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The paradox of progressivity in low-tax countries: income tax in Guatemala

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The Kakwani and Reynolds-Smolensky indices are used to analyse the consequences of tax reforms in terms of a tax's progressivity and redistributive capacity. Nonetheless, these indices can only serve as a basis for normative judgments in reforms where revenue remains constant. As this is generally not the case with tax reforms in practice, the Reynolds-Smolensky index is usually broken down into changes in the average tax rate and changes in the Kakwani index. This article argues that this procedure has serious disadvantages, especially in countries with low levels of tax revenue. To help overcome these problems, a number of alternative indicators are proposed based on the traditional indices, to make it possible to analyse the redistributive and progressivity effects of reforms that generate changes in revenue. These indicators are then used to analyse hypothetical reforms to income tax in Guatemala.

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I
Introduction

The literature generally analyses a tax reform's effects on progressivity and redistributive capacity through variations in the Kakwani (1977) and Reynolds-Smolensky (1977) indices. Nonetheless, these indices may not be appropriate as a basis for normative judgments in the case of tax reforms that involve significant changes in revenue. This problem has traditionally been overcome in two ways. The first consists of comparing the after-tax income distribution using generalized concentration curves (generalized Lorenz curves); while the second method uses a decomposition of the Reynolds-Smolensky index, which splits the variation of the tax's redistributive capacity into a portion caused by changes in the average effective rate and another part caused by changes in its progressivity.

Nonetheless, as this article will attempt to show, this net separation of the effects of a reform on the average rate and progressivity is questionable, because a reform that not only increases the redistributive capacity of the tax, but also widens the differences between the amounts of tax paid by high- and low-income taxpayers, might actually appear to be regressive. This problem, if it exists, is more serious in low-tax countries, where levels of evasion are also usually high and tax systems are inequitable. As a result, the reforms needed to increase public-sector funding may not be implemented because they are considered regressive, when in fact they could produce both a greater income-redistribution capacity and a significant difference between the amounts paid by high- and low-income taxpayers. In fact, in the specific case of Guatemala, one of the lowest-tax countries in Latin America, it will be shown how two measures that significantly increase income-tax revenue capacity may seem regressive if the traditional indicators are used. Nonetheless, this progressivity is merely apparent, and possibly contrary to the subjective perception that citizens have of progressivity.

Consequently, other mechanisms need to be developed to evaluate tax reforms that generate changes in revenue (as they usually do) and to complement the information provided by the traditional indicators. To that end, two concepts will be used which are indeed separable: the tax level and the differences between net incomes or tax liabilities. This separation, which will be used to designate level and distance effects, aims to provide an additional analytical tool for evaluating the progressivity and redistributive capacity of tax structures that produce different revenue outcomes, in each case estimating the individual contributions made by the two effects.

Sections II and III of this article describe the main weaknesses which, in the authors' opinion, the indices normally used to evaluate this type of reform suffer from. Section IV formulates a proposal; and, lastly, section V uses the indicators developed to evaluate hypothetical reforms to income taxes in Guatemala.

II
Measurement instruments: inequality, progressivity and redistribution

Any analysis of the redistributive effects of a tax reform firstly requires an instrument that summarizes the income distribution in the pre-and post-reform situations. A widely used tool for this purpose is the Lorenz curve (Lx), which provides a standardized system for measuring the percentage shares of total income received by different proportions of the population. The Gini coefficient (G_x), derived from the Lorenz curve, is generally used as a single synthetic indicator of relative inequality. Graphical speaking, this coefficient compares the area between the Lorenz curve and the diagonal and the total area under the diagonal, expressed mathematically for discrete income distributions as:

$$G_x = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|x_{ij} - x\right|}{2N^2\mu} \quad (1)$$

where μ represents average income, x_i and x_j are the incomes of individuals i and j respectively, and N represents the population. The Gini coefficient thus expresses the average difference between income pairs divided by twice the average income, and can take values between zero (absolute equality) and 1 (a single person receives the whole of the population's income). As is true of the Lorenz curve, this coefficient shows the relative inequality of a set of incomes, but not absolute inequality; so it is difficult to interpret in welfare terms when two populations have different average-income levels.

Just as these indicators can be used to compare different distributions in time and space, they can also be reformulated to compare changes in the income distribution caused by the tax system. To simplify, if all units of the population with the same income are assumed to have exactly the same tax pressure[1] —in other words, the amount of tax paid depends only on income— then the distribution of those incomes can be represented using a technique similar to that represented in the Lorenz curves, to obtain the income concentration curve (*Lt*) —and related concentration coefficient *Ct*, which is analogous to the Gini coefficient. We could also obtain the after-tax income concentration curve (*Lx-t*) and its corresponding concentration coefficient (*Cx-t*) (assuming for simplicity that no reordering occurs, then *Cx-t* = *Gx-t*) (see figure 1).

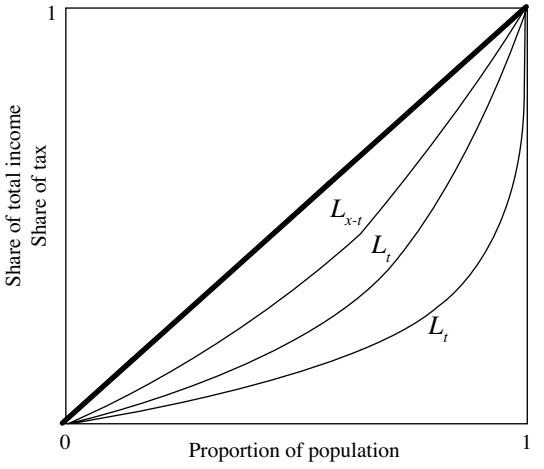
In particular, the tax liability concentration index would be

$$C_t = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i) - t(x_j)\right|}{2N^2\mu t};\ 0 \le t \le 1 \quad (2)$$

where $t(x_{i,j})$ represents the tax payable by taxpayers i and j, and t is the effective average rate. The after-tax income concentration coefficient would be:

FIGURE 1

Lorenz income curve and tax-liability and net-income concentration curves



Source: Prepared by the authors.

L_x: Pre-tax income concentration curve.
L_{x-t}: After-tax income concentration curve.
L_t: Tax liability concentration curve

$$C_{x-t} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t)} \quad (3)$$

In the case of a progressive tax, the amounts of tax payable depart systematically from proportionality with respect to pre-tax income. The fact that tax liabilities are more unequally distributed than incomes means that the tax liability concentration curve lies further from the diagonal than the pre-tax Lorenz income curve; in other words, using the normal notation, *Lx*>*Lt*. As *Lx* represents not only the Lorenz curve for pre-tax income, but also the tax liability concentration curve for a proportional tax of equal revenue capacity, the gap between the two curves (*Lx*-*Lt*) can be used to measure the departure of the tax from proportionality. This is precisely the purpose of the Kakwani index of departure from proportionality (*K*), which is widely used in literature, to measure twice the area between the Lorenz curve of pre-tax income and the tax liability concentration curve. In other words, it represents the difference between the tax liability concentration coefficient and the Gini coefficient of the distribution of pre-tax income:

[1] Following the ECLAC definition, "tax pressure" is understood to mean the ratio of total taxes paid to total household income.

$$K = Ct - Gx \quad (4)$$

A progressive tax would also generate changes in the income distribution before and after its payment. This redistributive effect is normally quantified by measuring the distance between the Lorenz curves before and after the tax (*Lx-t - Lx*), since the two curves would be the same in the case of a proportional tax. The gap between the two can be synthesized using the Reynolds-Smolensky index (*RS*):

$$RS = Gx - Cx\text{-}t \quad (5)$$

Clearly, a tax's departure from proportionality and its redistributive effect are two closely related phenomena; the corresponding indices are related by the following equality:[2]

$$RS = \frac{t}{1-t} K \quad (6)$$

This shows that the redistributive effect is determined by the departure from proportionality and the level of the tax. In other words, it depends not only on progressivity but also on level.

[2] This expression is explained in Lambert (2001, p. 206 and ff).

III

Progressivity, redistribution and tax reforms

The indices described above are those most commonly used to analyse the progressivity and income-redistribution consequences of tax reforms.[3] Nonetheless, they may not be suitable when analysing reforms that involve significant changes in revenue. The specific purpose of this article is to develop indicators that help overcome some of the disadvantages of these indices.

As noted above, the Lorenz curve compares the income distribution with respect to proportionality, whereas the Gini coefficient, derived from it, measures the sum of the differences between income pairs in relation to average income. Both are therefore relative comparisons in which proportions matter rather than levels. When comparing these indicators in situations where levels vary significantly in time or space, most studies explicitly admit the shortcomings of these instruments when making welfare judgments.[4] To overcome these problems, developments based on the work of Atkinson (1970) and Shorrocks (1983) are often used, through the generalized Lorenz curve —namely the ordinary Lorenz curve multiplied by average income. This makes it possible to compare not just distributions, but also levels, which is more appropriate for making a normative assessment of changes or differences in the income distribution across a wide range of situations, although several cases persist in which it is hard to make a welfare judgment.

Nonetheless, there seems to be less reticence when evaluating a tax reform, in which Lorenz and concentration curves (and their related indices of inequality, progressivity and redistribution) are widely used to compare pre- and post-reform values, and thus infer "normative" consequences of the design of the reform based on the differences observed. These comparisons and normative judgments are correct if total revenue remains unchanged. Otherwise, the fact that the reform produces a more progressive outcome or greater redistribution, for example, does not in itself have any normative content, because the "superiority" of a tax's progressivity or redistributive effect can only be justified by comparing it with a proportional tax that generates the same revenue.

To overcome this problem, two approaches have been used in studies that evaluate tax reforms. The first consists of comparing after-tax income distributions using generalized Lorenz curves. In our opinion, this approach is questionable. Imagine a tax reform that leaves the after-tax Lorenz curve unaltered when

[3] Many empirical studies have been undertaken, both nationally and internationally, using those indices.

[4] The same is true when the Lorenz curves intersect each other (see Lambert, 2001, p. 44 and ff).

taxes are reduced. In that case, using generalized curves would indicate a welfare improvement. Yet, this conclusion is highly debatable, since it assumes that public expenditure *per se* generates less utility than private expenditure; and that would be the sole reason for the apparent increase in welfare. The effect would be similar to that produced by constructing Lorenz curves after spending on a specific good. If expenditure on this good increases proportionately owing to a change in the population's preferences, the generalized curves would indicate that welfare had decreased, because there is less income available for other goods. Yet, in reality all that has happened is that preferences have changed. Moreover, it is possible for changes in revenue to be offset by other taxes, in which case their effects also need to be taken into consideration. Ultimately, a comparison using generalized Lorenz curves is justified because the income distribution is not the only thing that matters; the absolute level of average income is also relevant. Nonetheless, this does not seem appropriate in a tax reform, since the average pre-tax income of the country in question will not necessarily affected by the reform, at least in the short run; but if it is, the effect should be made explicit.[5]

The second approach to evaluating the effects of a tax reform that changes revenue uses the decomposition of the Reynolds-Smolensky index (*RS*), mentioned in the previous section, separating the variation in the tax's redistributive capacity caused by changes in its effective average rate (*t/1-t*) from the variation caused by changes in its progressivity (*K*). A decrease (increase) in the level of the tax owing to a decrease/increase in *t* would always have a negative (positive) effect on *RS* when the tax is progressive; and a decrease (increase) in progressivity would have the same effect, measured by *K*. Thus, with a reform that lowers *t*, one should only expect that the increase in progressivity is sufficient to compensate for the change in the level of the tax.

This procedure is useful because it seems to permit a separate evaluation of what happens in terms of revenue level and progressivity, making the trade-off "explicit". It would thus be possible, for example, to positively value the increase in progressivity, measured through *K* and attributable to the design of reform, while attributing the decrease (or smaller increase) in redistribution exclusively to the amount of the tax reduction.

Nonetheless, in the usual case of tax reforms that alter revenue, this separation of responsibilities between the design of the reform and the magnitude of its revenue effect is incorrect, since the change in revenue not only changes the measurement scale but also the distribution of tax pressure. Only a tax reform that altered all tax liabilities equi-proportionately would leave the progressivity indicator (*K*) invariant, so that all of the change in redistributive capacity (*RS*) could be attributed to changes in the tax's revenue capacity. Thus, even though the measurement of progressivity is scale-invariant in itself, a change in progressivity resulting from a specific reform will ultimately depend on the same decisions that change the level of the tax. Thus, since *RS* can be expressed as:

$$RS = \frac{t}{1-t}K = \frac{t}{1-t}(C_t - G_x) = \frac{t}{1-t}\left(\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i)-t(x_j)\right|}{2N^2\mu t} - G_x\right) \quad (7)$$

it is clear that progressivity is not separable from the level of the tax, since the latter affects the former, measured by *K*, through changes in the denominator of expression (7), whereas the individual distribution of the change in level affects *K* by altering its numerator. Only in the case of an equi-proportional change in all tax liabilities would these variations leave the quotient unaltered. In other words, level and progressivity are not separable concepts when evaluating the design of a tax reform and its effects; and using indicators derived from them to evaluate tax reforms could lead to errors of interpretation.

[5] A tax cut does not necessarily lead to an immediate economic expansion. Moreover is not easy to quantify its repercussion in economic contexts in which other variables play a significant role.

IV

Evaluating tax reforms: an alternative proposal based on level and distance effects

1. Tax reforms and redistribution

Although tax level and progressivity are not separable concepts in the sense discussed in the previous section, it is possible to separate changes in the tax level and in the differences between net incomes or tax liabilities, thus making it possible to more appropriately analyse tax reforms that cause changes in revenue. This is the basic idea underlying the proposal developed in this article; and, at this point, it is worth recalling that a reform will increase the redistributive effect of a tax if the Reynolds-Smolensky index after the change (*RS'*) is greater than it was before. Otherwise, the reform will reduce the redistributive effect, if $RS' - RS < 0$, or be neutral if $RS' = RS$.

The proposal of this article consists of decomposing the change in the Reynolds-Smolensky index, to separate changes in the differences between net incomes from changes in the average tax rate. In other words, starting from the expression:

$$RS' - RS = (G'x - C'_{x-t}) - (Gx - C_{x-t}) \tag{8}$$

and, to simplify, assuming that the Gini coefficient before and after the reform does not change,[6] in other words, $G'x = Gx$, then

$$RS' - RS = C_{x-t} - C'_{x-t} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t)} - \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t'(x_i)) - (x_j - t'(x_j))\right|}{2N^2\mu(1-t')} \tag{9}$$

Where the superscript (') represents the value of the variable in question after the reform. This expression can be broken down as follows:

$$RS' - RS = C_{x-t} - C'_{x-t} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t)} - \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t'(x_i)) - (x_j - t'(x_j))\right|}{2N^2\mu(1-t')} + \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t')} - \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t')} \tag{10}$$

So,

$$RS' - RS = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right|}{2N^2\mu(1-t)}\left(1 - \frac{1-t}{1-t'}\right) + \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right| - \sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t'(x_i)) - (x_j - t'(x_j))\right|}{2N^2\mu(1-t')} \tag{11}$$

To further clarify the meaning of this expression, let β represent the rate of change of average net income after tax; D the sum of the distances between net incomes before the reform; and D' the sum of distances between net incomes after the reform, in other words:

$$\beta = \frac{(1-t') - (1-t)}{(1-t)} \tag{12}$$

$$D = \sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t(x_i)) - (x_j - t(x_j))\right| \tag{13}$$

and

$$D' = \sum_{i=1}^{N}\sum_{j=1}^{N}\left|(x_i - t'(x_i)) - (x_{jj} - t'(x_{\ }))\right| \tag{14}$$

Thus, equation (11) can be written as

[6] In empirical exercises to evaluate tax reforms, the different fiscal structures resulting from the reform are generally applied to the same income distribution.

$$RS' - RS = C_{x-t}\left(1 - \frac{1}{1+\beta}\right) + \frac{D - D'}{2N^2\mu(1-t')} \qquad (15)$$

Consequently, the change in the Reynolds-Smolensky index would be the sum of what may be called a level effect (*LE*) and a distance effect (*DE*):

$$LE = C_{x-t}\left(1 - \frac{1}{1+\beta}\right) \qquad (16)$$

$$DE = \frac{D - D'}{2N^2\mu(1-t')} \qquad (17)$$

The two effects can be interpreted as follows. The level effect represents the difference between the net income concentration curve before the reform, and what it would have been if the reform had been implemented via an equal (positive or negative) transfer for all individuals, thus keeping distances between net incomes constant. It is important to note that, in our analysis, the "level effect" does not refer to the redistributive effect of any possible change in the tax that alters revenue by a given amount, but to that resulting from a change specifically made by transferring a lump sum to all taxpayers, for which reason it differs from the "average-type effect" present in the decomposition of the Reynolds-Smolensky index. Thus, for example, for a tax reduction, the graphic representation of this effect is shown in figure 2, where *Lx-tn* represents the concentration curve following that hypothetical reform.

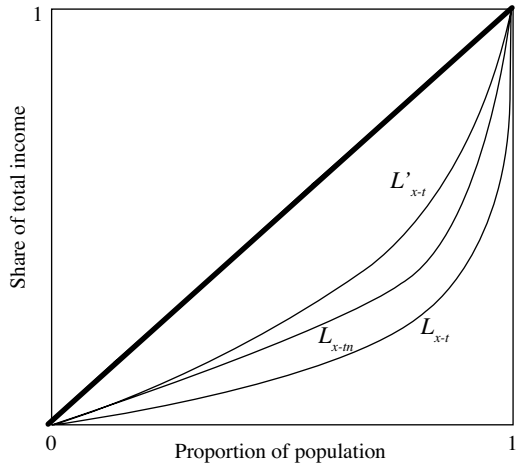
The distance effect, meanwhile, expresses the difference between the concentration curve that would exist if the reform had been implemented through equal transfers (positive or negative) for all individuals, holding constant the distances between net incomes and the concentration curve after the real reform (*L'x-t*) (which, strictly speaking, means evaluating the effects of a purely redistributive reform that alters the distances between net incomes by the same amount as the original reform analysed, but without changing revenue). For the case of a reduction in distances, this effect is also shown in figure 2.

The advantage of splitting the distributive effect into distance and level components, compared to the traditional division between level and progressivity, is that it makes it possible to clearly identify whether each of the factors —changes in the average rate and

FIGURE 2

Tax reform with an increase in redistribution

Level and distance effects



Source: Prepared by the authors.

L_{x-t}: After-tax income concentration curve (pre-reform)
L'_{x-t}: After-tax income concentration curve (post-reform)
L_{x-tn}: Income concentration curve following a reform of equal revenue effect made via a lump sum tax (in this case, transfer).

in distances— contributes positively or negatively to the change in the redistributive capacity of the tax, because it compares distances under a hypothetical equal-revenue scenario. Thus, both the level effect and the distance effect may be positive (greater redistribution) or negative (less redistribution).

In particular, for the level effect (*LE*):

If $\nabla t \Rightarrow \beta > 0 \Rightarrow LE > 0$
If $\Delta t \Rightarrow -1 < \beta < 0 \Rightarrow LE < 0$
If $\beta = 0 \Rightarrow LN = 0$

where ∇t represents a tax reduction, and Δt represents an increase.

Whereas for the distance effect (*ED*):

If $D > D' \Rightarrow DE > 0$
If $D < D' \Rightarrow DE < 0$
If $D = D' \Rightarrow DE = 0$

With this decomposition, the effect of changes in the tax level is perfectly isolated, which does not happen with the traditional breakdown. For example, if one imagines a tax reform that only lowers the average rate without altering the distances between individual tax

liabilities, the traditional breakdown might show that: (i) the redistributive capacity of the tax has increased; and (ii) the reduction in the average rate has contributed negatively to that increase; for which reason (iii) the increase in progressivity is exclusively responsible for the tax's greater redistributive capacity.

Clearly, however, any increase in progressivity is entirely due to the decrease in the average rate; so this has made a positive net contribution to redistributive capacity, and is in fact the only factor causing it to increase. In contrast, the breakdown presented here would show that the reduction in the average rate has a positive effect on the redistributive capacity of the tax and, moreover, is the only factor responsible for its increase, whereas the reform would be neutral in distance terms.

2. Tax reforms and progressivity

The decomposition applied to redistribution can also be done for progressivity, using the Kakwani index (K).

$$K'-K=(C't-G'x)-(Ct-Gx) \tag{18}$$

If, again to simplify, it is assumed that the Gini coefficient before and after the reform does not change, in other words $G'x=Gx$, then

$$K'-K=C'_t-C_t=\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t'(x_i)-t(x'_j)\right|}{2N^2\mu t'}-\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i)-t(x_j)\right|}{2N^2\mu t} \tag{19}$$

This expression can be rewritten as follows:

$$K'-K=C'_t-C_t=\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i)-t(x_j)\right|}{2N^2\mu t}\left(\frac{t}{t'}-1\right)+\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t'(x_i)-t'(x_j)\right|-\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i)-t(x_j)\right|}{2N^2\mu t'} \tag{20}$$

Defining β as the rate of change in the average tax rate, and D and D' as the sum of the distances between the pre-and post-reform tax liabilities, then

$$\beta=\frac{t'}{t}-1 \tag{21}$$

$$D=\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t(x_i)-t(x_j)\right| \tag{22}$$

and

$$D'=\sum_{i=1}^{N}\sum_{j=1}^{N}\left|t'(x_i)-t'(x_j)\right| \tag{23}$$

This would give the following expression:

$$K'-K=C_t\left(\frac{1}{1+\beta}-1\right)+\frac{D-D'}{2N^2\mu t'} \tag{24}$$

Thus, the variation in the Kakwani index would be the sum of the level effect (*LE*) and the distance effect (*DE*), now defined as

$$LE=C_t\left(\frac{1}{1+\beta}-1\right) \tag{25}$$

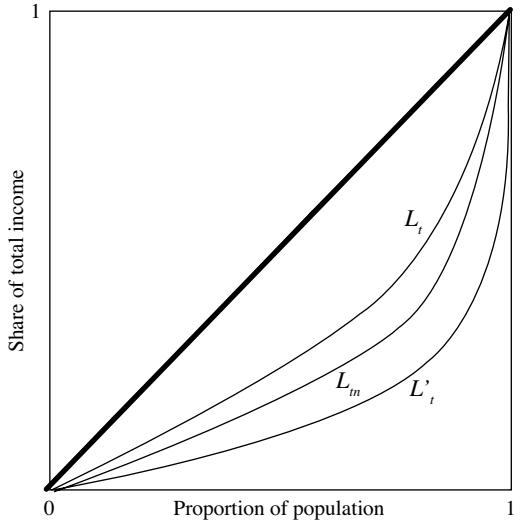
$$DE=\frac{D'-D}{2N^2\mu t'} \tag{26}$$

In this case, the level effect would represent the difference between the tax-liabilities concentration curve before the reform, and what it would be if the reform had been implemented through an equal (positive or negative) transfer for all individuals, keeping the distances constant. Figure 3 illustrates this effect, for the case of a hypothetical tax cut, where *Ltn* represents the post-reform tax-liabilities concentration curve. The distance effect, in contrast, measures the difference between the concentration curve that would exist if the reform had been made through equal (positive or negative) transfers for all individuals, holding constant the distances between tax liabilities and the concentration curve after the real reform (*L't*). For the case of an increase in distances, this effect would also be as shown in figure 3.

Once again, the advantage of this breakdown is that it makes it possible to separate the effect caused by the average tax level from that corresponding to

FIGURE 3

Level and distance effects in progressivity



Source: Prepared by the authors.

L_t: After-tax income concentration curve (pre-reform)
L'_t: Tax-liabilities concentration curve after the real reform
L_{tn}: Tax-liabilities concentration curve following a reform of equal revenue effect implemented with a lump sum tax (in this case, a transfer)

the differences between tax libilities. In other words, whereas the traditional analysis only shows whether progressivity has changed, but not whether this is caused by the change in the average tax rate or by real changes in the differences between individual tax liabilities, the decomposition proposed here does allow that distinction to be made. Thus, both the level effect and the distance affect can take a positive sign (positive contribution to progressivity) or a negative sign (negative contribution).

In particular, for the level effect (*LE*):

If $\Delta t \Rightarrow \beta > 0 \Rightarrow LE < 0$
If $\nabla t \Rightarrow <\beta<0 \Rightarrow LE > 0$
If $\beta = 0 \Rightarrow LE = 0$

where ∇t represents a tax reduction and Δt an increase.

Whereas, for the distance effect (*ED*):

If $D > D' \Rightarrow LE < 0$
If $D < D' \Rightarrow LE > 0$
If $D = D' \Rightarrow LE = 0$

3. Typology of tax reforms

Once the distance and level effects produced by a tax reform have been defined, the different tax-reform modalities can be classified in terms of those effects. In the case of the redistributive capacity of the tax, the classification proposed is shown in figure 4.

FIGURE 4

Redistribution. Types of tax reform

Types of reform
- ΔRS
  - $DE > 0$ Strong redistributive reform
  - $DE < 0$ Weak redistributive reform
- ∇RS
  - $DE > 0$ Weak non-redistributive reform
  - $DE < 0$ Strong non-redistributive reform

Source: Prepared by the authors.

RS: Reynolds-Smolensky index.
EE: Distance effect

Using this typology, tax reforms would be classified not only in terms of the tax's redistributive capacity, but also by what happens to the distances between taxpayers' net incomes. The following synthetic indicator (distance-level redistribution index) can be used to evaluate the different reforms:

$$I_R = \frac{\Delta RS}{|\Delta RS|}\left(1+\frac{DE}{|DE|+|LE|}\right)$$
$$\frac{\Delta RS}{|\Delta RS|} = \pm 1;\ 0 \le \left(1+\frac{DE}{|DE|+|LE|}\right) \le 2 \qquad (27)$$

The $\frac{\Delta RS}{|\Delta RS|}$ component would thus contribute the sign of the indicator, and $\left(1+\frac{DE}{|DE|+|LE|}\right)$ its absolute value, which would reflect the relative importance of the distance effect in the reform. Consequently, according to this indicator, reforms would be classified as:

(i) strong redistributive reform, if $1<I_R\le 2$ (ΔRS, $DE>0$)

(ii) weak redistributive reform, if $0< I_R \leq 1$ (ΔRS, $DE<0$).
(iii) weak non-redistributive reform, if $-2\leq I_R <-1$ (∇RS, $DE>0$)
(iv) strong non-redistributive reform, if $-1\leq I_R \leq 0$ (∇RS, $DE<0$)

The analysis in the case of progressivity is similar. Here again there would be four possible reform types based on the change in the Kakwani index and the sign of the distance effect; and the corresponding indicator (distance-level progressivity index) would be:

$$I_K = \frac{\Delta K}{|\Delta K|}\left(1+\frac{DE}{|DE|+|LE|}\right) \qquad (28)$$

$$\frac{\Delta K}{|\Delta K|} = \pm 1;\ 0 \leq \left(1+\frac{DE}{|DE|+|LE|}\right) \leq 2$$

The meaning and interpretation follow the same patterns, but in this case applied to progressivity:
(i) strong progressive reform, if $1<I_K\leq 2$ (ΔK, $DE>0$)
(ii) weak progressive reform, if $0< I_K \leq 1$ (ΔK, $DE<0$)
(iii) weak regressive reform, if $-2\leq I_K <-1$ (∇K, $DE>0$)
(iv) strong regressive reform, if $-1\leq I_K \leq 0$ (∇K, $DE<0$)

These indicators enhance the classification of tax reforms, augmenting the traditional classifications "redistributive" or "progressive" (based on the positive or negative value of *RS* and *K*) —which are consistent with the classical indicators— with the modifiers "strong" or "weak" obtained from the contribution made by the distance effect in each case. Moreover, provided the value of the indices is standardized to the magnitude of the revenue effects, it will be possible to compare tax reforms that have different quantitative effects.

4. Tax reform and elements of the tax: effects on level and distance

The decomposition of variations in the redistribution and progressivity indicators made in the foregoing subsections makes it possible to evaluate the effects of tax reforms, distinguishing between the amount of a tax cut and the effects of the various elements of the tax used to implement the reform. Thus, the level effect makes it possible to isolate the pure tax increase or decrease component, which is the same for all tax reforms that affect revenue equally. This procedure thus makes it possible to observe the differences between the various possible reforms that produce the same revenue change —differences that will be reflected in the distance effect. By way of example, table 1 summarizes the effects of three possible income-tax reform measures, where the previous tax rate was progressive.

TABLE 1
Distance and level effects in alternative reforms

1. Deductions from tax liability		
Introduction or increase in an equal deduction from tax liability for all taxpayers		
Progressivity	LE > 0 DE = 0	Increase in K
Redistribution	LE > 0 DE = 0	Increase in RS
2. Base reductions		
Introduction or increase in an equal deduction for all tax payers		
Progressivity	LE > 0 DE < 0	K
Redistribution	LE > 0 DE< 0	RS
3. Lowering of tax rates		
Lowering of marginal rates in the tax schedule (irrespective of which rates are reduced)		
Progressivity	LE > 0 DE < 0	K
Redistribution	DE > 0 LE < 0	RS

Source: Prepared by the authors.

LE: Level effect.
DE: Distance effect.
RS: Reynolds-Smolensky index.
K: Kakwani index.

The distance effect separately measures a variation in the distribution (or progressivity) and has normative significance, because it compares two income distributions (or two tax structures) in terms of their departure from proportionality, holding average net

income (or tax revenue) constant. As the level effect is constant for a given amount of tax reduction, the design of the reform (the instruments used) can be evaluated normatively. In relation to the examples given in table 1, the design of reform 1 (deductions from tax liability) would be neutral in terms of its contribution to progressivity and redistribution ($ED = 0$), whereas the design of reforms 2 and 3 (reductions in the base and lower tax rates) would be negative (a decrease) in terms of the progressivity and redistributive capacity of the tax ($ED < 0$). The valuation of other reform alternatives (deductions or reduction in amounts that vary according to income levels; alterations to the brackets of the tax schedule; a combination of increases and decreases in deductions, reductions or rates; changes in the calculation of taxable income, among others), and the joint effects of combining the different measures, is more complex, and the corresponding indicators would have to be calculated as appropriate.

V

An application to personal income tax in Guatemala

Despite efforts made over the last decade to improve the administration and design of Guatemala's fiscal policy, the country's tax take remains one of the lowest in Latin America.[7] Although nominal tax rates are not very different from the Latin American average, a high degree of informality, compounded by unequal income distributions, narrow tax bases and high levels of fraud explain these revenue shortfalls. Personal income tax plays a very small part in the Guatemalan tax structure,[8] whereas corporate and consumption taxes are relatively important (see table 2).

A more detailed analysis of taxation by income sources shows that wages (personal income tax on wages) contribute revenue equivalent to just 0.13% of GDP, or 3.92% of the total revenue raised through income tax. This contrasts with the share of wages in GDP, which was 30% in 2006 according to the national accounts. In other words, only 0.34% of total gross wages paid goes in tax, which is an excessively low proportion. Explanations for this low level of revenue go beyond the high level of informality and extreme inequality prevailing in Guatemala and include the legislation defining taxable income and deductible expenses. Firstly, incomes received in the form of gratifications, bonuses (*Bono 14*), length-of-service payments or pensions (retirement or other) are not subject to income tax. Secondly, deductions are allowed for life-insurance policies, certain donations, medical expenses and, also, a tax credit in respect of VAT paid on purchases for up to 12% of net

TABLE 2

Guatemala: tax revenue in 2006

(Percentages of GDP)

Direct taxes	2.9
Income tax	2.1
Corporate	1.7
Personal	0.3
Tax on financial products (corporations)	0.1
Tax on financial products (individuals)	0.0
IETAAP[a]	0.8
Wealth taxes	0.0
Indirect taxes	7.7
Domestic value added tax	1.9
Value added tax on imports	3.4
Customs duties	1.0
Tax on tobacco and tobacco products	0.1
Taxes on the distribution of beverages	0.2
Tax on vehicle circulation	0.1
Tax on the distribution of oil and petroleum products	0.7
Total tax revenue	11.1

Source: Superintendency of Tax Administration (SAT).

[a] Special temporary tax to support the peace accords.
GDP: Gross domestic product.

[7] Between 2003 and 2008, the tax burden in Latin America and the Caribbean as a whole increased from 15.5% to 17.8% of GDP, but in Guatemala it dropped from 11.9% to 11.6% of GDP (ECLAC, 2009).

[8] Nonetheless, this is in keeping with most tax systems in Latin America, where direct taxation remains weak despite partial reforms.

income. Lastly, there is a tax-free allowance of 36,000 quetzales, representing the minimum living wage and tax threshold, which, while not particularly high in the Central American context (2.03 times per capita GDP in 2006), nonetheless contributes to the loss of revenue and progressivity.

The taxation of personal capital is broadly based despite a clearly dual structure: capital gains pay income tax at a 10% rate, interest and other similar income pays financial products tax also at 10%, whereas dividends are exempt provided they have been subjected to tax withholding at source.

As there is no disaggregated information on taxable income and the taxes paid in Guatemala, personal income tax in the case of wage earners was analysed using data from the National Employment and Income Survey (ENEI) 2004. The database in question was adapted to the structure of the tax, making assumptions about the basic variables not included in the survey, to approximate the baseline scenario (legislation of 2006) to actual revenue outcomes.[9]

This replica of the 2006 baseline scenario reveals a low-revenue tax concentrated on a very small number of actual taxpayers, with little redistributive capacity despite its high formal progressivity. The exemption threshold is the first factor responsible for this low average revenue. Although there are four marginal rates: 15%, 20%, 25% and 31% (see table 3), 73% of wage earners fall outside the income tax net; and the top rate is applied only to very high incomes (16.7 times per capita GDP). All of this results in a scale of rates that is excessively complex in relation to its very narrow scope in terms of the income and individuals subject to it.

The existence of the VAT credit aggravates this situation, because after applying it, only 9.65% of formal workers pay the tax, all of whom are in the top decile of the distribution. Moreover, the VAT credit reduces the amount paid by 62%. A simulation shows that the joint effect of the minimum threshold and the VAT credit is such that eliminating the 31% tax rate would make no difference to revenue outcomes (no taxpayer would be affected). As a result of all of this, progressivity and redistribution indicators reveal a highly progressive tax (Kakwani = 0.6136), but one that is poorly redistributive (Reynolds-Smolensky = 0.0072), owing to its low revenue capacity (the effective average rate is 1.34%).

TABLE 3

Guatemala: personal income-tax rates, 2006

Tax brackets *(in quetzales)*	Marginal rate *(Percentages)*	Percentiles
up to 36 000[a]	0	1-73 (73%)
36 000 - 65 000	15	74-92 (19%)
65 000 - 180 000	20	93-99 (7%)
180 000 - 295 000	25	100 (1%)
over 295 000	31	

Source: Prepared by the authors.

[a] This amount is deducted from taxable income.

In view of this, and to highlight the shortcomings of traditional redistribution and progressivity indicators, this article has proposed two hypothetical reforms acting on these two elements of the tax. This first involves altering the minimum threshold. Here, it should be noted that the existence of the threshold pursues three basic objectives:[10] (i) to set the income threshold needed for a minimum living wage, exempting all incomes below this level; (ii) to reduce the tax burden in line with taxpayers' economic capacity, bearing in mind their family and personal circumstances; and (iii) to simplify the tax, both for the administration and for citizens, exempting large numbers of very low-income taxpayers.

When setting this minimum tax-exempt income threshold, reductions in the tax base (such as that in force in Guatemala), zero-rated income brackets, or tax credits may be equivalent; but the revenue cost is much higher in the case of reductions, and credits are less visible. Moreover, as the tax saving for each taxpayer occurs at his or her top marginal rate, the saving rises with income. Accordingly, at the international level, there is a trend to replace

[9] Incomes declared in the survey have been grouped in the following categories: taxable wage income, exempt wage income, pensions, interest, dividends, rental, capital gains, and incomes from agricultural and nonagricultural activities. These incomes have been adjusted to 2006 prices using the consumer price index, except for interest and dividends, where the recipients of such income have been imputed their proportional share of the total dividends and interest received by households, as reported in the national accounts. To calculate the baseline scenario of revenue equal to the actual figure, net income spent is estimated from the VAT credit at 45%. In addition, individuals below the minimum working age have been excluded from the database, and all persons lacking an employment contract have been classified as "informal". Lastly, the fact that the data were processed at the individual level (more appropriate for tax purposes), rather than by households, needs to be kept in mind when interpreting the inequality indicators.

[10] See, for example, Zee (2005).

reductions in the tax base by zero-rated income brackets or credits (OECD, 2006).

In view of the above, this article argues in favour of transforming the tax-exempt threshold into an equal-sized zero-rated bracket. In that case, revenue would increase by 21%, and there would be an increase in the Reynolds-Smolensky index and a fall in the Kakwani index. The interpretation of the reform based on these indicators would show higher redistributive capacity, but a reduction in progressivity, so the increase in redistributive capacity would merely be the consequence of a higher average rate (see table 4). Accordingly, a reform of this type could be criticized because the gain in redistributive capacity is merely the outcome of the higher average tax rate, whereas the tax is actually becoming less progressive. Nonetheless, as shown by the indices proposed here, what is really happening is that this reduction in progressivity, as measured by the Kakwani index, is also an outcome of the higher average rate. The level effect, related to the latter, contributes negatively to both progressivity and redistributive capacity. In contrast, the distance effect is positive, which means that not only are the distances between net incomes significantly reduced, but the differences between the amounts of tax paid by taxpayers grow. For that reason, it cannot really be said that the reform is regressive; and, if it was, the subjective perception that citizens have of progressivity would be lost. In contrast, the proposal developed in this article simulates a specific reform, separating what happens to the average rate from what happens to the differences between incomes and tax liabilities. In this example, where the difference between taxes paid by high-income and low-income individuals have widened, the indicators proposed would show that the reform was strongly redistributive (I_R=1.74) but weakly regressive (I_K=-1.50).

A second simulation involved a reform abolishing the VAT credit, which would generate a significant increase in revenue (164%). Its consequences for the redistributive capacity and progressivity of the tax would be the same as in the previous measure, namely an apparent loss of progressivity, resulting exclusively from the higher average rate (negative level effect) (see table 5). In contrast, the differences between taxes paid by low- and high-income individuals would increase (positive distance effect). This reform is again strongly redistributive (I_R=1,72) and weakly regressive (I_K=-1,47).

TABLE 4

Transformation of the minimum threshold to a zero-rated bracket

	Post reform	Pre reform	Variation
Revenue *(quetzales)*	354 348 097	291 670 901	21%
RS	0.0090	0.0072	0.0018
K	0.6119	0.6136	-0.0017
	RS	K	
Level effect	-0.0010	-0.1694	
Distance effect	0.0028	0.1677	
I_R	1.7381		
I_K		-1.4975	

Source: Prepared by the authors.

RS: Reynolds-Smolensky index.
K: Kakwani index.
I_R: Distance-level redistribution index
I_K: Distance-level progressivity index.

TABLE 5

Abolition of the VAT credit

	Post reform	Pre reform	Variation
Revenue *(quetzales)*	769 134 255	291 670 901	164%
RS	0.0189	0.0072	0.0118
K	0.5502	0.6136	-0.0634
	RS	*K*	
Level effect	-0.0076	-0.5944	
Distance effect	0.0194	0.5310	
I_R	1.7178		
I_K		-1.4718	

Source: Prepared by the authors.

RS: Reynolds-Smolensky index.
K: Kakwani index.
I_R: Distance-level redistribution index.
I_K: Distance-level progressivity index.
VAT: Value added tax.

VI
Conclusions

This article has attempted to highlight the shortcomings of the Kakwani and Reynolds-Smolensky indices for analysing the tax-progressivity and redistributive-capacity effects of tax reforms that produce changes in revenue. It has also shown that the traditional ways of overcoming these shortcomings by using generalized curves and the decomposition of the Reynolds-Smolensky index into effects caused by the average rate and progressivity, are questionable: in the first case, because they unjustifiably bias the results in favour of tax reductions; and, in the second case, because decomposing changes in the Reynolds-Smolensky index into effects caused by the average rate and by progressivity cannot be used to evaluate the design of the reforms, since the measurement of progressivity is altered in most real reforms by the same factors that alter the average tax rate. Consequently, indicators have been proposed that make it possible to quantify the effects of a tax reform involving changes in revenue based on concepts that are separable, namely the tax level and differences between net incomes or tax liabilities. These indicators make it possible to distinguish the effects on a tax's redistributive capacity and progressivity caused by changes in the average rate and variations in the differences in individual tax liabilities.

The level and distance effects thus developed also make it possible to partly recover the intuitive meaning of the concept of progressivity and redistribution. Deciding "who benefits most" from a tax reform is complicated and subject to value judgments. The traditional indicators (K, RS, and their respective breakdowns) provide a view based on relative differences in incomes or tax liabilities, which is very useful when making comparisons in a static context for reforms that do not cause changes in tax revenue. In other situations, the conclusions obtained may be counterintuitive. For example, how can a tax be made more progressive by a reform that lowers the tax liabilities of high-income individuals by much more, when they receive most of the tax reduction both in absolute and in relative terms? If this is true, then is it "good" to increase progressivity? Put another way, if they were well-informed, would a majority of citizens vote for a reform of this type?

As this article has attempted to show, interpreting the indicators used to evaluate tax reforms that change revenue causes confusion. This article proposes a different alternative. The level effect isolates the repercussions that a reform would have on income shares or tax liabilities between taxpayers (in particular, progressivity and redistribution indicators) if the distances between tax liabilities and incomes remain constant. The distance effect reflects the consequences of a specific reform design (in other words the elements of the tax that are altered) on progressivity and redistribution, when the level of revenue and total income remains constant. This separation of the effects, and the indicators constructed from it, make it possible to nuance and enhance the conclusions reached using the classical indicators.

In addition, this alternative breakdown of the effects of the tax reform makes it possible to highlight the effect of the change in distances between net incomes or between taxes payable, without ceasing to use traditional instruments that are based on a relative concept of inequality, which is of interest for two reasons. Firstly, given the explanation of the repercussions of a tax reform, public-sector managers and citizens may wish to know its consequences in absolute terms, and how it affects the distances between individual incomes (or tax liabilities). Secondly, the decomposition allows for an approach to "relative-income hypotheses". Although, strictly speaking, it cannot be claimed that the indicators described in this paper capture the effect on the relative position of taxpayers in the tax-reform scenario, they do reveal its aggregate effect on the set of relative positions through the calculation of the variation in distances between incomes or tax liabilities.

Lastly, it is worth noting that the problems with the traditional indicators discussed throughout this article are more serious in the case of low-tax countries. A reform that generates the necessary increase in the tax system's revenue capacity will often appear to be regressive, according to these indicators; and this may be used as an argument to reject the reform. Nonetheless, this apparent regressivity is merely the consequence of the increase in revenue capacity itself and not of a narrowing of the differences in the amount

of tax paid by high- and low-income taxpayers. As shown in the tax measures analysed for Guatemala, the traditional indicators would suggest that the tax has become less progressive. Nonetheless, in both cases the differences between taxes paid by higher- and lower-income individuals have actually widened, which seems to contradict the previous conclusion. In contrast, this proposal shows clearly that this reduction in progressivity is merely the consequence of the higher average rate following the reforms, but that the cost of the reforms will affect higher-income taxpayers more. In our opinion, this information is of considerable social interest.

(Original: Spanish)

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