THE NET FISCAL IMPACT OF SELECTED FEDERAL BLOCK GRANT PROGRAMS*

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ABSTRACT. This paper examines the net fiscal benefits of various federal grants and taxes paid to finance them. Net, effective tax rates are calculated for all county areas in the U.S. for seven measured grant programs, and the distributions of such tax rates are examined in conjunction with the median family incomes of the county areas. Inferences about the progressivity (or regressivity) of the grant programs are made, as well as inferences about the horizontal equity of the grant programs through the use of a new class of index numbers. It was found that more progressive grant formulas, which provide greater rates of subsidy to areas with lower median family incomes, also tend to be less horizontally equitable.

1. INTRODUCTION AND SUMMARY

Systematic evaluation of the distribution of federal grants among localities has usually been hampered by the absence of complete, reliable microdata which permit an independent analysis. The analyst who seeks to examine the intrastate impact of federal grants rapidly discovers that expenditure data on recipient governments or on characteristics of those residing within the jurisdictions are not available for all jurisdictions and/or are not available for variables that may be of interest. With respect to the availability of interesting evaluation variables, it frequently is the case that the factors in the federal allocation formula use up all the available data (i.e., on income, unemployment rates, poverty rates) at the micro-level so that independent measures (i.e., those not used to generate the observed grant distribution for evaluation purposes) are unavailable.

Two sorts of general research strategies have been pursued in light of these problems: (1) limit the analysis of just those governments for which data is available, or (2) create complex indices from indirectly available data for more governments to proxy for measures of such evaluation constructs as "need." The first approach, which addresses the problem of there not being extensive data for localities, limits the usefulness of the results, since large numbers of jurisdictions have to be omitted. The second approach, which addresses the problem of there not being enough directly measured variables to perform the analysis, runs the risk

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of having the ultimate evaluation results be questioned because the underlying definitions of need or fiscal capacity are not initially compelling.

Aside from whether or not one wishes to examine grant distributions for a small number of jurisdictions or examine grant distributions for a large number of jurisdictions with only indirect evaluations measures, there remains the difficult matter of operationally measuring federal fiscal flows. Recently, Anton, Cawley, and Kramer (1980) concluded, after a systematic attempt to trace who gets what, in a geographic sense, from the federal purse that "no one really knows where Federal dollars are spent."[1]

The research below addresses these difficult problems by performing the analysis at an intermediate level of geographic aggregation, the county area level, using as an evaluation tool a new data base, county area federal personal tax collections, and limiting analysis to several reliably measured federal grants: General Revenue Sharing, Countercyclical Revenue Sharing, aid to disadvantaged students in primary and secondary schools, the Community Development Block Grant program, and an overall measure of federal grant-in-aid developed by the Congressional Budget Office. These spending flows for the mid-to-late 1970's are juxtaposed against federal tax collections estimated to finance them at the county area level. Also, evaluation of grant and tax patterns is based on an explicit theoretical framework.

This study makes theoretical and empirical contributions to the problem of systematically assessing the net fiscal benefits of several federal block grants. With regard to theoretical contributions, the study develops a framework for comparing alternative expenditure programs and their funding by extending the concept of the net effective tax rate (usually applied to individuals) to aggregations of individuals in a geographic area. In particular, we examine the net fiscal flows (tax costs less expenditures benefits in conjunction with total residents' income to compute a net effective tax rate. Comparison of such values and the aggregation of such comparisons yield index number values which may be directly interpreted in terms of equity.

For areas whose family incomes are *similar,* the equity issue is whether or not the net, effective tax rates are the same. If the tax rates are the same, there is evidence of hornizontal equity; if the tax rates are different, there is evidence of horizontal inequity. For areas whose family incomes are *different,* the equity issue is whether the net effective tax rate is larger, the same, or smaller for areas with higher-income families. Such vertical equity comparisons would be, respectively, progressive, proportional, or regressive. Also, the resultant index number is found to be a sensible in terms of underlying assumptions as suggested by modern index number theory. Finally, the index number methodology is extended to examine the impact of moving funds from one program to another in terms of the impact on the *change* in equity.

With regard to the empirical part of the study, there are four important

[1]Anton, Cawley, and Kramer (1980, p. 127).

results. First, considering the effective tax rates and median family incomes of county areas, countercyclical revenue sharing has the most progressive net impact. That is, lower-income counties tend to face lower effective tax rates than higher-income counties. Even so, none of the programs was entirely progressive in impact. Countercyclical revenue sharing was progressive for 50 percent of the county area comparisons in contrast to general revenue sharing which was progressive for 39 percent of the county area comparisons.

Second, if we examine the net effective tax rate for the programs among counties with the same family income, no program succeeded in achieving horizontal equity for more than 24 percent of the county area comparisons. In other words, there is little evidence of horizontal equity among the programs.

Third, there is a clear, inverse relation between progressivity and horizontal equity. A 1 percent improvement in horizontal equity is accomplished by a 0.48 percent decline in vertical progressivity. Programs which have sought to be progressive in impact have sacrificed horizontal equity.

Fourth, if one were to contemplate moving funds from one program to another, it is not the case that there will be simple improvements in vertical progressivity. Indeed, moving funds from any program to another always results in significant worsening in progressivity (or greater regressivity).

2. A FRAMEWORK FOR ANALYZING THE EQUITY OF FEDERAL FISCAL FLOWS

2.1. *Introduction*

This section discusses how one can go about analyzing the equity of federal spending and taxes. First, some assumptions and notation are entertained. Second, we address the issue of how one chooses among competing index measures and the advantages of using an explicit social welfare function. This discussion characterizes the mathematical properties which an index number should contain. Third, explicit measures of the vertical and horizontal equity of any program and attending financing are developed by first building up scores within county areas, and then by building up equity scores among county areas. Fourth, an explicit measure of how vertical equity might be affected if one moved funds from one program to another is developed. Throughout this section, the development builds on the concepts of vertical and horizontal equity used in analyzing individual circumstances.

2.2. *Assumptions and Notation*

Imagine an area composed of $i = 1, \ldots, n$, individuals, who pay taxes, T_i, and receive benefits from expenditures, E_i, from a particular program. Further, suppose each individual has income Y_i. Note that we assume that benefits are coincidental with identified expenditures per person, and that indirect or external benefits (second-round or multiplier effects) are not included in the analysis.

It will be convenient below to consider several expenditure programs, E_{ij}, $j =$

1, . . ., m, and to recognize that total taxes, T_i, may easily exceed the financing costs of particular programs, i.e., $\Sigma_{i=1}^{n} \Sigma_{j=1}^{m} E_{ij} < \Sigma_{i=1}^{n} T_i$, for the ith person, jth program. That is, federal aid to education and general revenue sharing are but a part of the federal budget. Because we will want to compare different programs on the same basis, we need to fix the size of the budget of one grant program as the reference point or numeraire and make the other programs to be of equal size. Let α be the fraction of total taxes dedicated to the reference ($j = 1$) program:

$$\alpha_1 = \sum_{i=1}^{n} E_{i1} / \sum_{i=1}^{n} T_i \qquad (0 < \alpha_1 < 1) \tag{1}$$

If we wish to compare expenditures on the program to its net tax costs for the ith individual, we may calculate the net tax cost of the program as:

$$\alpha_1 T_i - E_{i1} \tag{2}$$

This assumes that the tax costs for an individual of a program are simply proportional to the program's share of the total budget or tax receipts. If general administration is 7 percent of the budget, then \$.07 of every taxpayer's dollar goes for it.

Since there are other programs, define δ_j as the other appropriate scale factor for each other program to put total expenditures for each program on the same basis:

$$\delta_j = \sum_{i=1}^{n} E_{ij} / \sum_{i=1}^{n} E_{i1} \tag{3}$$

Since the taxes needed to finance the jth program are proportional to the size of the program, $\delta_j \alpha_1$ represents the fraction of total taxes needed to finance the jth program in comparison to the numeraire. Thus, for the ith individual, $\delta_j \alpha_1 T_i$ is the normalized cost of the jth program, and $\delta_j E_{ij}$ is the benefit from the jth program in comparison to the numeraire. It follows, then, that the normalized net tax cost of the jth program is:

$$\delta_j(\alpha_1 T_i - E_{ij}) \tag{4}$$

If we divide the individual's net tax cost by his economic income, Y_i, we obtain the net effective tax rate, t_{ij} for the jth program:

$$t_{ij} = \delta_j(\alpha_1 T_i - E_{ij})/Y_i \tag{5}$$

2.3. *How to Choose an Index Number That Uses E, T, Y, α, and δ_j*

Given the constructs, E_{ij}, T_i, Y_i, α, and δ_j, the question arises as to how they should be combined to permit inferences about the relative equity of the n programs. Atkinson (1970) has argued that the particular form of the measure should be derived from a social welfare function (SWF), and he derived one index number by inverting a SWF of convenient functional form. On the other hand, Berliant and Strauss (1983) have suggested that such an approach is not necessary, and in fact much may be gained from viewing index numbers themselves as social welfare functions.[2] The major difficulty with Atkinson's approach is the fact that only univariate index numbers can be uniquely deduced from a SWF, while many normative issues are inherently multivariate in character.

Below we develop a class of S-index numbers suggested by Berliant and Strauss (1983), which is inherently multivariate in character and permits an evaluation of the net fiscal impact of selected block grants.

2.3.1. *Application of Berliant-Strauss S-index Number to Net Fiscal Analysis.* Any index number may be decomposed conceptually into two parts: (1) a set of rules that compares values of variables among individuals in the society, and as a result creates a score or initial index-number value, and (2) a set of aggregation rules which combine these individual-level scores to obtain an overall score or level of social utility for the entire society. Such aggregate scores may be compared at a moment in time for alternative policies (the approach to be used below), or compared over time for the same individuals to ascertain whether social welfare has increased or not.

Berliant and Strauss (1983) develop a very general class of index numbers based on making comparisons of individual's scores within and among groups of any arbitrary size, and apply this general methodology of relative comparisons of individual's positions within and among groups of size 2 to the case of the distribution of personal income taxes. The general form of the S-index number is

$$S = G[C(t_{1j}, t_{2j}), C(t_{1j}, t_{3j}), \ldots, C(t_{n-1j}, t_{nj})] \tag{6}$$

where C is a comparison function, say $\frac{1}{2}\,|y_i - y_j|^2$, and G is an aggregation function, say, $\Sigma_i \Sigma_j\ (i \neq j)$. Note that S is monotone in C, which may be undesirable, since the value of S depends on the initial distribution and units of y. Normalization of S by an aggregation of S, say Δ, eliminates this problem of unit dependence.

With these general considerations of the major components of an index number, we now turn to the formulation of one that will summarize tax and spending impacts. Our goal is to obtain t_{ij}'s at the individual level, compare, and aggregate them to make economy-wide S-scores of various programs. However, as is well known, T_i and E_{ij} simply are not available, and the question arises how one may reasonably obtain t_{ij} for some reasonable aggregation of i without having access directly to data on T_i and E_{ij}. The construct of the representative person among n individuals in a jurisdiction permits us to use $(\alpha_1 \Sigma_{i=1}^n T_i - \Sigma_{i=1}^n E_{i1})/\Sigma_{i=1}^n Y_i$ in lieu of $(\alpha_1/n)\ \Sigma_{i=1}^n [(T_i - E_{i1})/Y_i]$ as an estimate of the net effective rate of taxation for the numeraire and other programs.

In making comparisons across areas, we would like to compare representative

[2]It should be observed that an SWF is usually thought to be open-ended in value, so that higher levels of the SWF denote more well-being to society. Index numbers, to be useful, may be bounded, as the Gini is between zero and one. On the other hand, there are index numbers, widely used, which are not normalized or bounded, and may be thought to be structured in form identical with an SWF. In the index numbers developed in this paper, care is taken to distinguish between normalized versions both for numerical and evaluation purposes.

values of E, T, and Y. Let E_i^*, T_i^*, and Y_i^* be the representative person's expenditures, taxes, and income for an area. The representative net effective tax rate is given by

$$(7) \qquad \frac{\alpha_1 T_i^* - E_{i1}^*}{Y_i^*}$$

In a statistical sense, it is reasonable to generate such representative values from the first moments of each actual distribution:

$$(8) \qquad \epsilon(E_{i1}) \equiv E_{i1}^*, \epsilon(T_i) \equiv T_i^*, \text{ and } \epsilon(Y_i) \equiv Y_i^*$$

Now, asymptotically

$$(9) \qquad \frac{1}{n}\sum_{i=1}^{n} E_{i1} \to \epsilon(E_{i1}), \frac{1}{n}\sum_{i=1}^{n} T_i \to (T_i), \text{ and } \frac{1}{n}\sum_{i=1}^{n} Y_i \to \epsilon(y_i)$$

Combining (8) with this yields

$$(10) \qquad \frac{\frac{\alpha_1}{n}\sum_{i=1}^{n} T_i - \frac{1}{n}\sum_{i=1}^{n} E_{i1}}{\sum_{i=1}^{n} Y_i} \simeq \frac{\alpha_1 T_i^* - E_{i1}^*}{y_i}, \text{ or } \frac{\alpha_1 \sum_{i=1}^{n} T_i - \sum_{i=1}^{n} E_i}{\sum_{i=1}^{n} Y_i} \simeq \frac{\alpha T_i^* - E_{i1}^*}{Y_i^*}$$

2.3.2. *Operational Measures of Vertical and Horizontal Equity of Expenditure and Tax Programs.*[3] We now develop the C and G functions to characterize the distribution of spending and taxes for S county areas. To keep subsequent computations tractable, we compare all possible pairs of areas' variable values and thus fix the group size at 2. Also, because we are interested in the usual subjective notions of vertical and horizontal tax equity, we consider two variables per area in our development below: the pretax, pretransfer, average family income of the ith area, Y_i, and the net, effective tax rate of the area, t_i, which is the ratio of (taxes$_i$ − expenditures$_{ij}$)) to total area income, Y_i, as developed above. We take up first the single-grant case, and then the important two-grant case.

2.3.3. *S-Index Measure of E, t, and Y, j = 1: General Development.* To describe the vertical characteristics of the grant and tax system, we partition county areas into three groups: the fraction of areas whose net effective tax rates, t, vis-à-vis others is progressively distributed ϕ; the fraction of areas whose net liability is proportionately distributed, θ; and the fraction of areas whose liability is regressively distributed vis-à-vis others, γ, $(\phi + \theta + \gamma = 1)$. A comparison of two areas' net effective tax rates shows progressivity when both the average income and the effective tax rate of one are greater than the average income and effective tax rate of the other. Proportionality occurs when the average incomes of the two areas are different but the effective tax rates are the same. Regressivity is said to occur when one area has a larger income but a lower effective tax rate than the other. By adding up the number of each type of comparison and dividing by the total number

[3]The development in this section closely follows Berliant and Strauss (1983).

of comparisons, we obtain the fraction of areas displaying progressivity, proportionality, and regressivity in the net distribution of grants and taxes.

To ascertain the extent to which effective net tax rates are progressive, proportional, and regressive among areas, we take into account not only the count of each type of comparison, but also the degree of the income and tax rate disparity. Our subjective judgment is that it matters whether area 1, with net effective tax rate of 8 percent, and area 2, with net effective tax rate of 4 percent, have similar or very different average family incomes. Accordingly, we weight each comparison by the absolute difference in income of each pair of areas.

Similarly, it would seem to matter whether the net effective tax rates of areas 1 and 2 are similar or very different. If area 1 had an average income of $30,000 and area 2 had an average income of $15,000, it would seem important to observe whether their respective tax rates were 2.8 percent and 2 percent, or 3.2 percent and 1.8 percent. The former would appear to be a less progressive comparison than the latter. When we account for the disparity in tax rates, we weight by the ratio rather than the difference in tax rates for two reasons. First, using the ratio effectively distinguishes between a paired comparison of 1.4 percent and 1.0 percent vis-à-vis 5.4 percent and 5.0 percent, whereas using (absolute) differences in tax rates would not.[4] Second, using a ratio is more effective mathematically for dealing with proportional comparisons ($t_i = t_j, y_i = y_j$), since $t_i/t_j = 1$ while $|t_i - t_j| = 0$. In the latter case, such a formula would yield a weight of 0.

Our analysis of tax rates is in terms of net effective rates of taxation. Another approach would be to compare areas in terms of how much income they retain after grants and taxation, or their after-tax income rate. The two approaches are obviously related. If the effective tax rate is t, then the after-tax income approach to measuring vertical equity involves comparisons of $1 - t$. The scoring of comparisons in terms of progressivity, regressivity, and proportionality would be the same in both instances, except that progressivity would be deemed to occur when the fraction of retained or after-tax income declined as income rose. Mathematically, $\max\{t_1/t_2, t_2/t_1\}$ and $\max\{(1 - t_1)/(1 - t_2), (1 - t_2)/(1 - t_1)\}$ are monotonically related. Note, however, that the second expression is not invariant to scalar multiplication, and thus does not have all the desired properties associated with a modern index number.

The three fractions (progressive, proportional, and regressive) are obtained essentially by making all possible comparisons among areas and weighting each comparison by the income and tax rate disparities, and dividing the weighted count of these progressive, proportional, and regressive comparisons by the total number of weighted comparisons. Ideally, such analysis should be performed on each pair of county areas; however, in order to keep the analysis tractable, it is necessary to compare numbers of counties in income-effective tax rate classes with those in other income effective tax rate classes.

Unlike vertical equity, it would appear that the concept of horizontal equity

[4]It should be noted that the tax rate difference approach, although intuitively less plausible, is the weighting scheme used by Suits (1977) and Wertz (1978).

does not admit of progressive, proportional, or regressive distinctions. Usually, horizontal equity denotes identical tax treatment of those in the same economic circumstances. Measuring horizontal equity thus requires a plausible criterion for testing whether two areas' level of well-being are judged to be identical. Whether the absence of the same effective tax rates for areas in the same income class is in a sense "good" or "bad" becomes problematical.[5] Accordingly, we shall measure the extent to which effective rates are different instances of inequity among all paired comparisons of areas, and the extent to which effective tax rates are the same instance of equity within each income class. As with the measure of vertical equity, we weight by the ratio of the rank of effective tax rate classes to account for the extent to which horizontal inequity occurs.

2.3.4. *Algebraic Statement of S-Index.* To facilitate the algebraic development of the S-index numbers, let there be $i = 1, \ldots, m$ ordered effective tax rate classes and $j = 1, \ldots, n$ ordered family income classes for the first group of areas, and let there be $h = 1, \ldots, m$ effective tax rate classes and $k = 1, \ldots, n$ ordered family income classes of the second group of areas ($i \neq h$, and $j \neq k$, so we do not compare taxpayers to themselves). Further, let N_{ij} be the number of areas in ijth tax rate-family income group which is to be compared to N_{hk}, the number of areas in the hkth tax rate-economic income group. Note that increasing subscripts denotes higher family income and higher effective tax rate classes, and that $j = k = 1$ is the lowest negative tax rate class. To deal with a comparison between a positive and negative tax rate, we take a ratio of the tax rate class ranks (or subscripts) rather than the ratio of the average tax rates in the classes themselves.

Of course, any monotone, increasing transformation of tax rates, such as the rank, may be used in lieu of the rates themselves. Thus, negative tax rates may be handled in many ways; how the tax variable enters the index number determines the trade-offs associated with different comparisons. The same reasoning applies to the handling of negative incomes and the manner in which incomes enter into index number.

We obtain our measure of the extent to which taxes are proportionately distributed, θ, by making all possible comparisons among groups of areas in the same effective tax rate class but with different family income classes ($j \neq k$), and then add up these proportional comparisons from different effective tax rate classes to get the total number of proportional comparisons. Normalization by the sum of all weighted comparisons, Δ, provides the fraction of weighted comparisons

[5]Feldstein (1976), Atkinson (1979), and Plotnick (1980) discuss in some detail the conceptual problems of horizontal equity. Our approach here is simply to examine disparities in tax treatment of tax units with the same economic income, and abstract from the complex issues of differential behavioral response to preferential tax treatment of certain sources of income. We differ in our analysis of horizontal equity from Atkinson (1979) in that we view horizontal equity as a two-variable measurement problem, pretax economic income and tax rate, rather than a univariate measurement problem involving income. Our approach to measuring horizontal equality differs also from Brennan (1971) in that the number of unequal comparisons, weighted by the extent of the relative tax rate disparity, is analyzed, rather than the money value of the disparities. Thus, Brennan's approach would appear to be undesirably unit-dependent. For a critical review of this new view of horizontal equity, see Berliant and Strauss (1985).

in which tax liability is proportionately distributed:

$$\text{(11)} \qquad \theta = \frac{1}{\Delta} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{\substack{k=1 \\ k \neq j}}^{n} (N_{ij} N_{ik} \,|\, Y_{ij} - Y_{ik} \,|)$$

The fraction of taxpayers whose tax liability is progressively distributed, ϕ, is obtained by accumulating across comparisons in which the effective tax rate and economic income classes of the second group of taxpayers are smaller than those of the first group of taxpayers ($h < i, k < j$), and by accumulating across comparisons in which the effective tax rate and economic income of the second group of taxpayers are greater than the first group of taxpayers ($h > i, k > j$). Since tax rates vary now in these progressive comparisons, we weight by the ratio of the ranks of tax rate classes discussed above. Note that in forming the weight for the tax-rate ratio, we always divide the larger rank by the smaller rank of effective tax rates to insure that comparisons are treated symmetrically. Since the first group of progressive comparisons always entails $h < i$, we form the weight as i/h; similarly, since the second group of progressive comparisons always entails $h > i$, we form the weight as h/i. Thus, for ϕ, we have:

$$\text{(12)} \qquad \phi = \frac{1}{\Delta} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{h<1}^{m} \sum_{k<j}^{n} \left(N_{ij} \frac{i}{h} \,|\, Y_{ij} - Y_{hk} \,| \right) + \frac{1}{\Delta} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{h>i}^{m} \sum_{k>j}^{n} \left(N_{ij} N_{hk} \frac{h}{i} \,|\, Y_{ij} - Y_{hk} \,| \right)$$

The fraction of areas whose tax liability is regressively distributed, γ, is obtained in the same manner as the fraction of areas whose tax liability is progressively distributed, except now $h > i$, and $k > j$ in the first accumulation, and $h > i$ and $k > j$ in the second accumulation. For the comparisons to be regressive, the second group of areas either has lower effective tax rates and greater economic income, or higher effective rates and lower economic income than the first group of areas. Since in the first accumulation the effective rate of the second is lower than the first group of areas, our tax rate weight for regressivity is formed as i/h. Similarly, our tax rate weight for the second accumulation is γ:

$$\text{(13)} \qquad \gamma = \frac{1}{\Delta} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{h>i}^{m} \sum_{k<j}^{n} \left[(N_{ij} N_{hk}) \frac{i}{h} \,|\, Y_{ij} - Y_{hk} \,| \right] + \frac{1}{\Delta} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{h>i}^{m} \sum_{k<j}^{n} (N_{ij} N_{hk}) \frac{h}{i} \,|\, Y_{ij} - Y_{hk} \,|$$

As may be evident, Δ can be obtained from summing the right-hand sides of (11)–(13) without the initial $1/\Delta$ terms, or more compactly

$$\text{(14)} \qquad \Delta = \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{h=1}^{m} \sum_{\substack{k=1 \\ k \neq j}}^{n} \left[N_{ij} N_{hk} \max \left(\frac{i}{h}, \frac{h}{i} \right) |\, Y_{ij} - Y_{hk} \,| \right]$$

If one obtains Δ from (14), then γ may be obtained as $1 - \theta - \phi$.

Several comments about the index of vertical tax equity reflected in (11)–(14) are in order. First, it is invariant to linear transformation of income or tax rates, and is invariant with respect to multiplication or division by a constant. This means that the index is independent of the units of measure. Second, all variations of the numerator and denominator of the index are symmetric and additively separable with respect to comparisons of each of the three types. The index as a whole is invariant with respect to proportional shifts in any factor or factors. Thus, our empirical social welfare function/index number displays variants of the axioms Atkinson recommends for I and SWF.

Let us now turn to the matter of horizontal equity. Recall that the measurement of horizontal equity entails tax rate comparisons of areas with the same incomes. Thus, since analysis is done within each income class ($j = k$), there are no income differences to weight by. More precisely, we compactly define the fraction of areas with the same income, but whose tax liability is different from other taxpayers with same income, or the index of horizontal inequity, β, as

$$\beta = \frac{1}{\tau} \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{\substack{h=1 \\ h \neq 1}}^{m} \left[N_{ij} N_{hj} \max \left(\frac{i}{h}, \frac{h}{i} \right) \right] \tag{15}$$

where the sum of the inequity and equity comparisons, τ, is

$$\tau = \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{\substack{h=1 \\ h \neq 1}}^{m} \left[N_{ij} N_{hj} \max \left(\frac{i}{h}, \frac{h}{i} \right) \right] + \sum_{i=1}^{m} \sum_{j=1}^{n} [N_{ij} (N_{ij} - 1)] \tag{16}$$

The second term in (16) represents the number of comparisons in which the effective tax rates and income classes are the same ($i = h$), ($j = k$). A total of N_{ij}^2 comparisons are possible; however, this would involve N_{ij} inappropriate comparisons of areas with themselves. Eliminating these cases results in $N_{ij}(N_{ij} - 1)$ comparisons. The complement of β is our measure of horizontal equity. The fractions of β and $1 - \beta$ differ from those developed by Wertz (1975) in that the extent of effective tax rate differences are accounted for in (15) and (16).

2.3.5. *S-Index Measures of E_{ij}, T_i, and Y_i: The Multigrant case.* The vertical and horizontal group utility index numbers developed above, like other index numbers used for distribution analysis (e.g., the Gini or variance), are static portrayals of the distribution of income and net tax burdens among areas. The group-utility index numbers developed do have the desirable property that each is bounded by 0 and 1, so that one could compare, for example, θ for General Revenue Sharing and θ under Countercyclical Revenue Sharing. However, both the traditional vertical measure, such as the Gini, or θ, developed above, presume anonymity; that is, the switching of membership of rich and poor areas will not affect the value of the index number when computed. For policy purposes, this property of anonymity is unsatisfactory, because the policy maker is usually interested in how different the distributional impact would be if one used formula b instead of formula a, given all results of formula a to begin with. These considerations suggest that it would be useful to characterize the relative net tax positions of all pairs of county areas before and after the change to a new program, and therefore eliminate the anonymity property usually associated with index numbers. Below, we give an

FIGURE 1: Definition of Two-Grant Index Number Values.

Grant 1 Initial Comparison is:		Grant 2 More Progressive	No Change	More Regressive
Progressive	$y_1 > y_2$ $t_1 > t_2$	$\frac{t'_1}{t_1} > \frac{t'_2}{t_2}$	$\frac{t'_1}{t_1} = \frac{t'_2}{t_2}$	$\frac{t'_1}{t_1} < \frac{t'_2}{t_2}$
Proportional:	$y_1 \neq y_2$ $t_1 = t_2$	$t'_1 < t'_2$ for $y_2 < y_1$	$\frac{t'_1}{t_1} = \frac{t'_2}{t_2}$	$t'_1 < t'_2$ for $y_1 > y_2$
Regressive:	$y_1 < y_2$ $t_1 > t_2$	$\frac{t'_1}{t_1} < \frac{t'_2}{t_2}$	$\frac{t'_1}{t_1} = \frac{t'_1}{t_2}$	$\frac{t'_2}{t_1} > \frac{t'_2}{t_2}$

Notes: y is average family income in area 1 or 2 and Y is total area income; t is effective tax rate for grant 1, $t = (T - E)/Y$; t' is effective tax rate for grant 2, $t' = (T' - E')/Y$.

intuitive statement of how such a two-grant index of vertical equity may be developed.

To permit an intertemporal or two-grant comparison of relative vertical net tax status among pairs of areas, we need to characterize the vertical grant and net tax status among pairs of areas, were they to get the second grant in lieu of the first grant. No change is said to occur if the relative vertical distribution of taxes when comparing the net effective tax rate of the second grant to that of the first grant is maintained for the first grant after the net tax change. For example, if initially $y_1 =$ \$30,000, $y_2 =$ \$10,000, $t_1 = 0.15$, and $t_2 = 0.05$, we would score that as a progressive comparison for the first grant. If t_1 and t_2 remain the same for the second grant, the change is said to be "no change," because the relative net tax rates for the particular areas did not change. Note that economic income is defined to be independent of tax and expenditure schemes. We thus characterize any maintenance of relative net tax position for the second grant vis-à-vis the first grant, be it progressive as above, regressive, or proportional, as no change.

The characterization of multigrant progressive and regressive net tax changes then follows immediately. If the relative net tax position of a pair of areas is more progressive, less regressive, or involves movement from proportionality to progressivity, then the comparison for the second grant is said to be more progressive. Similarly, if the relative net tax position of a pair of areas in the second time period is less progressive, more regressive, or a movement from proportionality to regressivity, then the comparison for the second grant is characterized as more regressive.

Figure 1 displays the various possibilities for grant 1 and grant 2, and identifies which movements in relative net tax position are more progressive, no change, and more regressive.[6] Note that every comparison must fit into exactly one category. Once we have decided which comparisons are progressive, proportional,

[6]The mathematics underlying this measure may be found in Berliant and Strauss (1985).

or regressive, the index numbers are computed simply by counting the number of comparisons of each type and dividing the three counts by the total number of comparisons. To see that these index numbers are of form S^*, note that each numerator consists of the sum of paired comparisons: the comparison value is 1 if the comparison is of the proper type and 0 otherwise. Note that the determination of comparison type depends only on three variable values of each pair of areas. Thus, the numerators are of the form S. If every vertical comparison is given a score of 1 irrespective of the variable values, the sum of all comparisons, or the denominator, is of form S. Hence the index number is of the form S^*.

3. FEDERAL GRANT PROGRAMS AND TAXES ANALYZED: EMPIRICAL RESULTS

3.1. *Grant Programs and Data*

Four major federal grant-in-aid programs were selected for the equity analysis developed above: General Revenue Sharing (GRS), Anti Recession Countercyclical Assistance (ARFA), the Community Block Grant Program (CDBG), and Title II of the Elementary and Secondary Education Act of 1965 (LEA). In addition, we use the Congressional Budget Office's 1977 estimate of all federal grants in aid which are reliably kept in *Troubled Local Economies and the Distribution of Federal Dollars* [Congressional Budget Office (1977)].

Data on the above programs were obtained from a variety of sources. Information on local GRS and ARFA grants for Entitlement Period 1 were provided to the authors on magnetic tape by the Office of Revenue Sharing, U.S. Department of Treasury. These data reflect entitlement payments to counties, cities, townships, and qualified Indian tribes. Aggregate county area figures were obtained by aggregating across types of governments within each county area, and prorating on the basis of population over 2,000 jurisdictions which lie in more than one county.

Data on the Community Development Block Grant program were provided on magnetic tape to the authors by the U.S. Department of Housing and Urban Development. The data refer to two aspects of CDBG program: amounts approved for payment (CDBG 1), and amounts invited for the discretionary program (CDBG 2) under CDBG. These second allocations represent upper boundaries on grants which could be awarded and were, generally, to smaller jurisdictions. Approved amounts reflect amounts which were successfully applied for and which can ultimately be spent. The second amount reflects amounts of a discretionary nature which jurisdictions are invited to apply for; both refer to Federal FY 77.

Unpublished data on allocations for Title II of the Primary and Secondary were provided in hard copy form to the authors by the Congressional Research Service of the Library of Congress for 1977 and 1978. Data for CBO's estimate of total federal grants-in-aid were provided to the authors on magnetic tape by the Congressional Budget Office. Data on county area federal individual income tax collections were obtained in hard copy from Table 3 of Internal Revenue Service (1974) and put in machine readable form. Average family income was from the

TABLE 1: Percentage of County Areas by Region Receiving Selected Federal Grants

	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Northeast	100.0	97.0	77.6	74.6	100.0	100.0	100.0
Middle Atlantic	100.0	100.0	79.5	60.9	100.0	100.0	100.0
East North Central	100.0	93.8	52.4	43.0	100.0	100.0	99.8
West North Central	100.0	57.0	37.5	30.0	99.8	99.8	100.0
South Atlantic	99.7	93.2	46.4	34.3	100.0	100.0	100.0
East South Central	100.0	92.6	49.2	32.1	100.0	100.0	100.0
West South Central	100.0	74.3	40.6	30.0	100.0	100.0	100.0
Mountain	99.6	82.4	36.2	32.6	98.9	98.9	99.6
Pacific	91.3	92.0	61.3	46.7	100.0	100.0	100.0

1970 Census of Population, and represents the total money income of the average family.

3.2. *Empirical Results*

We provide here the results of applying the methodology developed in Section 2 to the data on federal grant programs described in Section 3.1. First, some total and regional characteristics of the data are described. Second, the equity analysis results are reported.

3.2.1. *Characteristics of the Data.* In most states, the concept of a county area is geographically precise, and the geo-matching of program grant data to the Census of Population's geographic concepts is straightforward. The states of Alaska and Virginia, however, proved to be quite challenging. In Alaska, the concept of county within which lie cities does not exist. Moreover, new incorporations and the complete revision of the Department of Treasury's Office of Revenue Sharing's (and Census Bureau's) geo-definitions during the period of grant data complicated the tasks even more. In Virginia, the rapid growth in the number of home-rule cities, which are treated as county areas for Census Bureau purposes, necessitated manual matches. For some areas, tax data from the Internal Revenue Service (1974) were not available. Overall, there were 3,146 county areas of which 3,137 were partly usable. Most analysis was performed on 3,121 county areas. The District of Columbia was included in all analysis as a local area. Where average family income was not available, it was forecast with the parameters of a polynomial regression relating average family income and per capita income for areas with both variables.

Of immediate interest is the general prevalence of the grants being analyzed. Table 1 displays, by region, the fraction of county areas in the data which received each grant as well as the total CBO figure.[7] GRS, LEA77, and LEA78, and CBO provided assistance to virtually all county areas in the U.S. ARFA and CDBG1 and

[7]It should be noted that, in the empirical work below, areas without expenditures from a grant program are treated as paying purely taxes.

CDBG2 showed greater variability in coverage. Thus, for example, while the aforementioned grants (GRS, LEA77, LEA78, and CBO) provided federal assistance in at least 91.3 percent of the county areas in each region, such programs as ARFA provided aid in as few as 57 percent of the county areas (in the West Central region), while CDBG1 provided aid in 36.2 percent of the Mountain region's county areas.

3.2.2. *Regional Characteristics of Per Capita Grant Payments and Taxes.* There is substantial variation in the regional per capita grants and taxes. Mean per capita payments are displayed in Panel A of Table 2. On this basis, the West North Central region's average county receives $18.59 per capita, contrasted to $22.04 for the Pacific region—a 19 percent differential. In terms of tax collections, the West North Central region's average county's residents paid $495.12 in federal personal taxes per capita, while the Middle Atlantic region's average county paid $534.19 per capita.

Finally, we may look at what areas received and what they paid on a relative basis per grant. Panel B of Table 2 contains, by region, the percent distribution of

TABLE 2: Regional Characteristics of Grants

Panel A
Mean Per Capita County Area Grants and Taxes

Census Region	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO	T
Northeast	24.89	5.34	13.85	1.76	5.94	6.69	295.90	513.90
Middle Atlantic	19.95	6.05	15.54	0.76	6.86	8.38	219.30	534.19
East North Central	19.18	3.56	10.81	0.36	6.81	7.53	200.00	523.96
West North Central	18.59	0.78	10.56	0.15	8.58	9.63	222.80	495.12
South Atlantic	20.15	3.35	11.17	0.24	12.82	14.58	256.20	422.12
East South Central	21.17	3.23	12.68	0.20	15.56	17.69	272.40	330.28
West South Central	20.26	2.89	11.44	0.21	12.92	14.71	253.20	419.60
Mountain	23.73	3.48	9.74	0.13	8.43	9.56	587.30	473.92
Pacific	22.04	8.42	10.19	0.30	8.47	9.39	493.50	579.34

Panel B
Percent Distribution of Total Grants and Taxes

Census Region	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO	T
Northeast	6.3	5.9	7.4	12.9[1]	4.1[2]	4.2	6.2	6.1
Middle Atlantic	19.8	33.0[1]	22.6	12.2[2]	18.9	18.7	19.1	19.4
East North Central	18.0[1]	13.2	18.7	17.3	15.9	15.3	17.1[1]	21.2
West North Central	7.1	2.1[2]	7.4	10.7[1]	6.4	6.3	6.9	7.5
South Atlantic	14.4	12.6[2]	13.7	15.6	17.9	18.2[1]	16.3	14.8
East South Central	6.6	4.1[2]	6.1	10.7[1]	9.9	10.0	6.3	4.7
West South Central	8.9	6.9	8.9	11.2	12.2	12.4[1]	8.7[2]	8.4
Mountain	4.5	3.5[2]	3.6	4.1	3.8	3.9	5.2[1]	4.0
Pacific	14.4	18.7	11.6	5.1[2]	11.0	11.0	14.0[1]	13.8
Total	100.0	100.0	100.0	99.8	100.1	100.0	98.8	99.9

Note: 1 = most favorable, 2 = least favorable. Totals may not add to 100 percent due to rounding.

grants and taxes. Thus, the Northeast received 6.3 percent of GRS and paid 6.1 percent, experiencing in effect a net gain. CDBG2 was the most favorable in this regard for the Northeast while LEA77 was least favorable.

3.3. *Equity Analysis*

3.3.1. *Single-Grant Results, National Level.* Table 3 reports the vertical and horizontal index numbers of the various grant programs. With regard to the vertical index number, recall that all possible paired comparisons of the 3,100 odd areas' effective tax rates can be characterized as progressive, regressive, or proportional when the rates are examined in conjunction with the average family income which proxies for the representative person's ability to pay. Of immediate interest is the finding that all programs, including the overall measure (CBO), display a significant amount of regressivity. For example, under GRS, 42.2 percent of the comparisons displayed regressivity—areas with higher average family income frequently experience lower net effective tax rates than areas with lower average family incomes. ARFA displayed the smallest fraction of regressivity; however, this lower bound was still quite high—37.4 percent.

With respect to progressivity, the most progressive grant program was ARFA which displayed progressivity in 51.9 percent of its comparisons, while the least progressive program was CDBG2 at 33.7 percent. Of interest is that the latter is the most discretionary of the programs examined.

Not only is there significant evidence of regressivity in every grant program's distribution, but there is also significant evidence of horizontal inequity. More than 76.3 percent of the horizontal comparisons under CDBG displayed horizontal inequity. That is, when we compare effective tax rates under CDBG2 for areas with the same average family income, we find that the effective rates differ 76.3 percent of the time. The most horizontally equitable program is CDBG2, while the least horizontally equitable program is ARFA.

The most vertically progressive program is the least horizontally equitable, and vice versa. To investigate this more systematically, we plot the progressive scores against the horizontal equity scores in Table 3. Figure 2 displays the plot and

TABLE 3: Vertical and Horizontal Equity of Selected Federal Block Grants

	Grant						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Vertical Equity: Fraction of Comparisons							
Progressive	39.1	51.9	50.6	33.7	41.9	41.2	44.7
Regressive	42.2	37.4	37.6	45.6	42.9	43.5	40.6
Proportional	18.7	10.8	11.8	20.8	15.2	15.3	14.7
Horizontal Equity: Fraction of Comparisons							
Equitable	20.5	8.3	14.1	23.7	17.8	18.6	15.3
Inequitable	79.5	91.7	85.9	76.3	82.2	81.4	84.7

visually confirms the conjectured inverse relationship between horizontal equity and vertical progressivity for the seven grants under investigation. We may put the relationship in Figure 2 in a statistical framework by estimating a regression of the form

$$\text{Progressivity} = \alpha_1 + \alpha_2 \text{ (Horizontal Equity)} + \epsilon$$

Using ordinary least squares we obtain

$$\text{Progressivity} = \underset{(t = 21.8)}{64.17} - \underset{(t = -7.4)}{1.235} \text{ (Horizontal Equity)} \qquad (R^2 = .90)$$

The linear relationship is quite strong. We may further refine our interpretation by evaluating the trade-off in relative terms by calculating the elasticity of progressivity with respect to horizontal equity implied in the data. Evaluated at the means, the elasticity is −0.48. That is, a 1 percent increase in horizontal equity is associated with a 0.48 percent decline in vertical progressivity.

3.3.2. *Single-Grant Results: Regional Disaggregation.* The inverse relationship between vertical and horizontal equity is an intriguing empirical regularity. The question arises whether or not the relationship displayed in Figure 2 is an artifact of aggregating the results of thousands of comparisons across seven grants. The regional character of the underlying data base permits us to repeat the above analysis for each grant for each census region. Regional stratification provides 63

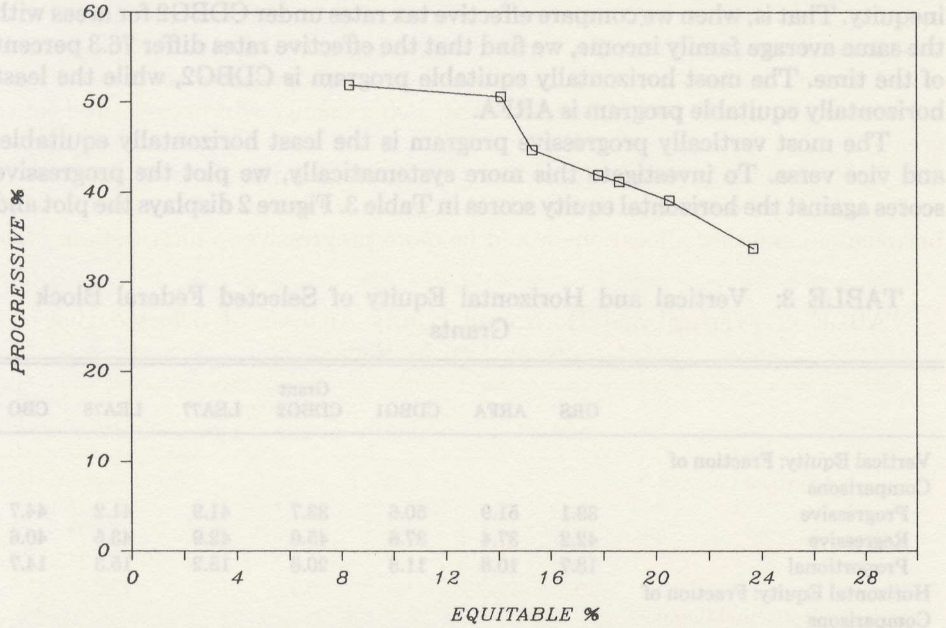

FIGURE 2: Plot of Fraction of Areas Showing Vertical Progressivity vs Horizontal Equity

joint observations on vertical progressivity and horizontal equity (9 census regions and 7 grants = 63 data points). The results of this stratification are contained in Table 4. Casual inspection of this table suggests that the inverse relation found above is consistent: however, some simple regression analysis can summarize the results of Table 4 more effectively. First, consider within each region that we have seven joint observations on vertical and horizontal equity which corresponds to each of the seven grants. Thus, nine regressions can be estimated which relate vertical to horizontal equity. Second, as we have seven grants across nine regions, we can analyze how variations in each grant's regional vertical and horizontal scores relate. Tables 5 and 6 contain these respective regression results.

This regional disaggregation continues to confirm the inverse relationship between vertical and horizontal equity. Within each region, statistically significant inverse relationships are apparent in six of nine regressions. In terms of the elasticity of progressivity with regard to horizontal equity, these results show elasticities ranging from −0.25 to −0.66. Analysis of each grant across regions reveals a significant, inverse relationship in six of the seven grants. Estimated elasticities are somewhat higher and range from −0.38 (CBO) to −0.89 (CDBG2). Based on the national and regional analysis, it is clear that to the extent federal block grants achieve vertical progressivity, they do so at the expense of horizontal equity.

3.3.3. *Multiple-Grant Equity Analysis.* The equity analysis so far has compared net effective tax rate distributions for different programs. From a policy perspective this may be less interesting than inquiring how areas would be affected if one were to move funds from one grant formula to another. For example, Table 2 suggests that GRS is less progressive than ARFA, and raises the question of whether taking funds from GRS and distributing them via the ARFA formula would indeed make the overall distribution more progressive. As noted in the discussion above it is not self-evident that such a change will necessarily lead to greater equity.

Table 7 contains the results of such a multiple-grant analysis. If one were to replace the GRS formula with the ARFA formula, 53 percent of the comparisons between old and new allocations would be more progressive in distribution. Note

TABLE 4: Vertical and Horizontal Equity Analysis of Selected Block Grants by Census Region

	NORTHEAST						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	9.6	17.9	40.1	22.5	6.0	8.1	28.1
Regressive	79.9	69.6	48.4	68.2	77.3	73.8	60.0
Proportional	10.5	12.5	11.5	6.3	16.7	18.0	11.9
Fraction of Horizontal Comparisons:							
Equitable	49.7	41.9	33.7	29.1	54.0	55.2	40.9
Inequitable	50.3	58.1	66.3	70.9	46.0	44.8	59.1

TABLE 4: Continued

	MIDDLE ATLANTIC						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	55.9	59.0	54.7	42.6	57.2	55.2	58.8
Regressive	29.1	33.2	34.2	41.5	30.0	30.9	29.6
Proportional	15.1	7.8	11.1	15.9	12.7	14.0	11.5
Fraction of Horizontal Comparisons:							
Equitable	22.0	17.9	29.2	28.1	20.5	21.5	20.3
Inequitable	78.0	82.1	70.8	71.9	79.5	78.5	79.7

	EAST NORTH CENTRAL						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	53.5	63.6	63.2	38.2	56.2	56.2	60.1
Regressive	24.3	24.3	26.3	42.1	25.9	25.4	26.6
Proportional	22.2	12.1	10.6	19.7	17.9	18.4	13.4
Fraction of Horizontal Comparisons:							
Equitable	25.3	18.8	20.7	31.3	18.5	19.8	20.2
Inequitable	74.7	81.2	79.3	68.7	81.5	80.2	79.8

	WEST NORTH CENTRAL						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	45.8	57.5	52.5	42.0	50.9	50.4	47.7
Regressive	33.3	32.2	38.4	40.1	31.7	32.1	38.8
Proportional	20.9	10.2	9.1	17.9	17.5	17.5	13.6
Fraction of Horizontal Comparisons:							
Equitable	25.0	17.8	20.2	30.0	18.2	19.5	20.0
Inequitable	75.0	82.2	79.8	70.0	81.8	80.5	80.0

	SOUTH ATLANTIC						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons							
Progressive	45.7	49.2	50.9	40.9	47.4	47.0	47.8
Regressive	35.5	39.3	38.7	42.7	40.7	41.5	38.0
Proportional	18.8	11.5	10.4	16.4	11.9	11.5	14.2
Fraction of Horizontal Comparisons:							
Equitable	23.6	15.4	17.7	26.2	17.1	18.1	18.9
Inequitable	76.4	84.6	82.3	73.8	82.9	81.9	81.1

TABLE 4: Continued

EAST SOUTH CENTRAL	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	50.7	54.7	50.1	55.2	60.1	59.4	50.9
Regressive	33.7	32.6	38.9	31.1	31.4	32.3	35.5
Proportional	15.6	12.7	11.0	13.7	8.6	8.3	13.6
Fraction of Horizontal Comparisons:							
Equitable	22.1	14.7	16.5	20.7	15.6	16.5	18.0
Inequitable	77.9	85.3	83.5	79.3	84.4	83.5	82.0

WEST SOUTH CENTRAL GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	45.0	52.2	50.3	50.3	54.5	53.9	48.8
Regressive	38.7	37.9	40.6	36.5	34.0	34.8	37.2
Proportional	16.3	9.9	9.1	13.2	11.0	11.3	13.9
Fraction of Horizontal Comparison:							
Equitable	22.5	13.5	15.3	19.9	15.7	17.0	16.8
Inequitable	77.5	86.5	84.7	80.1	84.3	83.0	83.2

MOUNTAIN GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	46.0	54.8	51.4	48.0	61.3	60.7	43.7
Regressive	35.1	34.1	37.2	36.0	24.2	24.6	43.2
Proportional	18.9	11.1	11.5	16.0	14.6	14.7	13.1
Fraction of Horizontal Comparisons:							
Equitable	20.7	13.2	14.8	20.0	15.9	17.1	16.5
Inequitable	79.3	86.8	85.2	80.0	84.1	82.9	83.5

PACIFIC GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	41.3	42.0	46.3	43.8	51.0	51.1	40.1
Regressive	41.4	51.0	40.6	36.4	32.2	32.1	46.0
Proportional	17.2	6.9	13.1	19.8	16.8	16.8	13.9
Fraction of Horizontal Comparisons:							
Equitable	20.8	12.3	14.1	24.5	18.1	18.9	19.2
Inequitable	79.2	87.7	85.6	75.5	81.9	81.1	80.8

TABLE 5: Relationship between Vertical Progressivity and Horizontal Equity by Census Region
[Progressivity = α_1 + α_2 (Horizontal Equity) + u]

	α_1	α_2	Elasticity	$\bar{R}^2$
All Regions	73.1*	−1.15*	−0.53	0.702
Northeast	62.3*	−1.01*	−0.44	0.591
Middle Atlantic	76.7	−0.96*	−0.40	0.426
East North Central	92.6*	−1.67*	−0.66	0.760
West North Central	70.5*	−0.97*	−0.42	0.694
South Atlantic	60.8*	−0.717*	−0.30	0.723
East South Central	65.8*	−0.64	−0.20	0.014
West South Central	63.7*	−0.76*	−0.25	0.397
Mountain	71.2*	−1.12	−0.36	0.024
Pacific	46.2*	−0.06	−0.02	0.010

*Denotes coefficient and elasticity significantly different from zero at 99 percent confidence level.

that going from GRS to ARFA would nonetheless lead to comparisons that would be more regressive; 40.7 percent of all comparisons display a deterioration in progression. Indeed, if one ignores the relationship between LEA77 and LEA78 (because they are the same formulas but reflect data for two years), any sort of replacement of one formula with another always will have a significant regressive element to it: the lower boundary is 38.8 percent in moving from CDBG2 to LEA77. The upper boundary on the improvement in vertical progressivity is 56.9 percent, again between CDBG2 and LEA78. The entries in Table 7 clearly indicate that if one keeps track of initial endowments when examining policy alternatives, one faces a series of Hobson's choices. Vertical enhancements are always accompanied by vertical deteriorations as well.

4. CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

The purpose of this study has been to develop a theoretical methodology for examining the geographic distribution of federal aid. Building on the concept of

TABLE 6: Regression Relationship between Vertical Progressivity and Horizontal Equity by Grants
[Progressivity = θ_1 + θ_2 (Horizontal Equity) + ϵ]

	θ_1	θ_2	Elasticity	$\bar{R}^2$
All Grants	73.1*	−1.15*	−0.53	0.705
GRS	78.5*	−1.35*	−0.79	0.801
ARFA	71.1*	−1.14*	−0.42	0.534
CDBG1	55.1*	−0.19	−0.08	0.001
CDBG2	80.4*	−1.479*	−0.89	0.449
LEA77	77.9*	−1.33*	−0.58	0.920
LEA78	77.4*	−1.25*	−0.58	0.920
CBO	65.6*	−0.86*	−0.38	0.371

*Denotes coefficient and elasticity significantly different from zero at 99 percent confidence level.

TABLE 4: Continued

	EAST SOUTH CENTRAL						
	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	50.7	54.7	50.1	55.2	60.1	59.4	50.9
Regressive	33.7	32.6	38.9	31.1	31.4	32.3	35.5
Proportional	15.6	12.7	11.0	13.7	8.6	8.3	13.6
Fraction of Horizontal Comparisons:							
Equitable	22.1	14.7	16.5	20.7	15.6	16.5	18.0
Inequitable	77.9	85.3	83.5	79.3	84.4	83.5	82.0

	WEST SOUTH CENTRAL						
GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	45.0	52.2	50.3	50.3	54.5	53.9	48.8
Regressive	38.7	37.9	40.6	36.5	34.0	34.8	37.2
Proportional	16.3	9.9	9.1	13.2	11.0	11.3	13.9
Fraction of Horizontal Comparison:							
Equitable	22.5	13.5	15.3	19.9	15.7	17.0	16.8
Inequitable	77.5	86.5	84.7	80.1	84.3	83.0	83.2

	MOUNTAIN						
GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	46.0	54.8	51.4	48.0	61.3	60.7	43.7
Regressive	35.1	34.1	37.2	36.0	24.2	24.6	43.2
Proportional	18.9	11.1	11.5	16.0	14.6	14.7	13.1
Fraction of Horizontal Comparisons:							
Equitable	20.7	13.2	14.8	20.0	15.9	17.1	16.5
Inequitable	79.3	86.8	85.2	80.0	84.1	82.9	83.5

	PACIFIC						
GRANT:	GRS	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
Fraction of Vertical Comparisons:							
Progressive	41.3	42.0	46.3	43.8	51.0	51.1	40.1
Regressive	41.4	51.0	40.6	36.4	32.2	32.1	46.0
Proportional	17.2	6.9	13.1	19.8	16.8	16.8	13.9
Fraction of Horizontal Comparisons:							
Equitable	20.8	12.3	14.1	24.5	18.1	18.9	19.2
Inequitable	79.2	87.7	85.6	75.5	81.9	81.1	80.8

TABLE 7: Changes in Vertical Equity Resulting from Changes in Grant Formulas
(Percent)

FROM: TO:	ARFA	CDBG1	CDBG2	LEA77	LEA78	CBO
GRS						
More Progressive	53.5	48.6	39.9	53.1	52.8	44.3
More Regressive	40.7	45.1	54.8	35.6	35.6	44.0
No Change	5.8	6.3	5.3	11.3	11.6	11.6
ARFA						
More Progressive		42.8	40.0	46.4	46.3	40.5
More Regressive		52.2	55.4	48.4	48.7	54.6
No Change		4.9	4.7	5.1	5.1	5.0
CDBG1						
More Progressive			40.5	49.7	49.3	44.2
More Regressive			54.1	43.6	44.3	49.5
No Change			5.4	6.7	6.3	6.3
CDBG2						
More Progressive				56.8	56.9	53.4
More Regressive				38.8	38.8	42.2
No Change				4.4	4.3	4.4
LEA77						
More Progressive					28.5	39.4
More Regressive					18.8	52.0
No Change					52.6	8.5
LEA78						
More Progressive						39.3
More Regressive						52.2
No Change						8.6

the effective rate of taxation used in the analysis of individual taxes and a series of innovative index numbers developed by Berliant and Strauss (1983) and Wertz (1975), the distribution of several federal block grants was analyzed. Of special utility is an index number that does not assume anonymity—that is, the indices keep track of welfare levels before and after a proposed policy change. In order to make comprehensive statements about the geo-distribution of these grants, the county area level was used as the basic geographic frame of analysis. This level of aggregation permitted the use of IRS tax collection data and the calculation of effective tax rates.

Four important empirical results were identified, as follows:

(1) The grant programs all displayed substantial progressivity and substantial regressivity; also, the overall measure of federal grant activity provided to the project by CBO displayed progressive and regressive elements.

(2) There is substantial, if not overwhelming, horizontal inequity in all of the grants when viewed on a net effective tax basis. Areas with the same average family income were most likely not to face the same effective tax rate at least 75 percent of the time.

(3) There is a definite trade-off between vertical progressivity and horizontal inequity in the grants analyzed. That is, where vertical progressivity becomes more

pronounced, it does so at the expense of horizontal equity. If one performs the equity analysis at the regional level, the three empirical regularities are further substantiated.

(4) If one analyzes the equity impact of going from one grant formula to another, such reallocation does not unambiguously improve progressivity as might be expected by looking at the progressivity score of the initial grant formula and the separate progressivity score of the new grant formula. Using the index number which keeps track of initial and subsequent tax rates resulted in significant (large) increases in regressivity and as well as large increases in progressivity.

With regard to future research, several comments may be made. First, the framework developed here is explicit, and makes clear the importance of identifying the beneficiaries of federal expenditures.[8] Data limitations necessitated the assumption that county residents benefited equally from each grant. This no doubt is a strong assumption; however, even if one had more microdata for individual municipalities or school districts within counties, one would still need to make the same sort of assumption—simply at a finer level of geographic detail. An important area for future research will be to identify more clearly the beneficiaries of federal (or state and local) grants. Second, this sort of effective tax rate analysis should be, in the authors' judgment, performed on more recent expenditure and tax data, and could be linked to regional models of income determination. Finally, the methodology should be applied to other major grant programs and used as a test methodology in the development of new grant-in-aid formulas.

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[8]Whether or not one finds the assumption that all residents (taxpayers) share equally in the benefits of federal block grant programs is to some extent a matter of taste. Even though some residents do not get services from, say, federal aid to disadvantaged students, they may derive substantial utility from the activity from the program which makes the equal benefit assumption more attractive. Also, the realities of fungibility may in fact result in equal service delivery levels.

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