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TAX REFORMS, WELFARE, AND EFFECTIVE TAX RATES

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February 1987

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Abstract

The measurement of marginal effective tax rates (METR's) has become so widespread that it has almost become a cottage industry. Yet despite this proliferation of effort, the welfare significance of this activity has seldom been carefully addressed. What inferences can be drawn about the efficiency of tax reforms from some knowledge of METR's? This paper attempts to answer that question and, as well, to consider how the methodology of measuring METR's can be extended to encompass the entire tax system.
TAX REFORMS, WELFARE, AND EFFECTIVE TAX RATES

As a result of their pathbreaking work, King and Fullerton (1984) have firmly implanted the concept of the marginal effective tax rate (METR) in the public finance literature and have begun to make policymakers aware of its significance in reforming tax systems. Nonetheless, the purpose of the King-Fullerton study was to show how the myriad complexities of capital income taxation could be incorporated into a measurement of the METR for different sectors, assets, investors and financial structurings. They did not attempt to show implicitly how these measurements influence the evaluation of alternative tax systems except to note that both a large average METR and a large variance for the individual METR's were both undesirable features of taxation.

The question arises, therefore, of what we may learn from these measurements and how we might use them to indicate desirable directions for tax reform. The dual purpose of this paper is to see what is involved in extending the King-Fullerton methodology to consider the entire tax system and to explore the welfare significance of tax reforms which alter the configuration of METR's in the economy. Would it be sufficient, for instance, to conclude that a particular reform has favorable allocative consequences if it reduces the magnitude of both the average METR and the variance of the METR's around that average? Or is more information than this required? In searching for answers an effort will be made to clarify the welfare-theoretic underpinnings of the METR.
I. Taxes and Welfare: A General Framework

If distributional considerations are set aside and the fiction of a single household is maintained, taxes may be seen to influence household welfare by affecting what is consumed and when it is consumed. That is, the utility enjoyed by a representative household can be expressed as a function of the level of current consumption of goods and services ($C_p$), the extent of future consumption ($C_f$) and the amount of leisure ($L$) consumed. In general notation this utility relationship can be expressed as:

\[
U = U(C_p, C_f, L)
\]

Leisure may also be a dated variable and consumed in different time periods but in the simple life cycle model presented below only current period consumption is considered and the age of retirement is assumed to be exogenous.

Taxes of various kinds typically reduce consumers' welfare and impose an efficiency cost on the economy by interfering with the ability of households to make efficient choices in choosing among current consumption, future consumption and leisure. By driving a wedge between the demand and supply price of a particular transaction taxes persuade households to forgo decisions which could enhance their utility. As a result of commodity taxes for instance, households will fail to shift their consumption demands from commodity X to more highly valued (and more heavily taxed) Y. Moreover, households could, but will not on account of commodity and labor income taxes,
convert untaxed leisure into higher valued consumption of goods and services. Similarly, because of taxes on capital income opportunities for exchanging current consumption for more highly valued future consumption will be passed up. In each of these cases the tax wedge exists at the margin of decision-making and is appropriately measured by a METR which captures the distorting influence of the tax system on consumer behavior.

In a tax system comprised of a large number of different taxes it is important to identify how each tax contributes to a particular kind of tax distortion. From above, tax wedges or distortions may be classified according to the consumption margin on which they operate. Tax distortions may be responsible for impairing the efficiency of inter-sectoral resource allocation, inter-temporal resource allocation or the allocation of time and effort between work and leisure. Inter-sectoral tax distortions lead to an inefficient composition of current consumption \(C_p\) and arise from the non-uniform tax treatment of either commodities or factor employments. Thus, an inter-sectoral METR will pay attention to the selective aspects of product market taxes and to the selective features of labor and capital taxes along with any sector-specific attributes of the provisions contained in the personal income tax. Trade taxes should be treated in the same manner as other selective product taxes except that in the case of import taxes there is an additional distortion concerning the choice between foreign and domestic sources of supply.

It might seem odd at first glance that no separate treatment is afforded the factor market inefficiencies of selective factor taxes. The
reason for this omission is that all of the factor market consequences of factor taxes can be usefully subsumed in the analysis of product markets. For example, it is commonplace to assert that the corporate income tax misallocates capital between the corporate and noncorporate sectors. As a result of the tax there is too little of the economy's capital employed in the corporate sector. Equivalently, it may be asserted that there is too little corporate output produced in the economy and it is this latter effect which is recognized in the analysis of inter-sectoral tax distortions. 1/

Inter-temporal tax distortions lead to an inefficient timing of consumption and arise because various taxes reduce the reward for saving and thereby make future consumption less attractive. In an open economy in which savers have access to a world capital market and invest at the world interest rate only the personal income tax - assuming it reaches foreign source income - diminishes the return to saving. Capital taxes do not interfere with the ability of domestic savers to convert present into future consumption in this situation. In a closed economy, on the other hand, the gross return to

1. For a demonstration of this equivalence see Anderson (1976) and Schmalensee (1976). Basically these authors show that under competitive conditions, the factor market measurement of the inefficiency associated with introducing a capital tax \( T_k \) in sector \( X \), viz. \( \frac{1}{2} \Delta K_x T_k \), where \( \Delta K_x \) is the tax induced reallocation of capital, can be alternatively captured by the product market expression \( \frac{1}{2} \Delta P_x \Delta X \) where \( \Delta X \) is the tax induced decline in the output of sector \( X \) and \( \Delta P_x \) is the cost-raising influence of the tax. That is, the tax induced increase in product price is \( \Delta P_x = \theta^X_k T_k \) where \( \theta^X_k \) is the cost share of capital in the production of \( X \).
to investment represents the social return to saving so that the inter-temporal
tax wedge would in this case include corporate income taxes, property taxes and
sales taxes (to the extent that they influence the price of capital goods) as
well as the personal income tax.

In an important paper Feldstein (1978) has convincingly demonstrated
that, in a closed economy a capital income tax should be viewed as a form of
excise tax on retirement consumption. In this life cycle context, current
savings are viewed as as the expenditure made to obtain future consumption, a
vital distinction in comparison with earlier work which tended to confuse saving
with the amount of future consumption. The argument runs as follows. Let \( g \) and
\( r \) denote the gross and net return to capital income such that \( r = g(1-t) \) where \( t \)
is the proportional rate of capital income taxation. Define \( P = e^{-rT} \) as the
current price of a dollar of future consumption where \( T \) is the length of time
that elapses between saving and dissaving. Thus, if \( S \) denotes current saving
and \( C_f \) is future consumption, \( S = C_f P \).

If a capital income tax is introduced, the price of future consumption
increases from \( P_0 \) \( (P_0 = e^{-gT}) \) to \( P_1 \) \( (P_1 = e^{-rT}) \). The welfare cost of this
excise tax on future consumption is conventionally given as

\[
\frac{1}{2} \Delta C_f \Delta P = \frac{1}{2} \frac{\partial C_f}{\partial P} \Delta P^2 = \frac{1}{2} \left( \frac{P_1}{C_f} \frac{\partial C_f}{\partial P} \right) (\Delta P/P_1)^2
\]

where the first expression in brackets is the elasticity of future consumption
with respect to its price. Feldstein's innovation was to show that this
elasticity differs from the savings elasticity and is in fact equal to the
savings elasticity minus one.2/ Thus, even if savings are completely unresponsive to changes in the reward for saving there can still be a considerable distortion in the timing of consumption on account of capital income taxes.

Finally, labor-leisure distortions diminish the reward for working either by reducing take-home pay or by raising the price of what that pay can purchase. Thus the METR on labor income is an amalgamation of payroll taxes (insofar as there is no ceiling on contributions), personal income taxes and the average product market tax imposed on the consumption spending of workers.

II. Welfare Measurements of Tax Reform

Most analyses of the efficiency cost of taxation, and in particular those that rely on a partial equilibrium approach, adopt a no-tax situation as the appropriate counterfactual. Sometimes, but not as a rule, the presence of other taxes in the economy is acknowledged. The reason for ignoring other taxes is that welfare comparisons of change from a tax ridden, initially distorted equilibrium are difficult to make. All of the complications associated with second-best analysis immediately come to the fore and clean, unambiguous results are not easily achieved.

2. This result can be easily obtained from the previous definition of current savings, $S = C_f P$. Differenting this expression for savings with respect to $P$, $\frac{\partial S}{\partial P} = C_f + P \frac{\partial C_f}{\partial P}$ so that if $n_{SP}$ and $n_{CfP}$ denote the savings and future consumption elasticities respectively, we have

$n_{SP} = 1 + n_{CfP}$ or $n_{CfP} = n_{SP} - 1$. 
Acceptable analysis of tax reform cannot avoid coming to grips with the second-best issue. New taxes are always introduced alongside other taxes and most reforms not only build on existing taxes but also primarily involve revisions to current tax bases and tax rates that change the configuration of METR's in the economy. Tax reform experiences have all of the elements of a second-best situation that is non pareil.

The claim that the welfare analysis of tax reform is not an easy or straightforward matter, does not mean, however, that it is impossible. Consider first a simpler economy comprised of only two taxed sectors, X and Y, no capital taxes and a fixed supply of labor. $T_x$ and $T_y$ indicate initial ad-valorem taxes imposed on X and Y respectively. $P_x$ and $P_y$ denote producer prices while $P_x (1 + T_x)$ and $P_y (1 + T_y)$ refer to the prices facing consumers. In this setting, McLure (1976), among others, has shown that the first-order welfare change, a measure of the excess burden (EB) of the tax system, is given by:
(2) \( P_x (1 + T_x) \, dXx + P_y (1 + T_y) \, dYy = P_x (T_x - T_y) \, dX. \)

To this expression for excess burden add and subtract the product \( P_x \bar{T} \, dX \), where \( \bar{T} \) is the average rate of commodity tax,

\[
\bar{T} = \frac{P_Y T_y + P_X T_x}{P_X + P_Y}.
\]

The equation above can then be rewritten as:

\[
(2)' \quad EB = P_x (T_x - \bar{T}) dX + P_x dX (\bar{T} - T_y).
\]

Recognizing that \( P_x \, dX + P_y \, dY = 0 \) in this model, equation (2)' is modified to become:

\[
(2)'' \quad EB = P_x (T_x - \bar{T}) dX + P_y (T_y - \bar{T}) dY.
\]

Clearly, the excess burden of the commodity tax system depends on departures from a uniform tax levied at the average rate.

3/ In the context of equation (1), utility of the household is defined as \( U = U(X, Y) \) where \( X \) and \( Y \) are both current consumption goods. Totally differentiating this utility function yields \( du = U_x \, dX + U_y \, dY \) where \( U_x \) and \( U_y \) indicate marginal utilities. Consumer equilibrium implies that

\[
U_x = \lambda P_x (1 + T_x) \quad \text{and} \quad U_y = \lambda P_y (1 + T_y)
\]

where \( \lambda \) represents the marginal utility of income. Substituting these relationships into the expression for the change in household utility gives

\[
dU/\lambda = P_x (1 + T_x) \, dX + P_y (1 + T_y) \, dY
\]

which can be interpreted in this situation as the tax induced decline in consumer welfare or, alternatively, as the excess burden of taxation.
Next, define $e_x$ as the elasticity of the output of sector X with respect to the deviation from a uniform tax. That is, $dX/X = e_x (T - \bar{T})$ If the elasticity $e_y$ is defined in a similar manner, substitution into equation (2)' yields:

$$(3) \quad EB = e_x P_x X (T_x - \bar{T})^2 + e_y P_y Y (Y_x - \bar{T})^2.$$  

If the excess burden is stated as a fraction of total expenditure $E$ and, further, if the special case is considered where the elasticities have the particular value of minus one, equation (3) appears as:

$$(3)' \quad EB/E = \theta_x (T_x - \bar{T})^2 + \theta_y (T_y - \bar{T})^2.$$  

The proportional excess burden is the sum of the weighted variances in commodity tax rates where the weights ($\theta_{kx}$ and $\theta_{ky}$) reflect the relative importance of each commodity in the household's consumption basket.4/

4/ In an analogous fashion, one can easily show that in the case of initial taxes on capital income the excess burden of differential capital income taxes in this two sector framework can be written as:

$$EB = P_k (T_{kx} - \bar{T}_k) dK_x + P_k (T_{ky} - \bar{T}_k) dK_y$$

where $P_k$ is the net return to capital, $T_{kx} (T_{ky})$ is the tax rate on capital income in sector X (Y), and $\bar{T}_k$ is the average rate of capital income tax in the economy. As before, if $e_{kx}^x$ is the elasticity of capital supply to sector X in response to differential taxation of capital in that sector,

$$dK_x/K = e_{kx}^x (T_{kx} - \bar{T})$$

and $e_{ky}^y$ is defined in a similar manner, substituting into the excess burden equation and dividing both sides by total income I equation gives:

$$\frac{EB}{I} = e_{kx}^x \theta_{kx}^x (T_{kx} - \bar{T}_k)^2 + e_{ky}^y \theta_{ky}^y (T_{ky} - \bar{T}_k)^2$$

where $\theta_{kx}^x (\theta_{ky}^y)$ is the ratio of net capital income in sector X (Y) to total income. Once again, the static welfare cost of taxation depends on the extent of the departure from uniform tax treatment as reflected in the sum of the weighted variances above. This provides a formal justification for the emphasis which King and Fullerton (1984) give to the variance in capital income tax rates in their empirical work.
In the two sector world considered here both commodities must be substitutes for each other and any deviation from the average rate of tax will augment the inefficiency of the tax system. More generally, this result will hold in a many-commodity world as long as the taxed item is not a complement with some other taxed items. Empirically, this suggests using broad commodity definitions in order to rule out, or minimize, the possibility of complementarity among taxed commodities. Theoretically, Hatta (1986) has recently shown that movement to a uniform commodity tax structure will improve welfare over a wide range of different economic conditions.

A key issue is whether this static framework can be extended to incorporate dynamic aspects of consumption behavior and a variable supply of labor. In principle, there are no conceptual or methodological barriers to extending the welfare analysis in these directions, although it is much less tidier than before. In order to appreciate what is at stake, assume there is a tax reform which increases taxes on capital income and simultaneously reduces them on labor income. Diagram I offers some visual assistance in understanding how economic welfare is, on balance, affected when the utility function in equation (1) applies.

Panel A of diagram I depicts a situation in which the tax on capital income (the METR) rises from $P_2$ to $P_1$. In response to this higher rate of tax retirement consumption is shown to decline from $C^0_f$ to $C^1_f$. As a result, economic welfare is diminished by the area $ABCE$. Algebraically, this area is equal to $\Delta C_f (P_2 - P_0) - \frac{1}{2} \Delta PAC_f$. However, the damage does not end there as
Diagram I

Welfare Consequences of Higher Capital and Lower Labor Income Taxes

A

Price

$P_0$

$P_1$

$P_c$

B

Real Wage

$\omega_i$

$\omega_L$

$\omega_L$

$\omega_S$

$\omega_S$

$H_D$

$H_S$

$H_1$

$H_2$

$H_3$

$H_4$

$H_5$

$H_6$

$H_7$

$H_8$

$H_9$

$H_{10}$
there is an indirect repercussion in the labor market. The increase in capital income taxation will likely cause leisure to be substituted for future consumption. If this happens the compensated supply curve for labor will shift leftward as shown in panel B. Given the (so far) fixed tax rate on labor income of \((W_1 - W_0)\) this labor supply shift will provoke an added welfare cost which is measured by the area ABCDE in panel B. Algebraically, this area is approximately equal to \(\Delta H \times (W_1 - W_0)\) or \(\Delta H \times \left(\frac{\partial H}{\partial P}\right) \times \Delta P\) \((W_1 - W_0)\). As shown in the diagram there is a modest tendency for both the pre-tax and after-tax wage to increase as a result of the reduction in labor supply.

This is not the end of the story though. Accompanying the higher capital tax is a slashed labor tax shown in panel B as the shrunken tax wedge of \((W_2 - W_3)\). Labor supply expands from \(H_1\) to \(H_2\) and there is a consequent gain in welfare in the labor market indicated by the Area AFGE. This area can be closely approximated as \((H_2 - H_1) \times (W_2 - W_3)\). The higher after-tax income enjoyed by workers should stimulate more spending both for current and future consumption. Because of this interaction between the labor and capital markets the demand for future consumption will shift rightward as is indicated by the dotted line. Future consumption will increase from \(C_f^1\) to \(C_f^2\) bringing with it an attendant welfare gain of AEFG, an area which can be measured by the expression \(\Delta C_f \times (P_2 - P_0)\) or, alternatively, as \(\Delta W \times \left(\frac{\partial C_f}{\partial W}\right) \times (P_2 - P_0)\)

The latter expression captures the impact on welfare of the capital markets benefit associated with a lower labor tax. More generally, whenever there are initial taxes, the mutual inter-action among different tax distortions must be taken into account.
A complete analysis of any tax substitution would consider the numerous inter-actions that occur among the triad of inter-sectoral, inter-temporal and labor-leisure distortions. Harberger (1964 and 1971) has hinted at how this might be accomplished if the consumer's welfare is represented by equation (1). He has shown that a measure of the welfare damage or excess burden attributable to a group of taxes in the economy can be expressed by the following summation:

\[ \frac{dU}{\lambda} = EB = - \frac{1}{2} \sum \sum S_{ij} T_i T_j, \]

where \( S_{ij} \) is the compensated change in the \( i' \) th quantity in response to an adjustment in the \( j' \) th price and \( T_i, T_j \) are the size of the tax distortions imposed on activities \( i \) and \( j \) respectively.

Equation (4) measures the tax-induced loss in household welfare in comparison with a no-tax world in which there are also no non-tax distortions. To standardize the notation in what follows, let \( T^c_i \) denote the size of the tax distortion on the \( i' \) th type of current consumption while \( T_k \) and \( T_L \) will refer to, respectively, the magnitude of the tax distortions affecting the choice of future over present consumption and the decision to consume leisure. Using equation (4) and recognizing the symmetry of the substitution matrix, the excess burden arising from this set of tax distortions is:
Each term in equation (4)' describes how one or another of the three tax distortions impinges on economic welfare either directly in the market where it is introduced or indirectly in other related markets.

From a tax reform perspective, however, it is the welfare changes that occur from an initial, distorted equilibrium that matter. Given that $T_1$, $T_k$, and $T_i$ are already in place, the relevant tax reform question is how excess burden is affected by changes in these tax distortions. In other words, the welfare consequences of a tax reform require examining the total derivative $dEB$, of equation (4)'

\[
(5) \quad dEB = \frac{1}{2} \sum_i \frac{\partial^2 E}{\partial p_i \partial T_i} (T_i)^2 - \sum_j \frac{\partial^2 E}{\partial T_i \partial p_j} T_i T_j - \sum_i \frac{\partial^2 E}{\partial T_i \partial T_i} T_i - \frac{1}{2} \frac{\partial^2 E}{\partial T_i \partial T_k} T_i T_k^2 - \frac{1}{2} \frac{\partial^2 E}{\partial T_i \partial T_L} T_i T_L^2
\]

While equation (5) is not a simple expression to deal with, its economic interpretation is reasonably straightforward. Each of the terms in this equation represents a rectangle of welfare change that is produced
whenever a particular tax rate is revised. Each tax change creates a welfare rectangle directly in either the labor, capital or commodity market in which it operates and indirectly in all of the other markets. The rectangles correspond to, and are linear approximations of the trapezoidal areas that are depicted in diagram I. 5/

The first term in equation (5) shows how an increase in a commodity tax distortion augments the loss in consumer welfare while the second term characterizes the gain in welfare when the higher rate of tax induces greater consumption of other taxed commodities. The next two terms indicate how commodity taxes may spillover and either exacerbate or alleviate the degree of distortion in labor and capital markets. It should be noted here that since leisure (L) is untaxed, the distortion $T_L$ is to be interpreted as the subsidy conferred by the tax system on the consumption of leisure and is really, therefore, a negative tax distortion. Excess burden is enhanced whenever a higher rate of commodity taxation provokes more consumption of leisure. The remaining terms in equation (5) illustrate how changes in the other two types of tax distortion either augment or subtract from consumer welfare.

Also, it may be noted that the equation above highlights the concerns of some of the literature on optimal taxation, namely that the derivative $\partial L/\partial T^i_C$ is probably not constant across commodities. More to the point for a given labor-leisure distortion $T_L$ the change in the amount of excess burden

5/ A more refined analysis would consider third-order terms in the Taylor series expansion of the utility function that would provide even closer approximations. This has been done by Green and Sheskiniski(1979).
will be greater the more closely the i' th commodity and leisure are
substituted in consumption.

Empirical implementation of equation (5) is most easily achieved if
the equation is recast in terms of elasticities. For that purpose the
following notation is introduced:

\[ Y_i^c: \] The value of the i' th commodity that is consumed currently.

\[ S: \] Level of current household savings

\[ W: \] Current labor income

\[ \gamma_{ij}: \] The elasticity of consumption of the i' th commodity with respect in
the j' th tax distortion. For example, \( \gamma_{CPL}^i \) is the elasticity of the i' th
commodity currently consumed with respect to changes in the labor-leisure
distortion. \( \gamma_{Lk} \), on the other hand, is the elasticity of
leisure consumed with respect to changes in the tax rate on capital
income.

\[ t_L: \] Effective tax rate on labor income, defined as the ratio of the
labor-leisure tax distortion \( T_L \) to the wage rate.

\[ t_k: \] Effective tax rate on capital income, defined as the ratio of the inter-temporal
tax distortion \( T_k \) to the before-tax rate of return to capital.

\[ t_i^c: \] Effective tax rate on the i' th commodity that is consumed currently,
defined as the ratio of the inter-sectoral tax distortion to the market
price of that commodity.
Making use of this notation and letting a circumflex "A" indicate percentage changes in a variable, it is easily seen that equation (5) can be rewritten in elasticity form as:

\[
(5)' \ dEB = - \sum_{i} t_{i}^c \gamma_{c}^i T_{c} - \sum_{j} t_{j}^c \gamma_{c}^j T_{c} \\
- \sum_{i} t_{i}^L \gamma_{c}^L T_{c} - \sum_{k} t_{k}^c \gamma_{c}^k T_{k} - t_{k}^L \gamma_{c}^L T_{L} \\
- t_{k}^c \gamma_{c}^k T_{k} - t_{L}^c \gamma_{c}^L T_{L}.
\]

A specific tax reform is represented, therefore, by the vector of percentage tax changes \( [\hat{T}_{i}^c, \hat{T}_{k}^c, \hat{T}_{L}^c] \). Obviously a large number of tax change configurations will satisfy the requirements for a revenue neutral tax reform.

The allocative consequences of the reform can be assessed if information is available on the marginal effective tax rates, the composition of consumer spending, the level of household savings and labor income and the magnitude of the several unobservable elasticities. Since these elasticities are of the compensated kind, the order in which the tax changes are imposed
should not affect the outcome.\footnote{It can be argued that the excess burden of taxation makes it impossible to restore consumers to their original level of welfare no matter how the public sector disposes of its revenue. In that case the use of uncompensated elasticities which incorporate the income effect of taxation is called for. This complication is ignored here. When income effects are present, however, the order in which tax changes are introduced affects the outcome of the tax reform.}

It will never be obvious whether a particular tax reform has improved resource allocation unless all of this information is brought to bear in evaluating equation (5)'.

One interesting finding that emerges from an inspection of equation (5)' is that calculation of the allocative impact of a tax reform requires prior determination of the initial METR's. Thus the METR is a vital component in determining the welfare effect of changing the pattern of METR's in the economy.

Another, although perhaps less obvious, finding is that the calculation of the tax reform based adjustment in excess burden automatically yields an estimate of the induced revenue consequences of a tax reform. This side benefit occurs because each term in equation (5)' indicates how the existing tax bases respond to a change in tax rates. Most revenue projections of a tax reform implicitly assume that the economy's tax bases will not react to a change in tax rates. Equation (5)' reveals how to relax this assumption and obtain a more refined estimate of the revenue consequences of a tax reform. It shows explicitly how tax changes will expand some tax bases and erode others. A revenue-neutral tax reform cannot be adequately designed unless it takes these induced revenue effects into account.
Empirical implementation of equation (5) may still appear to be a daunting task. It would be desirable, therefore, to strip equation (5)' down to its essential elements by considering the simplest possible case in which there are only two current consumer goods, future consumption and leisure. That is, the utility function in this skeletal version of the model is given by:

(b) \[ U = U(C_1, C_2, C_f, L) \]

Five margins of consumer substitution can be identified, that between \( C_1 \) and \( C_2 \), between \( C_f \) and both \( C_1 \) and \( C_2 \), and finally between leisure and each of the other consumer goods. Since leisure is non-taxable \( T_L \) may be set equal to zero leaving \( T_1^1, T_2^2, T_k^1 \) as the feasible set of changes in the tax instruments. A personal income tax may (but need not) be depicted as a uniform commodity tax such that \( T_1^1 = T_2^2 \) or, alternatively, \( T_1^1 = T_2^2 \).

Selective features of personal income taxation, however, would violate these equivalences.

Expansion of equation (5)' generates a 12 term expression in this streamlined case:

\[
\begin{align*}
\text{dEB} &= t_c^1 \gamma_c^1 \gamma^2 \hat{T}_c^1 - t_c^2 \gamma_c^2 \gamma^2 \hat{T}_c^1 - t_k \gamma_1 \gamma_3^1 \hat{T}_c^1 - t_L \gamma \hat{T}_c^1 \\
&\quad - t_c^1 \gamma_1 \gamma_2^2 \hat{T}_c^2 - t_c^2 \gamma_c^2 \gamma^2 \hat{T}_c^2 - t_k \gamma_2 \gamma_3^2 \hat{T}_c^2 - t_L \gamma \hat{T}_c^2 \\
&\quad - t_c^1 \gamma_c^1 \gamma_3^3 \hat{T}_k - t_c^2 \gamma_c^2 \gamma_3^3 \hat{T}_k - t_k \gamma_3 \gamma_3^3 \hat{T}_k - t_L \gamma \hat{T}_k
\end{align*}
\]
In order to conserve on notation the various substitutions have been numbered according to the order in which the consumption arguments appear in equation (6). Thus, for example, $\gamma^{21}$ denotes the elasticity of consumption of $C^2_p$ with respect to a change in the price of $C^1_p$.

One question that naturally arises is the amount of extra computation that occurs when additional distortions in the pattern of current commodity consumption are recognized. Adding one more commodity to current consumption will expand the size of equation (7) by eight more terms. More generally, doubling the number of currently consumed goods will quadruple the number of terms entering equation (7). Thus the amount of detail that can be accommodated within this welfare framework is reasonably limited and it is doubtful that in applying equation (5)', one would want to disaggregate current consumption much beyond ten separate items.

It is possible to ease the computational burden and simplify equation (7) by utilizing the symmetry properties of the substitution matrix. Thus, for example, $V^2_c \gamma^{23} = S \gamma^{32}$ and $V^1_c \gamma^{13} = S \gamma^{31}$, $W \gamma^{41} = V^1_c \gamma^{14}$.

Substitution of these conditions into equation (7) gives a more convenient expression which reduces the number of terms by half:

\begin{align*}
(7)' \quad dEB &= (\hat{T}^1_c - \hat{T}^2_c) V^1_c \gamma^{12} (t^1_c - t^2_c) \\
&\quad + (\hat{T}^1_c - \hat{T}^k_c) V^1_c \gamma^{13} (t^1_c - t^k_c) + (\hat{T}^2_c - \hat{T}^k_c) V^2_c \gamma^{23} (t^2_c - t^k_c) \\
&\quad + \hat{T}^1_c V^1_c \gamma^{14} (t^1_c - t^L_c) + \hat{T}^2_c V^2_c \gamma^{24} (t^2_c - t^L_c) + \hat{T}_k S \gamma^{34} (t^k_c - t^L_c)
\end{align*}
The first term in equation (7)' measures the changes in the extent of inter-sectoral tax distortions. The next two terms determine the change in the degree of inter-temporal tax distortions while the last three refer to the magnitude of the change in labor-leisure tax distortions. Since both current and future markets for consumption are initially distorted, a tax reform will typically shift consumption from one distorted market to another making, as each term in equation (7)' indicates, the difference in initial tax distortions an important factor in evaluating the allocative consequences of that reform.

Thus in understanding and gauging the welfare impact of tax reform three basic questions have to be raised and addressed:

(a) What is the pattern of initial METRs that distort consumption choices in the economy?

(b) How does tax reform alter the terms on which different consumption choices are made?

(c) How responsive are consumers to tax induced adjustments in their terms of trade?

The methodology for treating the first question is now well established in the public finance literature. The second question has been also dealt with...
extensively in the literature. Thus in the streamlined version of the tax reform model a comprehensive income tax change would take the form of
\[ \hat{T}_c^1 = \hat{T}_c^2, \hat{T}_k > 0. \] A capital income or saving exemption under the personal income tax would be modeled as \( \hat{T}_k = 0 \). Similarly, a non-uniform commodity tax reform or a reform of the personal income tax with discriminatory sectoral features would change tax rates such that
\[ \hat{T}_c^1 \geq \hat{T}_c^2, \hat{T}_k \geq 0. \]

The third question poses the issue of whether the analysis can proceed very far without a good grasp of the magnitude of the various elasticities contained in equation (5'). In one sense, one can never hope to have reliable and entirely satisfactory estimates of all of the relevant elasticities. Even in developed economies such as the United States the magnitude of the savings and labor supply elasticities continues to be subject to a lively econometric debate and advocates of a particular tax reform implicitly take stands on what their sizes are likely to be.\(^7\)

Sensitivity analysis is perhaps the best that can be done in this area. Agreement on the sign of the various elasticities is possible and perhaps also too on a reasonable range of values for them.\(^8\) Sensitivity analysis may permit an informed quantitative judgment, if not exactly a precise estimate, of the allocative consequences of a tax reform.

\(^7\) Expenditure tax proponents, for example, typically argue that the savings elasticity is much larger than the labor supply elasticity.

\(^8\) From the homogeneity conditions for demand functions and the budget constraint of the household certain restrictions can be imposed on the values that these elasticities may take.
III. Summary

This paper has had two major goals, to lay out a general framework for analyzing taxes and welfare and to investigate the methodology for measuring the welfare effects of tax reforms.

Four main conclusions stem from this effort:

(1) Tax distortions belong to one of the three types: those that distort the choice of current consumption, those that interfere with the choice between current and future consumption and those that affect the choice between work and leisure. Each tax instrument contributes to one or more marginal effective tax rates (METR's) measuring the magnitude of a particular tax distortion. Tax reform alters the configuration of METRs in the economy.

(2) For product (or factor) market distortions that influence the choice of current consumption the inefficiency of taxation is directly related to the variance of the effective tax rates. Larger variances impose greater tax inefficiencies. As a first approximation, welfare improving tax reforms diminish the sectoral variance in effective tax rates.

(3) Tax reform involves changes from a situation of initial economic inefficiency. Measuring the efficiency consequences of a tax reform requires two crucial bits of information, the initial METR in each
distorted market and knowledge of the behavioral elasticities which link tax induced reactions in one distorted market to those in other markets. Thus, for example, changes in tax distortions affecting the labor market will typically spillover and affect household behavior in both capital and commodity markets. A reliable measure of the welfare consequences of tax reform needs to encompass all of these reactions to a new tax environment.

(4) The calculation of the welfare change associated with a tax reform has the added advantage of indicating the indirect or induced revenue changes produced by that reform. Thus some of the revenue consequences of a tax reform are revealed as a by-product of the efficiency analysis of that reform.
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