On the Marginal Welfare Cost of Taxation

By EDGAR K. BROWNING*

This paper develops a rigorous partial-equilibrium analysis of the determinants of the marginal welfare cost (MWC) of taxes on labor earnings. It shows that four key parameters interact to determine the magnitude of MWC. Using aggregate data and plausible ranges of values for the parameters, MWC can vary from under 10 percent to more than 300 percent of marginal tax revenue, suggesting that, given available evidence, we cannot estimate MWC with much precision.

The marginal welfare cost of raising tax revenue is now understood to be an important factor in the analysis of government expenditure policies, and several recent studies have developed estimates suggesting its size is substantial.[1] In general, these studies have concluded that the marginal welfare cost is significantly larger than I found in my early study (1976). For example, I concluded that marginal welfare cost was likely to be between 9 and 16 percent of additional revenue raised, but Charles Ballard, John Shoven, and John Whalley (1985) suggest that it is in the 15 to 50 percent range, with Charles Stuart (1984) reporting similar results. Developing an analysis that clarifies why the estimates differ so markedly is a major purpose of the present paper.

Both Stuart and Ballard et al. employ general-equilibrium methodologies, while I used a simple partial-equilibrium formulation based on Arnold Harberger's (1964) approach. It is apparently widely believed that this difference in methodologies is responsible for the difference in results, with the general-equilibrium approaches capturing some essential elements that are missing in the partial-equilibrium approach. I do not believe that this is the case; almost all of the differences in results can be traced to different assumptions about key parameter values. To support this assertion, this paper develops the partial-equilibrium approach in a more careful and usable form, and shows that modest variations in four key parameters can account for much of the apparent differences in results. One of the virtues of the partial-equilibrium approach is that it clarifies the contribution these key parameters make to the final estimate, something that is often obscured in large-scale general-equilibrium models.[2]

Section I develops the theory necessary to estimate the total welfare cost due to labor supply distortions of the tax system. It also corrects an error in the original Harberger formulation that I used, which led to an underestimate of total and marginal welfare costs in my 1976 paper. Section II applies the theory to the calculation of the marginal welfare cost of raising tax revenue and shows that by varying four parameter values over a relatively narrow range, the estimated marginal welfare cost varies from under 10 percent to well over 100 percent.

I. The Total Welfare Cost

Here I will consider only the welfare cost that results from taxes on labor incomes, both because the theory is less controversial and because there is a greater consensus

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[1] See Charles Ballard et al. (1985), Ingemar Hansson and Charles Stuart (1983), Stuart (1984), and David Wildasin (1984).

[2] This is especially true in the case of Ballard et al. (1985), where the model is a multisector, dynamic computational general-equilibrium model. On the other hand, the far simpler two-sector general-equilibrium model of Stuart does a better job of focusing on the importance of key parameter values. The model in the present paper is more in the spirit of Stuart's approach.

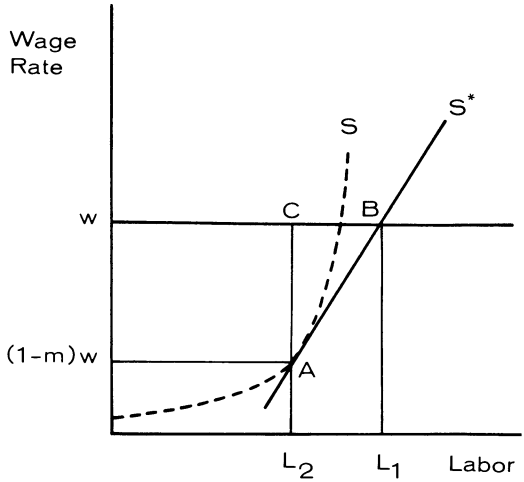

FIGURE 1

concerning empirical magnitudes than for taxes that fall on capital income. Figure 1 illustrates the usual representation of the welfare cost that results from a tax on labor income. The worker's wage rate is w (assumed to equal the marginal value product of his labor services), and labor earnings are subject to a tax at a marginal rate of m, so that the net marginal wage rate confronting the worker is $(1-m)w$. The equilibrium in the presence of the tax is at point A, where the quantity of labor supplied is L_2.[3] The compensated labor supply curve drawn for the utility level realized by the worker with the tax in place is S^*.[4] (Ignore supply curve S for the moment.) Thus, the total welfare cost is shown by area ACB, equal to the increase in earnings if the marginal tax rate is reduced to zero (but with the worker kept on the same indifference curve), CBL_1L_2, less the value of leisure given up in generating that increment in earnings, ABL_1L_2.[5]

It is important to recognize that area ACB is an exact measure of the welfare cost of the tax within the context of this model; there is no approximation involved. The key point is that I am using the compensated labor supply curve, which is necessary when evaluating welfare effects of changes in labor supply. However, note that this analysis is based on the assumption that the market wage rate remains unchanged when labor supply changes from L_2 to L_1. This assumption, common but not essential in partial-equilibrium models, differs from the general-equilibrium treatment in which the market wage rate is endogenously determined. The appropriateness of the fixed wage rate assumption will be discussed later.

To derive a formula that can be used to calculate the total welfare cost, it is assumed that the compensated labor supply curve is linear between L_2 and L_1. Then the welfare cost, W, equals one-half $CB \times AC$, or,

$$W = \tfrac{1}{2}(dL)wm. \tag{1}$$

The compensated change in the quantity of

[3]It is important to understand that the line between $(1-m)w$ and A in Figure 1 should not be interpreted to mean that the marginal tax rate is necessarily constant regardless of the level of earnings. The welfare cost depends on the marginal tax rate at the actual earnings level, which is identified here as m; the marginal tax rate(s) that applies to inframarginal earnings may differ from this. Thus, Figure 1 should not be taken to imply a proportional tax, but only to emphasize that it is the tax rate at the margin (evaluated at the worker's actual equilibrium position) that produces the distortion in the allocation of resources. In particular, note that if the tax is progressive, tax revenue will not be equal to the rectangle $wCA(1-m)w$; it will be smaller than this because the marginal tax rate that applies to earnings below wL_2 is less than m.

[4]This compensated supply curve is drawn for the utility level realized by the worker after adjustment to the tax and whatever benefits are received from government expenditures. Government expenditures are held constant along the compensated supply curve.

[5]Although Peter Diamond and Daniel McFadden (1974) have proposed a different measure of welfare cost, I believe this continues to be the standard measure. Put differently, area ACB is equal to the difference between the tax revenue actually collected and the revenue that could be collected with a lump sum tax that leaves the taxpayer on the same indifference curve that he attains under the actual tax. This is equivalent to the measure defended by J. A. Kay (1980) in his criticism of Diamond and McFadden; Kay describes the measure as the difference between tax revenue and the equivalent variation measure of the loss in consumers' surplus from the tax. By contrast, the Diamond-McFadden measure uses the compensating variation measure of the change in consumers' surplus and the tax revenue that would hypothetically be collected at the compensated equilibrium.

labor supplied can be expressed as the inverse of the slope of the compensated supply curve, dL/dw, times the change in the marginal wage rate, wm, so

$$W = \tfrac{1}{2}\left[\frac{dL}{dw}wm\right]wm. \tag{2}$$

Multiplying by $L_2(1-m)/L_2(1-m)$ yields

$$W = \tfrac{1}{2}\left[\frac{dL}{dw}\frac{w(1-m)}{L_2}\right]\frac{m^2}{1-m}wL_2. \tag{3}$$

Note that the term in brackets equals the elasticity of the compensated supply curve evaluated at the net of tax wage rate (point A in Figure 1). Expressing this compensated labor supply elasticity as η, equation (3) can be conveniently written as[6]

$$W = \tfrac{1}{2}\eta\frac{m^2}{1-m}wL_2. \tag{4}$$

In contrast to equation (4), the widely used Harberger formula for calculating the welfare cost is

$$W = \tfrac{1}{2}\eta m^2 wL. \tag{5}$$

It is easily shown that the Harberger formula correctly evaluates the welfare cost if we measure the compensated elasticity and the level of labor earnings at their undistorted levels, that is, at point B in the diagram. However, these values are not observable, and available estimates pertain to elasticities and earnings evaluated in the presence of distorting taxes, that is, at point A in the diagram. Consequently, equation (4) will generally be the appropriate way to estimate the total welfare cost of a tax on labor earnings.

In my earlier paper (1976), I started with (Harberger's) equation (5) and from it developed expressions to estimate the marginal welfare cost. This procedure led to an underestimate of total and marginal welfare costs; my earlier estimates should be multiplied by (approximately) $1/(1-m)$ to correct for this error. This is one reason why recent general-equilibrium studies have generally found larger welfare costs—an error in my use of, rather than a true shortcoming of, the partial-equilibrium approach.[7] I avoid this error here by not relying on the Harberger formula.

Before turning to the issue of marginal welfare cost, it will be helpful to consider the application of this approach to the estimation of the total welfare cost, in part because this clarifies several points that are also relevant for the estimation of marginal welfare costs. For this purpose, I propose to use equation (4) with aggregate rather than individual data. If all households confronted the same marginal tax rate and had the same labor supply elasticity, this approach would yield the correct result. However, as can easily be shown, when marginal rates and/or elasticities differ, this common approach understates the welfare cost, and the understatement is larger the greater the dispersion in marginal tax rates and elasticities. Although I do not believe the actual dispersion is large enough to greatly affect the estimates (at least relative to the other factors I wish to emphasize here), the downward bias of this approach should be kept in mind.[8]

[6]Note that the average tax rate does not enter into the determination of the welfare cost according to equation (4). However, this does not mean that the average tax rate plays no role; it can influence the welfare cost through its indirect effect on the labor supply elasticity and earnings. For example, for an unchanged marginal tax rate, a higher average tax rate will increase the wL term if leisure is normal, and since the worker ends up on a different indifference curve, the compensated supply elasticity may also be affected. To apply equation (4) correctly, we do not need to know the average tax rate, but we do need to know the compensated supply elasticity and earnings at the worker's actual equilibrium position, thereby incorporating whatever effect the average tax may have through these terms.

[7]This error in the use of the Harberger formula has been pointed out in Christopher Findlay and Robert Jones (1981).

[8]Jerry Hausman (1981) uses disaggregated data in his work estimating welfare costs. Potentially, this approach will yield more accurate estimates, but there are some serious problems with his implementation of this approach (see my 1985b paper), and he does not provide estimates that permit a comparison of the dif-

To apply equation (4), we require estimates of aggregate labor earnings, a weighted-average compensated labor supply elasticity for workers as a group, and a weighted-average marginal tax rate for workers as a group. Although the greatest uncertainty surrounds the appropriate value for the labor supply elasticity, there is no point in reviewing once again the econometric literature, and I will simply use values of 0.2, 0.3, and 0.4 here. While values substantially larger than 0.4 have been used in the literature, it seems unlikely to me that a value much in excess of this figure is plausible.[9]

The only subtle point to recognize in choosing a value for aggregate labor earnings is that labor supply should be valued at the marginal value product of labor since the theory is based on the tax wedge between the marginal value product and the net wage received by workers. (See Figure 1 where w is the marginal value product.) In the absence of indirect taxes collected from firms (and some other factors mentioned below), wage earnings received by workers would represent the appropriate magnitude. However, because of the employer portion of the Social Security payroll tax, fringe benefits, and indirect output taxes (sales and excise taxes), reported wage and salary incomes must be grossed up to a broader measure of before-tax labor compensation. A rough estimate of the required figure for 1984 is \$2400 billion.[10] This compares with wage and salary income of only \$1800 billion.

The weighted-average marginal tax rate should reflect the combined effect of all taxes and transfers in reducing the net marginal wage rate received by workers below the marginal value product of labor. Thus, the marginal tax rate should be measured relative to the broad before-tax measure of labor income. This means that statutory tax rates are not the appropriate values to use. To see this, consider the Social Security payroll tax which was levied at a 14.1 percent combined employer-employee rate in 1984. If a worker increases his labor supply sufficiently to receive an additional \$100 from his employer, he actually had to generate \$107.05 in additional product since the employer portion of the tax (\$7.05) is remitted to the government before the worker is paid. Thus, the marginal tax rate that applies to the worker's marginal value product is \$14.10/\$107.05, or 13.2 percent rather than 14.1 percent (assuming no other indirect taxes, fringe benefits, and so on).

Similarly, the effective marginal tax rate of personal income taxes is below the statutory

ference when aggregate data are used. An example of how sensitive the results are to dispersion in marginal tax rates is provided by the following. Consider three workers with respective earnings of \$10,000, \$20,000, and \$30,000, who confront marginal tax rates of 30, 37, and 44 percent, respectively. With a compensated labor supply elasticity of 0.3, using equation (4) with the individual data and summing yields an estimate of \$2400 for the total welfare cost. Using aggregate data—\$60,000 for earnings, 0.3 for the elasticity, and the weighted-average (weights equal to share of total labor income) marginal tax rate of 39.4 percent—the estimate is \$2305, only 4 percent less than the correct figure. Of course, the difference will be larger if the differences in marginal tax rates are greater. However, my paper with William Johnson (1984, Table 3) found that the average effective marginal tax rates for the top four quintiles of households range only from 39 to 47 percent when all taxes and implicit marginal tax rates of transfers are taken into account. Of course, there is also variation in marginal tax rates within quintiles, so the degree of understatement may be larger than these figures suggest.

[9] Numerous references to the relevant literature are contained in my paper with Johnson, Ballard et al. (1985), and Stuart. It should be noted that both Stuart and Ballard et al. use upper bound values for the compensated labor supply elasticity that exceed the 0.4 figure used in this paper. Stuart uses a value of 0.836; while Ballard et al. do not explicitly give the value they use, based on Table 1 of Ballard et al. (1982), the figure is apparently about 0.6. These figures seem too high to me, although there is some empirical evidence to support such values. Note that with a marginal tax rate of 43 percent, a compensated labor supply elasticity of 0.6 implies that reducing the marginal tax rate to zero in a compensated fashion would increase labor supply by 45 percent.

[10] The *Economic Report of the President* (1985, Table B-21) gives total compensation of employees (which includes the employer contribution to Social Security and some fringe benefits) for 1984 as \$2173 billion. To this can be added the approximate \$147 billion in sales and excise taxes which, according to M. Kevin McGee (1985), can be taken to fall on labor income. In addition, I assume that \$80 billion of the \$155 billion in proprietors' income represents labor compensation.

marginal tax rate that applies only to taxable income as defined by the tax laws. The significance of this point is evident from a comparison of the results of recent studies by Robert Barro and Chaipat Sahasakul (1983) and John Seater (1984). Barro and Sahasakul estimate a weighted-average marginal tax rate in 1980 for the federal individual income tax of 30.4 percent; this is simply an average of statutory marginal tax rates weighted by adjusted gross income. For the same year, Seater estimated a weighted-average marginal tax rate of 22.2 percent, but he arrived at his estimate by relating actual tax payments to variations in adjusted gross income (rather than to taxable income). For purposes of evaluating the labor supply distortions of taxes, the Seater approach comes closer to measuring the effective marginal tax rate that applies to the marginal value product of labor.[11]

In addition to measuring each tax's effective marginal tax rate consistently with respect to the same broad base, it is the combined marginal tax rate due to all factors that depress the marginal net wages received by workers that is relevant. Thus, the implicit marginal tax rates of means-tested transfer programs must also be included. One study that does measure marginal tax rates due to all taxes and transfers relative to a broad measure of income is my paper with William Johnson, which provides estimates for each quintile of households for 1976. A weighted average (weights equal to each quintile's share of labor income, broadly measured) of these marginal tax rates is 43 percent, and I will use this as my benchmark estimate for the effective marginal tax rate in 1984.[12]

There are, however, greater difficulties involved in accurately estimating the effective marginal tax rate than are commonly recognized, and the 43 percent figure should be viewed as subject to a significant margin for error.[13] For example, the Browning-Johnson estimate, as well as most others, treats the Social Security payroll tax as fully a distortion at the margin (except for those earning above the ceiling on taxable earnings). But if workers view, correctly or not, an additional dollar in Social Security taxes as purchasing deferred labor compensation in the form of a pension with a present value of a dollar, then the effective marginal tax rate of this tax would be zero.[14]

In view of this consideration, as well as others, it is appropriate to consider a range of values for the weighted-average effective marginal tax rate. Consequently, I use values of 38, 43, and 48 percent in the calculations. These estimates, together with the compensated labor supply figures (0.2, 0.3, and 0.4) and gross labor compensation ($2400 billion), can be inserted into equation (4) to estimate the total welfare cost of distorted labor supply decisions in 1984.

Table 1 displays the results, with the total welfare cost as a percentage of tax revenues from taxes that fall on labor income shown in parentheses.[15] What is perhaps most strik-

[11] To the extent that some exclusions and deductions are worth less at the margin than after-tax cash income, the approach used by Seater would understate the effective marginal tax rate to some degree.

[12] The Browning-Johnson estimate for 1976 is really a weighted-average marginal tax rate for labor and capital taxes together as they apply to an increment of labor and capital income. Insofar as the marginal tax rate on labor income is lower than the marginal tax rate on capital income, this figure would overstate the rate on labor income. However, since 1976, labor income has come to be taxed more heavily.

[13] See myself and Johnson, Barro-Sahasakul, and Seater for discussions of some of the technical problems.

[14] Three recent studies have investigated the linkage between social security taxes and future benefits (Roger Gordon, 1983; myself, 1985a; and Richard Burkhauser and John Turner, 1985), but with conflicting results. It seems quite possible, however, that the effective marginal tax rate of Social Security is somewhat less than the approximate 9 percentage point contribution it makes to the overall 43 percent rate cited above.

[15] Total tax revenues from taxes on labor income in 1984 are approximately $745 billion. This is the sum of Social Security payroll taxes ($242 billion), sales and excise taxes ($147 billion), state income taxes ($60 billion), and the federal individual income tax ($296 billion). Treating personal income taxes as falling fully on labor income rather than labor and capital income is something of an exaggeration, but because of the many special provisions favoring capital income contained in the income tax laws, the overstatement is probably not very large.

TABLE 1—TOTAL AND AVERAGE WELFARE COSTS, 1984 (Billions $)

m	η 0.2	0.3	0.4
0.38	$55.9	$83.8	$111.8
	(7.5)	(11.2)	(15.0)
0.43	77.9	116.8	155.7
	(10.5)	(15.7)	(20.9)
0.48	106.3	159.5	212.6
	(14.3)	(21.4)	(28.5)

Note: Percentages of tax revenues that fall on labor income are shown in parentheses.

ing is the wide range of the estimates: the welfare cost when $\eta = 0.4$ and $m = 48$ percent is nearly four times as large as when $\eta = 0.2$ and $m = 38$ percent. Varying the marginal tax rate alone from 38 to 48 percent approximately doubles the total welfare cost. The wide range of estimated welfare costs that results from use of a relatively narrow range of values for the two key parameters, η and m, shows how far we are from having reliable and precise estimates of the total welfare cost. Although my preferred parameter values are 43 percent and 0.3, the available empirical evidence certainly does not rule out the other possibilities; indeed, evidence can be cited to support a higher labor supply elasticity than 0.4.

Before turning to the extension of the analysis to marginal welfare costs, two reasons why this framework may overstate the total welfare cost should be discussed. (Recall, in addition, that use of aggregate data tends to work in the opposite direction.) First, this partial-equilibrium approach assumes the marginal value product of additional hours of work is constant. With a fixed capital stock, however, an increase in labor will reduce the marginal product of labor. How large a bias is introduced by assuming a fixed wage rate depends on the elasticity of the marginal product curve relative to the labor supply elasticity. With the demand elasticity high relative to the labor supply elasticity, the degree of overstatement is small. For example, with $\eta = 0.3$ and $m =$ 43 percent, assuming the marginal value product curve has an elasticity of two implies that the true welfare cost would be about 15 percent less than estimated using equation (4) and assuming the wage is constant. Moreover, the actual elasticity of the marginal value product curve is likely to be higher than two. For example, with a Cobb-Douglas technology and a labor share, α, equal to 0.75, the elasticity of the marginal product of labor curve is $1/(1-\alpha)$, or 4.0. Thus, the partial-equilibrium assumption of a fixed wage is not likely to have a quantitatively important effect on the estimation of welfare cost.[16]

The second problem is potentially more troublesome, and relates to the assumption that the compensated labor supply curve is linear which underlies the derivation of equation (4). When the supply curve is not linear, equation (4) does not provide an exact estimate of welfare cost. If, as seems likely, the actual compensated supply curve is concave, as illustrated by S in Figure 1, the estimate provided by equation (4), area ACB, will overstate the true welfare cost. The available evidence provides little basis for determining how much of a bias the assumption of linearity introduces. However, for my purposes, it is most important to note that when the approach developed here is extended to the measurement of marginal welfare cost, it is not necessary to assume linearity. Thus, estimates of marginal welfare cost may be more reliable than those of total welfare cost.

[16] Taking into account possible changes in the market wage rate when labor supply varies raises one other potentially important issue that is ignored here. When labor supply rises, the wage rate falls and the rate of return to the fixed capital stock rises. Thus, capital income rises and tax revenue from capital taxes will also rise. This general-equilibrium effect is potentially important for the estimation of marginal welfare costs that relate welfare costs to changes in revenue. Note that Stuart does not take this relationship into account in his model since he assumes that there are no taxes on capital income. It is not clear whether this effect is incorporated in the Ballard et al. (1985) model or not. Assuming a fixed wage rate, as here, sidesteps this issue since capital income is then unaffected by changes in labor supply, but the importance of this point deserves further investigation.

II. Marginal Welfare Cost

The marginal welfare cost is the ratio of the change in total welfare cost to the change in tax revenue produced when tax rates are varied in some specified way. With W representing the total welfare cost and R total tax revenue, it is simply dW/dR. Figure 2 illustrates the numerator, dW, of the marginal welfare cost ratio. When the marginal tax rate rises from m to m', there is a reduction in the quantity of labor supplied along the compensated supply curve to L_3. The increment in the total welfare cost produced by this increase in the marginal tax rate is shown by area $CDEA$.[17] Area $CDEA$ is dW; dividing this by the increase in tax revenues —which is not shown in the diagram since it does not identify what happens to either the average tax rate or the actual (as distinct from the compensated) quantity of labor—measures the marginal welfare cost of raising additional revenue from taxes falling on labor income.

An expression to estimate the marginal welfare cost can be derived easily. Note that[18]

$$dW = \tfrac{1}{2}(wm + wm')\,dL_2. \tag{6}$$

Since m' equals $m + dm$ and dL_2 equals $[\eta L_2/(1-m)]\,dm$, (6) can be rewritten as

$$dW = \left[\frac{m + 0.5\,dm}{1-m}\right]\eta w L_2\,dm. \tag{7}$$

[17]This assumes that the incremental government expenditure restores the individual to the same indifference curve, and that the benefits from marginal government spending are a perfect substitute for disposable income, assumptions to be explained more fully later. Under these conditions, the compensated supply curve doesn't shift. Different assumptions regarding the incremental expenditures require a different interpretation of marginal welfare cost, as explained later in this section.

[18]Equation (6) depends on the assumption that the compensated supply curve is linear for the change in labor produced by the change in the marginal tax rate (dm), that is, between points E and A in Figure 2. In developing the results that follow, I assume $dm = 0.01$. However, dm can be assumed to be as small as desired, and in the limit as dm approaches zero, it is, of course, not necessary to assume linearity at all.

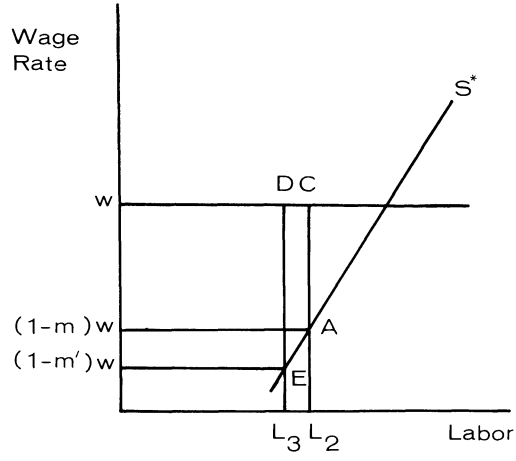

FIGURE 2

The change in tax revenue depends on how the average tax rate changes and on the change in actual labor income. It can conveniently be expressed as the sum of the additional tax revenue produced if earnings do not change and the revenue lost due to any reduction in earnings. Thus,

$$dR = wL_2\,dt + w\,dL(m + dm), \tag{8}$$

where dt is the change in the average tax rate evaluated at the initial level of earnings, wL_2. The first term in (8) thus gives the additional revenue produced if the average rate rises by dt and labor income remains unchanged. The second term in (8) gives the revenue lost when earnings fall by wdL. Note that dL in (8) need not be equal to $L_3 - L_2$ in Figure 2; $L_3 - L_2$ is the compensated change in labor supply while dL is the actual change in labor supply.

Combining (7) and (8) gives us a simple expression for marginal welfare cost:

$$\frac{dW}{dR} = \frac{\left[\dfrac{m + 0.5\,dm}{1-m}\right]\eta w L_2\,dm}{wL_2\,dt + w\,dL(m + dm)}. \tag{9}$$

In principle, equation (9) can be used to evaluate marginal welfare cost for any discrete change in tax rates, but to do so requires knowledge of how actual labor earnings, the wdL term, will be affected. In considering the effect on actual earnings, I should begin by noting that the conceptual experiment underlying the notion of marginal welfare cost is a balanced-budget operation in which the government spends the increment in tax revenue. This implies that the marginal welfare cost of raising additional tax revenue does not depend solely on the change in the tax system, but also on how the government spends the funds.[19]

The simple theory underlying equation (9) does not take into account the full range of possible ways expenditure side effects could reinforce or offset the added tax distortions of labor supply. It can, however, take into account government expenditures in an important special case. If the marginal government spending provides benefits that are a perfect substitute for the disposable incomes of taxpayers, then the spending has only an income effect that is equivalent to a lump sum transfer. (In other words, the marginal spending can be analyzed as a parallel shift in the after-tax budget constraint.) In this case, the income effect of the spending can be taken into account through its effect on the wdL term in equation (9). For example, if the marginal spending, in combination with the tax change, leaves taxpayers' utilities unchanged, the actual reduction in labor earnings, wdL, will equal the compensated change in labor earnings and can therefore be calculated using the assumed parameter values.

Although the assumption that government spending is a perfect substitute for disposable income is restrictive, it may be more widely applicable than it first appears. Note that the marginal change in government spending does not have to take the form of cash transfers for the assumption to be valid. In particular, if the government provides a service that taxpayers would otherwise have purchased on their own, then the spending would be a perfect substitute for disposable income. This may be largely correct in cases involving government provision of schooling, medical care, pensions, and other things taxpayers would purchase with their disposable incomes if the government did not provide them. Thus, treating government expenditures as a perfect substitute for disposable income appears reasonable and permits the simple framework employed here to incorporate expenditure side effects.

Granted this assumption, there are two polar cases that seem likely to span the range of plausible outcomes. First, marginal government spending is taken to provide no benefits to taxpayers, so there is an income effect from the balanced-budget operation that acts to counter the substitution effect. I assume that the net effect on actual labor earnings is zero, so the second term in the denominator of equation (9) is zero. In this case, the formula for marginal welfare cost simplifies to

$$(10)\qquad \frac{dW}{dR}=\left[\frac{m+0.5\,dm}{1-m}\right]\eta\frac{dm}{dt}.$$

The second polar case to be considered is when marginal government spending provides benefits that return taxpayers to their initial (i.e., before the tax and expenditure change) utility levels. When this is so, the wdL term in equation (9) is equal to the change in compensated labor earnings, or $-[dm/(1-m)]\eta wL_2$. Substituting this for wdL in (9) and simplifying yields the following expression for marginal welfare cost in this case:

$$(11)\qquad \frac{dW}{dR}=\frac{\left[\dfrac{m+0.5\,dm}{1-m}\right]\eta\dfrac{dm}{dt}}{1-\left[\dfrac{m+dm}{1-m}\right]\eta\dfrac{dm}{dt}}.$$

Equations (10) and (11) can be used to estimate marginal welfare cost for a discrete change in marginal tax rates under the assumed conditions. This analysis indicates

[19]Several recent papers have investigated the issue of balanced-budget changes and labor supply, both from the point of view of a positive analysis of labor supply (Assar Lindbeck, 1982; James Gwartney and Richard Stroup, 1983; Arthur Snow and Ronald Warren, 1985) and in connection with the determinants of marginal welfare cost (Wildasin).

that there are four key factors that interact to determine marginal welfare cost. Two of these, η and m, were also relevant in the estimation of total welfare cost. In addition, there are two other factors that were irrelevant for total welfare costs. The first is how the balanced-budget operation affects actual labor earnings, as reflected in the wdL term in equation (9) or in the choice between equations (10) and (11) for the two special cases I will examine. Second, equations (10) and (11) show that marginal welfare cost depends also on the parameter dm/dt. This term measures the progressivity of the *change* in the tax structure that produces the incremental tax revenue. As the equations show, the more progressive the tax change (the larger dm/dt is), the greater marginal welfare cost will be.

Since there are many different ways the tax structure could be modified to produce a change in revenue, dm/dt will depend on exactly how the tax structure is changed. Thus, we must consider the range of values that dm/dt could plausibly take on. The type of change in the tax system that would probably yield the smallest value for dm/dt would be to change the rates of sales or excise taxes, or to change the Social Security payroll tax rate. Raising additional revenue by increasing the rates of these taxes implies that the marginal tax rate would rise by less than the average tax rate;[20] a reasonable assumption might be that dm/dt equals 0.8. At the other extreme, use of the federal individual income tax will typically imply that dm/dt is greater than one since this tax is progressive. With the marginal tax rate of the federal income tax nearly twice its average rate at most income levels, it seems reasonable to assume marginal tax revenue from this source implies $dm/dt = 2.0$.[21]

Between these two extremes, two other possibilities merit consideration. One is to consider a proportionate increase in the rates of all taxes simultaneously so that m/t remains unchanged. Since m equals 43 percent in my benchmark case and t equals 31 percent, this sort of change implies $dm/dt = 1.39$. The other possibility is to consider some change where dm/dt equals one; this would be appropriate if a proportional tax were added to the present tax structure. While these four values for dm/dt do not exhaust the possibilities, they probably encompass most changes we are likely to see in the tax system.

At this point, a graphical treatment of marginal welfare cost for the case in which the benefit from the expenditure returns the taxpayer to his (her) initial indifference curve may prove helpful. In Figure 3, the before-tax budget constraint relating income and leisure is YN, and the initial tax—drawn as a proportional tax for simplicity—produces the constraint Y_1N. The worker is initially at point E, with tax revenue equal to HY since HH is drawn parallel to YN. Now let us consider a small increase in the tax rate which, ignoring expenditure side effects, produces the constraint Y_2N, drawn exaggerated for clarity. Assume that the expenditure is a perfect substitute for disposable income and the benefit from the expenditure returns the

[20]An increase in the rates of sales and excise tax will reduce the real tax base of personal income taxes, and so the increment in the effective combined marginal tax rate will decline with income. To see this, suppose a general sales tax is introduced at a rate of 10 percent, and this reduces factor prices by 10 percent while the price level is unchanged. For a person in a 50 percent income tax bracket, the 50 percent rate now applies only to 90 percent of his marginal value product, so the effective marginal rate of the income tax is reduced to 45 percent, and the combined rate is 55 percent. Thus, the sales tax increased this person's effective marginal tax rate from 50 to 55 percent. By contrast, for a person initially in a 20 percent income tax bracket, the increase would be from 20 to 28 percent. For the Social Security payroll tax, the ceiling on taxable earnings implies that an increase in its rate would increase the overall average tax rate more than its weighted-average marginal tax rate.

[21]In 1984, the average tax rates at one-half median income, the median income, twice median income, and five times median income were, respectively, 5.9, 11.9, 16.0, and 26.1 percent. The corresponding marginal tax rates were 14.0, 22.0, 33.0, and 45.0 percent (Congressional Budget Office, 1984, Table VI-3). These are, however, statutory rates; the effective rates would be lower. It is also worth noting that Seater's estimate of a weighted-average marginal tax rate for the income tax in 1980 is 22.9 percent, nearly double its average rate of about 12 percent.

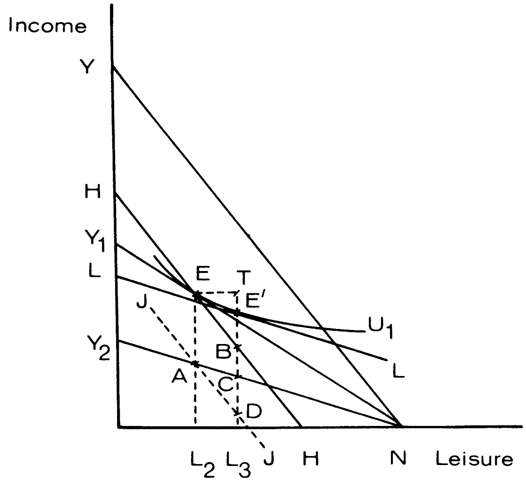

FIGURE 3

worker to his initial indifference curve. Then the effect of the expenditure can be shown as a parallel shift in Y_2N to LL, with LL tangent to U_1 at point E'.

Since the additional tax revenue is CB given the new equilibrium with labor of NL_3, the benefit from the expenditure of CB must be valued at CE' to return the worker to his initial indifference curve. Note that the required benefit, CB, is BE' greater than the additional tax revenue; BE' is the additional welfare cost. Thus, the marginal welfare cost, dW/dR, is BE'/CB. It is a compensating variation measure of the change in surplus, and shows how much greater the benefits from government spending must be than the tax revenues collected if the balanced-budget operation is to keep the worker on his initial indifference curve.

This particular way of defining marginal welfare cost produces a measure that is relevant for determining whether government expenditures combined with the taxes that finance them will leave taxpayers on balance better or worse off. In Figure 3, note that if the benefit from the expenditure of CB is anything less than CE', the worker will be worse off than he was at E, while if it is anything greater than CE', he will be better off. Put more generally, the marginal benefits from government spending must be more than one plus the marginal welfare cost (BE'/CB) per dollar spent if taxpayers are to be benefited on balance.[22] Other definitions of marginal welfare cost are possible. Stuart, for example, defines marginal welfare cost as the loss that results when the incremental tax revenue is returned to the worker as a lump sum payment. This produces a measure of the loss when outlays are valued at their budgetary cost, but it is not the appropriate definition to use in conducting a cost-benefit analysis of an expenditure policy.[23]

Note that equation (9) will estimate BE'/CB exactly. The numerator measures dW as the difference between the compensated reduction in earnings using the market wage rate, TB, less the increment in the value of leisure, TE'. The denominator

[22] Note that this measure of marginal welfare cost, based on the compensating variation, is similar to that proposed by Diamond and McFadden. The only difference is that my definition uses the utility level actually achieved with existing taxes and expenditures, whereas theirs uses the before-tax utility level. Note also that it is not inconsistent to use an equivalent variation measure of total welfare cost (as in Section I) and a compensating variation measure of marginal welfare cost. When the analysis is intended to provide a measure of marginal welfare cost useful for cost-benefit analysis, as explained in the text, the compensating variation measure is appropriate.

[23] Stuart's measure and mine yield the same result in the special case of zero income effects. In this case, if the incremental tax revenue is returned as a lump sum, the final equilibrium in Figure 3 will be at point B since an indifference curve will be tangent to the budget constraint (incorporating the lump sum transfer) that is parallel to Y_2N and passes through B. Stuart's measure is then the loss, BE', divided by the incremental tax revenue, CB. However, if leisure is a normal good, work effort will be greater than NL_3 when the tax revenue is returned as a lump sum due to the worker's loss in real income. The final equilibrium will then lie to the left of point B on the EB portion of HH, and Stuart's measure of marginal welfare cost will be smaller than BE'/CB since incremental tax revenue will be greater and the additional welfare cost will be smaller. For this case, Stuart's measure has the defect that even when the marginal expenditure is valued at one plus marginal welfare cost, the final equilibrium involves the worker being worse off than at point E because the income effect of the expenditure will lead to less work effort than the lump sum transfer. Thus, Stuart's measure does not identify how much the benefits of the expenditure must exceed additional tax revenue to exactly compensate the worker.

TABLE 2—MARGINAL WELFARE COST PER DOLLAR OF REVENUE
(Percentages)

		$m=$	0.38			0.43			0.48		
	$\frac{dm}{dt}$	$\eta=$	0.2	0.3	0.4	0.2	0.3	0.4	0.2	0.3	0.4
Earnings Constant	0.8		9.9	14.9	19.9	12.2	18.3	24.4	14.9	22.4	29.8
	1.0		12.4	18.6	24.8	15.3	22.9	30.5	18.7	28.0	37.3
	1.39		17.3	25.9	34.5	21.2	31.8	42.4	25.9	38.9	51.9
	2.0		24.8	37.3	49.6	30.5	45.8	61.1	37.3	56.0	74.6
Earnings Decline	0.8		11.0	17.6	24.9	13.9	22.5	32.4	17.6	28.9	42.7
	1.0		14.2	23.0	33.2	18.0	29.8	44.2	23.0	39.0	59.9
	1.39		20.9	35.1	53.1	27.0	46.9	74.3	35.1	64.1	108.9
	2.0		33.2	59.8	100.0	44.1	85.2	159.7	59.9	128.8	303.1
Average Welfare Cost			7.5	11.2	15.0	10.5	15.7	20.9	14.3	21.4	28.5

measures dR as the sum of the increment in tax revenue if earnings remain unchanged, EA ($=DB$, since JJ is parallel to HH), less the reduction in taxes due to the actual (and compensated, in this case) reduction in labor supply, CD.[24]

III. Results

To sum up, the range of values for the four key parameters that will be used here are:

m: .38, .43, and .48;
η: 0.2, 0.3, and 0.4;
dm/dt: 0.8, 1.0, 1.39, and 2.0;
wL: Unchanged, and reduced by the compensated change.

Table 2 displays the results of using equations (10) (Earnings Constant) and (11) (Earnings Decline) to calculate the marginal welfare cost for the 72 possible combinations of parameter values for an increase in the marginal tax rate on one percentage point ($dm=0.01$). The estimates range from a low of 9.9 percent to a high exceeding 300 percent! (Note, however, that only one combination of parameter values yields an estimate exceeding 159.7 percent.) If, as I believe to be the case, our empirical evidence and theory do not allow us to narrow substantially the range of possible parameter values from those used here, then we cannot provide a very precise estimate of the marginal welfare cost. My preferred estimates are based on $\eta=0.3$, $m=43$ percent, and $dm/dt=1.39$, implying that marginal welfare cost would lie between 31.8 and 46.9 percent, depending on what assumption is made about the extent to which tax payers benefit from the marginal government spending. It would be difficult, however, to defend these parameter values as necessarily more accurate than others used in the table.

The results here suggest that marginal welfare cost is significantly larger than implied by my 1976 paper. In part, the difference is due to correction of the error discussed above in Section I. The 9 to 16 percent range of my earlier paper was based on parameter values of (approximately) $\eta=0.2$, $m=.43$, $dm/dt=1.0$ and 1.39, with earnings constant. Table 2 shows the corrected estimates for these values would be 15.3 and 21.2 percent. The remaining difference in results, however, is due to the use here of a wider range of parameter values. What was not clear in my earlier paper, but Table 2 brings out forcefully, is how sensitive the results are to the combination of parameters used.

Even though this model is far simpler than the general-equilibrium models of Stuart and

[24] For a graphical treatment that can be used to show marginal welfare cost when the taxpayer is not returned to his original indifference curve, in which case an equivalent variation measure is used; see Figure 3 in my paper with Johnson. In this diagram, marginal welfare cost is DE/AH.

Ballard et al. (1985), the results seem quite similar for comparable parameter values. The approach used here yields estimates that are moderately larger than the Stuart model, but corrected for two differences in assumptions the results differ only negligibly.[25] Comparison with Ballard et al. is more difficult, since they are not explicit concerning all the parameter values emphasized here and their model also evaluates distortions other than the labor supply distortion. However, their general conclusion that marginal welfare cost is likely to be in the range of 15 to 50 percent accords well with the results in Table 2.

IV. Concluding Remarks

Other things the same, general-equilibrium results are to be preferred to partial-equilibrium results. Until it is shown that the general-equilibrium models provide significantly different and more accurate estimates (for the same parameter values), however, the partial-equilibrium approach has some advantages. First, it is easily understood, so it is less likely that critical assumptions will be obscured. The sensitivity of the results to the four key parameter values is quite apparent in this treatment, for example. Second, it is simple for other investigators to perform sensitivity analysis by modifying the assumptions regarding parameter values if such changes seem appropriate. Finally, on a more substantive matter, the results here seem to imply that arriving at a more precise estimate of marginal welfare cost may well depend more on empirical investigation that narrows the range of possible parameter values than on developing more rigorous models that yield slightly better estimates for given parameter values.

An important point concerning the proper use of estimates of marginal welfare cost is in order. These estimates are intended to provide the basis for comparing the costs with the benefits of government expenditure policies that do not have as a major consequence or goal a redistribution of income. Marginal welfare costs are relevant in analyzing redistributive programs, but the estimates here do not indicate how large the relevant effects are. For this purpose, it is necessary to estimate the costs borne by the group that loses separately from the benefits received by the group that gains, along the lines suggested by myself and Johnson.[26] In general, the relevant marginal welfare costs of redistribution are several times larger than the marginal welfare costs reported here. Basically, the reasons are that both the taxpayer's and recipient's decisions are distorted by a redistributive policy, and marginal tax rates necessarily rise quite sharply in comparison to the amounts redistributed.[27]

Finally, it should be recalled that the estimates relate only to the labor supply distortions of taxes. Actual taxes distort behavior on a number of other margins of choice, and ignoring these probably means that the estimates here understate the marginal welfare cost of raising tax revenue, subject to the usual second-best qualifications. Further research to incorporate these effects into the analysis would be worthwhile.

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[25]The first difference is that Stuart defines marginal welfare cost as the loss resulting when the expenditure is a lump sum transfer back to taxpayers. The second difference is that Stuart's general-equilibrium model effectively incorporates a downward-sloping marginal value product curve. These are not the only differences in the models, but they appear to account for most of the differences in results.

[26]In this connection, it is unfortunate that Stuart refers to one of his marginal welfare cost measures as relevant for analyzing redistributional social programs. In Stuart's model, this refers to the case where the revenues are returned to the taxpayer as a lump sum payment. Since Stuart's model is based on a single aggregate household, there is no real redistribution involved in this case, and this measure of marginal welfare cost gives no clue to the relevant distortions produced by redistributive programs.

[27]I have explained in greater detail the relationship between the marginal welfare cost of raising tax revenue as discussed here and the marginal welfare cost of redistributing income in my 1986 paper (Section IV).

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