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Reconciling Recent Estimates of the Marginal Welfare Cost of Taxation

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Much of welfare economics has been plagued by differences in the concepts used to measure changes in consumer welfare. One example of this problem is presented in striking clarity by three recent papers in *The American Economic Review* that calculate "marginal excess burden" for U.S. labor taxes. This note shows that almost all of the differences in results can be traced to differences in the definition of "marginal excess burden."

Each of the three papers includes several special cases, but for comparability, I concentrate on their calculations in which the uncompensated labor-supply elasticity is zero and the marginal dollar is spent on a public good that is separable in utility. Their results are summarized in Table 1. Charles Stuart (1984) builds a simple two-sector general-equilibrium model and finds in this case that "marginal excess burden" (MEB) is 7 cents. Charles Ballard, John Shoven, and John Whalley (henceforth, BSW) (1985) use a more complicated general-equilibrium model in which their "MEB" is 12 cents. Edgar Browning (1987) employs a simple partial-equilibrium model and obtains a corresponding figure of 21 cents. He concludes that "almost all of the differences in results can be traced to different assumptions about key parameter values" (p. 11).

The next row of Table 1 shows that the substitution of Stuart's parameters into Browning's formula (given in a footnote to the table) only changes Browning's measure from 21 cents to 24 cents. Thus, the large difference in published results (21 vs. 7 cents) is not due to parameters.

Since important differences in the definitions were not explained in the three papers, I state the three definitions explicitly and illustrate them diagrammatically. Rather than present new analytical results,[1] I return to the exact model of Stuart (1984), replicate his calculation, and add the other two "MEB" measures. When Stuart's "MEB" is 7 cents, Table 1 shows that the BSW measure is also 7 cents. With the same equilibrium outcome, Browning's measure is 25 cents. Thus, the results differ because the definitions differ.[2]

I. Three Definitions of "Marginal Excess Burden"

Stuart (1984) uses the compensating surplus (CS) of John Hicks (1943, 1954), and he subtracts the actual change in revenue (dR) to get the change in excess burden. He then divides by the actual change in revenue to get the change in excess burden per dol-

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[1]Relevant analytical results appear in Anthony Atkinson and Nicholas Stern (1974), David Wildasin (1979, 1984), Stuart (1982), Robert Triest (1988), Steven Slutsky (undated), and Joram Mayshar (1988a, b). The three *American Economic Review* papers are specifically discussed in Ballard (1987), Ingemar Hansson and Stuart (1988), Triest (1988), Shaghil Ahmed and Dean Croushore (1988), and Mayshar (1988a).

[2]Similar definitional differences carry over to the literature on the "marginal efficiency cost of redistribution" and may explain much of the remaining difference between results of Ballard (1988) and Browning and William Johnson (1984).

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TABLE 1—DIFFERENT MEASURES OF "MARGINAL EXCESS BURDEN" FOR U.S. LABOR TAXES

Source	(CS − *dR*)/*dR* (Stuart)	(EV − *dR*)/*dR* (BSW)	(EV − *dR**)/*dR* (Browning)
From the literature[a]			
Stuart (1984)	0.07	—	—
Ballard, Shoven, and Whalley (1985)	—	0.12	—
Browning (1987)	—	—	0.21
Using Browning's (1987) model[b] with Stuart's (1984) parameters	—	—	0.24
Using Stuart's (1984) model[c]			
Other measures calculated	0.07	0.07	0.25
Labor unchanged with variable wage	0.00	0.00	0.20
Labor unchanged with fixed wage	0.00	0.00	0.24

Notes: CS = compensating surplus; EV = equivalent variation; dR = change in actual revenue using average tax rates; dR^* = change in revenue along curve compensated to new utility, using marginal rates.

[a]Estimates from the literature all employ a zero uncompensated-labor-supply elasticity, where additional revenue is spent on government consumption, but they differ on other assumptions.

[b]Browning (1987) calculates the area between a fixed gross wage rate and an approximately linear compensated labor supply curve and shows that

$$\frac{EV - dR^*}{dR} = \left(\frac{m + 0.5\,dm}{1 - m}\right)\eta\left(\frac{dm}{dt}\right)$$

where $\eta = 0.2$ is the compensated labor supply elasticity, $m = 0.43$ is the marginal tax rate, and $t = 0.31$ is the average tax rate. The tax change is assumed to maintain progressivity, so $dm/dt = m/t = 1.39$. With $dm = 0.01$, this equation yields 21 cents for Browning's (1987) "MEB" as shown. With Stuart's (1984) parameters, $\eta = 0.2$, $m = 0.427$, $t = 0.273$, and $dm/dt = 1.564$, so this equation yields 24 cents.

[c]The text outlines Stuart's (1984) model, but more detail is in his paper. The text also describes why it is not possible to use the same assumptions in the model of Ballard, Shoven, and Whalley (1985).

lar of additional revenue, so his "MEB" is $(CS - dR)/dR$. BSW (1985) use the equivalent variation (EV) of the tax change (in old cum-tax prices), subtract the actual change in revenue, and calculate $(EV - dR)/dR$.[3] Browning (1987) also uses the equivalent variation,[4] but he subtracts the change in revenue along the compensated-labor-supply curve (dR^*). Per dollar of actual additional revenue, his "MEB" is $(EV - dR^*)/dR$.

It might appear that the measure of BSW (1985) is similar to that of Browning (1987), because both use the equivalent variation, while Stuart (1984) appears to differ by use of the compensating surplus. However, results below show that Stuart's measure is always very close to that of BSW. Indeed, for a truly marginal change in tax and hence in equilibrium prices, the measures of welfare (CS or EV) are equivalent.[5] Thus, the

[3]They never state this expression explicitly, however, so others misunderstand what was calculated. Triest (1988) assumes that this MEB is measured in pretax prices, when it is actually in prices of the original cum-tax equilibrium. Mayshar (1988b) introduces $EV - dR$ as a "new" measure, not knowing that this is the measure of BSW (1985).

[4]Browning (1987) uses the compensating variation (CV) in his diagram for the other case he considers, but he uses the equivalent variation for the case of interest here, where actual labor supply does not change (see his footnote 24).

[5]The choice of welfare measure is discussed in Peter Diamond and Daniel McFadden (1974), John Kay (1980), Elisha Pazner and Efraim Sadka (1980), Alan Auerbach and Harvey Rosen (1980), and Mayshar (1988b). This choice matters for *total* excess burden, where no-tax prices are very different from cum-tax prices, but not for "*marginal* excess burden." Mayshar (1988b) proves that the EV and CV are equal at the margin, and Eugene Silberberg (1978 pp. 257–9) can be used to show equivalence with the CS measure. For small but discrete changes here, my results confirm Stuart (1984 footnote 5) that "substitution of these alternative measures [EV, CV, or CS] was found to affect the results only at the third significant digit."

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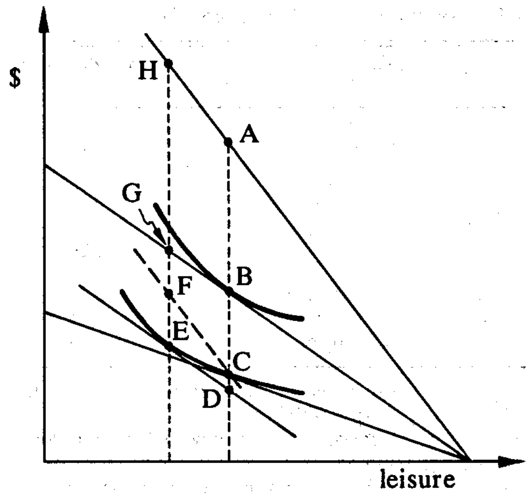

FIGURE 1. A CHANGE IN WAGE TAX WITH NO CHANGE IN ACTUAL LABOR

important difference is the revenue figure subtracted (dR or dR^*).

Figure 1 illustrates these definitions for the simple case in which a change in tax leaves actual labor unchanged. The uppermost budget line reflects a fixed gross wage, and the middle budget line reflects an initial proportional wage tax. The consumer chooses point B, and initial revenue is AB. When the wage tax is increased, the consumer chooses point C. The compensating surplus is the amount of the numeraire needed to get back to the old utility, without reoptimizing, the distance from C back to B. Since the actual revenue change is also BC, Stuart's "MEB" is (BC−BC)/BC = 0.

EV is the number of dollars taken away at old cum-tax prices that would reduce utility by an amount "equivalent" to the tax, distance BD. Therefore, BSW (1985) measure (BD − BC)/BC = CD/BC. This "MEB" may be larger than 0 for a discrete change in Figure 1, but it is 0 for a truly marginal change in tax. It is 0 regardless of the original tax rate or compensated-labor-supply elasticity.

In contrast, Browning (1987) follows Alan Auerbach (1985 p. 72) by subtracting the change in revenue if the consumer were held to the new utility level (dR^*). The new actual revenue is AC, which equals FH by construction. At the old tax rate, if held to the new utility, the consumer chooses point E. With this labor supply, revenue at the old rate would be GH. Thus, dR^* is the difference, FG, and Browning's "MEB" is (EG−FG)/BC = EF/BC. This measure of distortion can be large even if actual labor is unchanged.

Given these large conceptual differences, what are the pros and cons of each definition? Each measure has an appropriate use, but each can easily be misinterpreted. All three papers deal ultimately with the question of whether utility would rise if a marginal increase in the wage tax is used to fund a public project that is separable in utility.[6] In addressing this question earlier, Atkinson and Stern (1974) isolated two modifications to Paul Samuelson's (1954) rule that the sum of the marginal rates of substitution (ΣMRS) should equal the marginal rate of transformation (MRT). First, if the tax is not lump sum, the "distortionary effect" adds to the relevant costs. Second, in what they call a "revenue effect," changes in after-tax income affect consumer choices and thus affect tax revenue. If leisure is normal, an increased wage tax has an income effect that increases labor, increases revenue from the preexisting tax, and thus makes the project easier to fund. In this case, the "revenue effect" works in the opposite direction as the "distortionary effect."

In the special case in which actual labor does not change, the "distortionary effect" and the "revenue effect" exactly offset each other, so the project increases utility if ΣMRS exceeds the dollar cost of the project. This is the basis for the subsequent

[6]Using Ballard's (1987) terminology, it is a "balanced-budget" analysis. Stuart (1984) also performs a "differential" analysis, in which the additional tax revenue is returned to consumers in a lump sum, but this simulation has no counterpart in BSW (1985) or Browning (1987). Also, Browning (1987) includes a case in which the actual change in labor is the same as the compensated change in labor, but this has no counterpart in Stuart (1984) or BSW (1985). The only case that appears in all three papers is the balanced-budget spending on a separable public good.

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finding in the literature that the marginal cost of funds (MCF) is 1.0 when labor does not change.[7]

Since Browning (1987) compares the wage tax to a lump-sum tax, he measures only the distortionary effect. This measure can appropriately be used to compare one tax to another, as it is a correct measure of distortions. However, Browning leaves the incorrect impression that the cost–benefit analyst can use 1 plus his "MEB" as the marginal cost of funds. His measure is not generally enough information to evaluate the public project, because the decision rule should be modified by both the "distortionary effect" and the "revenue effect."[8]

As can be seen from above formulas, Stuart (1984) and BSW (1985) essentially define "marginal excess burden" as the MCF minus 1. With this definition, the cost–benefit analyst can appropriately use 1+MEB as the MCF. Since the "distortionary effect" and the "revenue effect" exactly offset each other in this special case, however, this "MEB" is zero. Such terminology may leave the incorrect impression that the tax is not distorting. The wage tax is distorting in the usual sense, in that it leaves consumers worse off than a lump-sum tax.

One might think that a lump-sum tax would have no excess burden. Yet for Stuart and BSW, with a preexisting wage tax, a lump-sum increment has "MEB" < 0. In Figure 2, the initial point B is the same as in Figure 1, but a small lump-sum tax moves the consumer to point C, where the new revenue CG exceeds old revenue FG by the amount CF. Stuart's "MEB" of this lump-sum tax is (CE − CF)/CF, which is negative.

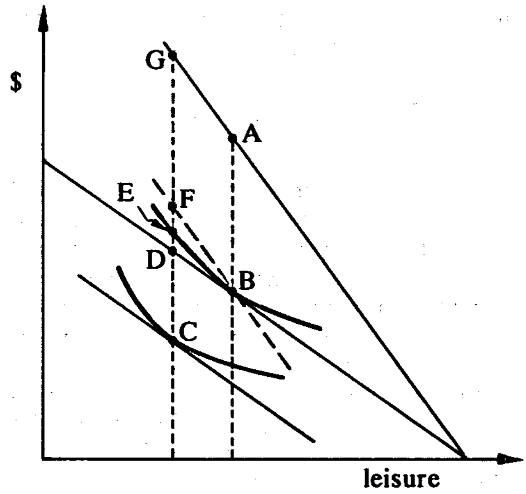

FIGURE 2. A LUMP-SUM TAX WITH A PREEXISTING WAGE TAX

The BSW measure is (CD − CF)/CF, which also is negative. Browning's "MEB" is (CD − CD)/CF = 0. The lump-sum tax has no distortionary effect, but it has a revenue effect because it reduces income and thus causes an increase in labor subject to the preexisting wage tax.

Thus, all three definitions have problems. My own view is that no measure of "marginal excess burden" is necessary. Instead, the marginal cost of funds is enough information. It can be used to compare one tax to another, like Browning's measure, and it can be used to evaluate the public project, like the other two measures. Why define "MEB" as MCF − 1? The marginal cost of funds is the relevant concept in any case, so the cost–benefit analyst must simply add back the 1 subtracted.

II. Comparable Calculations

To calculate his "MEB" in a general equilibrium model, Stuart (1984) first assumes that a representative consumer has an endowment of labor that can be supplied to the market sector or used in production at home. Production in each sector is Cobb-Douglas. Capital stocks are immobile, so labor has a diminishing marginal product

[7]This result is shown in, for example, Stuart (1982), Wildasin (1984), and Triest (1988). Geometrically, in Figure 1, the $MCF \equiv CS/dR = BC/BC = 1$. Equivalently, $MCF \equiv EV/dR = BD/BC$, which approaches 1.0 as the tax change becomes small.

[8]This problem is recognized by Browning (personal communication) and discussed by Hansson and Stuart (1988). It does not apply to the other case in Browning (1987), in which the public funds provide benefits that return taxpayers to the original indifference curve, because then the actual change in labor is the compensated change.

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in each sector. The consumer uses total income to maximize

$$(1)\quad U=\left[\alpha(\bar{Y}_1)^{-\rho}+(1-\alpha)(\bar{Y}_2-\delta)^{-\rho}\right]^{-1/\rho}$$

where δ is a "minimum required purchase," α is a share parameter, and the elasticity of substitution is $\sigma=1/(1+\rho)$. The nonmarket sector has no tax, so labor earns its marginal product, and consumption $\bar{Y}_2$ equals production Y_2. In the market sector, labor earns the equilibrium wage times 1 minus the marginal tax rate, and consumption $\bar{Y}_1$ is less than production Y_1 by the amount of tax paid (the wage bill times the average tax rate). The government spends marginal revenue on the market good.

Stuart (1984) provides detail on the model, and elsewhere (Fullerton, 1989), I further discuss the derivation of parameters and additional steps needed to calculate the other welfare measures. Using Stuart's (1984) model and parameters, I simulate a 1-percent increase in the marginal tax rate, m. Stuart's (1984) measure of "marginal excess burden" is 7 cents, just as in published results. Table 1 shows that the measure of BSW (1985) also rounds to 7 cents. Using the same equilibrium outcome, however, Browning's (1987) measure is 25 cents. Thus, the results differ because the definitions differ.

When labor did not change in Figure 1, Stuart's (1984) measure was shown to provide zero excess burden; so why does he get 7 cents? The reason is that this simulation with a zero uncompensated labor elasticity does not lead to zero change in actual labor supply. Ballard (1987) points out that this change in the progressive tax structure effectively changes the "virtual" income of the consumer. The change in the net wage by itself would not change labor supply, but the change in virtual income does. The condition for the marginal cost of funds to be 1.0 is not that the uncompensated elasticity is zero, but that actual labor does not change. Thus, Stuart's (1984) "MEB" (= MCF − 1) will not be zero whenever any aspect of the reform causes a response in the quantity of labor.

To set his parameters, Stuart (1984) differentiates labor supply with respect to the net wage and imposes an uncompensated elasticity of 0, a compensated elasticity of 0.2, and an initial MRS of 1. Together with his data, these three conditions determine the three parameters (δ, α, and ρ). This procedure is consistent with the definition of an elasticity, since the differentiation varies only the net wage. As an alternative, I search a three-dimensional grid for values of δ, α, and ρ where the compensated elasticity is still 0.2 and the MRS is 1, but where actual labor does not change in this particular simulation. In this case, Table 1 shows that Stuart's "MEB" is zero.[9]

Using these new parameters, the measure of BSW also is zero; so why do they get 12 cents? As pointed out by Ballard (1987), they have other taxes that introduce second-best effects. The simulation here demonstrates that their definition would yield a zero "marginal excess burden" in the case with no other taxes and an unchanged equilibrium supply of labor.[10]

The model of BSW (1985) is not used here to calculate the three measures. One reason is that this model has 12 different consumer groups with different marginal tax rates and elasticities. Another reason is that the calculation of dR^* would be extremely difficult with many tax instruments. It would require the compensated demand for each commodity, the sales tax on each compensated quantity, and all factor taxes on producers at those quantities.

Finally, I impose on Stuart's (1984) model the condition that production is linear, so the gross wage is constant in general equi-

[9]These new parameters are not preferred to those of Stuart (1984). Indeed, they imply that the uncompensated elasticity is (slightly) negative. They are used here only to illustrate the important conceptual point that Stuart's measure is zero when actual labor does not change. This point was not clear in Stuart's (1984) paper.

[10]The point of this note does not arise when their model is used in a revenue–neutral reform, as in every previous application, because the EV measures the change in welfare with no subtraction for any change in revenue.

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librium. Stuart's model then reduces exactly to Browning's (1987) model (where the wage was constant by assumption). An additional grid search is performed to impose the three conditions discussed above (the compensated labor supply elasticity is 0.2, the initial MRS is 1, and actual labor is unchanged in this simulation). Table 1 shows that Browning's "MEB" is 24 cents, while the other measures are zero. Browning's fixed wage therefore raises his own "MEB" by 20 percent (24 cents vs. 20 cents), relative to a comparable model with a varying wage.

III. Conclusion

With only the "distortionary effect," Browning's (1987) "marginal excess burden" is a familiar concept. It is the marginal analogue of total excess burden, defined as the welfare difference between a distorting tax and a lump-sum tax. However, it is not enough information to set public spending. With the addition of the "revenue effect," the measure of Stuart (1984) or of BSW (1985) does provide enough information to decide on a project that is separable in utility. However, it can be zero for a distorting tax. It is defined as the marginal cost of funds minus 1, but there is no need for a concept other than the MCF itself.

The marginal cost of funds can be used to compare the distorting effects of two different tax changes, because the marginal dollar always has the same revenue effect. For a given tax, the MCF can be compared to the benefits of a public project. In general, the MCF does depend on elasticities and tax rates in the model. If the project is not separable in utility, it also depends on the assumed effect of the public project on labor supply. For a marginal dollar of revenue, however, it does not depend on the definition of consumer welfare.

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