k} f_i (q_i + q_{i-1})$$

$$f_i = n_i/n$$

$$\mu_i = y_i/n_i$$

$$\mu = y/n$$

$$y = \sum_{i=1}^{k} y_i$$

$$q_i = \frac{1}{\mu} \sum_{j=1}^{i} f_j \mu_j , \quad i=1,2,\ldots\ldots\ldots,k$$

$$G_i = (2/15) (\Delta x_i / \mu_i) (9 \delta_i - 1 - 9 \delta_i^2), \quad i=1,2,\ldots\ldots,k-1$$

$$G_k = (\mu_k - x_{k-1})/(\mu_k + x_{k-1})$$

$$\Delta x_i = x_i - x_{i-1}$$

$$\delta_i = (\mu_i - x_{i-1})/ \Delta x_i$$

GL gives an estimate of income inequality (G) based on the assumption that inequality of income within each income class is zero.

The test of goodness of fit of the linear density functions within the income classes is conducted on the basic of the following inequality:

$$GL < G < GL + \bar{D}$$

Where $\bar{D}$, for the last income class as open ended class is given as

$$\bar{D} = \frac{1}{\mu} \left\{ \sum_{i=1}^{k-1} f_i^2 (\Delta x_i) \delta_i (1 - \delta_i) + f_k^2 (\mu_k - x_{k-1}) \right\}$$

The estimate of G satisfying the above inequality would mean that the fit is satisfactory. For an exposition to the above formulae see, for example Gastwirth (1972) and Kakwani (1976).

14. For the data grouped into K income classes, the Pareto distribution function is given by

$$P_i = (l_i/x_0)^{\beta} \text{ for } l_i > x_0$$

Where l_i is lower limit of the income class, and p_i is the proportion of taxpayers upto the ith income class as defined above proportion of taxpayers upto the ith income class as defined above proportion of taxpayers upto the ith income class as defined above in note 13. For existence of mean and variance of Pereto distribution, has to be greater than 2.
A simple double log-linear from of the distribution that is estimated is

$$\text{Log } p_i = \alpha - \beta \text{ Log } l_i$$

Where $\alpha = \beta \log x_0$; and are estimable parameters.

15. See, for example, Kakwani (1977, and 1980, pp.249-52).

16. Adjustments for higher order serial autocorrelation by using the Gauss-Newton iterative method have also been tried but were no better. Therefore these estimates are not reported. Further, Ramsay's RESET test has been used to test for mis-specification of the functional forms

17. Equation iv in Table 2 suggests that the redistribution impact of the tax declines with rise in tax progressivity as long as $|LTP| < 0.847$. This result is derived by taking elasticity of the redistributive impact with respect to tax progressivity to be less than zero (i.e., $1.6562 - 1.1889 / LTP^2 < 0$).

18. See, for example, Kakwani (1980), chapter 6.

19. The rise in tax level during 1961-62 to 1983-84 has been mainly due to raising of the marginal tax rates at low income levels. During this period, the minimum marginal tax rate has been raised from as low as 5 per cent to as high as 30 per cent.

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