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A NEW GLOBAL MEASURE OF
TAX PROGRESSIVITY

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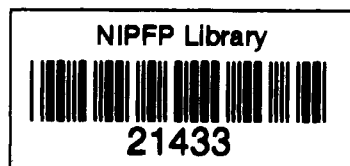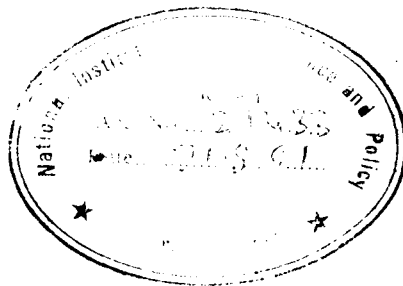
Acknowledgement

A NEW GLOBAL MEASURE OF TAX PROGRESSIVITY

Abstract

The study proposes a new global measure of tax progressivity
in terms of inequality indices of pre-tax income and tax defined
on the basis of concept of equally distributed equivalent level of
income. It is found invariant to tax scale. While the existing
measures in this class are found more suitable as indicators of
redistributive impact of the tax, the new measure seems more
suitable as measure of tax progressivity or graduation in the tax
schedule. The new measure along with the average tax rate is found
to help in understanding changes in redistributive impact of the
tax. The study reveals that comparison of tax progressivity or
redistributive impact over time or across different tax schedules
has to be associated with the measure of progressivity or the
welfare function associated with the relevant inequality indices.

A NEW GLOBAL MEASURE OF TAX PROGRESSIVITY

1. Introduction:

Progression in the income tax rate schedule implies departure from proportionality in the distribution of tax burden. It is characterised generally by an increasing average tax rate with income. There are several measures of tax progression which can be classified into three categories, namely, local (also known as structural or scheduler), global (also known as summary or distributional), and hybrid. A local measure constructs a schedule of tax rate or tax liability or post-tax income along the income scale[1]. A global measure takes the form of a single number and it focuses, in general, on the distributional aspect of the tax in terms of tax liability or pre- and post-tax incomes. A hybrid measure combines the character of both local and global measures[2]. This study focuses on global measures of tax progressivity.

Various global measures of tax progressivity, in common use, can be further classified into two broad categories: (i) those based on inequality indices of tax and pre- and post-tax incomes defined in terms of Gini indices or with reference to Lorenz curves and (ii) those based on inequality indices of tax and pre- and post-tax incomes defined in terms of the concept of equally distributed equivalent level of income developed by Kolm (1969), Atkinson (1970) and Sen (1973)[3]. Hereinafter, this concept is referred to as KAS concept and the inequality indices based on this concept are referred to as KAS inequality indices[4]. In the former category, some measures have been defined with reference to

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distribution of tax whereas in the latter category, no measure has been defined with reference to distibution of tax. Therefore, a new measure with reference to KAS inequality index of tax distribution is proposed in this study. In the class of measures based on KAS inequality indices, the new measure along with the average tax rate seems to help in understanding variations in redistributive impact or progressivity measured in terms of KAS inequality indices of pre- and post-tax incomes.

A progressive income tax is supposed to be inequality reducing for every pre-tax income distribution. Inequality can be viewed in terms of relative incomes or other than relative incomes such as in terms of absolute incomes. While a proportional tax is neutral to relative inequality, a poll tax is neutral to absolute inequality. The current study focuses on the measures of tax progressivity which are based on the value judgement that an income tax, to be progressive, should be `relative inequality reducing'. For an insight into the measures based on the value judgement that an income tax to be progressive should be `other than relative' inequality reducing, see Pfingsten (1986a, 1986b, 1987 & 1988) and Besley and Preston (1980).

The plan of the study is as follows. The salient features of various global measures of tax progressivity are given in Section 2. A new global measure of tax progressivity is proposed in Section 3. Application of the new measure in explaining variations in redistibutive impact or progressivity measured in terms of KAS inequality indices of pre- and post-tax incomes is shown in Section 4. The policy implications of these measures are discussed in Section 5. Conclusions are presented in section 6.

2. Salient Features of Global Measures

Different global measures of tax progressivity in each of the two broad categories can be subdivided into two classes: (i) those which are neutral to tax scale[5] and (ii) others. In the category of measures defined with reference to Lorenz curves or Gini indices, those introduced by Kakwani (1977 and 1978), Khetan and Poddar (1976), and Suits (1977) belong to the former class, and those proposed by Musgrave and Thin (1948), Pechman and Okner (1974) and Raynold and Smolensky (1977) belong to the latter class. Recently, Kakwani (1986) and Pfahler (1987) have advocated two general measures of tax progressivity - one based on the distribution of tax that is neutral to tax scale and the other based on distributions of pre- and post-tax incomes which is not neutral to tax scale. The earlier tax scale neutral measures in this category have been shown to be special cases of the general tax scale neutral measure, and the other earlier measures have been shown to be special cases of the other general measure of tax progressivity. In the category of measures based on KAS inequality indices, both the measures developed by Blackorby and Donaldson (1984), and Kiefer (1984) belong to the class of measures which are not neutral to tax scale. A summary of the main characteristics of the global measures is given in Table 1. A brief description of these measures by two broad categories and classes discussed above is given below. For this purpose, the following notations are used:

G (G*) = Gini index of pre-tax (post-tax) income

C (C1) = Tax concentration based on the concept of Gini index (KAS inequality)

A (A*) = KAS inequality index of pre-tax (post-tax) income

2.1 Measures based on Gini indices

At least three measures of tax progressivity based on Gini indices of pre- and post-tax incomes have been proposed. These are: effective progression (EP) defined by Musgrave and Thin (1948), relative redistribution of income (RRI) defined by Pechman and Okner (1974), and redistribution of income (RI) with negative sign proposed by Reynolds and Smolensky (1977). These can be expressed as:

$$EP = (1-G*)/(1-G) \qquad (1)$$

$$RRI = -(G-G*)/G \qquad (2)$$

$$RI = -(G-G*) \qquad (3)$$

For a progressive, proportional and regressive tax EP would be $\gtreqless 1$ respectively, and RRI and RI would be $\lesseqgtr 0$ respectively. These measures indicate essentially the redistributive impact of the tax that depends not only on graduation in tax rates but also on the level of taxation. These are not neutral to tax scale.

Four measures of tax progressivity which are neutral to tax scale have been suggested with reference to distribution of tax. Two of these are defined in terms of Gini indices of pre-tax income (G) and tax (C) - one by Khetan and Poddar (1976) referred to as Khetan-Poddar index (KPI) and the other by Kakwani (1977) referred to as Kakwani's concentration index (KCI). These can be expressed as:

$$KPI = (1-G)/(1-C) \qquad (4)$$

$$KCI = C-G \qquad (5)$$

For a progressive, proportional and regressive tax KPI would be $\gtreqless$ 1 respectively, and KCI would be $\gtreqless 0$ respectively.

The other two tax scale neutral measures are defined in terms of a single index of inequality in the distribution of tax, which has been defined with reference to income instead of population of taxpayers. Suits (1977) defined a progressivity measure as

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relative tax concentration (S.RTC) with reference to income. It is computable like Gini index by replacing the distribution of income with that of tax and the distribution of population with that of income. Khetan and Poddar (1976) defined another measure which is a sightly different formulation of this measure. Their measure referred to as KP-RTC can be expressed in terms of Suits measure as:

$$KP.RTC = 1/(1-S.RTC) \qquad (6)$$

For a progressive, proportional and regressive tax S.RTC would be $\gtreqless 0$ respectively, and KP.RTC would be $\gtreqless 1$ respectively.

The tax scale neutral measures indicate essentially the graduation in tax schedule. These measures have been criticised for not having any welfare significance[6].

2.2 Measures based on KAS inequality indices

Social welfare function (SWF) associated with the Gini index on which the measures of progressivity discussed earlier are based, has been criticized by several researchers. The criticism is based primarily on two grounds. First, the Gini index attaches most weight to income transfers among individuals with income levels close to the mode of income distribution rather than evenly distributing the weight or attaching more weight to transfers at the tails of the distribution. Second, the weight attached to an income transfer between two individuals depends on their relative rankings in the income distribution rather than on differences in their incomes[7]. Such characteristics are considered peculiar.

Blackorby and Donaldson (1984a) point out that, unlike Gini index, many inequality indices (including KAS inequality index) have the seemingly desirable property of attaching more weight to improving income distribution among the poor, if the distribution is highly skewed, while treating improvements in the distribution

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above and below the mean more symmetrically if the income distribution is less skewed[8]. Thereby Blackorby and Donaldson (1984a) defined a measure of progressivity (BDI) based on the KAS inequality indices of pre- and post-tax incomes. Subsequently, Kiefer (1984) defined another measure of progressivity (KI) which is slightly modified formulation of BDI. These measures can be expressed as:

$$BDI = \frac{1-A*}{1-A} - 1 \tag{7}$$

$$KI = A-A* \tag{8}$$

For a progressive, proportional, and regressive tax both BDI and KI would be $\gtrless 0$ respectively. These measures differ with respect to weight attached to an improvement in the social welfare at different levels of inequality in the distribution of income. Kiefer (1984) has argued that KI is preferable to BDI, as it gives equal weight to an improvement in the social welfare at different levels of inequality in income whereas the latter assigns weights inversely proportional to the level of inequality.

Both these measures are indicative of redistributive impact of the tax and are not neutral to tax scale.

3. A New Measure of Tax Progressivity

Tax scale neutral measures of tax progressivity are found relevant for policy purposes, as these, along with the average tax rate, help in explaining redistributive impact (or tax progressivity measured in terms of inequality indices of pre- and post-tax incomes) of the tax. These help in explaining trade-off between graduation in the tax schedule and average tax rate in obtaining a given level of income redistribution. This has been shown by Kakwani (1977) with reference to a tax scale neutral

measure defined in terms of Gini indices of pre-tax income and tax. While some tax neutral measures have been defined with reference to Gini indices, none has been defined with reference to KAS inequality indices. Both the measures described earlier, based on KAS concept of inequality, are not neutral to tax scale. Therefore, based on this concept of inequality, a new measure of tax progressivity (NMTP)is defined as:

$$NMTP = \frac{Y_{ede}}{\mu} - \frac{T_{ede}}{\tau}$$

$$= (1 - \frac{T_{ede}}{\tau}) - (1 - \frac{Y_{ede}}{\mu})$$

$$= C_1 - A$$

Where μ and τ denote average income and per capita tax respectively. Y_{ede} is the average income of an equally distributed income that gives the same level of social welfare as the actual distribution of income with average income μ. `Tax` can be viewed as negative income that leads to loss in social welfare. In this sense, T_{ede} can be interpreted as per capita tax of an equally distributed tax that results in the same level of loss in social welfare as the actual distribution of tax with per capita tax τ.

A tax is progressive, proportional and regressive according as NMTP $\gtreqless$ 0 respectively.

For applied use, following Atkinson (1970), for an additively separable, symmetric, increasing and concave social welfare function, and constant inequality aversion (ϵ), the KAS inequality indices $C1\epsilon$ and $A\epsilon$ for discrete distributions of tax and income can be expressed as:

$$C1\epsilon = 1 - [\sum_{i=1}^{n} (\frac{T_i}{\tau})^{1-\epsilon} f_i]^{1/(1-\epsilon)} \tag{10}$$

$$A\epsilon = 1 - [\sum_{i=1}^{n}(\frac{\mu i}{\mu})^{1-\epsilon} f_i]^{1/(1-\epsilon)} \qquad (11)$$

Where μi and τi are average income and tax of the ith income class , f_i is the proportion of persons in the ith income class and n is the number of income classes.

From equations 10 and 11, it is clear that the new measure NMTP is sensitive to a change in the distribution of income and that of tax. It may be noted from equation 10 that KAS index of tax concentration is invariant to proportional changes in average tax rates or tax liabilities of all taxpayers. This implies that NMTP is neutral to tax scale (or tax level). It would also be neutral to income scale provided the tax schedule is of constant average rate elasticity progression all along the income scale[9]. The proof of this proposition is trivial. For a rate schedule of constant `average tax rate elasticity progression´ all along the income scale, a proportional change in incomes of all taxpayers results in a constant proportional change in average tax rates of all taxpayers. This, as discussed above, leaves the tax concentration index unchanged implying that NMTP remains unchanged. Thus NMTP is income scale neutral provided the tax schedule is of constant `average rate elasticity progression´ all along the income scale. This also suggests that a tax scale neutral measure would be income scale neutral, provided the tax schedule is of constant average rate elasticity progression all along the income scale.

NMTP is indicative of graduation in tax schedule that does not depend on the tax scale, whereas the other two measures based on KAS inequality indices (BDI and KI) represent redistributive impact that depends on both the tax scale and graduation in tax schedule. Though all these three measures are useful as they reveal different characteristics of a tax schedule, the new measure seems to be more suitable as a measure of tax

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progressivity and the other two measures seem to be more suitable as measures of the redistributive impact of the tax. The new measure can be usefully employed in understanding the effect of tax scale and tax progressivity on redistributive impact of the tax. This is shown through an empirical exercise in the next section.

4. Application

Application of the new global measure in explaining redistributive impact of the tax is illustrated with the data on personal income tax payers in India for the period from 1961-62 to 1983-84. The coverage is restricted to a single major category of personal income tax payers - `individuals´.These account for more than 90 per cent of the number and taxable income of all the personal income taxpayers. Estimation of progressivity and redistributive measures requires obtaining inequality or concentration indices of income and tax. For this purpose, the data on income class-wise distribution of `individual´ taxpayers are compiled from All India Income Tax Statistics (AIITS) for each of the years covering the period from 1961-62 to 1983-84 excepting the years 1970-71 and 1973-74 for which the data have not been published. The limitations of these data have been widely discussed in the literature. For example, see Aggarwal (1990a), Bagchi and Aggarwal (1983) and Gupta and Aggarwal (1982). During the reference period, the number of income classes by which the data are reported has varied from 14 to 20. With a view to avoiding distortion due to changes in the level of disaggregation, the data have been reclassified into a homogeneous set of 14 income classes in each of the years.

The required inequality or concentration indices of income and tax are estimated as Gini indices and KAS inequality indices. Gini indices of pre- and post-tax incomes and that of tax are

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estimated, by accounting for distributions of income and tax within the income classes, following Aggarwal(1990a) and Kakwani(1980,Chapter 6) on the assumption of linear density functions within the income classes. Lower and upper values of the estimates were obtained to test for goodness of fit of the linear density functions within the income classes[10]. Estimated values of Gini indices 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 are given in Table 2 (columns 2 to 4).

KAS inequality indices of pre- and post-tax incomes and of tax are estimated by using equations 10 and 11 for different values of inequality aversion ranging from 0.50 to 4.00 with an interval of 0.25. There is no hard and fast rule for assigning a value to inequality aversion parameter. It is based on value judgement of a society's aversion towards income inequality. The estimates are reported for only two values of inequality aversion, being 0.50 and 3.75. The former is generally considerded as the minimum value and the latter is that value for which the estimates of income inequality are found in the vicinity of corresponding Gini indices. For inequality aversion as 0.50 and 3.75, estimates of inequality in pre-tax income are denoted by A2 and A3 respectively, estimates of inequality in post-tax income are denoted by A2* and A3* respectively and those of inequality in tax are denoted by C2 and C3 respectively. These estimates are also presented in Table 2 (columns 5 to 10).

Based on the estimates of inequality indices, estimates of three measures of redistributive impact (RI1,RI2, and RI3) and three tax scale neutral measures of tax progressivity (P1,P2, and P3) are obtained as follows:

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$$RI1 = G - G* \qquad (12)$$

$$RI2 = A2 - A2* \qquad (13)$$

$$RI3 = A3 - A3* \qquad (14)$$

$$P1 = C1 - G \qquad (15)$$

$$P2 = C2 - A2 \qquad (16)$$

$$P3 = C3 - A3 \qquad (17)$$

Tax scale is represented by average tax rate (ATR). It is taken to be tax liability as percentage of taxable income. The estimated values of ATR, progressivity and redistributive measures are given in Table 3.

From Table 2, it may be noted that post-tax income is more evenly distributed than pre-tax income implying that Indian personal income tax is progressive and results in redistribution of income. This is also evident from the estimates of measures of redistributive impact (Table 3, columns 3,5, and 7). It may also be noted that inequality in income has marked a declining trend over time.

It will be noted from Table 3 (columns 3,5 and 7) that the redistributive impact measured as RI1 and RI3 (the measure based on Gini indices and that based on KAS inequality with inequality aversion as 3.75) seem to show a rising trend, while that measured as RI2 (the measure based on KAS inequality with inequality aversion as 0.50) seems to show a declining trend over time. This contrast in the trends of redistributive impact suggests that a comparison of redistributive impact or tax progressivity over time or across tax schedules has to be associated with a measure of redistributive impact and welfare function associated with such a measure.

The above observed contrast in the trends of redistributive impact associated with different degrees of inequality aversion has been explained by Aggarwal (1990a) as follows." 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, the 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 a 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."

From Table 3, it would also be noted that, during the reference period, progressivity measured in terms of all the three tax scale neutral measures has followed a declining trend (columns 4, 6 and 8) with a marked sharply declining trend in tax progressivity associated with low level of inequality aversion (column 6), and the average tax rate has followed a rising trend (column 2). Both the rise in average tax rate and decline in tax progressivity are attributable partly to raising of marginal tax rates at low income levels. The decline in tax progressivity would have tended to decrease and the rise in average tax rate would have tended to increase redistributive impact of the tax. The observed trend in redistributive impact of the tax is the net effect of influence of these forces. At the low level of inequality aversion, the effect of sharply declining trend in tax progressivity seems to have dominated the effect of rising trend

in average tax rate on redistributive impact of the tax that has registered a declining trend (column 5). In the other two cases, the effect of rising trend in average tax rate seems to have dominated the effect of decline in tax progressivity on redistributive impact of the tax that has registered a rising trend (columns 3 & 7). Further, year to year fluctuations in redistributive impact can be explained in all the years in terms of year to year fluctuations in average tax rate and, tax progressivity. It may be noted from columns 2, 7 and 8 that the redistributive impact has decreased in the years 1964-65, 1965-66 and 1974-75 following decrease in both the average tax rate and progressivity, in the years 1978-79 and 1982-83 following decrease in progressivity and in the years 1963-64 and 1968-69 following decrease in average tax rate. The redistributive impact has increased during the years 1962-63 and 1983-84 following increase in both the average tax rate and progressivity in the years 1972-73, 1975-76, 1977-78, 1981-82 following increase in progressivity and in the years 1966-67, 1967-68, 1969-70, 1971-72, 1976-77 and 1980-81 following increase in average tax rate. Similarly, year to year fluctuations in redistributive impact measured by other measures can be explained in terms of year to year fluctuations in average tax rate and progressivity (see Table 4). Thus the new tax scale neutral measure of tax progressivity along with the tax level helps in understanding changes in redistributive impact or progressivity defined in terms of KAS inequality indices of pre- and post-tax incomes.

5. Policy Implications

Different measures of tax progressivity reflect on different aspects of a tax schedule. Two categories of measures of tax progressivity should be distinguished: (i) those based on inequality indices of pre- and post-tax incomes which indicate the redistributive effect of a tax, and (ii) those based on inequality

indices of pre-tax income and tax which are tax scale neutral and indicative of graduation in the tax schedule. It would be appropriate to call category (i) measures, as measures of redistributive impact, and category (ii) measures, as measures of tax progressivity or graduation in the tax schedule. Accordingly, the former category of measures can be used to compare redistributive impact and the latter category of measures can be employed to compare progressivity of different tax schedules[11].

It has been shown in the previous section that redistributive impact of a tax depends on tax level and tax progressivity or graduation in the tax schedule. Ceteris paribus, an increase in tax level or tax progressivity enhances redistributive impact of the tax. It, for given redistributive impact of a tax, reveals that there is a trade-off between tax level and graduation in the tax schedule[12]. Also it suggests that redistributive impact of a tax can be influenced through a change in either or both the tax level and graduation in the tax schedule. A change in tax level, with unchanged tax progressivity can be brought about through a proportional increase in average tax rates or tax liabilities of all taxpayers. A change in graduation in the tax schedule, however, may also cause a change in average tax rate. Such incidental change in tax level can be viewed as another change separately introduced. The change in average tax rate can be nullified or modified, as may be desired, through appropriate proportional change in tax liabilities of all taxpayers.

6. Conclusions

Various global measures of tax progressivity are classified into two broad categories: (i) those defined with reference to Lorenz curves or in terms of Gini indices and (ii) those defined in terms of KAS inequality indices. The measures in the latter category are based on the concept of inequality that possesses better social welfare implications.

A new global measure of tax progressivity that is tax scale neutral has been developed on the basis of KAS inequality indices of pre-tax income and tax. While the existing measures in this class are found more suitable as indicators of redistributive impact of the tax that depends on both the tax level and graduation in the tax schedule, the new measure seems more suitabl as measure of tax progressivity or graduation in the tax schedule that does not depend on the tax level. The new measure along with the average tax rate is found to help in understanding changes in redistributive impact of the tax.

Application of the new measure is explained with the data on personal income tax payers in India during the period 1961-62 to 1983-84. This measure along with the average tax rate is found to explain changes in redistributive impact of the tax.

The estimates of select measures of tax progressivity and redistributive impact suggest that comparison of tax progressivity or redistributive impact over time or across different tax schedules has to be associated with the measure of progressivity. At the low level of inequality aversion, redistributive impact of the tax seems to have marked a declining trend following a sharply declining trend in tax progressivity as measured by the new measure. On the other hand, at the high level of inequality aversion, redistributive impact of the tax seems to have

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registered a rising trend, despite the declining trend in tax progressivity as measured by the new measure. When the tax scale neutral measure based on Gini indices is used, the trend in redistributive impact of the tax corroborates with that obtained with the new measure at the high level of inequality aversion. The observed rising trend in the redistributive impact, in the latter cases seems to be attributable to the dominating effect of the rise in average tax rate or tax level, and the declining trend in the former case seems to be attributable to the dominating effect of the sharply declining trend in progressivity at the low level of inequality aversion.

TABLE 1

Salient Features of Global Measures of Tax Progression

| S.No. | Measure of Progression | Tax is progressive, proportional or regressive according as the measure is | Rise(↑) or fall(↓) in in progression due to a constant increase (decrease) in tax rates at all income levels | |
			Proportional change	Percentage point change
	(1)	(2)	(3)	(4)

A. Measures Based on Gini Indices

1.	Effective Progression (EP)	$\gtrless 1$	↑ (↓)	↑ (↓)
2.	Relative redistribution of income (RRI)	$\lessgtr 0$	↑ (↓)	↑ (↓)
3.	Redistribution of income (RI)	$\lessgtr 0$	↑ (↓)	↑ (↓)
4.	Khetan-Podder index (KPI)	$\gtrless 1$	neutral	↓ (↑)
5.	Kakwanis' Concentration index (KCI)	$\gtrless 0$	neutral	↓ (↑)
6.	Suits relative tax concentration (S.RTC)	$\gtrless 0$	neutral	↓ (↑)
7.	Khetan-Podder relative tax Concentration (KP.RTC)	$\gtrless 1$	neutral	↓ (↑)

B. Measures Based on KAS Inequality Indices

8.	Blackorby and Donaldson index of progressivity (BDI)	$\gtrless 0$	↑ (↓)	↑ (↓)
9	Kiefer index of progressivity (KI)	$\gtrless 0$	↑ (↓)	↑ (↓)
10.	A new measure of tax progressivity (NMTP)	$\gtrless 0$	neutral	↓ (↑)

Note: KAS inequality indices are based on the concept of equally distributed equivalent level of income advanced by Kolm (1969), Atkinson (1970) and Sen (1973).

TABLE 2

Inequality Indices of Pre- and Post-Tax Incomes and of Tax

Year	Gini index of			Atkinsons' index for $\epsilon=0.50$ of			Atkinsons' index for $\epsilon=3.75$ of		
	pre-tax income	post-tax income	tax	pre-tax income	post-tax income	tax	pre-tax income	post-tax income	tax
	G	G*	C1	A2	A2*	C2	A3	A3*	C3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1981-82	0.47546	0.41180	0.86241	0.14991	0.09726	0.66004	0.37395	0.29826	0.89719
1962-63	0.46004	0.39483	0.85615	0.14181	0.08987	0.64481	0.36314	0.28634	0.89051
1963-64	0.44954	0.38636	0.85435	0.13384	0.08439	0.64373	0.34086	0.26722	0.88242
1964-65	0.44570	0.38016	0.81366	0.12912	0.08242	0.60930	0.32661	0.25781	0.85007
1965-66	0.43710	0.37802	0.82414	0.12536	0.08070	0.59737	0.31117	0.24582	0.83218
1966-67	0.44396	0.37717	0.82119	0.13781	0.08762	0.58203	0.34529	0.27122	0.83673
1967-68	0.44502	0.37455	0.82314	0.14319	0.08972	0.58251	0.35829	0.27955	0.84335
1968-69	0.42570	0.35692	0.80632	0.13305	0.08535	0.55217	0.35895	0.28252	0.84892
1969-76	0.42126	0.35202	0.80160	0.13141	0.08400	0.54324	0.36055	0.28358	0.84705
1971-72	0.41102	0.34063	0.78957	0.13144	0.07987	0.52768	0.37395	0.29053	0.84193
1972-73	0.39636	0.32101	0.80314	0.12343	0.06612	0.55420	0.32701	0.23747	0.83617
1974-75	0.37320	0.30208	0.77501	0.10964	0.05956	6.51229	0.32088	0.23742	0.81119
1975-76	0.35411	0.28234	0.77482	0.10092	0.05639	0.50242	0.31498	0.23133	0.83941
1976-77	0.36065	0.29057	0.74621	0.11027	0.06524	0.47275	0.34659	0.26145	0.84815
1977-78	0.33123	0.25939	0.74881	0.09898	0.05400	0.48425	0.31703	0.23143	0.86340
1978-79	0.31610	0.24460	0.67988	0.09145	0.05022	0.39758	0.30541	0.22256	0.79056
1979-80	0.30840	0.23469	0.68285	0.09072	0.04865	0.39848	0.28869	0.20515	0.76604
1980-81	0.32260	0.24420	0.66770	0.09552	0.05208	0.37566	0.31059	0.22671	0.72507
1981-82	0.31246	0.23214	0.67974	0.09415	0.04870	0.39956	0.30095	0.21203	0.75493
1982-83	0.29120	0.22436	0.58639	0.07533	0.04162	0.30833	0.28587	0.21336	0.64536
1983-84	0.32181	0.23809	0.65592	0.09382	0.04972	0.36446	0.33477	0.24808	0.72984

Notes: 1. All these estimates are based on distribution of taxpayers into the same set of 14 income classes in each of the years.
2. ϵ= Parameter of inequality aversion.

TABLE 3

Estimates of Income Inequality, Tax Progressivity and Average Income

Year	Average tax rate (per cent) (ATR)	RI1 (G-G*)	P1 (C1-G)	RI2 (A2-A2*)	P2 (C2-A2)	RI3 (A3-A3*)	P3 (C3-A3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1961-62	12.73	0.06960	0.38695	0.05265	0.51013	0.07569	0.52324
1962-63	12.82	0.07025	0.39611	0.05194	0.50300	0.07680	0.52737
1963-64	12.08	0.06756	0.40481	0.04945	0.50989	0.07364	0.54156
1964-65	11.72	0.06313	0.36796	0.04670	0.48018	0.06880	0.52346
1965-66	14.26	0.06016	0.38704	0.04466	0.47201	0.06535	0.52101
1966-67	13.23	0.06749	0.37723	0.05019	0.44422	0.07407	0.49144
1967-68	14.11	0.07139	0.37812	0.05347	0.43932	0.07869	0.48506
1968-69	13.73	0.06759	0.38062	0.04770	0.41912	0.07643	0.48997
1969-70	13.92	0.06777	0.38034	0.04741	0.41183	0.07697	0.48650
1971-72	15.45	0.07340	0.37855	0.05157	0.39624	0.08342	0.46798
1972-73	15.30	0.07960	0.40678	0.05731	0.43077	0.08954	0.50916
1974-75	14.87	0.07405	0.40181	0.05008	0.40265	0.08346	0.49031
1975-76	14.27	0.07211	0.42071	0.04453	0.40150	0.08360	0.52443
1976-77	15.31	0.07108	0.38556	0.04503	0.36248	0.08514	0.50156
1977-78	14.61	0.07167	0.41758	0.04498	0.38527	0.08560	0.54637
1978-79	16.09	0.06914	0.36378	0.04123	0.30613	0.08285	0.48515
1979-80	16.54	0.07117	0.37445	0.04207	0.30776	0.08354	0.47735
1980-81	18.19	0.07576	0.34510	0.04344	0.28014	0.08388	0.41448
1981-82	17.60	0.07895	0.36728	0.04545	0.30541	0.08892	0.45398
1982-83	17.67	0.06607	0.29519	0.03371	0.23300	0.07251	0.35949
1983-84	19.58	0.08126	0.33411	0.04407	0.27064	0.08669	0.39507

Notes:
1. RI1 and P1 are measures of redistributive impact and tax progressivity respectively, based on Gini indices of inequality.
2. RI2 and P2 are measures of redistributive impact and tax progressivity respectively, based on EAS or Atkinsons' inequality indices for inequality aversion as 0.50.
3. RI3 and P3 are measures of redistributive impact and tax progressivity respectively, based on EAS or Atkinsons 'inequality indices for inequality aversion as 3.75.

Source: Table 2.

TABLE 4

Year to Year Rise or Decline in Redistributive Impact
of Personal Income Tax

RI	RI declines in the years following			RI increases in the years following		
	↓ P and ↓ ATR	↓ P and ↑ ATR	↑ P and ↓ ATR	↑ P and ↑ ATR	↑ P and ↓ ATR	↓ P and ↑ ATR
RI1	1964-65	1976-77	1963-64	1962-63	1972-73	1966-67
	1974-75	1978-79	1965-66	1967-68	1977-78	1969-70
		1982-83	1968-69	1983-84	1979-80	1971-72
			1975-76		1981-82	1980-81
RI2	1964-65	1962-63	1963-64	1983-84	1972-73	1966-67
	1965-66	1969-70	1977-78		1979-80	1967-68
	1968-69	1978-79			1981-82	1971-72
	1974-75	1982-83				1976-77
	1975-76					1980-81
RI3	1964-65	1978-79	1963-64	1962-63	1972-73	1966-67
	1965-66	1982-83	1968-69	1983-84	1975-76	1967-68
	1974-75				1977-78	1969-70
					1981-82	1971-72
						1976-77
						1980-81

Notes: ↓ P and ↓ ATR indicate decline in progressivity and average tax rate respectively. ↑ P and ↑ ATR indicate rise in progressivity and average tax rate respectively.

Source: Table 3.

NOTES

1. For a recent survey of local measures of tax progression see, for example, Aggarwal (1990b), Lambert (1989) and Poddar (1990).

2. For an exposition of hybrid measures of tax progression see Aggarwal (1991) and Baum (1987).

3. For some other categories of measures of tax progressivity, see, for example, Alchin (1984), Bracewell-Milnes (1971) and Dalton (1954). Bracewell-Milnes (1971) proposes three measures based on the concept of intention, and Dalton (1954) proposes two measures based on variations in average tax rates of taxpayers.

4. KAS inequality index (A) is defined as:

$$A = 1 - \frac{Yede}{\mu}$$

Where Yede is per capita income level of an equally distributed income that provides the same level of social welfare as the actual distribution of income with μ as the mean income.

Following Atkinson (1970), for an additively separable, symmetric, increasing and concave social welfare function, and constant inequality aversion (ϵ), the KAS inequality index ($A\epsilon$) for a discrete distribution of income can be expressed as:

$$A\epsilon = 1 - [\sum_{i=1}^{n}(\frac{\mu_i}{\mu})^{1-\epsilon} f_i]^{1/(1-\epsilon)}$$

Where μ_i is mean income of the ith income class, f_i is the proportion of persons in the ith income class and n is the number of income classes.

5. A progressivity measure is said to be neutral to tax scale, if it remains unchanged following a proportional change in average tax rates of all the taxpayers.

6. Blackorby and Donaldson (1984a), and Kiefer (1984) have argued that the tax scale neutral measures of progressivity cannot be interpreted as ethical indices primarily because the concentration index of taxes on which these are based
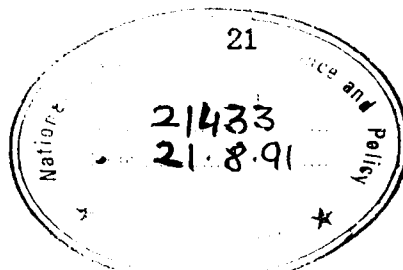
has no welfare significance and no interpretation of their impact in terms of identifiable policy goals (ability-to-pay or redistribution) is apparent. It, however, is noteworthy that the redistributive impact of a tax may change following a change in either of the level of taxation and distribution of tax. So distribution of tax burden in itself is no less important policy goal than the policy goal of redistribution of income.

7. For an extensive discussion of these issues, see Atkinson (1970); Dasgupta, Sen and Starrett (1973); and Sen (1973).

8. Also see Blackorby and Donaldson (1978 and 1984b).

9. Average rate elasticity progression at an income level is defined as the ratio of proportional change in average tax rate to proportional change in income at that income level. For an exposition of this local measure of tax progression see, Aggarwal (1980 and 1990b) and Lambert (1989).

10. The formulae used for this purpose can be described as follows. 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

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

$$f_i = n_i/n$$

$$\mu_i = y_i/n_i$$

$$\mu = y/n$$

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

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

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

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

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

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

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 basis of the following inequality:

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

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

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

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, Aggarwal (1990a), Gastwirth (1972), and Kakwani (1980).

11. The welfare implications with respect to progressivity of the tax schedules with varied tax yield, however, are not clear. Formby, Smith and Thistle (1990) argue that comparison of global progressivity of different rate schedules, in terms of measures based on Gini/Concentration indices, are consistent with the welfare theory only when average tax rates under different tax schedules are the same. Also see Formby, Smith and Thistle (1987) and Liu (1984 and 1985) for an exposition to difficulties in measuring tax progressivity.

12. In fact, Kakwani (1977) has shown that the measure of tax progressivity `RI´ that measures redistributive impact of a tax can be expressed as an exact function of average tax rate (tax level) and Kakwani´s concentration index of progressivity `KCI´ that is neutral to tax scale and indicates graduation in the tax rates.

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