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ON THE EFFICIENCY OF INCOME-TESTING IN TAX-TRANSFER PROGRAMS

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Abstract

The consensus of economic experts is that income-tested programs are more efficient than non-income-tested tax-transfer programs. Most widely favored as a policy proposal is the negative income tax, (NIT) an income-tested program. This view apparently stems from the widespread use of the target efficiency measure--a conceptually flawed measure of technical rather than economic efficiency. In this paper we examine the economic efficiency issue within a two-class model which includes taxpayers along with beneficiaries. Our theoretical analysis establishes the possibility that non-income-tested programs are more efficient than income-tested programs. However, no general qualitative conclusion on the efficiency of income-testing can be drawn. Rather, the theory indicates that the marginal efficiency of income-testing depends upon a number of program parameters and empirical magnitudes. For a simple two-class model, the marginal efficiency of income-testing improves as the substitution effect of poor workers declines relative to that of rich workers. The form of the NIT program and the relative sizes of beneficiary and non-beneficiary groups also affects the marginal efficiency of income-testing.

To illustrate some quantitative aspects of the efficiency of income-testing, we calculate several feasable overlapping NITs and their corresponding credit income taxes (CIT)'s. These are based upon empirical estimates of the labor-supply functions and substitution effects for a national cross-section of U.S. prime-age married males. Some observations are also made for the fully integrated NIT. We present measures of the marginal efficiency of income-testing and of the relative efficiency in terms of welfare loss for comparable NIT

and CIT programs. For relatively generous programs, CITs are superior at the margin and entail less welfare loss than comparable NITs. For the less generous programs examined here, the CIT retains its superiority over certain NITs but some income-testing becomes desirable at the margin. More important, the difference in welfare loss between the two programs is invariably small-less than one-half of one percent of aggregate earnings.

Perhaps the major implication of our findings for policy formulation is that any differential economic efficiency costs between CIT and NIT schemes may well be dominated by other program differences.

ON THE EFFICIENCY OF INCOME-TESTING IN TAX-TRANSFER PROGRAMS*

I. Introduction

Within the economics profession and among public policymakers, there now appears to be a strong preference for income-tested as opposed to non-income-tested tax-transfer programs. The belief that income-testing makes such programs efficient would seem to underlie this preference. The authors of Setting National Priorities: The 1973 Budget argue:[1]

> ...universal payment systems are a very inefficient means for helping those with low incomes, since the benefits are not concentrated where the need is greatest. Large numbers of families would receive allowances and at the same time have their taxes increased to pay for the allowances. Tax rates would have to be raised simply to channel money from the family to the government and back to the family again.

The argument against non-income-tested programs has never really been elaborated beyond this level. Yet, income-tested schemes such as the negative income tax have been the subject of voluminous theoretical analyses, cost estimates, field experiments, and policy proposals.

This paper examines the contention that income-tested tax-transfer programs offer greater economic efficiency than non-income-tested programs. The non-income-tested program explored here is the credit income tax (CIT), sometimes called a "demogrant."[2] This is a single linear tax-transfer schedule with a per capita credit which is "refundable" for households with low incomes. The income-tested program is a negative income tax with a positive income tax; we shall refer to the combined system as an NIT. This is a two-segment piecewise-linear schedule, with the positive tax assumed to be levied at a flat marginal rate.[3] A single marginal tax rate confronts beneficiaries and nonbeneficiaries alike under the CIT. The NIT places a higher marginal tax rate on beneficiaries than the rate imposed on nonbeneficiaries in the positive tax range. Income-testing is said to occur in the NIT because of the higher marginal tax rate faced by beneficiaries.

Our analysis of economic efficiency will abstract from considerations of program administration.[4] Still, much of the interest in distinguishing between income-tested and non-tested programs stems from their administrative methods. While these programs could in principle be administered similarly, they are not likely to be in practice. Because some households will have no income during part or all of the year, any income transfer program must make provisions for payments during the year rather than once annually. Therefore, the question arises of who is to be eligible to receive such payments.

An NIT is almost certain to attempt to limit net payemtns during the year to those who would be net beneficiaries throughout the year. Divergent marginal tax rates in the negative and positive income tax systems combined with fluctuations in income around the break-even level can yield over-payments on an annual basis. Recapture of over-payments by the government--to preserve "annual" horizontal equity--demands large repayments at year's end by some households with relatively low incomes. To avoid this situation, the NIT is likely to require that potential beneficiaries file income report froms during the year in addition to the year-end reckoning with the positive income tax.[5] Some variant of the income report form has been utilized in all NIT experiments and has been proposed in all NIT legislative bills. Thus, the NIT creates a new system of income-testing additional to and separate from that of the positive income tax.

In a credit income tax, an additional income-testing system is unnecessary to avoid overpayments and to achieve "annual" horizontal equity. Because all income is taxed at a constant marginal rate, the accounting period is immaterial and overpayments cannot occur.[6] Under a CIT, gross benefits equal to the credits could be paid to everyone periodically. For persons who were employed, the CIT could be administered as an offset to positive income taxes withheld by the employer, although this is not an essential feature. The CIT does not distinguish beneficiaries from nonbeneficiaries in its administration. In this way it eliminates any aura of a "means test."

Before proceeding to the primary task, we explore non-economic notions of efficiency which have affected thinking on the issue. Then, after an examination of the properties of a two-class model, we present theoretical and empirical analyses of the problem. The theoretical treatment is divided into diagrammatic and algebraic sections. The former suffices to show the basic qualitative findings, but the latter is required for empirical implementation in anything other than polar cases.

II. Target Efficiency

The concept of target efficiency has been used widely by governmental and academic policy analysts as a criterion for evaluating alternative income-transfer programs.[7] It clearly pervades the earlier cited passage which argues against non-income-tested programs. Target efficiency is defined as the proportion of total transfer benefits which accrue to some target group--usually the pre-transfer poor. A target efficiency ratio is a measure of output divided by a measure of input. Target efficiency thus refers not to economic efficiency but to some notion of technical efficiency.

Even as a measure of technical efficiency, though, the target efficiency ratio is flawed. Its denominator, total transfer benefits, is not necessarily a useful measure of inputs or costs. In an income-tested program, total transfer benefits paid are a measure of the cost to government and might approximate the net cost of the program to nonbeneficiaries.[8] In a non-income-tested program, while total transfer benefits are a measure of the cost of the program to government, they do not gauge the net cost of the program to the net losers. Thus, so long as ultimate interest lies in the well-being of people rather than the accounts of government, target efficiency ratios will not even be a good measure of technical efficiency.

A simple example illustrates the preceding point. Imagine a two-man economy with one rich man and one poor man. For now assume that tax-transfers induce no behavioral changes. Suppose that the government decided to increase the poor man's income by $1000. The government could tax the rich man $1000 and transfer this sum to the poor man. Alternatively the government could tax the rich man $2000 and transfer $1000 to both the rich and the poor man. In the former program benefits would be income-tested; in the latter they would not be income-tested.

As conventionally computed, the target efficiency ratios of these two programs would be 1 and 0.5. If the target efficiency ratios of the two programs were computed with the analytically correct measure of cost--the net cost to the rich man--they would both equal unity.[9]

Given its severe deficiencies, how can the widespread use of target efficiency be explained? If there is a fixed budget constraint, then target efficiency will accurately rank the extent to which alternative programs reduce poverty. Suppose that a $5 billion surplus became available for transfer expenditure in the U.S., but that larger expenditures were not politically feasible. In this circumstance, poverty is reduced most by using an income test. To forego its use is to spread the comparatively small sum of $5 billion over such a large number of people (more than 215 million) that benefits would amount to less than $25 per person per year. Such an amount would not make a dent in poverty. If the same $5 billion were expended on an income-tested program, so that only those with incomes below the poverty line benefitted, the U.S. poverty gap would be cut nearly half.

But why budgets should be so limited for transfer programs is not clear.[10] Rational individuals who understood what they would lose from a transfer program should be indifferent as to whether or not programs are income-tested, if their net loss is identical. Yet many persons do not understand how much they are likely to lose or gain from various proposed transfer programs. The Johnson and Nixon Administrations and the Congress approached the area of welfare reform as if there were a relatively fixed budget constraint. Moreover, reactions against

Senator McGovern's "$1000 a head" CIT proposal in 1972 indicated that the electorate are simply scared by large budgetary costs.

Aside from the political constraints which today limit the transfer budget, are there sound economic grounds for doing so? If income-testing in transfer programs does not promote economic efficiency, then a CIT is economically optimal.[11] A credit income tax requires large gross transfers to benefit the poor materially. The expansion of transfer expenditures in this fashion is conventionally gauged as a low target efficiency ratio. Regardless, economic efficiency is the proper guide in maximizing the well-being of society. The remainder of this paper inquires into the economic efficiency of income testing in tax-transfer programs.

III. Properties of a Two-Class Model

Our goal is to evaluate income-testing in tax-transfer programs on the basis of economic efficiency alone. This exercise is possible only for a model with two classes of workers. A model with more than two classes of workers requires the specification of an explicit social-welfare function. This follows because it is not possible to hold constant the utility levels of more than one class of workers while varying the relevant tax-transfer program parameters.[12] An evaluation of economic efficiency proceeds by comparing utility levels of a second class of workers under the two tax-transfer programs.

Let us call the two classes of the model the "poor" and the "rich," distinguished by their hourly market wage rates. We assume that there is only one time period--thereby abstracting from any possible differential effects of the programs on savings. It is therefore natural to assume that neither class possesses any nonemployment income.[13] All market income in this model is earned income, and both classes participate in the labor force.[14] The poor workers, with wage rate W_p, are beneficiaries under either program. The rich workers, with wage rate W_R, are nonbeneficiaries or net taxpayers under either program.

This two-class model may be contrasted with models found in the theoretical literature on optimal income taxation.[15] Those models assume a continuum of skill levels of workers and thus encompass many classes.[16] They require a social welfare function which incorporates ethical views on distribution as well as on the trade-off with economic efficiency. To determine whether the optimal income-tax schedule has a falling, flat, or rising marginal tax rate, the social welfare function must be specified explicitly.[17]

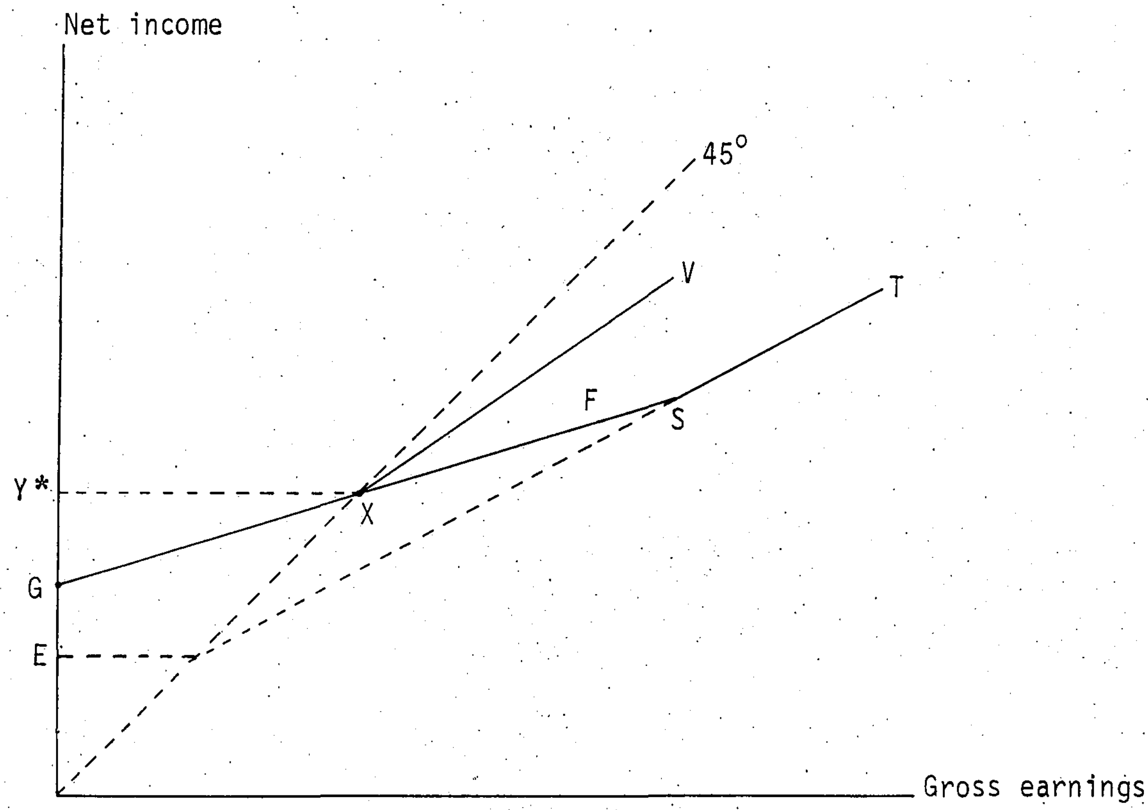
A two-class model can make the pure efficiency assessment without the need for such a statement of values, but this advantage does carry a cost. There is no way to make within-class comparisons in the two-class model. This may be of concern if the two-class model is viewed as a simplification of the continuous reality. Thus, the two transfer programs may bring the representative poor man to the same utility level. The NIT will still tend to convey greater equalization within the poor class, but perhaps less within the rich class, than will the equivalent CIT.[18] Any such "within-class" differences lie beyond the scope of the two-class model. Subject to this limitation, the two-class model achieves a ranking of the two programs that is consistent with <u>any</u> individualistic social welfare function.

Conventional optimal income-tax models restrict workers' tastes for income and leisure to be the same across the entire population. The two-class model developed here requires no such restriction. All members of each class have the same tastes, but these tastes may differ as between classes. This is a decided advantage both for the generality of theoretical analysis and the realism of empirical implementation.

In a two-class model, the two-segment piecewise-linear NIT schedule must be restricted to make the problem meaningful. Otherwise the schedule can be fashioned so as to impose no tax distortion on one of the classes. The two-class model would then have little relevance in a continuous world, as all members of one class would pay the same tax or receive identical net transfers despite their differing earnings. A sufficient restriction on the NIT budget is that its kink occur at an income level appropriately below the equilibrium of the typical rich man but not lower than the break-even income level. In the analogue of the continuous world, the kink separates the class of rich men from the class of poor men. Since in reality there will be dispersion of wage rates within the rich class, the net income of the rich man will lie above the budget kink.

The first of two major ways in which negative and positive income taxes can be merged is a "fully integrated" system. This form sets the personal exemption in the positive tax equal to the break-even income level in the NIT. The budget kink coincides with the break-even income level and hence this case corresponds to one extreme of the restriction. Figure 1 illustrates such a fully integrated NIT by the budget GXV. Gross earnings of a <u>member</u> of either class are charted on the horizontal

Figure 1: Budgets of Programs



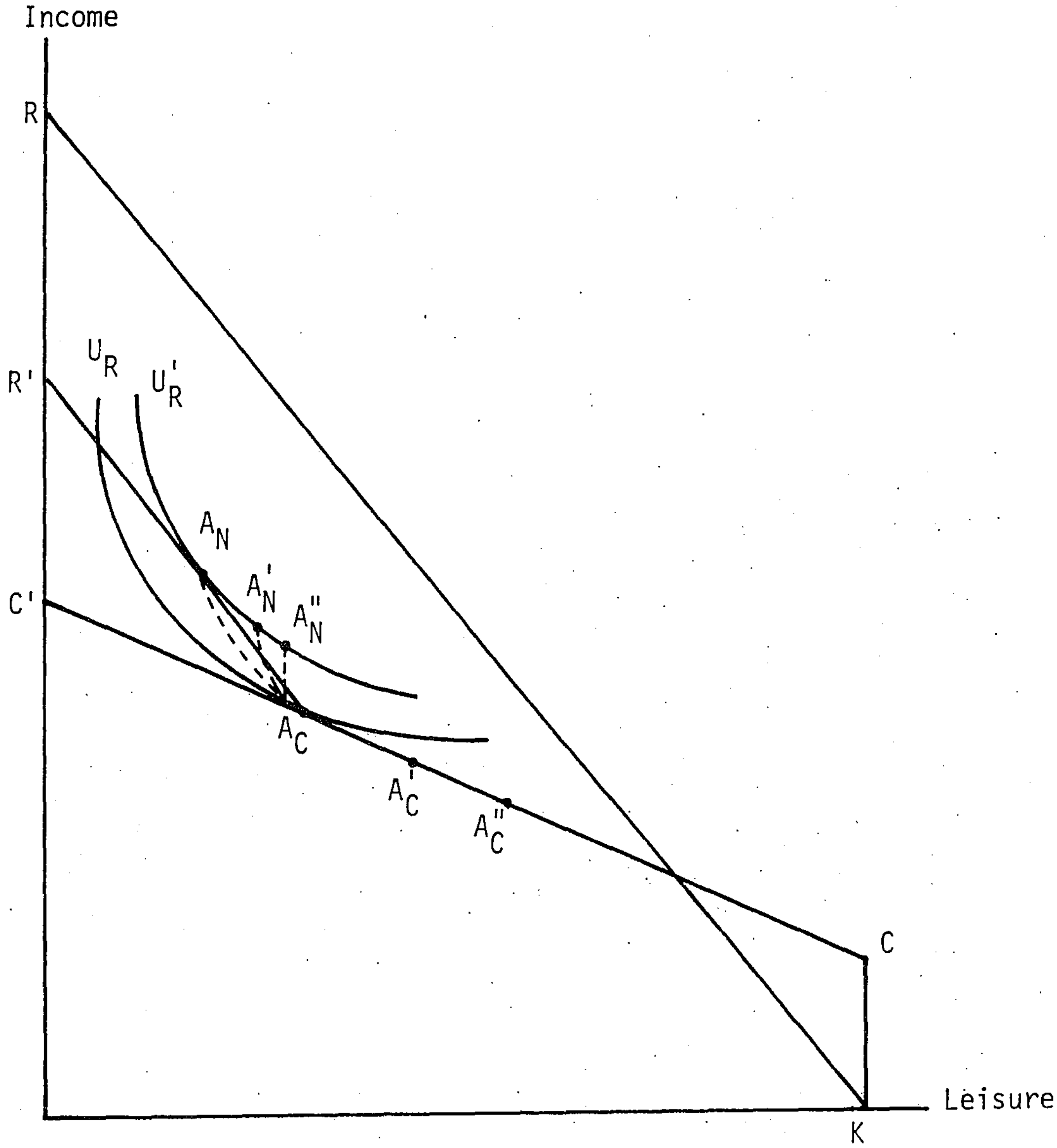
axis, while net (after-tax, after-transfer) income is plotted vertically. It is apparent that a fully integrated NIT must impose tax distortions on members of both classes. Its positive tax range will also exhibit progressivity in <u>average</u> tax rates.

The second major way to integrate the negative and positive income taxes is an "overlapping" system. This form sets the personal exemption below the break-even income level, but the NIT marginal tax rate extends above the break-even income until intersecting the positive tax schedule. That is, the NIT is actually serving to gather tax revenue over a range of gross earnings. In the continuous analogue, some beneficiaries may be net taxpayers, though presumably their tax burdens are reduced by virtue of the NIT. Figure 1 portrays the overlapping NIT with exemption level E by the budget GST. So long as a positive exemption is retained for the positive income tax, it will be progressive in average rates despite its constant marginal tax rate.

The overlapping NIT corresponds to the other extreme of the budget restriction. If the kink is not restricted to lie sufficiently below the equilibrium of the typical rich man, we can always construct an overlapping NIT that is superior to any given feasible CIT. This problem is an application of the optimal income tax theorem that the marginal tax rate applicable to the richest person in the society must be zero.[19] For a simple two-class model the outcome is a nondistorting lump-sum tax on members of the rich class.

The welfare desirability of a nondistorting tax on members of the rich class appears in Figure 2. A representative rich man has an equilibrium at point A_c, with utility U_R, under a hypothetical CIT

Figure 2: Rich Man



schedule CC'. A superior overlapping NIT can be constructed by kinking the budget at A_c. Budget A_cR' is drawn parallel to the rich man's laissez-faire budget KR and therefore carries a zero marginal tax rate. If the CIT is feasible in terms of the government budget, so must be the constructed NIT. Since the constructed NIT does not alter the budget constraint below income of A_c, the poor man's utility will be identical under the two programs. Superiority of the constructed NIT follows from the higher utility level, U_R', attainable by the rich man.

The next step is to make the kink in the NIT budget fall below the mean rich man's net income under a CIT. For example, in Figure 2, of kink at point A_c' and various marginal tax rates less than that of the CIT yield a price-consumption path A_cA_N'. A portion of this price-consumption path lies below the zero marginal rate schedule A_cR'. Hence, a superior overlapping NIT can be constructed for kink level A_c', although its positive income tax marginal rate will exceed zero. For a sufficiently low kink level, such as A_c'', the associated price-consumption curve, A_cA_N'', lies entirely above the zero marginal rate schedule. Because tax revenues collected from the rich for redistribution to the poor must be sacrificed to improve the utility of the rich, the NIT is no longer Pareto-superior to the CIT.

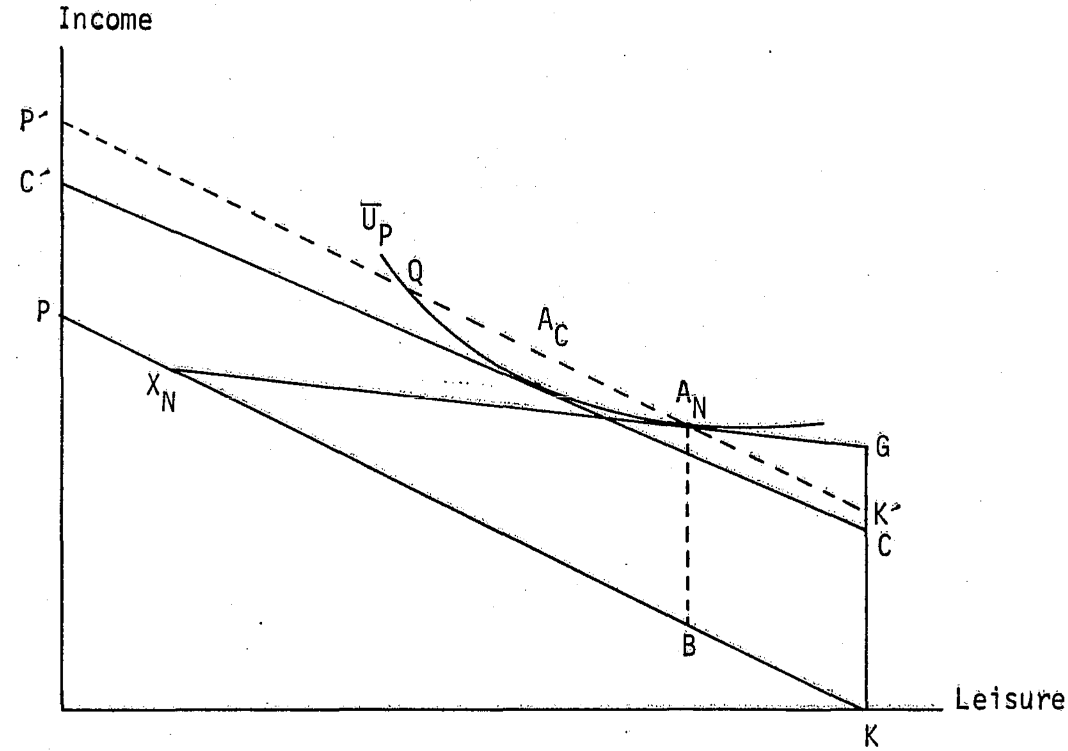
The superiority of an overlapping NIT to a CIT is clearly sensitive to the relation between the budget kink and the net income of the mean rich man. With no restriction on the kink, a superior NIT can always be constructed. A realistic restriction on the kink follows from the interpretation of a two-class model as a simplification of a continuous wage-rate distribution. The kink then arises at the earnings of a worker at the boundary of the two classes. These relations will reappear in the ensuing theoretical analysis and will be exploited in the final empirical analysis.

IV. Diagrammatic Analysis

We now implement the model in a diagrammatic analysis which attempts to ascertain the relative economic efficiency of CIT and NIT programs. We consider both fully integrated and overlapping NITs, but for brevity we shall concentrate on the former. The exposition is simplified by referring to the classes as the poor man and the rich man. If the two classes are of unequal size, the net revenue gathered per rich man will differ from the net transfer garnered per poor man by the relative class sizes. The diagrammatic exposition assumes the classes to be of equal size. Our procedure is to hold constant the utility of the poor man under the two programs and then to examine the conditions under which the utility of the rich man is higher under one or the other program.

Figure 3 portrays the situation of the poor man. Hours of leisure are measured along the horizontal axis and income or consumption along the vertical axis. The laissez-faire, pre-transfer budget constraint of the poor man is KP. The fully integrated NIT program offers the budget KGX_NP. The poor man's equilibrium under this program will be at a point such as A_N, where his indifference curve, $\bar{U}_p$, is tangent to the GX_N segment of his budget constraint. The net transfer to the poor man is the distance A_NB.

Figure 3: Poor Man

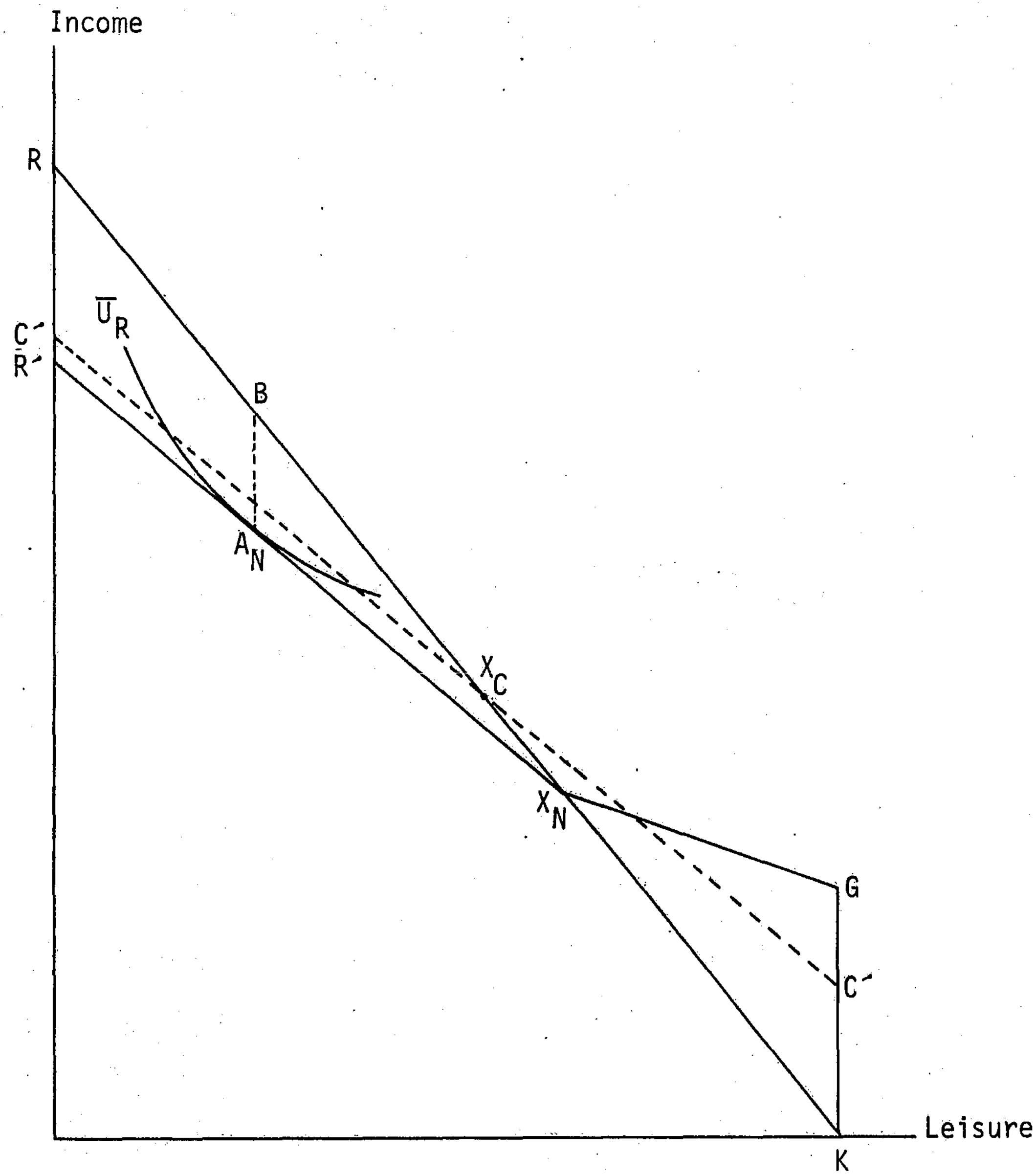


It can be shown that, holding the poor man's utility constant, the net transfer he receives must be smaller under the CIT than under the NIT. Note the line K'P' which is parallel to KP and passes through point A_N. All points along this line entail net transfers of $A_N B$, as the marginal tax rate along this line is equal to zero. A zero marginal tax rate cannot raise revenue from the rich man to finance the CIT. Consequently, the poor man's equilibrium under the CIT, A_C, must lie somewhere to the right of Q along $\bar{U}_P$. Since the CIT's marginal tax rate must be smaller than that in the lower segment of the NIT, its budget line CC' must be steeper than GX_N. Therefore the poor man's equilibrium under the CIT, A_C, must lie to the left of A_N along $\bar{U}_P$. All the points along $\bar{U}_P$ between Q and A_N will entail net transfers which are smaller than $A_N B$. Our interpretation is that the NIT must compensate the poor man with more income because its higher marginal tax rate vis-a-vis that of the CIT is more distorting and entails more welfare loss.

Now consider the situation of the rich man under the tax-transfer programs. There are two possible cases. If the marginal tax rate in the CIT is equal to or lower than the marginal tax rate in the positive income tax which is required to finance the net NIT transfer to the poor man, the CIT will be superior to the NIT. If the marginal tax rate in the CIT is higher than the marginal rate in the positive income tax, the ranking of the programs is ambiguous.

These two cases are discussed with the aid of Figure 4. The rich man's NIT budget constraint is $KGX_N R'$. The positive income tax portion of his budget constraint, $X_N R'$, is constructed so that in

Figure 4: Rich Man



equilibrium the rich man will pay exactly enough taxes, BA_N, to finance the net NIT transfer to the poor man. Suppose for the moment that we needed to raise BA_N to finance the CIT. Imagine a line through A_N that had a steeper slope than X_NR'. Such a line would of necessity intersect the indifference curve $\bar{U}_R$ and be tangent to a higher indifference curve to the left of A_N. Too much revenue would be raised. Suppose the marginal tax rate in the CIT is smaller than the rate in the positive income tax under the NIT regime. Then in order to raise the same amount of revenue, the CIT line would have to lie completely above the NIT regime equilibrium as does CC' in Figure 4. This conclusion is reinforced by the lesser revenue needed from the rich man to finance the CIT than is required to finance the NIT.

Apparently, previous discussion of the relationships of tax rates in the two programs has ignored two important features captured in our model. First, the net transfer required to keep the poor man indifferent between the two programs will be less under the CIT than under the NIT because of less tax distortion. Second, while the CIT pays out more money than the NIT, it taxes all earnings, from the first dollar, at a uniform rate. An NIT in effect taxes the earnings up to the exemption level at a zero rate for rich persons. The contrast is analogous to that between personal exemptions and refundable tax credits. Obviously, the lower is the value of personal exemptions, the more likely it is that the marginal tax rate in the positive income tax of the NIT will be lower than the marginal tax rate in the CIT. Thus an overlapping NIT is more likely to have lower marginal tax rates compared to those in a comparable CIT than is a fully integrated NIT.

Now consider the second case, where the marginal tax rate in the CIT is higher than the marginal tax rate in the positive income tax. The ranking of programs in this case is indeterminate. If equal tax revenue were required for both programs, the NIT regime would be superior because of the lower tax rate. But the CIT requires less revenue for transfer to the poor man. Hence, either the CIT or the NIT will be superior, depending upon whether the CIT budget constraint intersects or lies below the indifference curve tangent to the income tax constraint. Without more information on the tastes of the rich and poor man it is not possible to rule out this case or either outcome. (The reader can confirm this by pivoting CC' in Figure 4 around C and imagining a set of alternative indifference curves for the rich man.)

In the polar cases of perfectly inelastic labor supply by either man, a determinate ranking of the transfer programs is easily made. If the rich man's labor supply is perfectly inelastic, the CIT will be more efficient than the NIT. If the poor man's labor supply is completely inelastic, the NIT will be at least as good as any CIT and superior to most. Finally, if the labor supply of both is completely inelastic, the two programs will be equally efficient.

We consider only the first polar case, with perfectly inelastic labor supply by the rich man. The illustration would be similar to Figure 4. However, the rich man's equilibria must all assume the same leisure hours as A_N, his NIT equilibrium point. His CIT equilibrium must lie above A_N along A_NB, because less tax revenue is required to finance the CIT net transfer than BA_N. Therefore the CIT will be superior to the NIT. Demonstrations of the other polar cases are similarly straightforward.

V. Algebraic Analysis

An algebraic analysis can rank the CIT and NIT programs when neither class of workers has perfectly inelastic labor supply. This yields a general condition for determining which of the diagrammatic cases hold empirically. The condition further permits an explicit study of the effects of relative class size and of transfer program adequacy on the efficiency of income-testing. The initial analysis deals with a budget constraint kinking at break-even income, or the fully integrated NIT. The results are then extended to the overlapping NIT.

The analysis is undertaken free from any particular specification of workers' utility functions. Instead we use the labor-supply response coefficients of each class--income, wage, and substitution effects. As a result, the conclusions are couched in terms of the social desirability of marginal changes from any feasible transfer program toward more or toward less income-testing. If we begin with a feasible NIT, the analysis can tell whether more or less income-testing promotes economic efficiency. Or if we begin with a feasible CIT, then we shall find the conditions under which a departure toward income-testing enhances efficiency.

Individual Behavior--All Programs

Several results are presented on the behavior of a worker in either class. All individual variables are subscripted i, where i = P,R. The utility of a member of class i is:

$$U_i = U_i\ (Y_i,\ L_i),$$

where the arguments stand for net income and leisure time. Each worker maximizes his utility subject to his tax-transfer-inclusive budget constraint:

$$Y_i = \tau W_i(K-L_i) + G,$$

where K is total hours in the period, τ is unity minus the marginal tax rate, and G is the lump-sum transfer implicit in the CIT or NIT. The maximization yields individual demand functions:

$$Y_i = Y_i(\tau W_i,\ G), \qquad \text{and}$$

$$L_i = L_i(\tau W_i,\ G),$$

from which the individual labor-supply function follows:

$$H_i = K-L_i(\tau W_i,\ G).$$

It is also useful to construct the individual's indirect utility function:

$$V_i(\tau W_i,\ G) = U_i(Y_i(\tau W_i,\ G),\ L_i(\tau W_i,\ G)) = U_i(Y_i,\ L_i).$$

Result 1: $\partial V_i/\partial G = \partial U_i/\partial Y_i = \alpha_i$, the marginal utility of income. (1)

Result 2: $\tau W_i(K-L_i) + G - Y_i = 0$, individual budget constraint.

$W_i(K-L_i) - \tau W_i \partial L_i/\partial\tau - \partial Y_i/\partial\tau = 0$, differentiating.

$W_i H_i = \tau W_i\ \partial L_i/\partial\tau + \partial Y_i/\partial\tau$, rearranging.

$$\frac{\partial V_i}{\partial \tau} = \frac{\partial U_i}{\partial Y_i}\ \frac{\partial Y_i}{\partial \tau} + \frac{\partial U_i}{\partial L_i}\ \frac{\partial L_i}{\partial \tau}\text{, differentiating.}$$

$$\left.\begin{aligned} \partial U_i/\partial Y_i &= \alpha_i \\ \partial U_i/\partial L_i &= \alpha_i \tau W_i \end{aligned}\right\}\ \text{first-order conditions for utility maximization,}$$

$$\frac{\partial V_i}{\partial \tau} = \alpha_i \frac{\partial Y_i}{\partial \tau} + \alpha_i \tau W_i \frac{\partial L_i}{\partial \tau}\text{, substituting.}$$

$\partial V_i/\partial\tau = \alpha_i W_i H_i$, substituting from above. (2)

Result 3: $$\left.\frac{dG}{d\tau}\right|_{\bar{V}_i} = -\frac{\partial V_i/\partial\tau}{\partial V_i/\partial G}\text{, implicit function theorem.}$$

$$\left.\frac{dG}{d\tau}\right|_{\bar{V}_i} = -\frac{\alpha_i W_i H_i}{\alpha_i}\text{, substituting (1) and (2)}$$

$$\left.\frac{dG}{d\tau}\right|_{\bar{V}_i} = -W_i H_i\text{, simplifying} \qquad (3)$$

Result 4:

$$S_i \equiv \left.\frac{\partial H_i}{\partial(\tau W_i)}\right|_{\bar{U}_i} \text{, definition of Slutsky substitution effect.}$$

$$S_i = \frac{\partial H_i}{\partial(\tau W_i)} - H_i \frac{\partial H_i}{\partial G} \text{, from Ashenfelter and Heckman (p. 268).}$$

$$S_i = \frac{1}{W_i} \left.\frac{\partial H_i}{\partial \tau}\right|_{\bar{U}_i} \text{, differentiation holding } W_i \text{ constant.} \tag{4a}$$

$$S_i = \frac{1}{W_i} \frac{\partial H_i}{\partial \tau} - H_i \frac{\partial H_i}{\partial G} \text{, holding } W_i \text{ constant.} \tag{4b}$$

Aggregate Relations--CIT and Fully Integrated NIT

At this point we distinguish between the two linear segments of the individual's NIT budget constraint. For the segment faced by class P, we use the subscript 1 on G and τ; for the segment faced by class R, we use the subscript 2 on G and τ. Taking the market wage rates W_p and W_R as parametric, the basic behavioral responses are:

$$\frac{\partial H_p}{\partial G_1}, \frac{\partial H_R}{\partial G_2}, \frac{\partial H_p}{\partial \tau_1}, \text{ and } \frac{\partial H_R}{\partial \tau_2}.$$

Terms which are mixed in the sense of showing one class's response to the other's budget parameter--for instance $\partial H_R/\partial \tau_1$--must be reduced via the aggregate relations of the model. When $\tau_1 = \tau_2$ the tax-transfer budget becomes a CIT.

Result 5: The restriction that the kink in a fully integrated NIT budget occur at the break-even level of income is equivalent to stating that the two linear segments have identical break-even levels:

$$\frac{G_1}{1-\tau_1} = \frac{G_2}{1-\tau_2}$$

$$G_2 = \left(\frac{1-\tau_2}{1-\tau_1}\right) G_1, \text{ rearranging.} \tag{5}$$

Result 6: The government budget of transfers and taxes must balance. Class P is normalized to one person and receives net transfers:

$$G_1 - (1-\tau_1)W_pH_p \ .$$

Class R has N persons and pays net taxes:

$$N[(1-\tau_2)W_RH_R - G_2] \ .$$

Aggregate budget balance thus requires:

$$N[(1-\tau_2)W_RH_R - G_2] = G_1 - (1-\tau_1)W_pH_p. \tag{6a}$$

$$N(1-\tau_2)\left(W_RH_R - \frac{G_1}{1-\tau_1}\right) = (1-\tau_1)\left(\frac{G_1}{1-\tau_1} - W_pH_p\right), \text{ using (5) and rearranging.}$$

$$\left.\begin{aligned} P &\equiv \frac{G_1}{1-\tau_1} - W_pH_p \\ R &\equiv W_RH_R - \frac{G_1}{1-\tau_1} \\ A &\equiv P/R \end{aligned}\right\} \text{ introducing new notation.}$$

$N(1-\tau_2) = (1-\tau_1)A$, substituting.

$\tau_2 = 1-(1-\tau_1)A/N$, rearranging. (6b)

$\frac{1-\tau_2}{1-\tau_1} = \frac{A}{N}$, rearranging.[20] (6c)

<u>Result 7</u>: $\frac{dG_2}{d\tau_1} = \left(\frac{1-\tau_2}{1-\tau_1}\right) \left.\frac{dG_1}{d\tau_1}\right|_{\bar{\bar{V}}_p} + G_1 \frac{d}{d\tau_1}\left(\frac{1-\tau_2}{1-\tau_1}\right)$, differentiating (5).[21]

$\frac{dG_2}{d\tau_1} = \frac{A}{N}(-W_pH_p) + G_1 \frac{d}{d\tau_1}(A/N)$, using (3) and (6c).

$B \equiv dA/d\tau_1$, introducing new notation.

$\frac{dG_2}{d\tau_1} = \frac{-AW_pH_p}{N} + \frac{G_1B}{N}$, substituting. (7)

<u>Result 8</u>: $\frac{d\tau_2}{d\tau_1} = \frac{A}{N} - \frac{(1-\tau_1)B}{N}$, differentiating (6b). (8)

<u>Result 9</u>: $\frac{dH_R}{d\tau_1} = \frac{\partial H_R}{\partial \tau_2}\frac{d\tau_2}{d\tau_1} + \frac{\partial H_R}{\partial G_2}\frac{dG_2}{d\tau_1}$, complete differentiation.

$$\frac{dH_R}{d\tau_1} = \frac{\partial H_R}{\partial \tau_2}\left(\frac{A}{N} - \frac{(1-\tau_1)B}{N}\right) + \frac{\partial H_R}{\partial G_2}\left(\frac{-W_pH_pA}{N} + \frac{G_1B}{N}\right),$$

substituting (7) and (8).

$$\frac{dH_R}{d\tau_1} = \frac{1}{N}\left\{A\left[\frac{\partial H_R}{\partial \tau_2} - W_R H_R \frac{\partial H_R}{\partial G_2} + (W_R H_R - W_p H_p)\frac{\partial H_R}{\partial G_2}\right]\right.$$

$$\left. -B(1-\tau_1)\left[\frac{\partial H_R}{\partial \tau_2} - W_R H_R \frac{\partial H_R}{\partial G_2} + \left(W_R H_R - \frac{G_1}{1-\tau_1}\right)\frac{\partial H_R}{\partial G_2}\right]\right\},$$

manipulating.

$$\frac{dH_R}{d\tau_1} = \frac{1}{N}\left\{A\left[W_R S_R + (P+R)\frac{\partial H_R}{\partial G_2}\right] - B(1-\tau_1)\left(W_R S_R + R\frac{\partial H_R}{\partial G_2}\right)\right\}, \qquad (9)$$

using (4b).

<u>Result 10</u>:

$$B = \frac{d(P/R)}{d\tau_1}$$, substituting.

$$B = \left\{R\left[\frac{(1-\tau_1)\left.\frac{dG_1}{d\tau_1}\right|_{\bar{V}_p} + G_1}{(1-\tau_1)^2} - W_p\frac{dH_p}{d\tau_1}\right]\right.$$

$$\left. -P\left[W_R\frac{dH_R}{d\tau_1} - \frac{(1-\tau_1)\left.\frac{dG_1}{d\tau_1}\right|_{\bar{V}_p} + G_1}{(1-\tau_1)^2}\right]\right\} \div R^2,$$ differentiating.

$$B = \left\{\frac{-(1-\tau_1)\ W_p H_p + G_1}{(1-\tau_1)^2} - W_p^2 S_p - A\left[W_R\frac{dH_R}{d\tau_1} + \frac{(1-\tau_1)W_p H_p - G_1}{(1-\tau_1)^2}\right]\right\} \div R\ ,$$

using (3) and (4) and manipulating.

$$B = \left\{\frac{(A+1)P}{1-\tau_1} - W_p^2 S_p - AW_R\frac{dH_R}{d\tau_1}\right\} \div R,$$ simplifying.

$$B = \frac{\frac{A(P+R)}{1-\tau_1} - W_p^2 S_p - \frac{A^2 W_R}{N}\left(W_R S_R + (P+R)\frac{\partial H_R}{\partial G_2}\right)}{R\left[1 - \frac{AW_R}{N}(1-\tau_1)\left(\frac{W_R S_R}{R} + \frac{\partial H_R}{\partial G_2}\right)\right]}, \text{ using (9) and rearranging.} \quad (10)$$

Criterion--CIT and Fully Integrated NIT

The sign of $dV_R/d\tau_1$ can now be evaluated. Based on the preliminary results, this derivative holds constant the utility of each poor man at $\bar{V}_p$ and simultaneously satisfies the aggregate budget constraint and the restriction on the fully integrated NIT budget. Both classes of workers maximize their respective utility levels.

$$\frac{dV_R}{d\tau_1} = \frac{\partial V_R}{\partial \tau_2}\frac{d\tau_2}{d\tau_1} + \frac{\partial V_R}{\partial G_2}\frac{dG_2}{d\tau_1}, \text{ complete differentiation.}$$

$$\frac{dV_R}{d\tau_1} = \alpha_R W_R H_R\left(\frac{A}{N} - \frac{(1-\tau_1)B}{N}\right) + \alpha_R\left(\frac{-W_p H_p A}{N} + \frac{G_1 B}{N}\right),$$

using (1), (2), (7), and (8).

Because the rich man's marginal utility of income, α_R, and N are both positive, we can equivalently evaluate the sign of:

$$\frac{N}{\alpha_R}\frac{dV_R}{d\tau_1} = A(W_R H_R - W_p H_p) + B(G_1 - (1-\tau_1)W_R H_R), \text{ rearranging.}$$

$$\frac{N}{\alpha_R}\frac{dV_R}{d\tau_1} = A(P+R) - (1-\tau_1)BR, \text{ manipulating.}$$

$$\frac{N}{\alpha_R}\frac{dV_R}{d\tau_1} = \frac{\frac{-A^2 W_R{}^2 S_R}{NR}(P+R) + W_p^2 S_p + \frac{A^2 W_R^2 S_R}{N}}{\frac{1}{1-\tau_1} - \frac{AW_R}{N}\left(\frac{W_R S_R}{R} + \frac{\partial H_R}{\partial G_2}\right)}$$, using (10) and manipulating.[22]

$$\frac{N}{\alpha_R}\frac{dV_R}{d\tau_1} = \frac{W_p^2 S_p - \frac{A^3 W_R^2 S_R}{N}}{\frac{1}{1-\tau_1} - \frac{AW_R}{N}\left(\frac{W_R S_R}{R} + \frac{\partial H_R}{\partial G_2}\right)}$$, simplifying. (11)

Aggregate Relations--CIT and Overlapping NIT

The algebraic analysis can be extended to the comparison of a CIT with an overlapping NIT. All individual behavior is the same as under the fully integrated NIT, and therefore results 1 through 4 remain valid. The new assumption is that the budget kink occurs at a gross earnings level above that of break-even income. Thus, we must begin by restating result 5 and then work out the implications of the new assumption. As before, subscripts 1 and 2 on τ and G refer to the budget segments faced by class P and class R workers, respectively. In addition to being net taxpayers, all class R workers are assumed to have earnings above the budget kink.

Result 5': We specify a level of gross earnings Z at which the overlapping NIT budget kinks. Net income of the two linear segments must be equal at gross earnings level Z.

$$Z > \frac{G_1}{1-\tau_1}$$, restriction. (5a')

$$G_2 + \tau_2 Z = G_1 + \tau_1 Z$$, restriction.

$$G_2 = G_1 + (\tau_1 - \tau_2)Z$$, rearranging. (5b')

Result 6': Aggregate budgetary balance still requires:

$$N[(1-\tau_2)W_RH_R-G_2] = G_1-(1-\tau_1)W_pH_p, \text{ repeating (6a).}$$

$$N[(1-\tau_2)W_RH_R-G_1-(\tau_1-\tau_2)Z] = G_1-(1-\tau_1)W_pH_p, \text{ substituting (5').}$$

$$\left.\begin{aligned} P' &\equiv Z - W_pH_p \\ R' &\equiv W_RH_R - Z \\ C &\equiv [P' + (N+1)\left(\frac{G_1}{1-\tau_1} - Z\right)]/R' \end{aligned}\right\} \text{ introducing new notation.}$$

$$N(1-\tau_2) = (1-\tau_1)C, \text{ manipulating.}$$

$$\tau_2 = 1-(1-\tau_1)C/N, \text{ rearranging.} \qquad (6a')$$

$$\left(\frac{1-\tau_2}{1-\tau_1}\right) = \frac{C}{N}, \text{ rearranging.}^{23} \qquad (6b')$$

Result 7':

$$\frac{dG_2}{d\tau_1} = \left.\frac{dG_1}{d\tau_1}\right|_{\bar{V}_p} + Z - Z\,\frac{d\tau_2}{d\tau_1}, \text{ differentiating (5b').}$$

$$\frac{dG_2}{d\tau_1} = -W_pH_p + Z - Z\,\frac{d\tau_2}{d\tau_1}, \text{ using (3).} \qquad (7')$$

Result 8':

$$D = \frac{dC}{d\tau_1}, \text{ introducing new notation.}$$

$$\frac{d\tau_2}{d\tau_1} = \frac{C}{N} - \frac{(1-\tau_1)D}{N}, \text{ differentiating (6a').} \qquad (8')$$

Result 9':

$$\frac{dH_R}{d\tau_1} = \frac{\partial H_R}{\partial \tau_2}\frac{d\tau_2}{d\tau_1} + \frac{\partial H_R}{\partial G_2}\frac{dG_2}{d\tau_1}, \text{ complete differentiation.}$$

$$\frac{dH_R}{d\tau_1} = \frac{D(1-\tau_1)}{N}\left(Z\frac{\partial H_R}{\partial G_2} - \frac{\partial H_R}{\partial \tau_2}\right) + \frac{C}{N}\left(\frac{\partial H_R}{\partial \tau_2} - Z\frac{\partial H_R}{\partial G_2}\right)$$

$$+ P'\frac{\partial H_R}{\partial G_2}, \text{ using (7') and (8').}$$

$$\frac{dH_R}{d\tau_1} = \frac{1}{N}[C-D(1-\tau_1)]\left(W_R S_R + R\frac{\partial H_R}{\partial G_2}\right) + P'\frac{\partial H_R}{\partial G_2},$$

using (4) and rearranging. (9')

Result 10':

$$D = \frac{d}{d\tau_1}\left\{\left[P' + (N+1)\left(\frac{G_1}{1-\tau_1} - Z\right)\right]/R'\right\}, \text{ substituting.}$$

$$D = \left\{R'\left[-W_p\frac{dH_p}{d\tau_1} + (N+1)\left[\frac{(1-\tau_1)\left.\frac{dG_1}{d\tau_1}\right|_{\bar{V}_p} + G_1}{(1-\tau_1)^2}\right]\right]\right.$$

$$\left.-CR'W_R\frac{dH_R}{d\tau_1}\right\} \div R'^2.$$

$$D = \left\{ -W_p^2 S_p + \left(\frac{N+1}{1-\tau_1} \right) P \right.$$

$$\left. -CW_R \left[\frac{1}{N} \left[C - D(1-\tau_1) \right] \left(W_R S_R + R' \frac{\partial H_R}{\partial G_2} \right) + P' \frac{\partial H_R}{\partial G_2} \right] \right\} \div R'.$$

using (3), (4a), and (9').

$$D = \frac{-W_p^2 S_p + \left(\frac{N+1}{1-\tau_1} \right) P - \frac{C^2 W_R^2 S_R}{N} - CW_R \left(\frac{CR'}{N} + P' \right) \frac{\partial H_R}{\partial G_2}}{R' \left\{ 1 - \frac{CW_R (1-\tau_1)}{N} \left(\frac{W_R S_R}{R'} + \frac{\partial H_R}{\partial G_2} \right) \right\}} \qquad (10')$$

Criterion--CIT and Overlapping NIT

The sign of $dV_R/d\tau_1$ can now be evaluated.

$$\frac{dV_R}{d\tau_1} = \frac{\partial V_R}{\partial \tau_2} \frac{d\tau_2}{d\tau_1} + \frac{\partial V_R}{\partial G_2} \frac{dG_2}{d\tau_1}, \text{ complete differentiation.}$$

$$\frac{dV_R}{d\tau_1} = \alpha_R W_R H_R \frac{d\tau_2}{d\tau_1} + \alpha_R \left(-W_p H_p + Z - Z \frac{d\tau_2}{d\tau_1} \right), \text{ using (2) and (7').}$$

$$\frac{1}{\alpha_R} \frac{dV_R}{d\tau_1} = P' + R' \frac{d\tau_2}{d\tau_1}, \text{ manipulating.}$$

$$\frac{1}{\alpha_R} \frac{dV_R}{d\tau_1} = P' + \frac{R'C}{N} - \frac{(1-\tau_1)R'D}{N}, \text{ substituting (8').}$$

$$\frac{N}{\alpha_R} \frac{dV_R}{d\tau_1} = \frac{W_p^2 S_p - \frac{CP'}{R'} W_R^2 S_R}{\frac{1}{1-\tau_1} - \frac{CW_R}{N} \left(\frac{W_R S_R}{R'} + \frac{\partial H_R}{\partial G_2} \right)}, \text{ substituting (10') and much manipulating.} \qquad (11')$$

Determinants of Efficiency

Before examining the determinants of the efficiency of income-testing, we demonstrate the marginal criteria (11) and (11') for the two NIT types to be identical under polar assumptions. Let us evaluate both at a CIT ($\tau_c = \tau_1 = \tau_2$; $G_c = G_1 = G_2$). For the present purpose we also fix the overlapping NIT's budget to kink at break-even income ($Z = G_c/(1-\tau_c)$). From the earlier definitions and intermediate results, it follows that P = P', R = R', A = N, and C = N. The results for both NIT forms simplify to:

$$\frac{N}{\alpha_R}\frac{dV_R}{d\tau_1} = \frac{W_P^{\,2}S_P - N^2W_R^{\,2}S_R}{\frac{1}{1-\tau_1} - W_R\left(\frac{W_RS_R}{R} + \frac{\partial H_R}{\partial G_2}\right)} \tag{12}$$

The denominator for the marginal criterion of the fully integrated NIT is:

$$\frac{1}{1-\tau_1} - \frac{AW_R}{N}\left(\frac{W_RS_R}{R} + \frac{\partial H_R}{\partial G_2}\right),$$

and that for the overlapping NIT merely replaces A with C and R with R'. The rate τ_1 is bounded by the interval (0,1); thus $1/(1-\tau_1)$ is positive and bounded by the interval $(1,\infty)$. The normality of leisure restricts the income response term $\partial H_R/\partial G_2$ to be negative. Multiplying the term by $-AW_R/N$ adds another positive, albeit small, element to the denominator. The theoretical restriction on substitution term S_R is positive, which adds a negative element to the denominator. Empirical studies indicate

S_R to be sufficiently small that the overall positive sign of the denominator is most unlikely to reverse.[24]

Because of its determinate positive-signed denominator, each marginal criterion will take the sign of its numerator. Recall that the criterion measures $dV_R/d\tau_1$ when the utility of the poor class is held constant. A positive marginal criterion evaluated for a program means that efficiency is improved by raising τ_1--less income-testing. A negative marginal criterion suggests the desirability of reducing τ_1, or more income-testing. In comparing any two programs we can in effect ignore the size of the criterion's denominator. We imagine that one of the two programs has been adjusted to its optimal degree of income-testing, if any, so that the criterion numerator equals zero. Then the sign of the criterion numerator in the other program relates the effects of its features on the optimal degree of income-testing.

For the fully integrated NIT, the numerator of the marginal criterion can be written:

$$T_{NF} = W_p^{\,2} S_p - \left(\frac{1-\tau_2}{1-\tau_1}\right)^3 N^2 W_R^{\,2} S_R \ .$$

How does relative class size affect the efficiency of income testing when transfer adequacy is held constant? The latter carries an unchanged break-even income level.[25] Clearly, the result is:

$$\frac{dT_{NF}}{dN} = -2\left(\frac{1-\tau_2}{1-\tau_1}\right)^3 N W_R^{\,2} S_R < 0 \ ,$$

so that more income-testing is desirable with a smaller beneficiary population. We next take the fully integrated NIT evaluated at a CIT:

$$T_{NF}^{c} = W_p{}^2 S_p - N^2 W_R{}^2 S_R$$

and can again conclude that income-testing is enhanced with fewer beneficiaries relative to nonbeneficiaries.

For the overlapping NIT, the numerator of the marginal criterion can be written:

$$T_{NO} = W_p{}^2 S_p - \left[P' + (N+1)\left(\frac{G_1}{1-\tau_1} - Z\right)\right] \frac{P'}{R'^2}\; W_R{}^2 S_R .$$

To determine the effects of relative class size we differentiate:

$$\frac{dT_{NO}}{dN} = \left(Z - \frac{G_1}{1-\tau_1}\right) \frac{P'}{R'^2}\; W_R{}^2 S_R > 0 .$$

The placement of the budget kink above the break-even income assures that this will be positive. For the overlapping NIT evaluated at a CIT, this need no longer be true. There is nothing to prevent $(Z-G_c/(1-\tau_c))$ from being negative, that is, the CIT break-even may exceed the point of incipient budget kink. If this is the case, then a smaller beneficiary group will increase the efficiency of marginal income-testing.

Finally, the marginal efficiency of income-testing beginning with a CIT is compared for the two NIT forms. The comparable numerators are: T_{NF}^{C}, given above, and:

$$T^C_{NO} = W_p^2 S_p - \frac{P'}{R'} NW_R^2 S_R \ .$$

The relative sizes of the two numerators hinges on the comparisons of P'/R' with N. Note that:

$$\frac{P'}{R'} = \frac{Z-G_c/(1-\tau_c) + P}{G_c/(1-\tau_c) - Z + R} \ .$$

Consequently,

$$\frac{P'}{R'}\begin{cases} > \frac{P}{R} = N \rightarrow T^c_{NF} > T^c_{NO} & \text{if } Z > G_c/(1-\tau_c) \\ < \frac{P}{R} = N \rightarrow T^c_{NF} < T^c_{NO} & \text{if } Z < G_c/(1-\tau_c). \end{cases}$$

The ranking of the marginal efficiency of income-testing under the two NIT forms depends upon which kinks at the higher income. This finding accords with the earlier diagrammatic analysis. The closer the budget kink lies to the rich man's equilibrium, the greater will be the marginal efficiency of income-testing.

As an alternative to the strict interpretation of two discrete classes, assume now that the classes are means of the two tails of a continuous wage-rate distribution. How is the efficiency of income-testing affected by transfer-program adequacy? This question is more realistic but analytically much more complex than the previous one, which held constant program adequacy. As the break-even income level is varied, the mean wage rates and substitution effects of the two tails of the distribution are altered. The exact form of the wage distribution and of differential labor supply behavior by wage rate must be known. No general analytic solution is possible, but our empirical simulations investigate this problem further.

VI. Empirical Analysis

The previous section demonstrated that the marginal efficiency of income testing depends upon a host of empirical relationships. We now develop some illustrative empirical estimates of both the marginal efficiency of income testing and of the relative efficiency costs of comparable NIT and CIT programs. The empirical findings should be viewed as illustrative because: 1) the theoretical model involves several simplifying assumptions; 2) the results are quite sensitive to estimates of the substitution effects; and 3) these estimates are sensitive to specification of the underlying labor supply equations. Despite these limitations, the empirical analysis does provide insight into the issue of income-testing.

Fully Integrated NIT

Result (12) shows the relative magnitude of the rich and poor men's substitution effects to be a key determinant of the marginal efficiency of income-testing. The sign of the criterion's numerator determines whether a marginal move from a CIT toward more or less income-testing is optimal. For the fully integrated NIT, we can calculate the threshold values for S_P/S_R which change the sign of the numerator (T^c_{NF}). Table 1 presents the results for U.S. prime-age married males with various relative class sizes and the associated mean wage rates.[26] For ratios of S_P to S_R greater than the threshold values T^c_{NF} will be positive. Hence a marginal move away from a CIT toward income-testing will be inefficient. Conversely, for S_P/S_R less than the threshold values, a

Table 1. Threshold for S_P/S_R in Criterion for Fully Integrated NIT or CIT

Rich/Poor Percentages	N	W_P	W_R	$N^2 W_R^{\ 2}/W_P^{\ 2}$
40/60	.667	3.42	6.70	1.71
50/50	1.000	3.21	6.27	3.82
60/40	1.500	2.99	5.90	8.76
70/30	2.333	2.74	5.59	22.66
80/20	4.000	2.45	5.31	75.16

marginal move toward income-testing via a fully integrated NIT is efficient.

Two points stand out in Table 1. First note that the threshold value of S_P/S_R increases as N increases. For given S_P and S_R, therefore, $\frac{dV_R}{dt_1}$ will be smaller in algebraic value the higher is N or the lower is the break-even income level. Consequently, for the empirical continuous wage-rate distribution, the marginal efficiency of income-testing increases, ceteris paribus, as the break-even income level decreases. Our prior expectation is that S_P/S_R exceeds unity, owing to the more limited substitution possibilities for higher-wage workers. These stem from institutional rigidities and the greater importance of stable job attachment in higher-wage occupations. Note in Table 1 the case where 60 percent of the population are net beneficiaries (N=.667); even here the substitution effect of the poor class must be more than 1.71 times as large as that of the rich class in order for the CIT to be efficient at the margin.

Estimation

We turn now to the estimation of class labor-supply schedules and substitution effects. The data base is the income dynamics panel study conducted by the Michigan Institute for Social Research. The panel study was a five-year longitudinal study conducted during the years 1968 through 1972. The sample consisted of a national cross-section of the U.S. population plus a supplementary sample of low-income families. We confine our analysis to married males aged 25-54 in 1971.[27] The samples for rich and poor classes were taken to be individuals with wage rates above and below the median, respectively. Since the wage rate measures were five-year averages, no truncation bias enters via the sample selection procedure.

For each class sample a labor-supply schedule was estimated for the functional form:[28]

$$H = a_0 + a_1 G + a_2 \ln W + a \cdot V,$$

where:

H = annual hours of work,

G = nonemployment income receipts not conditioned on hours worked,

W = five-year average of hourly wage rate,

V = vector of demographic traits including race, family size, health status dummies, net value of car and home, nonrecurring income receipts, and a retirement pension dummy.

Estimation was performed by ordinary least squares regression. The five-year-average definition of the wage-rate variable and the exclusion of income-conditioned transfers from the nonemployment income variable avoid some common econometric problems.

When we estimated two separate class equations, the nonemployment income coefficient (a_1) for the poor class sample was positive though not statistically significant. This in turn implied a negative substitution effect and thus violates the theoretical sign restriction. The source of the problem is that few married males with wage rates below the median receive any nonemployment income other than income-conditioned transfers. For the rich class sample the estimated income coefficient was negative and implied a positive substitution effect. Since the natural variation provided no direct way to obtain good estimates of poor workers' income effect, it was decided to re-estimate their equation constraining their income elasticity of labor supply to be the same as that estimated for rich workers.

The final estimates follow:[29]

$$H_R = -.0337\ G_R - 207.6\ \ln W_R + 2542. \tag{14}$$

$$H_P = -.0783\ G_P - 252.6\ \ln W_P + 2489. \tag{15}$$

The associated substitution effects for the rich and poor classes are calculated to be 40.12 and 94.76, respectively. The ratio of S_P/S_R is 2.36 and falls below the critical threshold in Table 1 for programs with half or less of the population as beneficiaries. Thus, income-testing under a fully integrated NIT will be efficient at the margin for all but the most generous of programs. More than half the population would have to be beneficiaries for the CIT to be more efficient than a marginal move toward a fully integrated NIT.

Overlapping NIT

Using the estimated labor-supply schedules for the two classes, we undertake simulations to compare overlapping NITs with CITs. Each of the simulations holds constant the utility of the poor man as between programs. Interest attaches to the marginal efficiency of income testing at both the NIT and the corresponding CIT. We shall further calculate global measures of the efficiency change in moving from specifed NITs to comparable CITs.

For each case we begin by specifying the relative size of the rich class to the poor class (N). The mean class wage rates W_R and W_P as well as the wage rate of the boundary between classes can be calculated for given N. Using the boundary wage rate, a consistent value of the budget kink in gross earnings (Z) can be obtained iteratively as part of the simulation. The rich man's budget is determined by the program parameters E and τ_2, which also fix G_2 as $(1-\tau_2)E$. This budget constraint and labor-supply equation (14) yield the tax revenues for transfer to the poor class. We can apply relation (6a') to determine a feasible overlapping NIT. An iterative pivoting of the poor man's budget around the appropriate point, along with labor-supply equation (15), tells when aggregate budget balanced is achieved. Criterion (11') is calculated for the feasible overlapping NIT and is called M_N.

The next part of each case is to derive a CIT which holds constant the poor man's utility (U_p) at its NIT level. We take successive small increments (.001) in τ_1 and maintain U_p constant by changes in G_1 satisfying relation (3). Concomitant adjustments in τ_2 and G_2 are undertaken to balance the aggregate budget at each increment in τ_1. The budget kink is maintained at gross earnings of Z, and labor-supply responses of both classes are endogenous to the process. Iterations are terminated when $\tau_1 = \tau_2$, which we call τ_c; this further implies by relation (5b') that $G_1 = G_2$, which we call G_c. The criterion (11') is calculated for such a corresponding CIT and is called M_c.

A case may exhibit a positive value of M_N at the overlapping NIT and a negative value of M_c at its corresponding CIT. This situation arises when the optimal degree of income-testing exceeds that of the CIT but is less than the rate $(1-\tau_1)$ of the original NIT. We seek a global measure of the efficiency or welfare difference between programs to handle this possibility. A Harberger-type measure of deadweight loss can be adapted to the problem:

$$L = 50 \frac{\frac{1}{1+N} S_p W_p^{\,2}[(1-\tau_1)^2 - (1-\tau_c)^2] + \frac{N}{1+N} S_R W_R^{\,2}[(1-\tau_2)^2 - (1-\tau_c)^2]}{\frac{1}{1+N} W_p H_p + \frac{N}{1+N} W_R H_R}$$

which is the differential welfare cost of the NIT vis-a-vis the corresponding CIT as a percentage of total labor income. A positive value for L indicates the welfare superiority of the CIT.

Along the preceding lines, we have simulated numerous cases of overlapping NITs and corresponding CITs. Table 2 displays five of the cases which yield further insight into the properties of the programs. Cases 1 through 3 take the population to be evenly divided between the rich and the poor classes (N=1). This is consistent with the labor-supply estimates which lie behind the simulations. In contrast with the relatively large beneficiary group of the previous cases, cases 4 and 5 show a more modest net beneficiary group of 30 percent (N=2.333). The same labor-supply estimates are used for these cases.

Case 1 provides zero exemptions (E) and a 7 percent marginal tax rate $(1-\tau_2)$ in its positive tax range. The associated feasible overlapping NIT offers a guarantee (G_1) of \$5082 and an offsetting tax rate $(1-\tau_1)$ of about 63 percent. The simulated budget kink (Z) arises at \$9103, above the NIT break-even level $(G_1/(1-\tau_1)$ of \$8089. The corresponding CIT provides a guarantee or "refundable credit" (G_c) of \$2796 and a marginal tax rate $(1-\tau_c)$ of 28 percent. Its break-even level $(G_c/(1-\tau_c)$ is \$9995. It should be clear from the earlier

Table 2. Overlapping NITs and Corresponding CITs, Simulation Results

Case	1	2	3	4	5
N	1.000	1.000	1.000	2.333	2.333
E	0	0	4000	0	4000
Z	9103	9222	9118	7641	7655
τ_2	.930	.975	.930	.975	.975
τ_1	.372	.767	.588	.502	.678
G_2	0	0	280	0	100
G_1	5082	1920	3400	3616	2375
$G_1/(1-\tau_1)$	8089	8232	8249	7257	7370
P_N	955	339	671	714	480
M_N	557	206	344	326	201
τ_c	.720	.902	.809	.840	.893
G_c	2797	999	1927	1641	1103
$G_c/(1-\tau_c)$	9995	10168	10073	10241	10284
P_c	948	323	639	697	463
M_c	16.7	10.6	20.0	-70.7	-42.4
L	.481	.072	.199	.124	.049

diagrammatic analysis that the net CIT transfer to a poor man (P_c) will be less than the net NIT transfer to a poor man (P_N) for two programs that maintain the poor man's utility constant.

We turn to the efficiency assessment of the overlapping NIT and corresponding CIT of case 1. The criterion for the marginal efficiency of income-testing is positive at both the NIT (M_N) and at the CIT (M_C). The finding that income-testing is inefficient at the margin under the overlapping NIT is not inconsistent with the opposite finding for the fully-integrated NIT. It is explained by the numerical outcome $Z < G_c/(1-\tau_c)$ in case 1 and an earlier analytical ranking for the programs in this subcase. The measure of differential welfare loss between programs (L) is positive, indicating that efficiency is enhanced by adopting the CIT rather than the NIT. In the limited context of a two-class model we would also say that social welfare is higher with the CIT. The welfare gain is about 0.481 of one percent of total labor incomes.

Moving from case 1 to case 2 carries only a change in τ_2. Less revenue is collected from the rich for transfer to the poor. The main resultant difference is a lower NIT offsetting tax rate of about 23 percent. With lesser tax distortion in the NIT, the move to the associated CIT carries less welfare gain than in case 1. Case 3 is seen to be similar to case 2, although now the lesser revenues for redistribution result from a positive income tax exemption (E=4000) rather than a reduced marginal tax rate on the rich. In all of the first three cases the CIT is superior to the NIT. Furthermore, even marginal moves toward income-testing from the point of the CIT are judged to be undesirable by positive values of M_c.

Cases 4 and 5 portray a smaller target group of beneficiaries than the preceding cases. Comparison of case 4 with case 2 shows identical values for E and τ_2--the parameters which define the tax schedule for nonbeneficiaries. Because less of the population are net beneficiaries, the average net transfer (P_N) is substantially larger in case 4 than in case 2. Introduction of a positive exemption in case 5 has effects similar to those found in case 3. Like in the earlier cases, the CIT is found to have less efficiency cost than corresponding NITs in cases 4 and 5. However, negative values calculated for M_c show that smaller, marginal moves toward income-testing would enhance efficiency. The initial NITs given for cases 4 and 5 simply embody too much income-testing.

In all of the cases tabulated and in most of other cases simulated, the differential welfare cost of the NIT is less than a half percent and usually much less. These results are clearly contingent upon the underlying labor-supply estimates, which in turn are sensitive to specification and data base. Alternative estimates which yield a lower ratio of substitution effects (S_P/S_R) will favor the CIT less strongly or even make the NIT preferred on efficiency grounds. The primary point of these simulation exercises is not the finding that the CIT is superior on efficiency grounds. Rather, it is that the efficiency differences between programs is quite small relative to total labor incomes. This is bound to remain valid for alternative labor-supply estimates so long as they are highly inelastic.

VII. Efficiency and Other Considerations

The consensus of economic experts is that income-tested programs are more efficient than non-income-tested tax-transfer programs. Most widely favored as a policy proposal is the negative income tax, an income-tested program. These views apparently stem from the widespread use of the target efficiency measure--a conceptually flawed measure of technical rather than economic efficiency. We have examined the economic efficiency issue within a two-class model which includes taxpayers along with beneficiaries. Our theoretical analysis establishes the possibility that non-income-tested programs are more efficient than income-tested programs. However, no general qualitative conclusion on the efficiency of income-testing can be drawn. Rather, the theory indicates that the marginal efficiency of income-testing depends upon a number of program parameters and empirical magnitudes. For a simple two-class model, the marginal efficiency of income-testing improves as the substitution effect of poor workers declines relative to that of rich workers. The form of the NIT program and the relative sizes of beneficiary and nonbeneficiary groups also affects the marginal efficiency of income-testing.

To illustrate some quantitative aspects of the efficiency of income-testing, we have calculated several feasible overlapping NITs and their corresponding CITs. These are based upon empirical estimates of the labor-supply functions and substitution effects for a national cross-section of U.S. prime-age married males. Some observations are also made for the fully integrated NIT. We have presented measures of the marginal efficiency of income-testing and of the relative efficiency in terms of welfare loss for comparable NIT and CIT programs. For relatively generous programs, CITs are superior at the margin and entail less welfare loss than comparable NITs. For the less generous programs examined here, the CIT retains its superiority over certain NITs but some income-testing becomes desirable at the margin. More important, the difference in welfare loss between the two programs was invariably small--less than one-half of one percent of aggregate earnings.

Perhaps the major implication of our findings for policy formulation is that any differential economic efficiency costs between CIT and NIT scheme may well be dominated by other program differences. Features of the CIT include: a) no need for periodic income report forms from potential net beneficiaries and no need to distinguish them from the rest of the population, hence minimal participation stigma; b) application of a uniform tax withholding rate on all sources of income, with resulting minimal enforcement and accounting costs;[30] and c) no tax incentives affecting the timing of income receipts or deductible expenses or the formation of the household unit, with simplified tax planning and cheaper tax compliance by individuals.[31] Features such as these were stressed by early advocates of demogrants and CITs including Lady Juliet Rhys-Williams and Earl Rolph. They would also seem appealing to the laissez-faire philosophy of Milton Friedman, an early and persuasive advocate of the NIT. A further political consideration favoring the CIT was expressed by Eveline Burns, "Programs that deal only with 'the poor' run the danger, not only of being poor programs, but also of polarizing society into two groups, the poor and the non-poor, the one receiving benefits and the other footing the bill."[32]

While an NIT integrated onto a progressive income tax lacks all of the foregoing attractive features of a tax-transfer system, it does offer the potential of more finely graduating the structure of effective tax rates. The U.S. income tax does not exploit this potential well owing to exempted sources of income, nonbusiness deductions, and capital gains provisions. Despite its constant marginal tax rate, the simple CIT can achieve substantial progressiviity in average tax rates.[33] Still greater progressivity could be instilled in CIT with a surtax marginal rate on high incomes; this would restrict the problems of timing incentives and income averaging to a small part of the population. We have seen the NIT's advantage of low budgetary costs relative to the CIT to be fundamentally illusory. The NIT creates greater equalization of incomes within the class of beneficiaries than does the CIT.

One remaining appeal of the NIT is that its adoption does not face the political hurdles of overhauling the entire income tax. Yet, the CIT is probably more amenable to piecemeal implementation within the existing U.S. income tax.[34] A logical first step is to convert the personal exemptions into refundable per capita credits;[35] this might be accompanied by hikes in the lower-bracket marginal rates. Beyond this, the long-run goal would be to broaden the tax base in several ways.[36] First, itemized nonbusiness deductions would be progressively restricted; eventually the much-reduced itemized deductions along with the standard deduction would be exchanged for larger credits. Second, tax-exempt forms of income including the untaxed portion of capital gains would be gradually brought into the tax base. These revisions would be made more politically palatable by simultaneously lowering the marginal rates in the higher brackets and allowing inflation adjustments in the calculation of capital gains.[37] With marginal tax rates converging for all income classes the final product would be a credit income tax.

Notes

*Subtitle: "Professor Friedman, Meet Lady Rhys-Williams". The authors acknowledge the helpful comments of Jonathan Dickinson on a fragmentary draft.

[1]Schultze, et. al. (p. 200). The authors of the Brookings volume on the 1975 budget take a somewhat more open view on universal demogrants, but still reject them on grounds of political feasibility (Blechman, et. al., pp. 198-200).

[2]For early demogrant and CIT proposals, see Rhys-Williams and Rolph; see also the treatment by Green (1967) of "social dividend taxation." For a careful set of estimates on demogrant alternatives, see Okner. For some macroeconomic considerations which may favor a CIT, see Green (1973).

[3]In fact the great majority of taxpayers under the U.S. income tax are found in a relatively narrow band of marginal tax rates. Among 60 million returns subject to tax in 1971, fewer than 8 percent faced marginal rates above 25 percent. Of the remainder, the returns in the 14 to 18 percent marginal brackets faced relatively small tax liabilities. (U.S. Internal Revenue Service, pp. 139-141). Consideration of payroll taxes further reinforces this observation.

[4]We assume that the utility of beneficiaries and nonbeneficiaries is unaffected by the method of program administration, thereby abstracting from the issue of stigma. We also assume that the time horizon of both groups is at least as long as one year with no discounting.

[5]Even if they are recaptured in full, overpayments amount to loans. The federal government will not want to make itself vulnerable to the charge of providing interest-free loans; yet, the imposition of an interest rate on overpayments would subject it to charges of "penalizing the poor." Minimizing overpayments by making payments on a net basis thus becomes an attractive political alternative. Under the CIT, of course, the loan problem does not arise.

[6]The typical CIT scheme also eliminates personal exemptions and most nonbusiness deductions. How long the accounting period should be and whether payments should be based on current, future, or previous income are important issues in the design of a NIT program. See Allen.

[7]See Barth, Haveman, Musgrave et al., and Rea. Rea presents measures of both target efficiency and economic efficiency.

[8]Even ignoring labor-supply and other behavioral effects, the two need not be identical. Enactment of the transfer payments may require raising exemptions and deductions in the positive income tax to avoid a notch at the break-even level of income. Then gross benefits paid out plus tax relief to those just above the break-even level of income will measure the cost to nonbeneficiaries.

[9]By assumption, this model eliminates deadweight losses or costs to society as a whole.

[10]Musgrave, Heller, and Peterson dismiss the feasibility of a major demogrant on the grounds that "...income maintenance must be

approached within a realistic budget constraint" (p. 140). No further explanation is given.

[11]A form of CIT called a "universal refundable tax credit" is generally praised in the study of the Administration Task Force on Welfare Reform by Barth, Carcagno, and Palmer (pp. 53-54). Still, they rate it low in target efficiency and politically infeasible because of the requisite changes in the present tax structure.

[12]More general nonlinear tax-transfer schedules could achieve this for more than one class of workers, but such schedules do not relate directly to the issue being investigated here.

[13]With no possible distortions to savings in a one-period model, both tax-transfer programs would optimally tax away non-employment incomes before taxing any earned incomes.

[14]Individuals who choose not to work at their market wage rates may form yet another class which can be handled in a separate categorical transfer program. The present analysis ignores nonparticipants.

[15]See especially Mirrlees, Atkinson, Sheshinski (1972), and Sadka.

[16]The closest analogue to the present problem is a two-class model with two-segment piecewise linear schedule (Sheshinski, 1971). Unfortunately, this model has individual utility dependent only upon income and an educational choice rather than a labor-supply choice.

[17]Some other qualitative properties of the optimal income-tax schedule can be obtained from a general individualistic function.

[18] Whether the NIT or CIT achieves greater equality within the rich class depends upon the relative tax rates in the two schemes.

[19] Sadka demonstrates this property in his Theorem 5 for both utilitarian and maxi-min versions of social welfare.

[20] Result 6c has a natural interpretation. Both classes of equal size (N=1) under a CIT ($\tau_1 = \tau_2$) requires that A=1. This means that the rich man and the poor man must each have gross earnings equi-distant from the break-even income (P=R). With unequal size classes ($N \neq 1$), a CIT requires that A=N. This means that each worker has gross earnings which differ from the break-even in inverse proportion to his class's relative size.

[21] Recall that τ_1 and G_1 are always adjusted so as to hold constant $\bar{U}_p$ and $\bar{V}_p$.

[22] The term A(P+R) is factored out in the previous line and then the terms are recombined.

[23] Result 6b' carries a natural interpretation for the CIT ($\tau_1 = \tau_2$). Here C=N, which by definition of C implies:

$$P' = R'N + (N+1)\left(Z - \frac{G_1}{1-\tau_1}\right) .$$

Aggregate budget balance requires, as in the CIT case of the fully integrated NIT, that P=RN. But the gaps P' and R' are measured as departures from Z instead of from $G_1/(1-\tau_1)$. This necessitates the final term in the expression, which is premultiplied by the total population (normalized to the poor class size).

[24] For empirical results on income and substitution effects, see the studies in Cain and Watts and that of Garfinkel and Masters. All our empirical examples yielded a positive denominator. The theoretically possible exception arises with very small R or R'. Recall that the continuous analogue to the two-class model suggests that we should not consider such a case.

[25] In a world with a continuous distribution of wage rates, this in turn implies that the mean wage rates of the two classes are unchanged. The substitution term for each class is also unaffected. These facts substantially simplify the analysis.

[26] The data base for these calculations is described below.

[27] Because labor-supply responses vary by demographic group, it is inappropriate to estimate a single labor-supply function for all household heads. If we had included all family heads rather than just prime-age married males, the substitution effect estimates would be more favorable to the CIT. The substitution effects of groups other than prime-aged married males are larger, and these other groups tend to be concentrated in the lower part of the distribution (Garfinkel and Masters).

[28] For a detailed discussion of other aspects of the specification, see Garfinkel and Masters.

[29] The constant terms include the effects of the demographic variables (V) evaluated at their sample mean values.

[30]Barber reports British estimates of a saving of about 15,000 civil servants and an equal number of private employees from the simplified paperwork in moving to a CIT scheme. Scaled up to the U.S. population at average civil service and industry wages, we estimate a savings of nearly one-sixth percent of total labor incomes.

[31]Virtually all of the advantages of Vickrey's lifetime averaging scheme are achieved automatically within a CIT. That is because the progressive marginal rate structure introduces the difficulties into the income tax.

[32]A similar argument was made by early proponents of family allowances in the U.S. These plans were demogrants to families with children but did not contain the reformed tax base or the linearization of the tax schedule as in the CIT.

[33]We take Okner's estimates of a feasible plan that in 1970 would have generated the observed nontransfer tax revenues while offering a gross benefit of $4000 to a married couple with two children. Accompanied by a comprehensively reformed tax base, the requisite marginal tax rate would have been 40.2 percent. We calculate the average tax rates for families with the following gross incomes: $5000, -60 percent; $10,000, 0 percent; $15,000, 14 percent; $20,000, 20 percent; $30,000, 27 percent; and $50,000, 32 percent.

[34] The Canadian income tax is still more amendble to the CIT form because of its existing family allowances and elderly demogrants, its more comprehensive tax base, and its larger personal exemptions. Further, its individual filing unit with no family income-splitting provisions predispose the system toward the CIT as against the NIT. These facts were not fully recognized by the Federal-Provincial Working Party on Income Maintenance.

[35] See Danziger and Kesselman.

[36] Okner also provides estimates for a CIT with a "partially" reformed tax base. Comparable to the results cited in note 33, the requisite marginal tax rate would have been 43.8 percent.

[37] A CIT scheme is otherwise automatically indexed for inflation with a constant marginal tax rate so long as the credits are adjusted for cost-of-living changes.

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